STEEL BOX GIREDER BRIDGE
(3-SPAN)

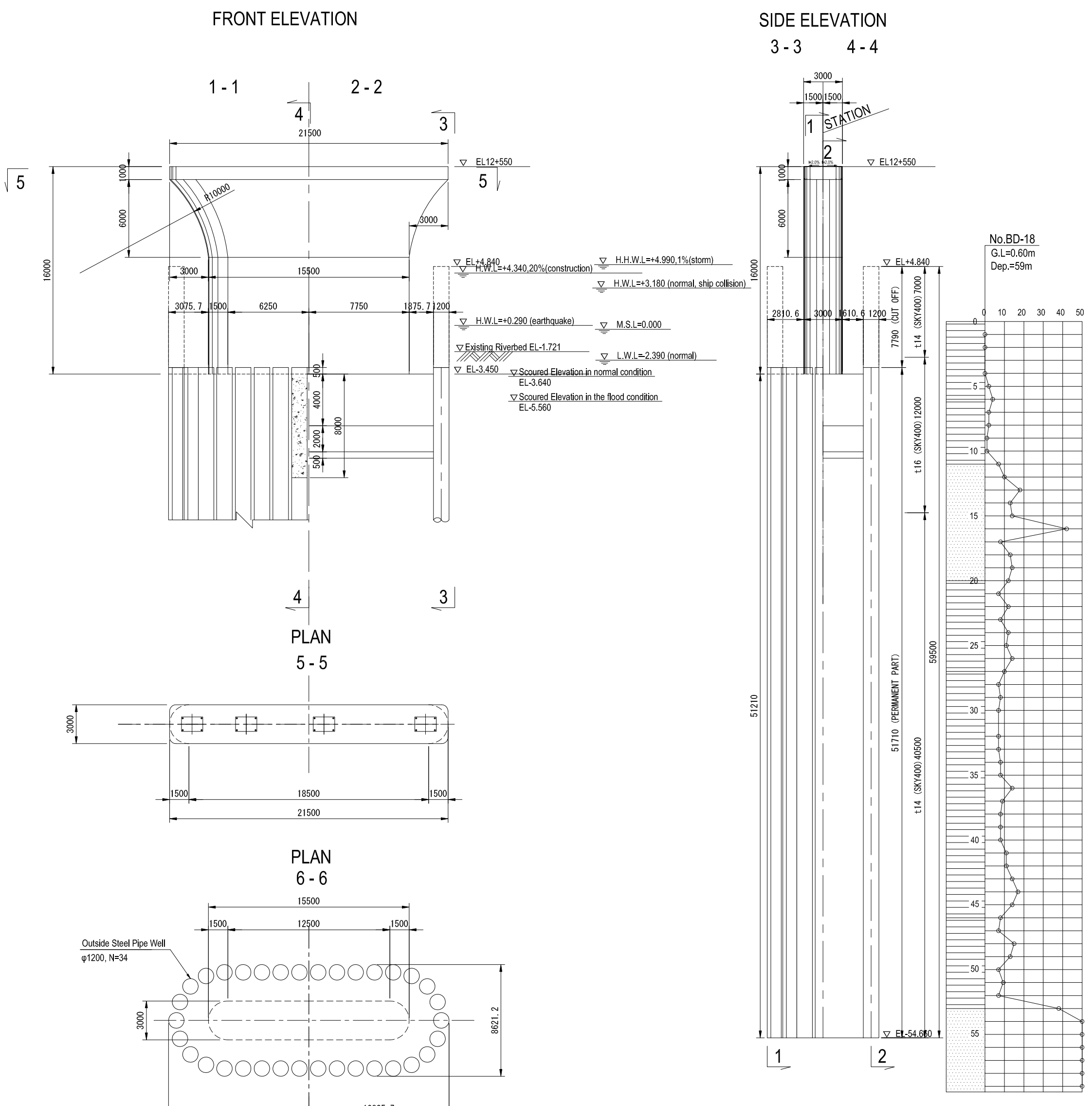
SUBSTRUCTURE

CONTENTS

CHAPTER 1. GENERAL

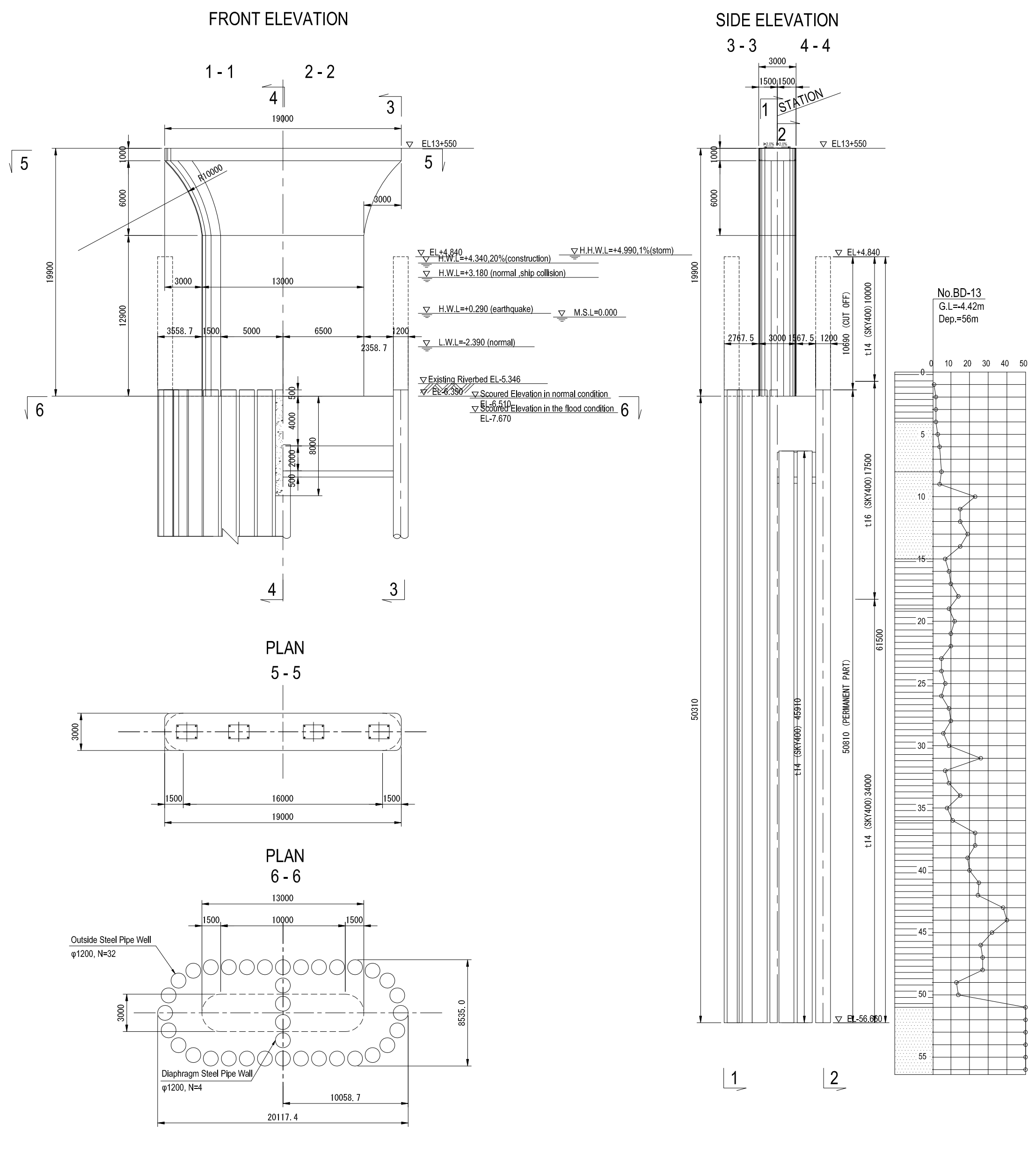
1.1 STRUCTURAL DRAWING WITH SOIL PROFILE, GEOTECHNICAL DESIGN PARAMETERS AND DESIGN WATER LEVEL

General View of P6 Pier



	Soil Name	Average N-Value	Unit Weight γ_{Sat} (kN/m³)	Cohesion C_u (kN/m²)	Friction Angle φ (°)	Modulus of Elasticity E_0 (kN/m²)	Liquefaction Coefficient D_E
5850 (867 / 4983)	Clay-I	1	17.5	10	0	900	-
3090	Sandy Clay-I	3	17.5	15	0	2,000	Liquefaction D_E = 1/3
3350 (1060 / 2290)	Clay Sand-A	3	18.5	0	28	1,200	D_E = 1/3 D_E = 2/3
8560	Silty Sand-I	13	18.0	0	33	5,200	-
8680	Clay-AII	7	17.5	42	0	4,900	
22570	Clayey-AIII	18	18.0	108	0	12,600	-
6140	Clayey Sand-II	50	20.0	0	35	35,000	-

General View of P7 Pier



	Soil Name	Average N-Value	Unit Weight γ_{Sat} (kN/m³)	Cohesion C_u (kN/m²)	Friction Angle φ (°)	Modulus of Elasticity E_0 (kN/m²)	Liquefaction Coefficient D_E
1930 2070	Clay-I	1	17.5	10	0	900	Liquefaction D_E = 1/3
4000	Clay Sand-A	3	18.5	0	28	1,200	Liquefaction D_E = 1/3
7000	Silty Sand-I	13	18.0	0	33	5,200	Liquefaction D_E =1 -
4000	Sandy Clay-II	9	17.5	54	0	6,300	-
17000	Clay-AII	7	17.5	42	0	4,900	-
15000	Clayey-AIII	18	18.0	108	0	12,600	-
5400	Clayey Sand-II	50	20.0	0	35	35,000	-

1.2 STANDARD AND DESIGN CRITERIA

- ✓ Specifications for Highway Bridges Part-I, IV, V 2012 (Japan Road Association)
- ✓ Design and construction handbook for Steel Sheet Pile Foundation Method 1997 (Japan Road Association)
- ✓ AASHTO LRFD Bridge Design Specifications 2014
- ✓ JIS A5530, Japanese Industrial Standard for Steel Pipe Sheet Pile
- ✓ JIS G3444 STK400, Japanese Industrial Standard for Interlocking Pipe

1.3 ANALYTICAL SOFTWARE FOR DESIGN

- ✓ UC-1 Foundation Design developed by Forum 8 for SPSP Foundation
- ✓ UC-1 Substructure Design developed by Forum 8 for RC Pier

1.4 MATERIALS TO BE USED

(1) Concrete

Unit N/mm^2

Design Strength	[σck]	21	24	30
Allowable Compressive Stress	[σca]	7.00	8.00	10.00
Allowable Shear Stress	[τ a1]	0.22	0.23	0.25
Allowable Adhesive Stress (with rebar)	[τ oa]	1.40	1.60	1.80
Average Shear Stress	[τ c]	0.33	0.35	0.37
Young's Modulus	[Ec]	2.35 x 10^4	2.50 x 10^4	2.80 x 10^4
Members to be used	-	Bottom slab concrete, Concrete filling to steel pipe	Footing (top slab concrete)	Pier column and beam

(2) Reinforcement Bar

Unit N/mm^2

Grade		SD345	SD390
Allowable Tensile Strength (normal member)	[σsa]	180.00	180.00
Allowable Tensile Strength (water member)	[σsa]	160.00	160.00
Allowable Tensile Strength*1	[σsa]	200.00	230.00
Allowable Tensile Strength*2	[σsa]	200.00	200.00
Yield Stress (axial rebar)	[σy]	345.00	390.00
Yield Stress (except axial rebar)	[σy]	345.00	345.00
Members to be used		main reinforcement of pier column, rebar for footing, pier head, shear reinforcement for pier column	Not used

Note: *1/ Coefficient of increase allowable stress is more than 1.5 and used for axial rebar.
*2/ Coefficient of increase allowable stress is more than 1.5 and used except for axial rebar.

Unit N/mm^2

Young's Modulus	2.00 x 10^5
Young's Modulus Ratio	15.00

(3) Steel Sheet Pile

Unit N/mm^2

Grade		SKY400,	SKY490
Allowable Strength	[σsa]	140.00	185.00
	[τ a]	80.00	105.00
Allowable Strength (factory welding)	[σsa]	140.00	185.00
	[τ a]	80.00	105.00
Allowable Strength (during construction)	[σsa]	210.00	280.00
	[τ a]	120.00	160.00
Yield Stress (except axial rebar)	[σy]	235.00	315.00
Members to be used		SPSP, this grade is used in all members.	Not used

CHAPTER 2. LOADS AND LOAD COMBINATION

2.1 LOAD COMBINATION

Table Load Combination and Allowable Stress in Pier Column and Foundation Design

Load Combination		Design Water Level (MSL+m)		Water Velocity (m/s) for flowing water pressure	Local Scouring	Increase of Allowable Stress
A.	Ordinary Condition	High tide in spring tide	3.18m	No consideration	No consideration	1.0
					Maximum	
		Low tide in spring tide	-2.39m	No consideration	No consideration	
					Maximum	
B.	Ordinary condition with effect of temperature change *only for longitudinal direction	High tide in spring tide	3.18m	No consideration	No consideration	1.15
					Maximum	
		Low tide in spring tide	-2.39m	No consideration	No consideration	
					Maximum	
C.	Extreme wind situation with effect of temperature change	HHWL(1%)	4.99m	No consideration	No consideration	1.35 *1.25 for transversal direction
					1/2 of maximum	
D.	Vessel Collision for P6, P7	High tide in spring tide	3.18m	No consideration	No consideration	1.5
					1/2 of maximum	
E.	Earthquake Condition (Level-1)	Average	0.29m	0.6m/s for dynamic water pressure	No consideration	1.5
					1/2 of maximum	
F.	During Construction	HWL(5%)	4.34m	0.65m/s	No consideration	1.5
		Low tide in spring tide	-2.39m			

Table Load Combination and Allowable Stress in Pier Beam Design

Load Combination		Increase of Allowable Stress
Vertical Direction		
G.	Ordinary Condition *live load with impact	1.0
H.	Earthquake Condition	1.5
Horizontal Direction		
I.	With effect of temperature change	1.15
J.	Earthquake Condition	1.5

2.2 EXTERNAL FORCES

(1) Loads from Superstructure

Table Dead Load and Live Load with/without Impact for the Substructure Design

Loads (kN)	P5	P6	P7	P10
Dead Load	7,200	16,700	21,400	9,000
Live Load with Impact	2,700	4,700	5,400	2,900
ΣD+L+I	**9,900**	**21,400**	**26,800**	**11,900**
Dead Load	7,200	16,700	21,400	9,000
Live Load w/o Impact	2,500	4,500	5,200	2,700
ΣD+L	**9,700**	**21,200**	**26,600**	**11,700**
Horizontal Force due to temperature change ±15°	400	200	200	500

Values of P5 and P10 are loads only from 3-span bridge.

(2) Shared Weight of Superstructure on Substructures

Since the structure which can distribute inertial force of earthquake into several substructures is applied for the 3-continuous spans, a shared weight on each substructure is calculated by Eigenvalue analysis using framed structure model as shown in the figure below.

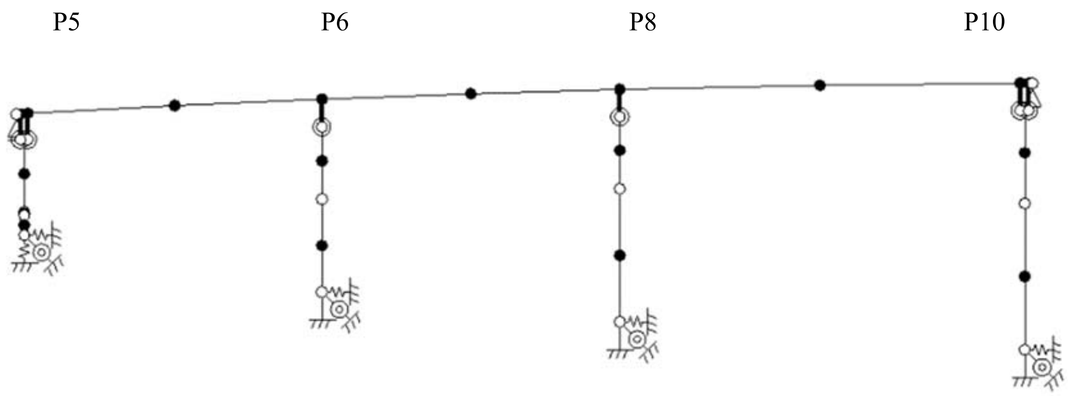


Figure Framed Structure Model

1) Coordinate of Nodes

Structure Component	Node No.	Coordinate		Weight Wi(kN)
		X (m)	Y (m)	
Superstructure	23	0.900	1.371	3672.000
	25	38.700	2.106	7662.000
	26	76.500	2.735	8328.000
	28	114.750	3.263	8746.000
	29	153.000	3.682	10680.000
	31	204.400	4.074	10536.000
	32	255.800	4.278	4584.000
	24	0.900	-0.898	0.000
	27	76.500	0.530	0.000
	30	153.000	1.503	0.000
	33	255.800	2.077	0.000
P5	1	0.000	-1.401	0.000
	2	0.000	-4.729	17309.250
	3	0.000	-8.401	0.000
	4	0.000	-8.576	695.898
	5	0.000	-8.751	0.000
	6	0.000	-9.701	13406.400
	7	0.000	-10.651	0.000
P6	8	76.500	0.108	0.000
	9	76.500	-3.188	9738.750
	10	76.500	-6.892	0.000
	11	76.500	-11.392	9827.373
	12	76.500	-15.892	0.000
P7	13	153.000	1.108	0.000
	14	153.000	-2.157	8452.500
	15	153.000	-5.892	0.000
	16	153.000	-12.342	11715.526
	17	153.000	-18.792	0.000
P10	18	257.000	1.663	0.000
	19	257.000	-2.443	28297.500
	20	257.000	-7.337	0.000
	21	257.000	-14.437	27111.376
	22	257.000	-21.537	0.000

2) Span Arrangement

	Length (m)	Node
LL	0.800	----------
S1	75.600	1
S2	76.500	1
S3	102.800	1
LR	1.000	----------

3) Weight of Node

Node	H1 (m)	H2 (m) Point of Inertial Force from bottom flange	Weight(kN)	Dead Load(kN)
1	1.035	1.783	3672.000	7195.000
2	1.035	--------	7662.000	--------------
3	1.035	1.783	8328.000	16656.000
4	1.035	--------	8746.000	--------------
5	1.035	1.783	10680.000	21361.000
6	1.035	--------	10536.000	--------------
7	1.035	1.783	4584.000	8997.000
$\sum$			54208.000	54209.000

4) Member

<u>Bridge Axis Direction</u>

Structure Component	Node No.	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)	Area (m^2)	Level-1 Iz (m^4)
Superstructure	23- 25	2.000E+008	7.700E+007	1.2055	1.4087
	25- 26			1.2055	1.4087
	26- 28			1.1685	1.4191
	28- 29			1.1685	1.4191
	29- 31			1.2110	1.6999
	31- 32			1.2110	1.6999
	24- 23	2.000E+008	7.700E+007	1000.0000	1000.0000
	27- 26				
	30- 29				
	33- 32				
P5	1- 2	2.800E+007	1.217E+007	81.1543	130.2383
	2- 3	2.800E+007	1.217E+007	81.1543	130.2383
	3- 4	2.800E+007	1.217E+007	81.1543	130.2383
	4- 5	2.800E+007	1.217E+007	81.1543	130.2383
	5- 6	2.800E+007	1.217E+007	4000.0000	7000.0000
	6- 7	2.800E+007	1.217E+007	4000.0000	7000.0000
P6	8- 9	2.800E+007	1.217E+007	44.5686	32.1011
	9- 10	2.800E+007	1.217E+007	44.5686	32.1011
	10- 11	2.800E+007	1.217E+007	44.5686	32.1011
	11- 12	2.800E+007	1.217E+007	44.5686	32.1011

P7	13- 14	2.800E+007	1.217E+007	37.0686	26.4761
	14- 15	2.800E+007	1.217E+007	37.0686	26.4761
	15- 16	2.800E+007	1.217E+007	37.0686	26.4761
	16- 17	2.800E+007	1.217E+007	37.0686	26.4761
P10	18- 19	2.800E+007	1.217E+007	77.9286	313.5187
	19- 20	2.800E+007	1.217E+007	77.9286	313.5187
	20- 21	2.800E+007	1.217E+007	77.9286	313.5187
	21- 22	2.800E+007	1.217E+007	77.9286	313.5187

Axis Perpendicular Direction

Structure Component	Node Nos.	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)	Level-1	
				Iy (m^4)	J (m^4)
Superstructure	23- 25	2.000E+008	7.700E+007	69.7551	1.3440
	25- 26			69.7551	1.3440
	26- 28			55.5912	1.3751
	28- 29			55.5912	1.3751
	29- 31			46.0013	1.4689
	31- 32			46.0013	1.4689
	24- 23	2.000E+008	7.700E+007	1000.0000	1000.0000
	27- 26				
	30- 29				
	33- 32				
P5	1- 2	2.800E+007	1.217E+007	2219.5525	461.7063
	2- 3	2.800E+007	1.217E+007	2219.5525	461.7063
	3- 4	2.800E+007	1.217E+007	2219.5525	461.7063
	4- 5	2.800E+007	1.217E+007	2219.5525	461.7063
	5- 6	2.800E+007	1.217E+007	50000.0000	23000.0000
	6- 7	2.800E+007	1.217E+007	50000.0000	23000.0000
P6	8- 9	2.800E+007	1.217E+007	824.6239	116.6981
	9- 10	2.800E+007	1.217E+007	824.6239	116.6981
	10- 11	2.800E+007	1.217E+007	824.6239	116.6981
	11- 12	2.800E+007	1.217E+007	824.6239	116.6981
P7	13- 14	2.800E+007	1.217E+007	475.6907	94.2007
	14- 15	2.800E+007	1.217E+007	475.6907	94.2007
	15- 16	2.800E+007	1.217E+007	475.6907	94.2007
	16- 17	2.800E+007	1.217E+007	475.6907	94.2007
P10	18- 19	2.800E+007	1.217E+007	752.3293	811.7399
	19- 20	2.800E+007	1.217E+007	752.3293	811.7399

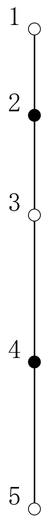
	20- 21	2.800E+007	1.217E+007	752.3293	811.7399
	21- 22	2.800E+007	1.217E+007	752.3293	811.7399

5) Support Condition (for Level-1)

	Axis Direction (kN/m)	Axis Perpendicular Direction (kN/m)	Vertical Direction (kN/m)	Rotation in Bridge Axis Direction (kN.m/rad)	Rotation in Axis Perpendicular Direction (kN.m/rad)	Rotation in Vertical Axis (kN.m/rad)
1	Elastic 1.851300E+4	Fix	Fix	Fix	Free	Free
2	Elastic 2.557900E+4	Fix	Fix	Fix	Free	Free
3	Elastic 2.557900E+4	Fix	Fix	Fix	Free	Free
4	Elastic 1.848600E+4	Fix	Fix	Fix	Free	Free

6) Model of Substructure

[P5]



Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	17309.250
4	695.898
6	13406.400

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.3280	81.15431	2.80E+007	1.22E+007
2 - 3	3.6720	81.15431	2.80E+007	1.22E+007
3 - 4	0.1750	81.15431	2.80E+007	1.22E+007
4 - 5	0.1750	81.15431	2.80E+007	1.22E+007
5 - 6	0.9500	4000.00000	2.80E+007	1.22E+007
6 - 7	0.9500	4000.00000	2.80E+007	1.22E+007

Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	130.23827	2219.55246	461.70631			
2 - 3	130.23827	2219.55246	461.70631			
3 - 4	130.23827	2219.55246	461.70631			
4 - 5	130.23827	2219.55246	461.70631			
5 - 6	7000.00000	50000.00000	23000.00000			
6 - 7	7000.00000	50000.00000	23000.00000			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	4.252528E+006	kN/m	Kx(Arr)	Elastic	9.525137E+008	kN.m/rad
Ky(Avv)	Fix	1.808485E+007	kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	3.014590E+008	kN.m/rad	Kz(Ass)	Elastic	4.252528E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-1.551309E+007	kN/rad	Kxz(Ars)		-1.551309E+007	kN.m/m
Kyz(Avr)		0.000000E+000	kN/rad	Kyz		0.000000E+000	kN.m/m
Position of Foundation Elastic (m) = 0.000							

[P6]

Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	9738.750
4	9827.373

Member

Node	Length(m)	Area(m²)	Young's Modulus (kN/m²)	Shear Modulus (kN/m²)
1 - 2	3.2962	44.56858	2.80E+007	1.22E+007
2 - 3	3.7038	44.56858	2.80E+007	1.22E+007
3 - 4	4.5000	44.56858	2.80E+007	1.22E+007
4 - 5	4.5000	44.56858	2.80E+007	1.22E+007

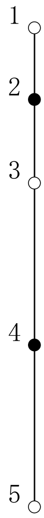
Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	32.10108	824.62387	116.69811			
2 - 3	32.10108	824.62387	116.69811			
3 - 4	32.10108	824.62387	116.69811			
4 - 5	32.10108	824.62387	116.69811			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	4.126200E+006	kN/m	Kx(Arr)	Elastic	1.809100E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	6.362100E+008	kN.m/rad	Kz(Ass)	Elastic	6.805500E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-4.159100E+007	kN/rad	Kxz(Ars)		-8.061700E+007	kN.m/m
Kyz(Avr)		0.000000E+000	kN/rad	Kyz		0.000000E+000	kN.m/m
Position of Foundation Elastic (m) = 0.000							

[P7]



Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	8452.500
4	11715.526

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2652	37.06858	2.80E+007	1.22E+007
2 - 3	3.7348	37.06858	2.80E+007	1.22E+007
3 - 4	6.4500	37.06858	2.80E+007	1.22E+007
4 - 5	6.4500	37.06858	2.80E+007	1.22E+007

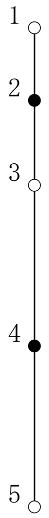
Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	26.47608	475.69066	94.20068			
2 - 3	26.47608	475.69066	94.20068			
3 - 4	26.47608	475.69066	94.20068			
4 - 5	26.47608	475.69066	94.20068			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	6.333000E+006	kN/m	Kx(Arr)	Elastic	1.508900E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	6.655100E+008	kN.m/rad	Kz(Ass)	Elastic	8.199300E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-5.059000E+007	kN/rad	Kxz(Ars)		-7.432600E+007	kN.m/m
Kyz(Avr)		0.000000E+000	kN/rad	Kyz		0.000000E+000	kN.m/m
Position of Foundation Elastic (m) = 0.000							

[P10]



Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	28297.500
4	27111.376

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	4.1061	77.92865	2.80E+007	1.22E+007
2 - 3	4.8939	77.92865	2.80E+007	1.22E+007
3 - 4	7.1000	77.92865	2.80E+007	1.22E+007
4 - 5	7.1000	77.92865	2.80E+007	1.22E+007

Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	313.51868	752.32933	811.73989			
2 - 3	313.51868	752.32933	811.73989			
3 - 4	313.51868	752.32933	811.73989			
4 - 5	313.51868	752.32933	811.73989			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	9.541000E+006	kN/m	Kx(Arr)	Elastic	1.542000E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	1.247000E+009	kN.m/rad	Kz(Ass)	Elastic	9.679500E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-7.521600E+007	kN/rad	Kxz(Ars)		-7.663100E+007	kN.m/m
Kyz(Avr)		0.000000E+000	kN/rad	Kyz		0.000000E+000	kN.m/m
Position of Foundation Elastic (m) = 0.000							

7) Result of Shared Weight

Table Summary of Shared Weight of Superstructure on Substructures

Item		P5	P6	P7	P10
Bridge Axis Direction					
-	Shared Weight (kN)	12,800	15,300	14,500	11,800
-	Natural period of oscillation of the bridge (second)	1.60(s)			
Bridge Axis Perpendicular Direction					
-	Shared Weight (kN)	6,700	16,300	23,100	8,400
-	Natural period of oscillation of the bridge (second)	0.28(s)	0.38(s)	0.45(s)	0.51(s)
		0.45(s) in oscillation unit consisting of all substructures			

Values of P5 and P10 are loads only from 3-span bridge.

<u>Details</u>

Bridge Axis Direction

Oscillation Unit		Structure Component	T(sec)	Khg	Kho	Khi	Kh	F (kN)	H (kN)	Wu (kN) shared weight
1	plural	P5	1.604	0.24	0.300	0.30	0.30	24449.349	7334.805	24449.349*
		P6		0.24	0.300	0.30		15269.889	4580.967	15269.889
		P7		0.24	0.300	0.30		14429.274	4328.782	14429.274
		P10		0.24	0.300	0.30		11759.489	3527.847	11759.489*
										*including dead load of neighbor

Bridge Axis Perpendicular Direction

Oscillation Unit		Structure Component	T(sec)	T/Tmin	Khg	Kho	Kh	F (kN)	H (kN)	Wu (kN) shared weight
1	plural	P5	0.447	1.000	0.24	0.30	0.30	15530.141	4659.042	15530.141*
		P6		1.381	0.24	0.30	0.30	16219.593	4865.878	16219.593
		P7		1.613	0.24	0.30	0.30	23030.205	6909.061	23030.205
		P10		1.841	0.24	0.30	0.30	13428.061	4028.418	13428.061* *including dead load of neighbor

8) Result of Natural Period

$$T = 2.01\sqrt{\delta} = 1.604 \ (s)$$

$$\delta = \frac{\Sigma Wi \times Ui^2}{\Sigma Wi \times Ui} = \frac{35852.718}{56309.845} = 0.637 \ (m)$$

Displacement when horizontal force equivalent to the weight of superstructure and substructure works:

Structure Component	Node No.	Weight Wi (kN)	Displacement Ui (m)	Wi × Ui (kN.m)	Wi × Ui^2 (kN.m^2)
Superstructure	1	3672.000	0.7363	2703.843	1990.949
	2	7662.000	0.7380	5654.371	4172.790
	3	8328.000	0.7380	6145.756	4535.341
	4	8746.000	0.7393	6466.248	4780.741
	5	10680.000	0.7393	7895.404	5836.835
	6	10536.000	0.7399	7795.361	5767.620
	7	4584.000	0.7384	3384.802	2499.320
P5	1	0.000	0.0426	0.000	0.000
	2	17309.250	0.0346	598.931	20.724
	3	0.000	0.0261	0.000	0.000
	4	695.898	0.0257	17.901	0.460
	5	0.000	0.0253	0.000	0.000
	6	13406.400	0.0232	311.648	7.245
	7	0.000	0.0212	0.000	0.000
P6	1	0.000	0.1370	0.000	0.000
	2	9738.750	0.1146	1116.343	127.965
	3	0.000	0.0905	0.000	0.000
	4	9827.373	0.0643	631.884	40.629
	5	0.000	0.0442	0.000	0.000
P7	1	0.000	0.1704	0.000	0.000
	2	8452.500	0.1414	1195.417	169.065
	3	0.000	0.1094	0.000	0.000
	4	11715.526	0.0610	715.140	43.654
	5	0.000	0.0295	0.000	0.000
P10	1	0.000	0.0974	0.000	0.000
	2	28297.500	0.0835	2363.521	197.411
	3	0.000	0.0672	0.000	0.000
	4	27111.376	0.0448	1213.291	54.297
	5	0.000	0.0256	0.000	0.000
Neighboring Bridge (PC Box Girder Bridge)	1	11700.000	0.6923	8099.986	5607.672
Total				56309.845	35852.718

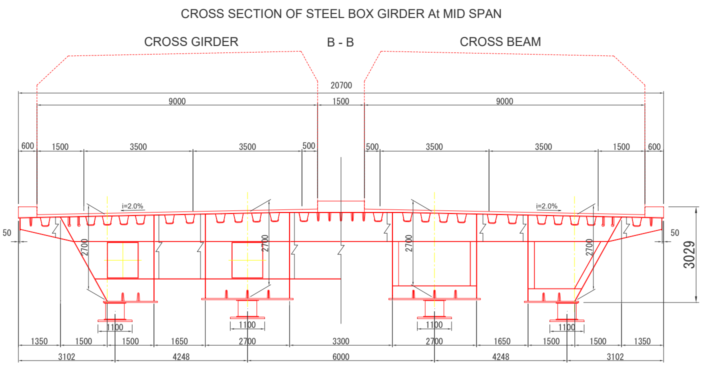
(3) Other Design External Forces

For substructure designs, various forces including earth pressure, water pressure, wind loads, effect of temperature change, collision load of vessel, flowing water pressure and hydrodynamic pressure during earthquake are properly considered as critical load combination.

1) Wind Loads

Wind Loads Refer to Specifications for Highway Bridges Part-I chapter 2.2.9 page-53

1)Wind load working on Superstructure ※Load as horizontal force in bridge axis perpedicular direction



B: Width of bridge(m)	24.1
D:Height of Superstructure(m)	3.429
B/D	7.0
Wind Load (kN/m)	8.9

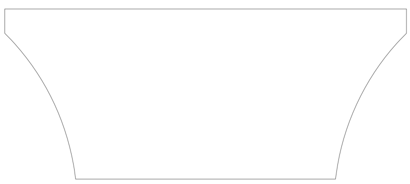
Average of Width of bridge	24.1
P5	27.3
P6	24.4
P7	21.8
P10	22.9

	P5	P6	P7	P10
Length of bridge in Bridge Axis Direction(m)	38.25	76.5	90.25	52
Wind load at support(kN)	340.425	**680.85**	**803.225**	462.8
Work Elevation(MSL+)	1.715	15.072	16.006	1.715
Height from Top of pier to working point(m)	1.715	**18.522**	**22.356**	1.715

2)Wind Load working on Substructure

*Horizontal force on Bridge Axis Perpedicular Direction and Bridge Axis Direction

*0.75kN／m2 at live load condition for oval shape



Area of Beam: :

P6	127.288 m2
P7	109.788 m2

Bridge Axis Perpedicular Direction	P5	**P6**	**P7**	P10
Projected area(m2)		22.68	25.68	
Wind Load (kN)		**17.1**	**19.3**	
Pier Top Elevation（MSL+)		12.55	13.55	
Water Level（MSL+)		4.99	4.99	
Height from top of footing to collision point(m)		**12.22**	**15.62**	
Bridge Axis Direction				
Projected area(m2)		135.968	130.068	
Wind Load (kN)		**102.0**	**97.6**	
Height from water Level to loading point(m)		4.62	4.62	
Height from top of footing to loading point(m)		**13.060**	**15.960**	

2) Vessel Collision Load

Vessel Collision Force Based on AASHTO LRFD

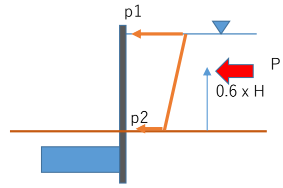
Pier		P6	P7
Collision Force（kN）	Bridge Axis Perpedicular Direction	**6,319**	**7,433**
	Bridge Axis Direction	**3,160**	**3,717**
Elevation of Collision(MSL+)		3.98	3.98
Height from top of footing to collision point(m)		**7.43**	**10.33**
Speed at collision(m/s)		1.34	2.95

3) Flowing Water Pressure

Flowing Water Pressure	Specifications for Highway Bridges Part-IV Chapter 2.2.7 page-49

1) During Construction(temporary cofferdam)

Item	P6	P7
Water Level(MSL+)	4.34	4.34
Existing Ground Level(MSL+)	-1.721	-5.346
Water Depth H(m)	6.061	9.686
Pier Shape Factor K	0.4	0.4
velocity (m/s)	0.65	0.65
Projected Area(m2)	52.25309	82.67001
Flowing Water Pressure P(kN)	8.830773	13.97123
Working height(m) 0.6 x H	3.6366	5.8116
Flowing Water Pressure, p1(k N/m)	**0.2704**	**0.2704**
Flowing Water Pressure, p2(k N/m)	**0.0676**	**0.0676**



2) Collision of Vessels (during service stage)

※For P7, no consideration of Flowing Water Pressure

2-1) W/O Scouring(existing ground elevation)

Item	**P6**
Water Level(MSL+)	2.530
Existing Ground Elevation (MSL+)	-1.721
Water Depth H(m)	4.251
Pier Shape Factor K	0.4
velocity (m/s)	1.19
Projected Area(m2)	12.753
Flowing Water Pressure P(kN)	**8.0**
Working height(m) 0.6 x H	2.5506
Height from footing top to working point(m)	**4.280**

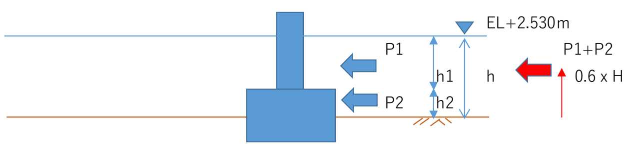
2-2) 1/2 of Maximum Scouring

I. A part of fooring above ground level after scouring (P6)

Item	**P6**
Water Level(MSL+)	2.530
Footing top elevation (MSL+)	-3.45
1/2 of Maximum Scouring (MSL+)	-3.64
water depth, h1(m)	5.980
water depth, h2(m)	0.19
Shape factor K	0.4
velocity (m/s)	1.19
projected area, a1(m2)	17.94
projected area, a2(m2)	1.638028
Flowing Water Pressure P(kN)	**12.0**
Working height(m) 0.6 x H	3.702
Height from footing top to working point(m)	**3.512**

II. No part of fooring above ground level after scouring

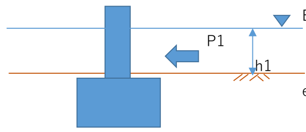
item	
Water Level(MSL+)	
1/2 of Maximum Scouring (MSL+)	
water depth H(m)	
Shape factor K	
velocity (m/s)	
projected area (m2)	
Flowing Water Pressure P(kN)	
Working height(m) 0.6 x H	
Height from footing top to working point(m)	



4) Hydrodynamic Pressure during Earthquake

Hydrodynamic Pressure during Earthquake

Refer to Specifications for Highway Bridges Part-V Page-77



※P1 works at hg（=3/7 x h1)

W/O Scouring Case

1．Bridge Axis Direction

P1(k N)				**P6**	
kh=	0.3		h1(m)	2.011	
w0=	10	kN/m3	b/h1	7.7	
A0=	44.565	m2		b/h>4.0	
a=	3	m	**P1(kN)**	**313**	
b=	15.5	m	hg(m)	0.86	from ground level
				2.59	from footing top

P1(k N)				**P7**	
kh=	0.3		h1(m)	5.636	
w0=	10	kN/m3	b/h1	2.3	
A0=	37.065	m2		2.0<b/h<4.0	
a=	3	m	**P1(kN)**	**956**	
b=	13	m	hg(m)	2.42	from ground level
				3.42	from footing top

2．Bridge Axis Perpedicular Direction

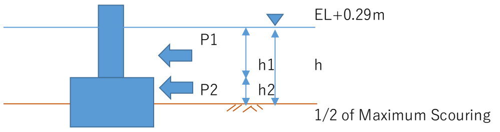
P1(k N)				**P6**	
kh=	0.3		h1(m)	2.011	
w0=	10	kN/m3	b/h1	1.5	
A0=	44.565	m2		<2.0	
a=	15.5	m	**P1(kN)**	**25**	
b=	3	m	hg(m)	0.86	from ground level
				2.59	from footing top

P1(k N)				**P7**	
kh=	0.3		h1(m)	5.636	
w0=	10	kN/m3	b/h1	0.5	
A0=	37.065	m2		<2.0	
a=	13	m	**P1(kN)**	**95**	
b=	3	m	hg(m)	2.42	from ground level
				3.42	from footing top

1/2 of Maximum Scouring Case

I.A part of fooring above ground level after scouring(P6,P7)

1． Bridge Axis Direction



*For simplification, P(=P1+P2) works at hg（=3/7xh). And, P2 is calculated by extracting resultant pressure for the depth of h from the resultant pressure for the depth of h1.

P1(k N)

kh=	0.3		
w0=	10 kN/m3		
A0=	44.565 m2		
a=	3 m		
b=	15.5 m		

	P6
h1(m)	3.74
b/h1	4.1
	b/h>4.0
P1(kN)	**582**

P2(k N)

kh=	0.3
w0=	10 kN/m3
A0=	130.912 m2
a=	8.6212 m
b=	21.6514 m

h2(m)	0.19	
b/h	5.5	
	b/h>4.0	
P2(kN)	43	
P1+P2(kN)	**625**	
hg(m)	1.68	from ground level
	1.49	from footing top

P1(k N)

kh=	0.3
w0=	10 kN/m3
A0=	37.065 m2
a=	3 m
b=	13 m

	P7
h1(m)	6.64
b/h1	1.96
	b/h<2.0
P1(kN)	**1226**

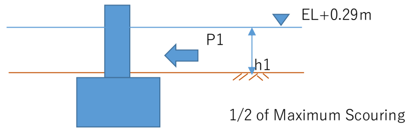
P2(k N)

kh=	0.3
w0=	10 kN/m3
A0=	117.0639 m2
a=	20.117 m
b=	8.535 m

h2(m)	0.16	
b/h	1.3	
	<2.0	
P2(kN)	18	
P1+P2(kN)	**1244**	
hg(m)	2.91	from ground level
	2.75	from footing top

II.No part of fooring above ground level after scouring

1． Bridge Axis Direction



※P1 works at hg（=3/7 x h1)

h1(m)
b/h1

P1(kN)
hg(m)

h1(m)
b/h1

P1(kN)
hg(m)

2. Bridge Axis Perpedicular Direction

2. Bridge Axis Perpedicular Direction

P1(k N)				**P6**	
kh=	0.3		h1(m)	3.74	
w0=	10	kN/m3	b/h1	0.8	
A0=	44.565	m2		<2.0	
a=	15.5	m	P1(kN)	59	
b=	3	m			
P2(k N)					
kh=	0.3		h2(m)	0.19	
w0=	10	kN/m3	b/h	2.2	
A0=	130.912	m2		2.0<b/h<4.0	
a=	21.6514	m	P2(kN)	16	
b=	8.6212	m			
			P1+P2(kN)	**75**	
			hg(m)	1.68	from ground level
				1.49	from footing top

h1(m)
b/h1
P1(kN)
hg(m)

P1(k N)				**P7**	
kh=	0.3		h1(m)	6.64	
w0=	10	kN/m3	b/h1	0.5	
A0=	37.065	m2		<2.0	
a=	13	m	P1(kN)	114	
b=	3	m			
P2(k N)					
kh=	0.3		h2(m)	0.16	
w0=	10	kN/m3	b/h	3.0	
A0=	117.0639	m2		2.0<b/h<4.0	
a=	8.535	m	P2(kN)	70	
b=	20.117	m			
			P1+P2(kN)	**184**	
			hg(m)	2.91	from ground level
				2.75	from footing top

h1(m)
b/h1
P1(kN)
hg(m)

2.3 DESIGN EXTERNAL FORCE FOR SPSP AND PIER COLUMN

Design external force acting as point forces through the axis of centroid on center of bottom of the pier is considered for SPSP foundation design and Pier Column Design as shown in following figure and tables. These forces include loads from superstructure (dead load, live load, horizontal force due to temperature change, seismic horizontal force), weight of pier, wind load, collision load, Flowing Water Pressure, Hydrodynamic Pressure during Earthquake.

For SPSP design, other loads such as weights of footing, filled concrete inside steel piles, soil on the footing and buoyancy of pier, and inertial forces working on the projected parts if the footing projects due to local scouring will be added to the weights shown in the tables in the structural analysis software.

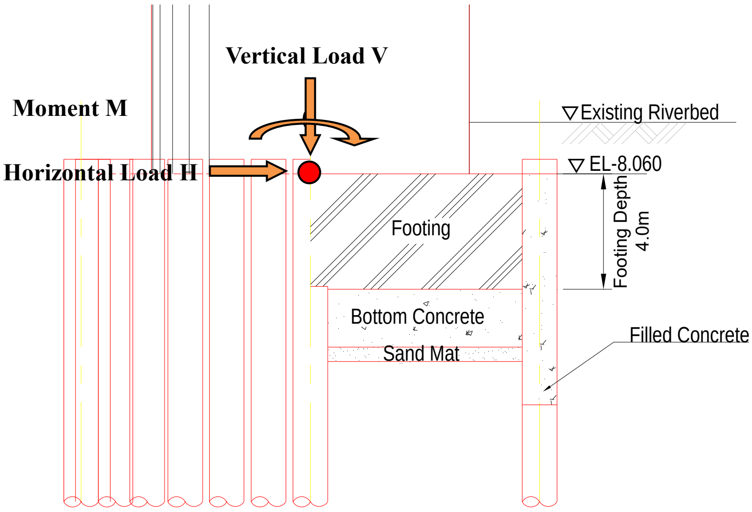


Figure Point of loading of Design External Forces

External Forces at bottom of Pier Column 2017/9/30

P6 Pier ※ Roundup by 100 k N

Direction		Load Component	V（k N)	kh	H（k N)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	16,700				
		Live Load	4,500				
		Weight of Pier	19,300				
		Total	40,500		0		0
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	16,700				
		Live Load	4,500				
		Horizontal Force due to temperature change effect			200	16.00	3,200
		Weight of Pier	19,300				
		Total	40,500		200		3,200
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	16,700				
		Live Load	4,500				
		Horizontal Force due to wind			200	13.06	2,612
		Horizontal Force due to temperature change effect			200	16.00	3,200
		Weight of Pier	19,300				
		Total	40,500		400		5,900
	D.Ordinary Condition＋Collision Load	Dead Load	16,700				
		Live Load	4,500				
		Weight of Pier	19,300				
		Collision Load			3,200	6.78	21,696
			40,500		3,200		21,700
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	16,700				
		(shared weight)	15,300	0.3	4,590	16.00	73,440
		Weight of Pier	19,300	0.3	5,790	8.52	49,308
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			700	1.49	1,046
		Total	36,000		11,100		123,800
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	16,700				
		(shared weight)	15,300	0.3	4,590	16.00	73,440
		Weight of Pier	19,300	0.3	5,790	8.52	49,308
		Hydrodynamic Pressure during Earthquake(without scouring)			400	2.59	1,036
		Total	36,000		10,800		123,800
Bridge Axis Perpedicular Direction	A.Ordinary Condition	Dead Load	16,700			0.357	5,962
		Live Load	4,500			0.165	743
		Weight of Pier	19,300				
		Total	40,500		0		6,800
	C.Extreme wind situation	Dead Load	16,700			0.357	5,962
		Live Load	4,500			0.165	743
		Horizontal Force due to wind			700	18.52	12,965
		Horizontal Force due to wind			100	12.22	1,222
		Weight of Pier	19,300				
		Total	40,500		800		20,900
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	16,700			0.357	5,962
		Live Load	4,500			0.165	743
		Weight of Pier	19,300				
		Flowing Water Pressure(without scouring)			100	4.28	428
		Collision Load			6,300	6.78	42,714
		Total	40,500		6,400		49,900
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	16,700			0.357	5,962
		Live Load	4,500			0.165	743
		Weight of Pier	19,300				
		Flowing Water Pressure(1/2 of maximum scouring depth)			100	3.51	351
		Collision Load			6,300	6.78	42,714
		Total	40,500		6,400		49,800
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	16,700			0.357	5,962
		(shared weight)	16,300	0.3	4,890	18.63	91,085
		Weight of Pier	19,300	0.3	5,790	8.52	49,308
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			100	1.49	149
		Total	36,000		10,800		146,600
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	16,700			0.357	5,962
		(shared weight)	16,300	0.3	4,890	18.63	91,085
		Weight of Pier	19,300	0.3	5,790	8.52	49,308
		Hydrodynamic Pressure during Earthquake(without scouring)			100	2.59	259
		Total	36,000		10,800		146,700

Design Ground Level etc.

P6 Pier

Load Combination		Water Level (MSL+m)		Flowing Water Pressure (velocitym/s)		Scouring	Increase Coefficient of Allowable Stress	Case No.	Existing Ground Level	Design Ground Level: Ordinary Condition	Design Ground Level: Earthquake Condition	Earth Height	Water Level: Ordinary Condition	Water Level: Earthquake Condition	Water Level: During Construction
A.	Ordinary Condition	High tide in spring tide	3.18m	X	-	W/O Scouring	1.0	A1		EL-3.45		EL-1.721	EL+3.18		
						Maximum Scouring		A2		EL-5.56		EL-5.56			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-3.45		EL-1.721	EL-2.39		
						Maximum Scouring		A4		EL-5.56		EL-5.56			
B.	Ordinary Condition + Effect of Temperature Change ※Only Bridge Axis Direction	High tide in spring tide	3.18m	X	-	W/O Scouring	1.15	B1		EL-3.45		EL-1.721	EL+3.18		
						Maximum Scouring		B2		EL-5.56		EL-5.56			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-3.45		EL-1.721	EL-2.39		
						Maximum Scouring		B4		EL-5.56		EL-5.56			
C.	Extreme wind situation + Effect of Temperature Change※ Wind load is only Bridge Axis Perpedicular Direction	HHWL (1%)	4.99m	X	-	W/O Scouring	1.35 ※1.25	C1		EL-3.45		EL-1.721	EL+4.99		
						1/2 of Maximum Scouring		C2		EL-3.64		EL-3.64			
D.	Ordinary Condition + Collision Load P7	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1							
						1/2 of Maximum Scouring		D2							
	P6	Maximum Velocity	2.53m	○	1.19m/s ※Only Bridge Axis Perpedicular Direction	W/O Scouring		D3		EL-3.45		EL-1.721	EL+2.53		
						1/2 of Maximum Scouring		D4		EL-3.64		EL-3.64			
E.	Earthquake Condition	Average Water Level	0.29m	○	0.6m/s ※same direction as inertial force	W/O Scouring	1.5	E1			EL-3.45	EL-1.721		EL+0.29	
						1/2 of Maximum Scouring		E2			EL-3.64	EL-3.64			
F.	During Construction	HWL(5%)	4.34m	○	0.65m/s ※Only Bridge Axis Perpedicular Direction	W/O Scouring	1.5	F1	EL-1.721						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

External Forces at bottom of Pier Column 2017/9/30

P7 Pier ※ Roundup by 100 k N

Direction	Load Component		V（kN)	kh	H（kN)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	21,400.00				
		Live Load	5,200.00				
		Weight of Pier	19,900.00				
		Total	46,500.00		0.00		0.00
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	21,400.00				
		Live Load	5,200.00				
		Horizontal Force due to temperature change effect			200.00	19.90	3,980.00
		Weight of Pier	19,900.00				
		Total	46,500.00		200.00		4,000.00
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	21,400.00				
		Live Load	5,200.00				
		Horizontal Force due to wind			100.00	15.96	1,596.00
		Horizontal Force due to temperature change effect			200.00	19.90	3,980.00
		Weight of Pier	19,900.00				
		Total	46,500.00		300.00		5,600.00
	D.Ordinary Condition＋Collision Load	Dead Load	21,400.00				
		Live Load	5,200.00				
		Weight of Pier	19,900.00				
		Collision Load			3,400.00	10.33	35,122.00
			46,500.00		3,400.00		35,200.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	21,400.00				
		(shared weight)	(14500.00)	0.3	4,350.00	19.90	86,565.00
		Weight of Pier	19,900.00	0.3	5,970.00	10.62	63,425.28
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			1,300.00	2.75	3,580.57
		Total	41,300.00		11,700.00		153,600.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	21,400.00				
		(shared weight)	(14500.00)	0.3	4,350.00	19.90	86,565.00
		Weight of Pier	19,900.00	0.3	5,970.00	10.62	63,425.28
		Hydrodynamic Pressure during Earthquake(without scouring)			1,000.00	3.42	3,419.43
		Total	41,300.00		11,400.00		153,500.00
Bridge Axis Perpedicular Direction	A.Ordinary Condition	Dead Load	21,400.00			0.115	2,461.00
		Live Load	5,200.00			0.111	577.20
		Weight of Pier	19,900.00				
		Total	46,500.00		0.00		3,100.00
	C.Extreme wind situation	Dead Load	21,400.00			0.115	2,461.00
		Live Load	5,200.00			0.111	577.20
		Horizontal Force due to wind			900.00	22.36	20,119.95
		Horizontal Force due to wind			100.00	15.62	1,562.00
		Weight of Pier	19,900.00				
		Total	46,500.00		1,000.00		24,800.00
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	21,400.00			0.115	2,461.00
		Live Load	5,200.00			0.111	577.20
		Weight of Pier	19,900.00				
		Flowing Water Pressure(without scouring)			0.00	0.00	0.00
		Collision Load			6,800.00	10.33	70,244.00
		Total	46,500.00		6,800.00		73,300.00
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	21,400.00			0.115	2,461.00
		Live Load	5,200.00			0.111	577.20
		Weight of Pier	19,900.00				
		Flowing Water Pressure(1/2 of maximum scouring depth)			0.00	0.00	0.00
		Collision Load			6,800.00	10.33	70,244.00
		Total	46,500.00		6,800.00		73,300.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	21,400.00			0.115	2,461.00
		(shared weight)	(23100.00)	0.3	6,930.00	22.47	155,746.21
		Weight of Pier	19,900.00	0.3	5,970.00	10.62	63,425.28
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			200.00	2.75	550.86
		Total	41,300.00		13,100.00		219,800.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	21,400.00			0.115	2,461.00
		(shared weight)	(23100.00)	0.3	6,930.00	22.47	155,746.21
		Weight of Pier	19,900.00	0.3	5,970.00	10.62	63,425.28
		Hydrodynamic Pressure during Earthquake(without scouring)			100.00	3.42	341.94
		Total	41,300.00		13,000.00		219,600.00

Design Ground Level etc.

P7 Pier

	Load Combination	Water Level (MSL+m)		Flowing Water Pressure (velocitym/s)		Scouring	Increase Coefficient of Allowable Stress	Case No.	Existing Ground Level	Design Ground Level: Ordinary Condition	Design Ground Level: Earthquake Condition	Earth Height	Water Level: Ordinary Condition	Water Level: Earthquake Condition	Water Level: During Construction
A.	Ordinary Condition	High tide in spring tide	3.18m	X	-	W/O Scouring	1.0	A1		EL-6.35		EL-5.346	EL+3.18		
						Maximum Scouring		A2		EL-7.67		EL-7.67			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-6.35		EL-5.346	EL-2.39		
						Maximum Scouring		A4		EL-7.67		EL-7.67			
B.	Ordinary Condition + Effect of Temperature Change ※Only Bridge Axis Direction	High tide in spring tide	3.18m	X	-	W/O Scouring	1.15	B1		EL-6.35		EL-5.346	EL+3.18		
						Maximum Scouring		B2		EL-7.67		EL-7.67			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-6.35		EL-5.346	EL-2.39		
						Maximum Scouring		B4		EL-7.67		EL-7.67			
C.	Extreme wind situation + Effect of Temperature Change※ Wind load is only Bridge Axis Perpedicular Direction	HHWL (1%)	4.99m	X	-	W/O Scouring	1.35 ※1.25	C1		EL-6.35		EL-5.346	EL+4.99		
						1/2 of Maximum Scouring		C2		EL-6.51		EL-6.51			
D.	Ordinary Condition + Collision Load P7	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1		EL-6.35		EL-5.346	EL+3.18		
						1/2 of Maximum Scouring		D2		EL-6.51		EL-6.51			
	P6	Maximum Velocity	2.53m	○	1.19m/s ※Only Bridge Axis Perpedicular Direction	W/O Scouring		D3							
						1/2 of Maximum Scouring		D4							
E.	Earthquake Condition	Average Water Level	0.29m	○	0.6m/s ※same direction as inertial force	W/O Scouring	1.5	E1			EL-6.35	EL-5.346		EL+0.29	
						1/2 of Maximum Scouring		E2			EL-6.51	EL-6.51			
F.	During Construction	HWL(5%)	4.34m	○	0.65m/s ※Only Bridge Axis Perpedicular Direction	W/O Scouring	1.5	F1	EL-5.346						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

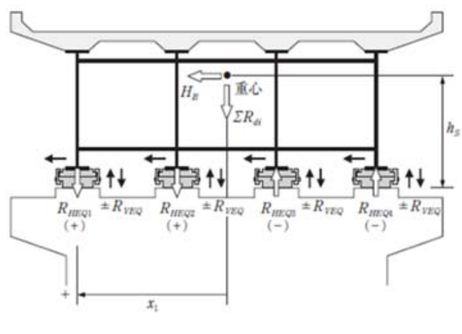
2.4 DESIGN EXTERNAL FORCE FOR PIER BEAM

Table Summary of Design Loads for Pier Beam Design

Condition	Load Component	P6		P7	
		G1	G4	G1	G4
Vertical Section					
Ordinary Condition (Dead + Live Loads)	Dead Load	4,000	4,800	5,700	6,000
	Live Load with Impact	2,000	2,200	2,300	2,400
	Weight of Beam	1,223	1,223	1,223	1,223
	Total	**7,223**	**8,223**	**9,223**	**9,623**
Earthquake Condition (Dead Load + Effect of earthquake)	Dead Load	4,000	4,800	5,700	6,000
	Weight of Beam	1,223	1,223	1,223	1,223
	Vertical reaction force due to earthquake from Superstructure*1	700	800	900	1,000
	Total	**5,923**	**6,823**	**7,823**	**8,223**
Additional load in the earthquake condition for corbel design	Inertia force on superstructure	1,300	1,300	1,800	1,800
	Inertia force on the beam	400	400	400	400
	Total	**1,700**	**1,700**	**2,200**	**2,200**
Horizontal Section					
Effect of temperature change	Horizontal force due to temperature change	**100**	**100**	**100**	**100**
Earthquake Condition	Inertia force on superstructure	1,200	1,200	1,100	1,100
	Inertia force on the beam	400	400	400	400
	Total	**1,600**	**1,600**	**1,500**	**1,500**

Vertical reaction force due to earthquake from Superstructure is calculated in accordance with Chapter 15.4 of Specifications for Highway Bridges Part-V 2012 (Japan Road Association) as follows:

$$R_{HEQi} = \frac{H_B h_S}{\Sigma x_i^2} x_i \quad \cdots\cdots \text{(解15.4.2)}$$



$$R_{VEQ} = \pm k_V R_D \quad \cdots\cdots (15.4.3)$$

Coefficient of Kv

	レベル1地震動	レベル2地震動	
		タイプI	タイプII
係数	0.5	0.5	0.67

Table Vertical reaction force due to earthquake from Superstructure

Pier No.	P6		P7	
Girder No.	G1	G4	G1	G4
R_D (Reaction on bearing due to dead load of superstructure), kN	+3960	+4774	+5629	+5951
R_{VEQ} (Inertial force in vertical direction), kN	±475.2	±572.9	±675.5	±714.1
R_{HEQ} (Vertical reaction on the bearing due to horizontal inertial force) kN	+506	-506	+565	-565
Vertical reaction force due to earthquake from Superstructure $\sqrt{R_{VEQ}^2 + R_{HEQ}^2}$	694 (700)	765 (800)	880 (900)	910 (1000)

CHAPTER 3. SPSP FOUNDATION DESIGN

3.1 SUMMARY

(1) Design Flow

Detailed design of the SPSP foundation is carried out based on the flow as shown in the figure below.

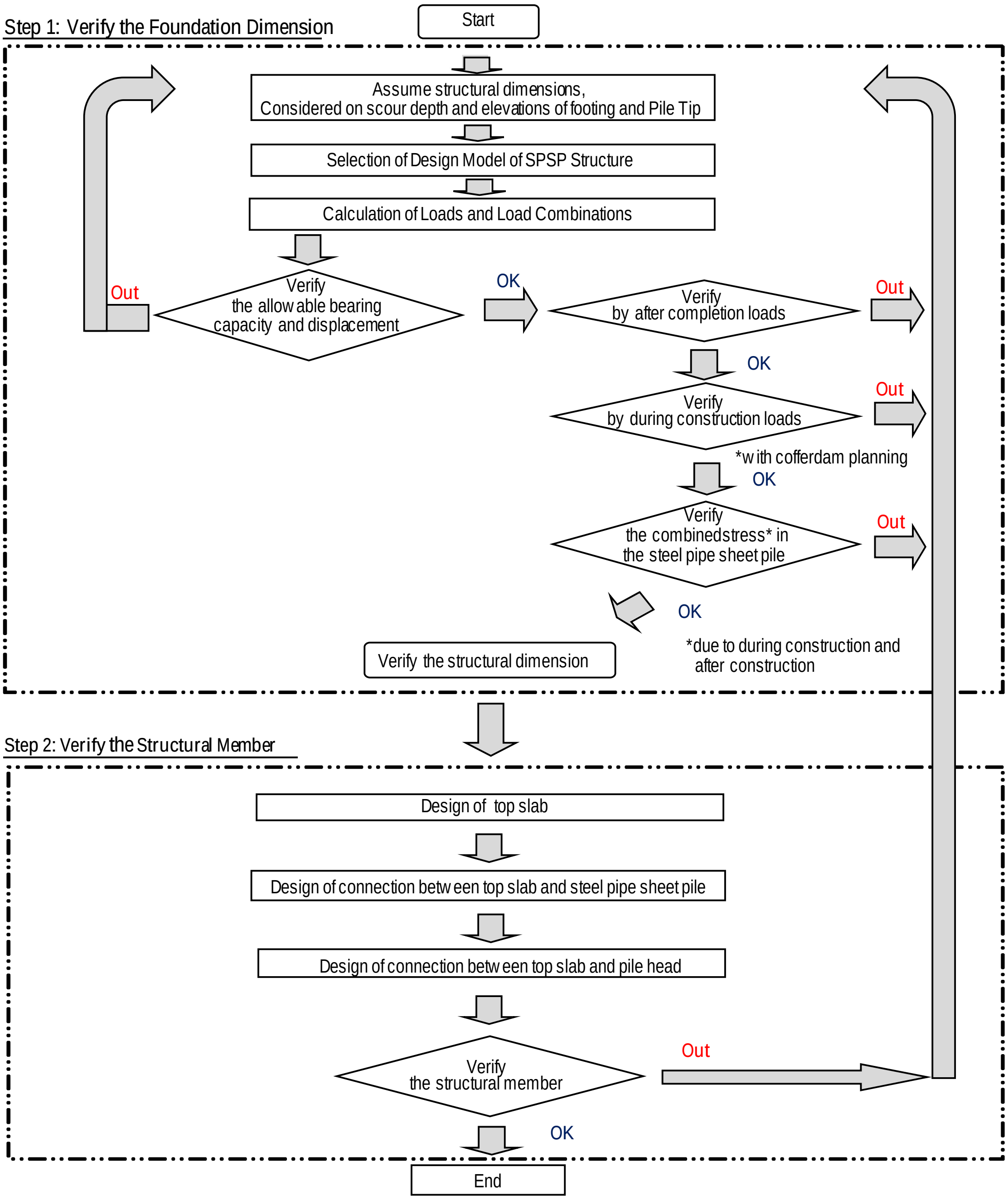


Figure Design Flow for the Basic Design of the SPSP Foundation

(2) Footing Top Elevation

Since it is located at the riverbank, footing top elevation is set to deeper one, of which more than 1 m from the elevation of existing riverbed or from the lowest water level (L.W.L.=-2.39m) to prevent projection of steel pipe above the water.

Table Setting of Footing Top Elevation

Pier No.	Scour of Components				Riverbed Elevation (MSL+m)	Footing Top Elevation (MSL+m)	Scoured Level (MSL+m)
	Total Scour (m)	Scour for Pier (m)	Scour for Pile Cap (m)	Contraction Scour (m)			
P6	3.84	3.15	0.36	0.33	-1.72	-3.45	-5.56
P7	2.32	1.01	0.99	0.33	-5.35	-6.35	-7.67

(3) Pile Tip Elevation

Pile tip is set into the bearing layer of Clayey Sand-II with N-value 50 (sand soil) to more than the length of the diameter of pile 1.2 m, and the pile tip elevation is EL-54.660m at P6 and EL-56.660m at P7 as shown in the figure below.

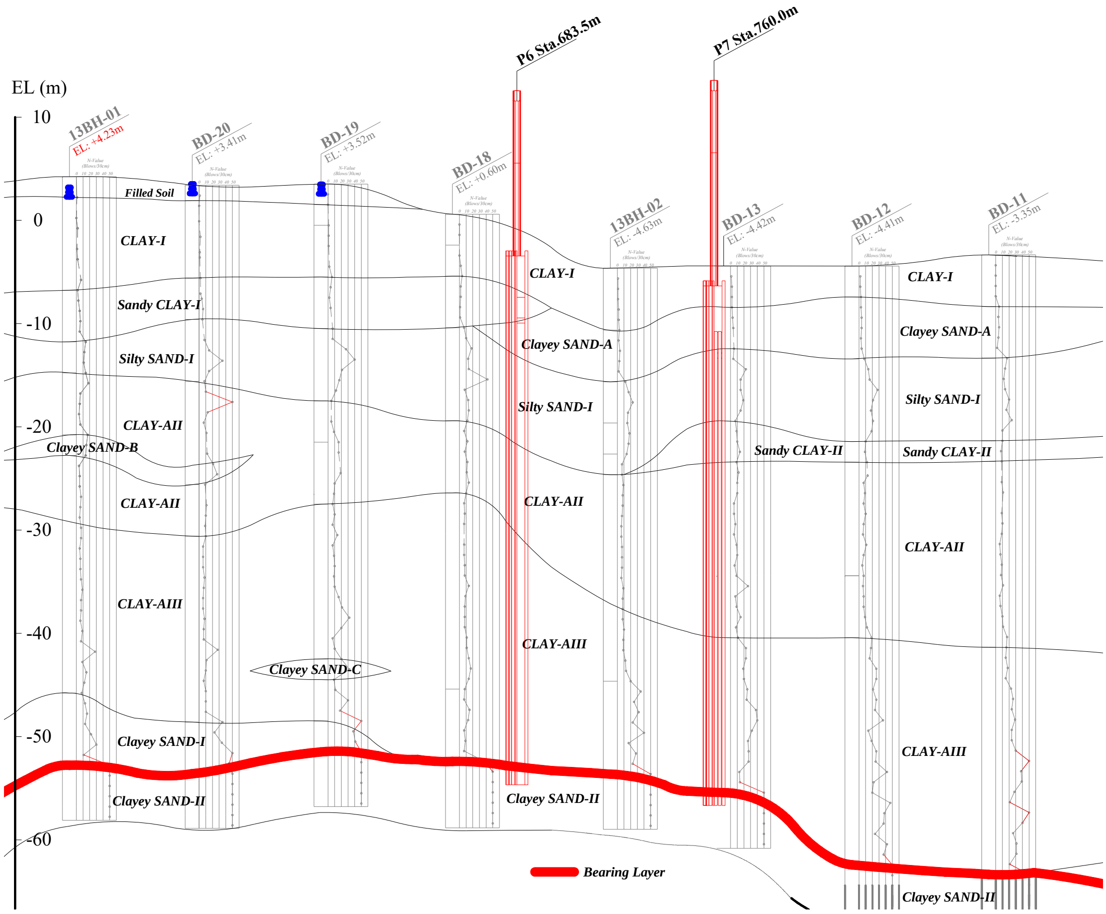


Figure Soil Profile and Pile Tip Position

(4) Design Model of SPSP Structure

Finite-length beam on an elastic ground is applied for the design model of the SPSP structure for all foundations of P6 and P7 as same as the cases of 7-span bridge.

Table Selection of the Design Model of the SPSP Structure

Pier No.	P6	P7
D (m)	21.7	20.1
L/D	2.37	2.50
βL_e	1.46	1.45

D (m): width of foundation: larger value among D (m) or B (m)

L (m): length of steel pipe pile

L_e (m): embedded length of foundation underground

B (1/m): characteristic factor of foundation

(5) Design External Force

For critical design load combination, the combined external forces during earthquake condition (Level-1) are summarized in the table below.

Table Design External Force (V_0,H_0,M_0) at the top of footing during Earthquake

Load Direction		V_o (kN)	H_0 (kN)	M_0 (kN.m)
P6	Bridge axis direction	45,335	11,100	123,800
	Bridge axis perpendicular direction	45,335	10,800	146,600
P7	Bridge axis direction	48,932	11,700	153,600
	Bridge axis perpendicular direction	48,932	13,100	219,800

(6) Verification of Foundation Dimension

1) Bearing Capacity and Displacement

Stability of the SPSP foundation is verified by bearing capacity and displacement and its results are summarized in the tables below.

Table Verification of Bearing Capacity

Bride Axis Direction Unit: kN

Pier No.	Item	Ordinary Condition*1			Earthquake Condition*2		
		Vertical Reaction	Allowable Value	Judgement	Vertical Reaction	Allowable Value	Judgement
P6	Axial compression resistance	1,567<	3,946	OK	1,379<	5,919	OK
	Pulling-out resistance	1,567>	-1,863	OK	1,288>	-3,196	OK
P7	Axial compression resistance	1,554<	3,273	OK	1,412<	4,909	OK
	Pulling-out resistance	1,544>	-1,686	OK	1,306>	-2,855	OK

Bridge Axis Perpendicular Direction Unit: kN

Pier No.	Item	Ordinary Condition*1			Earthquake Condition*2		
		Vertical Reaction	Allowable Value	Judgement	Vertical Reaction	Allowable Value	Judgement
P6	Axial compression resistance	1,567<	3,946	OK	1,388<	5,919	OK
	Pulling-out resistance	1,567>	-1,863	OK	1,279>	-3,196	OK
P7	Axial compression resistance	1,554<	3,273	OK	1,390<	4,909	OK
	Pulling-out resistance	1,544>	-1,686	OK	1,328>	-2,855	OK

Note: *1: ordinary condition at low tide in spring tide w/o local scouring

*2: earthquake condition at 1/2 of maximum local scouring

Table Verification of Displacement

Pier No.	Item	Earthquake Condition*1		
		Displacement*2	Allowable Value	Judgement
P6	Bride Axis Direction	2.2cm <	5.0cm	OK
	Bridge axis perp. direction	1.6cm <	5.0cm	OK
P7	Bride Axis Direction	1.9cm <	5.0cm	OK
	Bridge axis perp. direction	1.8cm <	5.0cm	OK

Note: *1: earthquake condition at 1/2 of maximum local scouring*2: displacement at design ground level

2) Stress of Outer Steel Pipe Sheet Piles

As explained in 7-span bridge part, cofferdam walls shall be verified to be safe against the loads acting during temporary work.

a) Construction Step of Temporary Cofferdam

The underwater/atmospheric excavation method is applied because the stress during drainage and residual stress can be smaller. The construction step of temporary cofferdam for the case of P7 is shown in the figure below, and P6 cases have similar steps as that of P7.

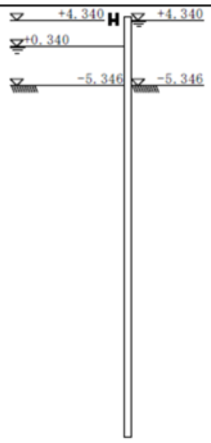
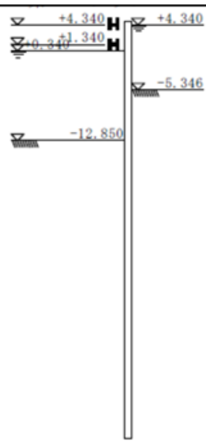
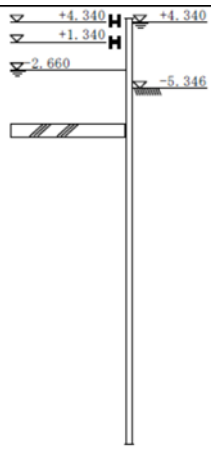
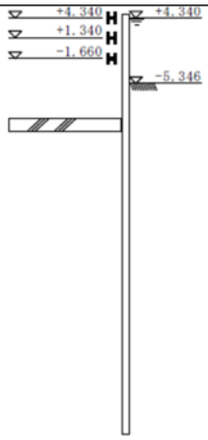
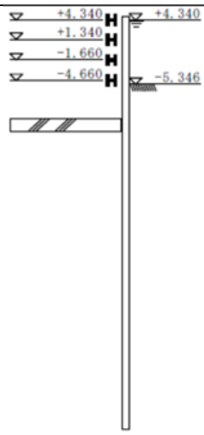
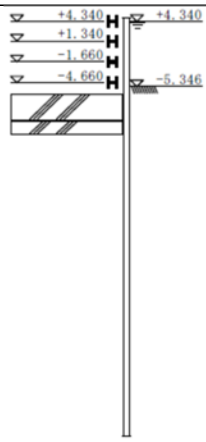
Schematic			
Work activities	Step-1: Install 1st support and drainage up to EL+0.34 m	Step-2: Install 2nd support and excavate up to EL-12.850 m	Step-3: Placement of bottom slab concrete and drainage up to EL-2.660 m
Schematic			
Work activities	Step-4: Install 3rd support and dry up inside well	Step-5: Install 4th support	Step-6: Construction of footing

Figure Construction Step of Temporary Cofferdam by Combined Underwater and Atmospheric Excavation (P7 Case)

At the construction step just before construction of footing concrete, namely Step-5, residual stress of the pile will be considered. Diagram of the displacement and bending moment for the case of P7 is shown in the figure below, and the maximum displacement due to moment occurs between the lowest support and bottom slab concrete.

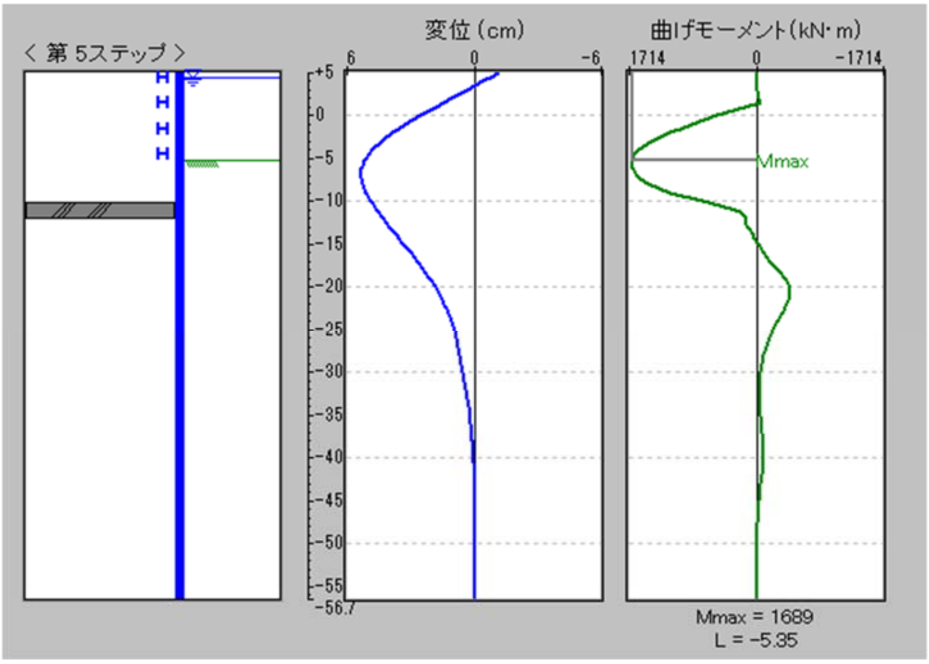
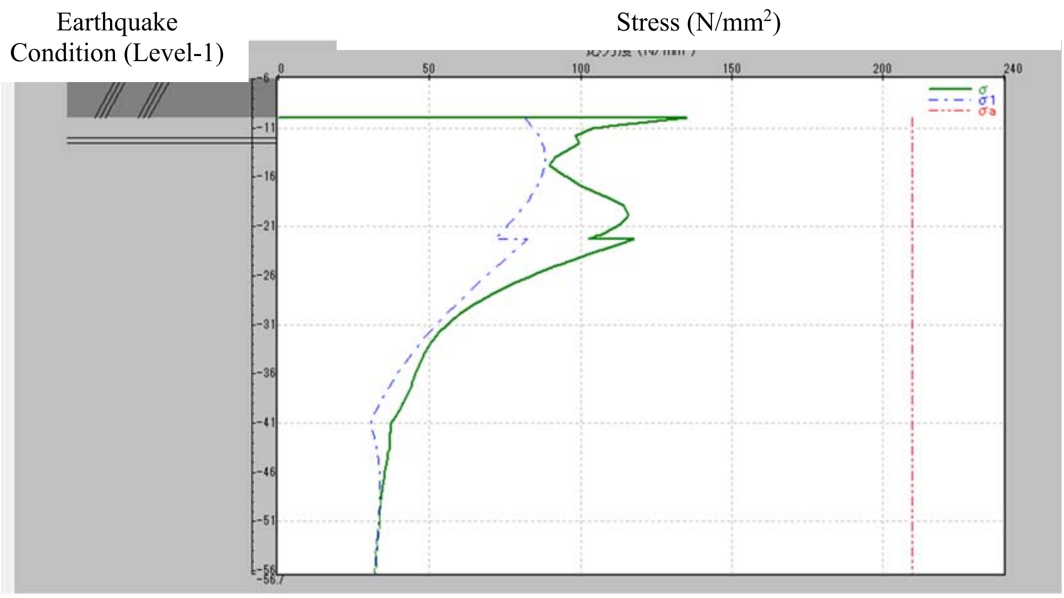


Figure Diagram of Displacement and Bending Moment at the Construction Step when Residual Stress of the Pile is Considered (P7 Case)

b) Combined stress of the pile during construction and due to the design external forces

The following figure shows that combined stress is within the allowable stress under earthquake condition.



where

σ : combined stress (= σ1+σ2), σ1 : stress after completion loads.

σ2 : residual stress during construction, σa : allowable stress in steel pipe sheet pile

Figure Combined Stress for the SPSP of P7 at Earthquake Condition

Table Verification of SPSP (SKY400 part) Combined Stress at Ordinary Condition

Bridge Axis Direction

Pier	Elevation (m)	$\sigma 1^{*1}$ (N/mm^2)	$\sigma 2$ (N/mm^2)	σ_{max} (N/mm^2)	σa (N/mm^2)	Judgement
P6	-11.16	30.14	66.97	97.12<	140	OK
P7	-10.35	30.37	53.58	83.94<	140	OK

Bridge Axis Perpendicular Direction

Pier	Elevation (m)	$\sigma 1^{*1}$ (N/mm^2)	$\sigma 2$ (N/mm^2)	σ_{max} (N/mm^2)	σa (N/mm^2)	Judgement
P6	-11.16	31.46	69.36	100.82<	140	OK
P7	-10.35	31.02	63.08	94.11<	140	OK

**1: ordinary condition at low tide in spring tide w/o local scouring*

Table Verification of SPSP (SKY400 part) Combined Stress at Earthquake Condition

Bridge Axis Direction

Pier	Elevation (m)	$\sigma 1^{*1}$ (N/mm^2)	$\sigma 2$ (N/mm^2)	σ_{max} (N/mm^2)	σa (N/mm^2)	Judgement
P6	-11.45	75.16	66.85	142.00<	210	OK
P7	-10.35	81.65	53.58	135.23<	210	OK

Bridge Axis Perpendicular Direction

Pier	Elevation (m)	$\sigma 1^{*1}$ (N/mm^2)	$\sigma 2$ (N/mm^2)	σ_{max} (N/mm^2)	σa (N/mm^2)	Judgement
P6	-11.16	69.57	69.36	138.93 <	210	OK
P7	-10.35	84.46	63.08	147.54<	210	OK

**1: earthquake condition at 1/2 of maximum local scouring*

(7) Verification of Structural Members

1) Footing (Top Slab)

a) Design Sections

The same sections of footing as 7-span bridge will be verified in terms of bending moment and shear force.

b) Design Conditions

- Width of footing for design b = 100.0 cm, thickness of footing h = 400.0 cm
- Concrete design strength: 24 N/mm^2
- Applied reinforcement bar: SD345 (underwater member)

c) Rebar Arrangement

P6

Bridge Axis Direction
Upper tension: cover 150 mm D32@288
Lower tension: cover 150 mm D32@203
cover 300 mm D32@208
Bridge Axis Perpendicular Direction
Upper tension: cover 120 mm D29@189
Lower tension: cover 118 mm D32@189
cover 268 mm D32@201

P7

Bridge Axis Direction
Upper tension: cover 150 mm D29@278
cover 300 mm D29@286
Lower tension: cover 290 mm D38@228
cover 440 mm D38@234
Bridge Axis Perpendicular Direction
Upper tension: cover 121 mm D29@198
cover 271 mm D29@410
Lower tension: cover 236 mm D38@198
cover 386 mm D38@212

It is noted that shear reinforcement is arranged by D22 at approximately 600mm at chessboard patterns, which quantity is equal to approximately 0.15%, although it is not required in the calculation.

d) Verification of Stress in Footing and Content of Rebar

Design of bending moment is verified by tensile stress and content of rebar in the section as deep beam which has a deeper depth of the footing than 1/2 of design span that is the distance from the edge of pier column to the inside surface of the outer steel sheet pile.

Design of shear force is verified so that average shear stress should be within the allowable shear stress of concrete or allowable shear stress of concrete and shear reinforcement.

Verification of the footing structure is summarized in the table below.

Table Verification of Footing Structure

Bridge Axis Direction

Pier No.	Item	Ordinary Condition*1			Earthquake Condition*2		
		Stress/Rebar Content	Allowable Value	Judgement	Stress/Rebar Content	Allowable Value	Judgement
P6	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 0.95 < σ_s:90.63<	12 300	OK OK
	Lower tensile stress	σ_c: 1.41 < σ_s: 77.49 <	8 160	OK OK	σ_c: 3.06 < σ_s:167.85<	12 300	OK OK
	Rebar Content	77.31 >	56.84	OK	77.31 >	65.67	OK
	Shear stress	τ_m: 0.26 <	0.88	OK	τ_m: 0.54<	1.34	OK
P7	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 1.31< σ_s:95.73<	12 300	OK OK
	Lower tensile stress	σ_c: 1.51 < σ_s:70.73 <	8 160	OK OK	σ_c: 3.64< σ_s:170.30<	12 300	OK OK
	Rebar Content	98.72 >	63.03	OK	98.72 >	80.94	OK
	Shear stress	τ_m: 0.28 <	0.96	OK	τ_m: 0.66 <	1.45	OK

Note: Unit stress in N/mm², Rebar Content in cm²

Bridge Axis Perpendicular Direction

Pier No.	Item	Ordinary Condition*1			Earthquake Condition*2		
		Stress/Rebar Content	Allowable Value	Judgement	Stress/Rebar Content	Allowable Value	Judgement
P6	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 0.25< σ_s:21.51<	12 300	OK OK
	Lower tensile stress	σ_c: 1.73 < σ_s: 92.56 <	8 160	OK OK	σ_c:3.06< σ_s:163.70	12 300	OK OK
	Rebar Content	81.53 >	72.19	OK	81.53 >	68.09	OK
	Shear stress	τ_m: 0.26 <	0.84	OK	τ_m:0.45<	1.28	OK
P7	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 1.66< σ_s:117.85<	12 300	OK OK
	Lower tensile stress	σ_c: 1.93 < σ_s:85.27 <	8 160	OK OK	σ_c: 4.55 < σ_s:200.69<	12 300	OK OK
	Rebar Content	111.35 >	86.71	OK	111.35 >	108.83	OK
	Shear stress	τ_m: 0.28 <	0.82	OK	τ_m: 0.63<	1.25	OK

Note: Unit stress in N/mm², Rebar Content in cm²

**1: ordinary condition at low tide in spring tide w/o local scouring*

**2: earthquake condition at 1/2 of maximum local scouring*

2) Connection between SPSP and Footing

The required number of moment and shear reinforcement for connection between SPSP and footing by Reinforcement Stud Method is calculated as follows:

a) Design Condition

- Applied reinforcement bar: SD345 (underwater member), Diameter 22 mm
- Concrete design strength: 24 N/mm²
- Material of SPSP: SKY400
- Joint method: Reinforcement Stud Method

b) Required Number of Moment and Shear Reinforcement

The required number of reinforcement is 12 and 13 for moment and 43 and 50 for shear, respectively at P6 and P7. Therefore, 16 studs for moment at both piers, 56 studs for shear at P6 and 64 studs for shear at P7 are arranged as shown in the figure below and it was verified by the allowable stress summarized in the table below.

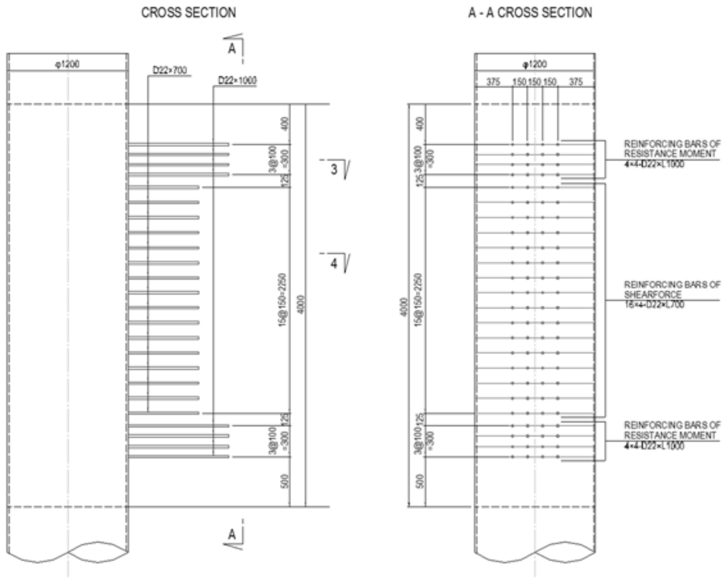


Figure Layout of Reinforcement Stud (P7)

Table Verification of Connection between SPSP and Footing

Bridge Axis Direction

Pier No.	Critical condition	σ_s	σ_{sa}	nb nba	Critical condition	τ_s	τ_{sa}	ns nsa
P6	Wind+ Temperature	158.0<	216.0	16 ≥12	Earthquake	136.2<	180.0	56 ≥43
P7	Wind+ Temperature	166.2<	216.0	16 ≥13	Earthquake	140.5<	180.0	64 ≥50

Bridge Axis Perpendicular Direction

Pier No.	Critical condition	σ_s	σ_{sa}	nb nba	Critical condition	τ_s	τ_{sa}	ns nsa
P6	Wind	147.4<	200.0	16 ≥12	Earthquake	113.9<	180.0	56 ≥36
P7	Wind	155.8<	200.0	16 ≥13	Earthquake	133.9<	180.0	64 ≥48

Note: *σs: tensile stress of the moment reinforcing bar caused by moment and horizontal force (N/mm^2)*

σsa: allowable tensile stress of the reinforcing bar (N/mm^2)

nb: number of moment reinforcement *nba: required number of moment reinforcement*

τs: shear stress of shear reinforcement (N/mm^2)

τsa: allowable shear stress (N/mm^2)

ns: number of shear reinforcement *nsa: required number of shear reinforcement*

3) Connection between Footing and Pile Head of Bulkhead Piles

Since P7 has the bulkhead steel sheet pile, the connection of the pile head is verified in terms of stress and content of reinforcement as follows:

a) Design Condition

- Applied reinforcement bar: SD345 (underwater member)
- Concrete design strength: 24 N/mm^2

b) Rebar Arrangement

Steel pile is inserted at 100 mm to the footing and it is fixed by 12 numbers of main reinforcements of φ22 mm and filled concrete as shown in the figure below.

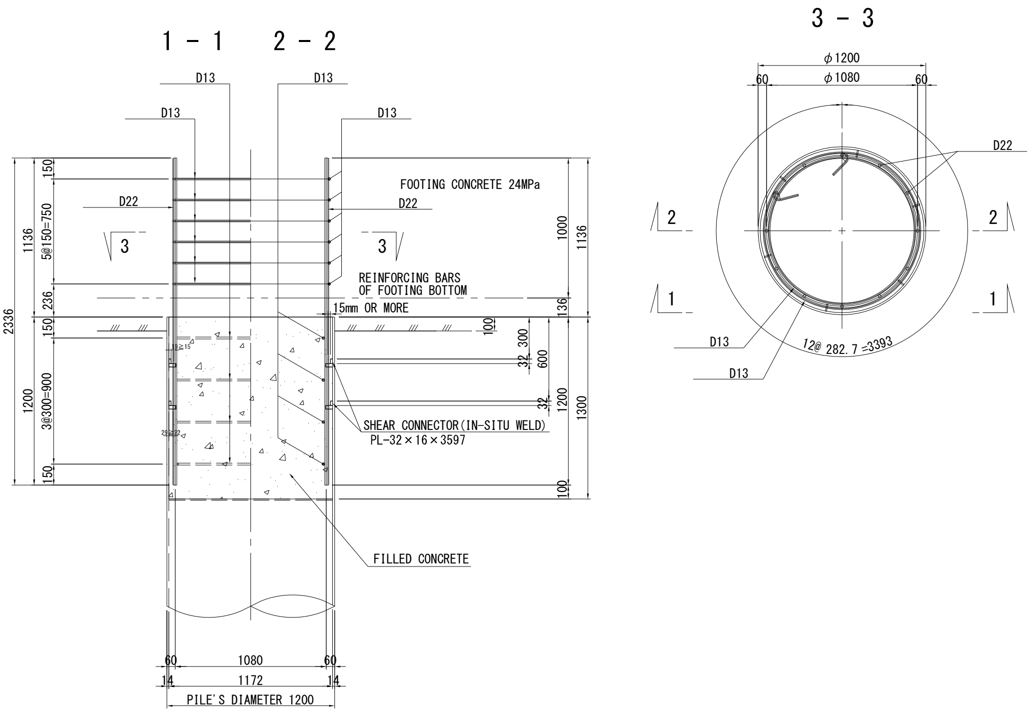


Figure Detail of Pile Head Connection (P7)

c) Verification of Required Content of Reinforcement and Stress

The result of the verification of the connection between footing and bulkhead pile for the case of critical condition is summarized in the table below.

Table Verification of Connection between Footing and Bulkhead Pile

<u>Bridge Axis Direction</u>

Pier No.	Critical Condition	Load on the Pile Head		Content of Rebar (cm^2)	Required Content of Rebar(cm^2)	σ_s (N/mm^2)	σ_{sa} (N/mm^2)
		Moment (kN.m)	Axial Load(kN)				
P7	Earthquake	188.0	Min -18.0 Max 2178	46.5 >	13.3	92.95	300.0

d) Required Anchorage Length of Reinforcing Bars

Anchorage length of reinforcing bars, L = 1,000 mm, from the main reinforcement of footing must be longer than L0+10 x φ.

$$Lo = \frac{\sigma sa}{4 \cdot \tau oa} \phi = 688mm$$

L ≥ Lo + 10 x φ = 908 (mm)

σsa: allowable tensile stress of the reinforcing bar 200.00 (N/mm^2)

τsa: allowable shear stress 1.600 (N/mm^2)

φ: Diameter of Reinforcing bar: φ22mm

3.2 DETAIL CALCULATION SHEET OF SPSP OF P6 (LOAD CASE-1)

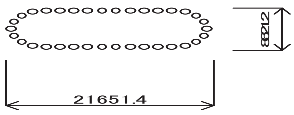
Load Case-1 is the case which considers:

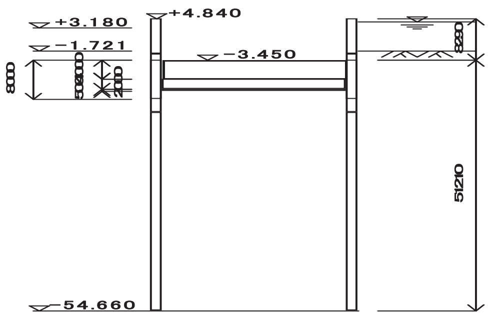
- without local scouring, thus design elevation is set on the elevation of top of footing EL-3.45m.
- High tide and Low tide in spring tide
- Load combinations of Ordinary Condition, Ordinary Condition＋Effect of Temperature Change, Extreme wind situation＋Effect of Temperature Change, Vessel Collision, Earthquake Condition

Contents

1 concrete body calculation

1.1 foundation shape dimension diagram





1.2 steel pipe sheet pile composing points

1)periphery sheet pile

external diameter = 1200.0(mm)
pile length = 59.500(m)
number = 34(number)

steel pipe thickness (mm)	length (m)	material
14.0	7.000	SKY400
16.0	12.000	SKY400
14.0	40.500	SKY400

1.3 ground condition

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m³)		c (kN/m²)	Phi. (angle)	modulus of elasticity Alp.*Eo(kN/m²)		reduction coefficient		
				Gam.	Gam.'			usual	earthquake	DE	DE' Type1	DE' Type2
1	chsv	4.983	1.0	17.5	7.5	10.0	0.00	3600	7200	1.000	1.000	1.000
2	chsv	3.090	3.0	17.5	7.5	15.0	0.00	8000	16000	0.333	0.333	0.333
3	sand	1.060	3.0	17.5	8.5	0.0	28.00	4800	9600	0.333	0.333	0.333
4	sand	2.290	3.0	17.5	8.5	0.0	28.00	4800	9600	0.666	0.666	0.666
5	sand	8.560	13.0	17.0	8.0	0.0	33.00	20800	41600	1.000	1.000	1.000
6	chsv	8.680	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
7	chsv	22.570	18.0	18.0	8.0	108.0	0.00	50400	100800	1.000	1.000	1.000
8	sand	6.140	50.0	19.0	10.0	0.0	35.00	140000	280000	1.000	1.000	1.000

1.4 section properties

(1)section properties of steel pipe pile body

errosion margin external side = 2.0 (mm) internal side = 0.0 (mm)

1)periphery sheet pile Do = 1200(mm) number = 34

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
16.0	10.710	519.9	908031	15184	SKY400
14.0	40.500	446.4	782242	13081	SKY400

(2)sum of squared distance from centroid of steel pipe sheet to neutral axis of horizontal section of celler IB(m^2)

	bridge axis direction	perpendicular direction
periphery sheet pile	357.98	1536.40

(3)sum of moment of inertia in celler part I(m^4)

bridge axis direction I = SumIoi + Mu * Sum(Aoi * Yi^2)

perpendicular direction I = SumIoi + Mu * Sum(Aoi * Xi^2)

Mu : composite efficiency - 0.75

No	L(m)	bridge axis direction	perpendicular direction
1	10.710	14.266469	60.213367
2	40.500	12.250007	51.699783

foundation length = 51.210 (m)

(4)coordinates of cetroid of steel pipe sheet pile

1) periphery sheet pile

No	Y(m)	X(m)	number
1	3.7106	0.7239	4
2	3.7106	2.1717	4
3	3.7106	3.6195	4
4	3.7106	5.0673	4
5	3.7106	6.5151	4
6	0.0000	10.2257	2
7	1.4200	9.9432	4

No	Y(m)	X(m)	number
8	2.6238	9.1389	4
9	3.4281	7.9351	4

1.5 ground constant

(1) ground modulus of elasticity

layer No	usual time		earthquake time		
	layer thickness (m)	Alp.*Eo(kN/m^2)	layer thickness (m)	Alp.*Eo(kN/m^2)	DE
protrusion length	0.000	------	0.000	------	----
1	3.254	3600	3.254	7200	1.000
2	3.090	8000	3.090	16000	0.333
3	1.060	4800	1.060	9600	0.333
4	2.290	4800	2.290	9600	0.666
5	8.560	20800	8.560	41600	1.000
6	8.680	19600	8.680	39200	1.000
7	22.570	50400	22.570	100800	1.000
8	1.706	140000	1.706	280000	1.000

(2)vertical modulus of subgrade reaction

$$kv = \frac{1}{0.3} * Alp. * Eo * \left(\frac{Bv}{0.3}\right)^{-3/4}$$

where kv : vertical modulus of subgrade reaction (kN/m^3)

Alp.*Eo: ground modulus of elasticity (kN/m^2)

usual time = 140000

earthquake time = 280000

Bv : foundation equivalent loading width of foundation (m) -- external diameter of steel pipe sheet pile main body

	Bv (mm)	kv(kN/m^3)	
		usual	earthquake
periphery sheet pile	1200.0	164992	329983

(3)horizontal modulus of subgrade reaction

$$kH = \frac{1}{0.3} * Alp. * Eo * \left(\frac{BH}{0.3}\right)^{-3/4}$$

where kH : horizontal modulus of subgrade reaction (kN/m^3)

BH : equivalent loading width of foundation in orthogonal to load working direction (m)

$BH = \sqrt{D/Beta} \;\; <= \;\; \sqrt{De*Le}$

D : loading width of foundation in orthogonal to load working direction (m)

De : effective loading width of foundation in orthogonal to load working direction (m)

1/Beta : ground depth to relate with horizontal resistance, less than foundation length (m)

Beta : characteristic value of foundation(m^{-1})

$$Beta = \sqrt[4]{\frac{kH*D}{4*E*I}}$$

E : Young's modulus of foundation = 2.00 * 10^8(kN/m^2)

I : moment of inertia of foundation (m^4)

Le : effective embedment depth of foundation(m)

$$kH1 = (1 + Alp.H)*kH*\left(\frac{y}{yo}\right)^{-1/2}$$

where kH1 : in case of considering strain-dependance, standard modulus of subgrade reaction in horizontal direction (kN/m^3) (assuming y = yo, standard value)

Alp.H : shear subgrade reaction on celler part side in horizontal direction and resistance of internal soil increment coefficient including sharing etc (= 1.00)

y : horizontal displacemen of foundation on design ground surfacet (m)

yo : standard displacement (m)

	bridge axis direction		perpendicular direction	
	usual time	earthquake time	usual time	earthquake time
I (cm^4)	1.4266E+009		6.0213E+009	
D (cm)	2165.14		862.12	
Beta(cm^{-1})	0.000433	0.000433	0.000285	0.000285
1/Beta(cm)	2310.5	2310.5	3511.9	3511.9
average Alp.*Eo (N/cm^2)	1409.4	1409.4	2315.6	2315.6
BH, $\sqrt{De*Le}$ (cm)	2236.6 < 3329.8	2236.6 < 3329.8	1740.0 < 2101.2	1740.0 < 2101.2

layer No	layer thickness (m)		Alp.*Eo(kN/m^2)		bridge axis direction kH1(kN/m^3)		perpendicular direction kH1(kN/m^3)	
	usual	earthquake	usual	earthquake	usual	in earthquake	usual	in earthquake
protrusion length	0.000	0.000	------	------	------	------	------	------
1	3.254	3.254	3600	7200	946	1892	1142	2284
2	3.090	3.090	8000	16000	2102	1400	2538	1690
3	1.060	1.060	4800	9600	1261	840	1523	1014
4	2.290	2.290	4800	9600	1261	1680	1523	2028
5	8.560	8.560	20800	41600	5465	10931	6598	13195
6	8.680	8.680	19600	39200	5150	10300	6217	12434
7	22.570	22.570	50400	100800	13243	26486	15987	31974
8	1.706	1.706	140000	280000	36786	73572	44408	88816

horizontal modulus of subgrade reaction(using value)(kN/m^3)

layer No	layer thickness (m)		bridge axis direction		perpendicular direction	
	usual time	in quakes	usual time	in quakes	usual time	in quakes
protrusion length	0.000	0.000	------	------	------	------
1	3.254	3.254	946	1892	1142	2284
2	3.090	3.090	2102	1400	2538	1690
3	1.060	1.060	1261	840	1523	1014
4	2.290	2.290	1261	1680	1523	2028
5	8.560	8.560	5465	10931	6598	13195
6	8.680	8.680	5150	10300	6217	12434
7	22.570	22.570	13243	26486	15987	31974
8	1.706	1.706	36786	73572	44408	88816

(4)horizontal direction shear modulus of subgrade reaction at bottom of celler

ks = 0.3 * kv

where ks :horizontal direction shear modulus of subgrade reaction at bottom of celler (kN/m^3)

	usual time	in quakes
periphery sheet pile	49497	98995

(5)spring constant at bottom of celler

1)vertical spring constant

$$Kv = \sum_{i=1}^{3}\left((ni*kvi*A1i)\right) \ (kN/m)$$

where A1i : close sectional area of steel pipe sheet pile and intermediate driven single pile (m^2)

periphery sheet pile		separation wall sheet pile		intermediate driven pile		Kv (kN/m)	
A11(m^2)	n1(number)	A12(m^2)	n2(number)	A13(m^2)	n3(number)	usual time	earthquake time
1.1310	34	0.0000	0	0.0000	0	6.3444E+006	1.2689E+007

2) shear spring constant

$$Ks = \sum_{i=1}^{2}\left((ni*ksi*A1i)\right) \ (kN/m)$$

usual time	in quakes
1.9033E+006	3.8067E+006

3)rotational spring constant

$$Kr = \sum_{i=1}^{2}\left((kvi*A1i*IBi)\right) \ (kN.m/rad)$$

where IB : celler composed with steel pipe sheet pile

sum of squared distance from centroid to neutral axis of horizontal section of celler (m^2)

	periphery sheet pile IB1 (m^2)	separation wall sheet pile IB2 (m^2)	Kr (kN.m/rad)	
			usual time	in quakes
bridge axis direction	357.98	0.00	6.6800E+007	1.3360E+008
perpendicular direction	1536.40	0.00	2.8669E+008	5.7339E+008

spring constant at bottom of celler(using value)

		usual time	in quakes
vertical spring Kv (kN/m)		6.3444E+006	1.2689E+007
shear spring Ks (kN/m)		1.9033E+006	3.8067E+006
rotational spring Kr (kN.m/rad)	bridge axis direction	6.6800E+007	1.3360E+008
	perpendicular direction	2.8669E+008	5.7339E+008

1.6 allowable bearing capacity

(1)allowable compressive bearing capacity of steel pipe sheet pile

work method : driven construction method

steel pipe sheet pile main body external diameter :Phi.1200.0 (mm)

$$Ra = \frac{1}{n} * Ru$$

$$Ru = qd*A1 + \frac{1}{n1+n2+n3} * \{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

where Ra: allowable compressive bearing capacity of steel pipe sheet pile(kN/pile)

n : factor of safety usual time n = 3

earthquake time n = 2

Ru: ultimate bearing capacity of steel pipe sheet pile in lower ground (kN)

A1: close sectional area of steel pipe sheet pile body (m^2)

A1 = 1.131 (m^2)

qd: ultimate bearing capacity per unit area supporting steel pipe sheet pile tip (kN/m^2)

$$\frac{\text{equivalent embedment depth to bearing strata}}{\text{pile diameter}} = \frac{1.700}{1.2000} = 1.42$$

$qd / \bar{N} = 85$

$\bar{N}$:design N value in steel pipe sheet pile tip ground $\bar{N}$ = 40.0

qd = 85 * 40.0 = 3400 (kN/m^2)

n1 : celler part periphery steel pipe sheet pile number (number) n1 = 34

n2 : number of steel pipe sheet pile in separation wall part (number) n2 = 0

n3 : intermediate driven single pile number (number) n3 = 0

U1 : enveloping celler part periphery length (m) U1 = 53.145 (m)

U2 : enveloping celler part and separation wall part periphery length and sum of perimeter of intermediate driven single pile U2 = 45.605 (m)

Li : thickness which celler skin friction of external periphery is considered (m)

fi : maximum skin friction angle of layer which celler skin friction of external periphery is considered (kN/m^2)

Lj : thickness which celler skin friction of internal periphery is considered (m)

fj : maximum skin friction angle of layer which celler skin friction of internal periphery is considered (kN/m^2)

range of internal soil short side length(Lo) from bottom is only considered

Lo = 6.221 (m)

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m^2) usual time	fi (kN/m^2) in quakes	DEi	Li*fi(DEi) (kN/m) usual time	Li*fi(DEi) (kN/m) in quakes
1	cohesv	1.0	3.254	0.0	0.0	1.000	0.0	0.0
2	cohesv	3.0	3.090	0.0	0.0	0.333	0.0	0.0
3	sandy	3.0	1.060	0.0	0.0	0.333	0.0	0.0
4	sandy	3.0	2.290	0.0	0.0	0.666	0.0	0.0
5	sandy	13.0	8.560	26.0	26.0	1.000	222.6	222.6
6	cohesv	7.0	8.680	70.0	70.0	1.000	607.6	607.6
7	cohesv	18.0	22.570	150.0	150.0	1.000	3385.5	3385.5
8	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			51.210				4386.3	4386.3

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m^2) usual time	fj (kN/m^2) in quakes	DEj	Lj*fj(DEj) (kN/m) usual time	Lj*fj(DEj) (kN/m) in quakes
7	cohesv	18.0	4.515	150.0	150.0	1.000	677.2	677.2
8	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			6.221				847.8	847.8

DE: reduction coefficient in earthquake time

ultimate bearing capacity

$$Ru = qd*A1 + \frac{1}{n1+n2+n3} * \{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

= 3845 + 7993 = 11839 (kN/number) (usual time)

= 3845 + 7993 = 11839 (kN/number) (earthquake time)

allowable compressive bearing capacity

usual time Ra = (1 / 3) * 11839 = 3946 (kN/number)

earthquake Ra = (1 / 2) * 11839 = 5919 (kN/number)

(2)allowable uplifting force of steel pipe sheet pile

$$Pa = \frac{1}{n} * Pu + W$$

$$Pu = \frac{1}{n1+n2+n3} * \left\{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \right\}$$

where, Pa: allowable uplifting force of steel pipe sheet pile(kN/number)
n : factor of safety   usual time   n = 6
earthquake time n = 3
Pu: determined from ground, ultimate uplifting force of steel pipe sheet pile (kN/number)
W : effective weight of steel pipe sheet pile(kN)

effective weight of steel pipe sheet pile W(= w1 + w2 + w3 + w4)

		usual time	earthquake time
steel pipe weight	w1 (kN) =	158.4	158.4
joint weight	w2 (kN) =	0.0	0.0
soil weight inside of pipe	w3 (kN) =	372.7	372.7
filling concrete weight	w4 (kN) =	0.0	0.0
	W (kN) =	531.1	531.1

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m²) usual time	fi (kN/m²) in quakes	DEi	Li*fi(DEi) (kN/m) usual time	Li*fi(DEi) (kN/m) in quakes
1	cohesv	1.0	3.254	0.0	0.0	1.000	0.0	0.0
2	cohesv	3.0	3.090	0.0	0.0	0.333	0.0	0.0
3	sandy	3.0	1.060	0.0	0.0	0.333	0.0	0.0
4	sandy	3.0	2.290	0.0	0.0	0.666	0.0	0.0
5	sandy	13.0	8.560	26.0	26.0	1.000	222.6	222.6
6	cohesv	7.0	8.680	70.0	70.0	1.000	607.6	607.6
7	cohesv	18.0	22.570	150.0	150.0	1.000	3385.5	3385.5
8	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			51.210				4386.3	4386.3

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m²) usual time	fj (kN/m²) in quakes	DEj	Lj*fj(DEj) (kN/m) usual time	Lj*fj(DEj) (kN/m) in quakes
7	cohesv	18.0	4.515	150.0	150.0	1.000	677.2	677.2
8	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			6.221				847.8	847.8

DE: reduction coefficient in earthquake time

ultimate uplifting force
Pu = 7993 (kN/number) (usual time time)
Pu = 7993 (kN/number) (earthquake time)

allowable uplifting force
usual time   Pa - (1 / 6) * 7993 + 531 - 1863 (kN/number)
earthquake   Pa - (1 / 3) * 7993 + 531 - 3196 (kN/number)

allowable compressive bearing capacity / uplifting force of steel pipe sheet pile(using value)(kN/number)

allowable compressive bearing capacity	usual time	3946
	in quakes	5919
allowable uplifting force bearing capacity	usual time	1863
	in quakes	3196

1.7 design force

in steel pipe sheet pile foundation, for coffering double use method, external force which works at the center of crest is considered. yet, vertical load is sum of crest of pile cap load, pile cap weight, filling concrete weight and backfilling soil weight consider

(1) input shape, unit weight and design seismic coefficient

```
pile cap shape     :oval
pile cap dimension :  8.6212 (m)  *  21.6514 (m)
pile cap thickness                          h1    =   4.000 (m)
steel pipe pile body external diameter       Phi.  = 1200.0 (mm)
number of external wallsteel pipe sheet pile n     =  34
filling  concrete cast height                h2    =   8.000 (m)
leg column cross sectional area              Ap    =  44.570 (m²)
                                 shape      :   oval
                                 dimension  : a    =  15.500 (m)      perpendicular direction
                                            : b    =   3.000 (m)      bridge axis direction
unit weight : backfilling soil(wet)         Gam.t  = 17.5  (kN/m³)
              backfilling soil(saturated)  Gam.sat = 17.5  (kN/m³)
              pile cap concrete             Gam.c1 = 24.5  (kN/m³)
             filling concrete               Gam.c2 = 23.0  (kN/m³)
             footing concrete                      = 23.0   (kN/m³)
             paving sand (wet)                     = 19.0   (kN/m³)
                         (saturated)               = 20.0   (kN/m³)
                          water             Gam.w  = 10.00 (kN/m³)
design seismic coefficient  :  pile cap       kh   =  0.30    bridge axis direction
                                  kh   =  0.30    perpendicular direction
             internal soil                    kh   =  0.00    bridge axis direction
                                  kh   =  0.00    perpendicular direction
ground surface in seismic design                   =  0.000 (m) ( depth from crest of  )
```

1)bridge axis direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-1.721	3.180
2	Oridinary(low tide)	-1.721	-2.390
3	Ord+Temp(high tide)	-1.721	3.180

No	load name	backfilling soil height (m)	water table height (m)
4	Ord+Temp(low tide)	-1.721	-2.390
5	Wind+Temp	-1.721	4.990
6	Ord+Collision	-1.721	3.180
7	Earthquake	-1.721	0.290

2)perpendicular direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-1.721	3.180
2	Oridinary(low tide)	-1.721	-2.390
3	Wind	-1.721	4.990
4	Ord+Collision	-1.721	3.180
5	Earthquake	-1.721	0.290

(2) working force at leg column bottom

1)bridge axis direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Oridinary(high tide)	40500.0	0.0	0.0
2	Oridinary(low tide)	40500.0	0.0	0.0
3	Ord+Temp(high tide)	40500.0	200.0	3200.0
4	Ord+Temp(low tide)	40500.0	200.0	3200.0
5	Wind+Temp	40500.0	400.0	5900.0
6	Ord+Collision	40500.0	3200.0	23800.0
7	Earthquake	36000.0	10800.0	123800.0

2)perpendicular direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Oridinary(high tide)	40500.0	0.0	6800.0
2	Oridinary(low tide)	40500.0	0.0	6800.0
3	Wind	40500.0	800.0	20900.0
4	Ord+Collision	40500.0	6400.0	54300.0
5	Earthquake	36000.0	10800.0	146700.0

(3) pile cap area

oval

$$A1 = \frac{Pai}{4}*(B-D)^2 + (B-D)*(L-B) - \frac{Pai}{4}*D^2*\frac{n}{2} = 120.728\ (m^2)$$

filling concrete area

$$A2 = \frac{Pai}{4}*D^2*n = 38.453\ (m^2)$$

backfilling soil area

$A3 = A1 + A2 - Ap = 114.611\ (m^2)$

1)bridge axis direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	OD(HT)	6.630	1.729	7002.2	3999.1	1486.2	2955.0	9532.6
2	OD(LT)	1.060	1.729	7002.2	3999.1	2253.0	472.4	12781.9
3	OD-TM(HT)	6.630	1.729	7002.2	3999.1	1486.2	2955.0	9532.6
4	OD-TM(LT)	1.060	1.729	7002.2	3999.1	2253.0	472.4	12781.9
5	WN-TM	8.440	1.729	7002.2	3999.1	1486.2	3761.7	8725.8
6	OD-CL	6.630	1.729	7002.2	3999.1	1486.2	2955.0	9532.6
7	ETQ	3.740	1.729	7002.2	3999.1	1486.2	1666.9	10820.6

2)perpendicular direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	OD(HT)	6.630	1.729	7002.2	3999.1	1486.2	2955.0	9532.6
2	OD(LT)	1.060	1.729	7002.2	3999.1	2253.0	472.4	12781.9
3	WN	8.440	1.729	7002.2	3999.1	1486.2	3761.7	8725.8
4	OD-CL	6.630	1.729	7002.2	3999.1	1486.2	2955.0	9532.6
5	ETQ	3.740	1.729	7002.2	3999.1	1486.2	1666.9	10820.6

hw: water table(m), height upward from crest of pile cap
V1: weight of pile cap
V2: weight of filling concrete
V3: backfilling soil weight
Vp: buoyancy works at column
V1 = A1*{ h11*Gam.c1 + h21*(Gam.c1 - Gam.w) }
V2 = A2*{ h12*Gam.c2 + h22*(Gam.c2 - Gam.w) }
V3 = A3*{ h13*Gam.t + h23*(Gam.sat - Gam.w) }
h1i: thickness upper than water table(m)
h2i: thickness lower than water table(m)
Vp = Ap*hw*Gam.w
ƒ°V= V1 {V2 {V3 |Vp

(4) design external force sum up

1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	50032.6	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	53281.9	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	50032.6	200.0	3200.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	53281.9	200.0	3200.0	1.15	usual time	usual time
5	Wind+Temp	49225.8	400.0	5900.0	1.35	usual time	usual time
6	Ord+Collision	50032.6	3200.0	23800.0	1.50	usual time	usual time
7	Earthquake	46820.6	10800.0	123800.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	50032.6	0.0	6800.0	1.00	usual time	usual time
2	Oridinary(low tide)	53281.9	0.0	6800.0	1.00	usual time	usual time
3	Wind	49225.8	800.0	20900.0	1.25	usual time	usual time
4	Ord+Collision	50032.6	6400.0	54300.0	1.50	usual time	usual time
5	Earthquake	46820.6	10800.0	146700.0	1.50	earthquake time	earthquake time

1.8 design external force(using value)

1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	50032.6	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	53281.9	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	50032.6	200.0	3200.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	53281.9	200.0	3200.0	1.15	usual time	usual time
5	Wind+Temp	49225.8	400.0	5900.0	1.35	usual time	usual time
6	Ord+Collision	50032.6	3200.0	23800.0	1.50	usual time	usual time
7	Earthquake	46820.6	10800.0	123800.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	50032.6	0.0	6800.0	1.00	usual time	usual time
2	Oridinary(low tide)	53281.9	0.0	6800.0	1.00	usual time	usual time
3	Wind	49225.8	800.0	20900.0	1.25	usual time	usual time
4	Ord+Collision	50032.6	6400.0	54300.0	1.50	usual time	usual time
5	Earthquake	46820.6	10800.0	146700.0	1.50	earthquake time	earthquake time

1.9 calculation result table

1)bridge axis direction

item			unit	OD(HT)	OD(LT)	OD-TM(HT)
working force		Vo	kN	50032.6	53281.9	50032.6
		Ho	kN	0.0	0.0	200.0
		Mo	kN.m	0.0	0.0	3200.0
foundation crest	displacement	Del.1	cm	0.000	0.000	0.045
	deflexion angle	Theta.1	mrad	0.000	0.000	-0.036
design ground surface	displacement	Del.2	cm	0.000	0.000	0.045
	deflexion angle	Theta.2	mrad	0.000	0.000	-0.036
celler part maximum bending moment		Mmax	kN.m	0.0	0.0	-4127.0
Mmax accrue location		Lm	m	-3.450	-3.450	-13.450
stress	periphery sheet pile(SKY400)	Sigmax	N/mm^2	32.97	35.11	34.25
		Lm	m	-14.160	-14.160	-14.160
	periphery sheet pile(SKY490)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY490)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm^2	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm^2	--------	--------	--------
celler partbottom bending moment		MB	kN.m	0.0	0.0	69.0
vertical reaction	maximum	Rmax	kN/num	1472	1567	1472
	minimum	Rmin	kN/num	1472	1567	1471
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3946	3946	3946
	uplifting force	Pa	kN/num	-1863	-1863	-1863
	stress(SKY400)	Sig.a	N/mm^2	140.00	140.00	161.00
	stress(SKY490)	Sig.a	N/mm^2	--------	--------	--------

note)Lm is elevation

item			unit	OD-TM(LT)	WN-TM	OD-CL
working force		Vo	kN	53281.9	49225.8	50032.6
		Ho	kN	200.0	400.0	3200.0
		Mo	kN.m	3200.0	5900.0	23800.0
foundation crest	displacement	Del.1	cm	0.045	0.087	0.530
	deflexion angle	Theta.1	mrad	-0.036	-0.068	-0.384
design ground surface	displacement	Del.2	cm	0.045	0.087	0.530
	deflexion angle	Theta.2	mrad	-0.036	-0.068	-0.384
celler part maximum bending moment		Mmax	kN.m	-4127.0	-7831.0	-43238.0
Mmax accrue location		Lm	m	-13.450	-13.450	-14.450
stress	periphery sheet pile(SKY400)	Sigmax	N/mm^2	36.40	34.88	46.50
		Lm	m	-14.160	-14.160	-14.450
	periphery sheet pile(SKY490)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY490)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm^2	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm^2	--------	--------	--------
celler partbottom bending moment		MB	kN.m	69.0	132.0	777.0
vertical reaction	maximum	Rmax	kN/num	1568	1449	1480
	minimum	Rmin	kN/num	1566	1446	1463
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3946	3946	3946
	uplifting force	Pa	kN/num	-1863	-1863	-1863
	stress(SKY400)	Sig.a	N/mm^2	161.00	189.00	210.00
	stress(SKY490)	Sig.a	N/mm^2	--------	--------	--------

note)Lm is elevation

item			unit	ETQ
working force		Vo	kN	46820.6
		Ho	kN	10800.0
		Mo	kN.m	123800.0
foundation crest	displacement	Del.1	cm	2.059
	deflexion angle	Theta.1	mrad	-1.591
design ground surface	displacement	Del.2	cm	2.059
	deflexion angle	Theta.2	mrad	-1.591
celler part maximum bending moment		Mmax	kN.m	-188293.0
Mmax accrue location		Lm	m	-14.450
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	89.76
		Lm	m	-14.450
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------
		Lm	m	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	--------
		Lm	m	--------
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------
		Lm	m	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------
celler partbottom bending moment		MB	kN.m	4125.0
vertical reaction	maximum	Rmax	kN/num	1420
	minimum	Rmin	kN/num	1334
allowable value	displacement	Del.a	cm	5.000
	compressive bearing capacity	Ra	kN/num	5919
	uplifting force	Pa	kN/num	-3196
	stress(SKY400)	Sig.a	N/mm²	210.00
	stress(SKY490)	Sig.a	N/mm²	--------

note)Lm is elevation

2)perpendicular direction

item			unit	OD(HT)	OD(LT)	WN
working force		Vo	kN	50032.6	53281.9	49225.8
		Ho	kN	0.0	0.0	800.0
		Mo	kN.m	6800.0	6800.0	20900.0
foundation crest	displacement	Del.1	cm	0.029	0.029	0.178
	deflexion angle	Theta.1	mrad	-0.018	-0.018	-0.090
design ground surface	displacement	Del.2	cm	0.029	0.029	0.178
	deflexion angle	Theta.2	mrad	-0.018	-0.018	-0.090
celler part maximum bending moment		Mmax	kN.m	-6800.0	-6800.0	-27049.0
Mmax accrue location		Lm	m	-3.450	-3.450	-16.450
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	34.46	36.60	38.74
		Lm	m	-14.160	-14.160	-16.450
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------	--------
celler partbottom bending moment		MB	kN.m	-43.0	-43.0	-1475.0
vertical reaction	maximum	Rmax	kN/num	1472	1567	1458
	minimum	Rmin	kN/num	1471	1567	1438
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3946	3946	3946
	uplifting force	Pa	kN/num	-1863	-1863	-1863
	stress(SKY400)	Sig.a	N/mm²	140.00	140.00	175.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------	--------

note)Lm is elevation

item			unit	OD-CL	ETQ
working force		Vo	kN	50032.6	46820.6
		Ho	kN	6400.0	10800.0
		Mo	kN.m	54300.0	146700.0
foundation crest	displacement	Del.1	cm	0.941	1.522
	deflexion angle	Theta.1	mrad	-0.417	-0.772
design ground surface	displacement	Del.2	cm	0.941	1.522
	deflexion angle	Theta.2	mrad	-0.417	-0.772
celler part maximum bending moment		Mmax	kN.m	-117601.0	-250147.0
Mmax accrue location		Lm	m	-20.450	-18.450
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	60.38	89.16
		Lm	m	-20.450	-18.450
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------
		Lm	m	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	--------	--------
		Lm	m	--------	--------
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------
		Lm	m	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------
celler partbottom bending moment		MB	kN.m	-11089.0	-7648.0
vertical reaction	maximum	Rmax	kN/num	1545	1428
	minimum	Rmin	kN/num	1398	1326
allowable value	displacement	Del.a	cm	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3946	5919
	uplifting force	Pa	kN/num	-1863	-3196
	stress(SKY400)	Sig.a	N/mm²	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------

note)Lm is elevation

1.10 detail output

(1)bridge axis direction

1)Oridinary(high tide)

working force	vertical force	Vo	kN	50032.6
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	0.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.000

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	946	2115
2	2102	4700
3	1261	2820
4	1261	2820
5	5465	12220
6	5150	11516
7	13243	29612
8	36786	82256

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-3.450	0.000	0.000	0.0	0.0	28.31	0.00	*
-4.450	0.000	0.000	0.0	0.0	28.31	0.00	
-5.450	0.000	0.000	0.0	0.0	28.31	0.00	
-6.450	0.000	0.000	0.0	0.0	28.31	0.00	
-6.704	0.000	0.000	0.0	0.0	28.31	0.00	
-7.450	0.000	0.000	0.0	0.0	28.31	0.00	
-8.450	0.000	0.000	0.0	0.0	28.31	0.00	
-9.450	0.000	0.000	0.0	0.0	28.31	0.00	
-9.794	0.000	0.000	0.0	0.0	28.31	0.00	
-9.950	0.000	0.000	0.0	0.0	28.31	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-10.450	0.000	0.000	0.0	0.0	28.31	0.00	
-10.854	0.000	0.000	0.0	0.0	28.31	0.00	
-11.450	0.000	0.000	0.0	0.0	28.31	0.00	
-12.450	0.000	0.000	0.0	0.0	28.31	0.00	
-13.144	0.000	0.000	0.0	0.0	28.31	0.00	
-13.450	0.000	0.000	0.0	0.0	28.31	0.00	
-14.160	0.000	0.000	0.0	0.0	28.31	0.00	
-14.160	0.000	0.000	0.0	0.0	32.97	0.00	
-14.450	0.000	0.000	0.0	0.0	32.97	0.00	
-15.450	0.000	0.000	0.0	0.0	32.97	0.00	
-16.450	0.000	0.000	0.0	0.0	32.97	0.00	
-17.450	0.000	0.000	0.0	0.0	32.97	0.00	
-18.450	0.000	0.000	0.0	0.0	32.97	0.00	
-19.450	0.000	0.000	0.0	0.0	32.97	0.00	
-20.450	0.000	0.000	0.0	0.0	32.97	0.00	
-21.450	0.000	0.000	0.0	0.0	32.97	0.00	
-21.704	0.000	0.000	0.0	0.0	32.97	0.00	
-22.450	0.000	0.000	0.0	0.0	32.97	0.00	
-23.450	0.000	0.000	0.0	0.0	32.97	0.00	
-24.450	0.000	0.000	0.0	0.0	32.97	0.00	
-25.450	0.000	0.000	0.0	0.0	32.97	0.00	
-26.450	0.000	0.000	0.0	0.0	32.97	0.00	
-27.450	0.000	0.000	0.0	0.0	32.97	0.00	
-28.450	0.000	0.000	0.0	0.0	32.97	0.00	
-29.450	0.000	0.000	0.0	0.0	32.97	0.00	
-30.384	0.000	0.000	0.0	0.0	32.97	0.00	
-30.450	0.000	0.000	0.0	0.0	32.97	0.00	
-31.450	0.000	0.000	0.0	0.0	32.97	0.00	
-32.450	0.000	0.000	0.0	0.0	32.97	0.00	
-33.450	0.000	0.000	0.0	0.0	32.97	0.00	
-34.450	0.000	0.000	0.0	0.0	32.97	0.00	
-35.450	0.000	0.000	0.0	0.0	32.97	0.00	
-36.450	0.000	0.000	0.0	0.0	32.97	0.00	
-37.450	0.000	0.000	0.0	0.0	32.97	0.00	
-38.450	0.000	0.000	0.0	0.0	32.97	0.00	
-39.450	0.000	0.000	0.0	0.0	32.97	0.00	
-40.450	0.000	0.000	0.0	0.0	32.97	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-41.450	0.000	0.000	0.0	0.0	32.97	0.00	
-42.450	0.000	0.000	0.0	0.0	32.97	0.00	
-43.450	0.000	0.000	0.0	0.0	32.97	0.00	
-44.450	0.000	0.000	0.0	0.0	32.97	0.00	
-45.450	0.000	0.000	0.0	0.0	32.97	0.00	
-46.450	0.000	0.000	0.0	0.0	32.97	0.00	
-47.450	0.000	0.000	0.0	0.0	32.97	0.00	
-48.450	0.000	0.000	0.0	0.0	32.97	0.00	
-49.450	0.000	0.000	0.0	0.0	32.97	0.00	
-50.450	0.000	0.000	0.0	0.0	32.97	0.00	
-51.450	0.000	0.000	0.0	0.0	32.97	0.00	
-52.450	0.000	0.000	0.0	0.0	32.97	0.00	
-52.954	0.000	0.000	0.0	0.0	32.97	0.00	
-53.450	0.000	0.000	0.0	0.0	32.97	0.00	
-54.450	0.000	0.000	0.0	0.0	32.97	0.00	
-54.660	0.000	0.000	0.0	0.0	32.97	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	32.97	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 0.0 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)
periphery n1 = 34 (number) IB1 = 357.98 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.711
maximum Rmax = 1472 (kN/number)
minimum Rmin = 1472 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	53281.9
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	0.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.000

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	946	2115
2	2102	4700
3	1261	2820
4	1261	2820
5	5465	12220
6	5150	11516
7	13243	29612
8	36786	82256

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.000	0.000	0.0	0.0	30.14	0.00	*
-4.450	0.000	0.000	0.0	0.0	30.14	0.00	
-5.450	0.000	0.000	0.0	0.0	30.14	0.00	
-6.450	0.000	0.000	0.0	0.0	30.14	0.00	
-6.704	0.000	0.000	0.0	0.0	30.14	0.00	
-7.450	0.000	0.000	0.0	0.0	30.14	0.00	
-8.450	0.000	0.000	0.0	0.0	30.14	0.00	
-9.450	0.000	0.000	0.0	0.0	30.14	0.00	
-9.794	0.000	0.000	0.0	0.0	30.14	0.00	
-9.950	0.000	0.000	0.0	0.0	30.14	0.00	
-10.450	0.000	0.000	0.0	0.0	30.14	0.00	
-10.854	0.000	0.000	0.0	0.0	30.14	0.00	
-11.450	0.000	0.000	0.0	0.0	30.14	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.000	0.000	0.0	0.0	30.14	0.00	
-13.144	0.000	0.000	0.0	0.0	30.14	0.00	
-13.450	0.000	0.000	0.0	0.0	30.14	0.00	
-14.160	0.000	0.000	0.0	0.0	30.14	0.00	
-14.160	0.000	0.000	0.0	0.0	35.11	0.00	
-14.450	0.000	0.000	0.0	0.0	35.11	0.00	
-15.450	0.000	0.000	0.0	0.0	35.11	0.00	
-16.450	0.000	0.000	0.0	0.0	35.11	0.00	
-17.450	0.000	0.000	0.0	0.0	35.11	0.00	
-18.450	0.000	0.000	0.0	0.0	35.11	0.00	
-19.450	0.000	0.000	0.0	0.0	35.11	0.00	
-20.450	0.000	0.000	0.0	0.0	35.11	0.00	
-21.450	0.000	0.000	0.0	0.0	35.11	0.00	
-21.704	0.000	0.000	0.0	0.0	35.11	0.00	
-22.450	0.000	0.000	0.0	0.0	35.11	0.00	
-23.450	0.000	0.000	0.0	0.0	35.11	0.00	
-24.450	0.000	0.000	0.0	0.0	35.11	0.00	
-25.450	0.000	0.000	0.0	0.0	35.11	0.00	
-26.450	0.000	0.000	0.0	0.0	35.11	0.00	
-27.450	0.000	0.000	0.0	0.0	35.11	0.00	
-28.450	0.000	0.000	0.0	0.0	35.11	0.00	
-29.450	0.000	0.000	0.0	0.0	35.11	0.00	
-30.384	0.000	0.000	0.0	0.0	35.11	0.00	
-30.450	0.000	0.000	0.0	0.0	35.11	0.00	
-31.450	0.000	0.000	0.0	0.0	35.11	0.00	
-32.450	0.000	0.000	0.0	0.0	35.11	0.00	
-33.450	0.000	0.000	0.0	0.0	35.11	0.00	
-34.450	0.000	0.000	0.0	0.0	35.11	0.00	
-35.450	0.000	0.000	0.0	0.0	35.11	0.00	
-36.450	0.000	0.000	0.0	0.0	35.11	0.00	
-37.450	0.000	0.000	0.0	0.0	35.11	0.00	
-38.450	0.000	0.000	0.0	0.0	35.11	0.00	
-39.450	0.000	0.000	0.0	0.0	35.11	0.00	
-40.450	0.000	0.000	0.0	0.0	35.11	0.00	
-41.450	0.000	0.000	0.0	0.0	35.11	0.00	
-42.450	0.000	0.000	0.0	0.0	35.11	0.00	
-43.450	0.000	0.000	0.0	0.0	35.11	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	0.000	0.000	0.0	0.0	35.11	0.00	
-45.450	0.000	0.000	0.0	0.0	35.11	0.00	
-46.450	0.000	0.000	0.0	0.0	35.11	0.00	
-47.450	0.000	0.000	0.0	0.0	35.11	0.00	
-48.450	0.000	0.000	0.0	0.0	35.11	0.00	
-49.450	0.000	0.000	0.0	0.0	35.11	0.00	
-50.450	0.000	0.000	0.0	0.0	35.11	0.00	
-51.450	0.000	0.000	0.0	0.0	35.11	0.00	
-52.450	0.000	0.000	0.0	0.0	35.11	0.00	
-52.954	0.000	0.000	0.0	0.0	35.11	0.00	
-53.450	0.000	0.000	0.0	0.0	35.11	0.00	
-54.450	0.000	0.000	0.0	0.0	35.11	0.00	
-54.660	0.000	0.000	0.0	0.0	35.11	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	35.11	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 0.0 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)

periphery n1 = 34 (number) IB1 = 357.98 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.711

maximum Rmax = 1567 (kN/number)
minimum Rmin = 1567 (kN/number)

3)Ord+Temp(high tide)

working force	vertical force	Vo	kN	50032.6
	horizontal force	Ho	kN	200.0
	moment	Mo	kN.m	3200.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.045

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	946	2115
2	2102	4700
3	1261	2820
4	1261	2820
5	5465	12220
6	5150	11516
7	13243	29612
8	36786	82256

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-3.450	0.045	-0.036	-200.0	-3200.0	29.17	0.00	
-4.450	0.041	-0.035	-180.2	-3390.0	29.22	0.00	
-5.450	0.038	-0.033	-162.0	-3560.9	29.26	0.00	
-6.450	0.035	-0.032	-145.3	-3714.5	29.30	0.00	
-6.704	0.034	-0.032	-141.3	-3750.9	29.31	0.00	
-7.450	0.032	-0.031	-116.4	-3846.9	29.34	0.00	
-8.450	0.029	-0.029	-85.7	-3947.7	29.37	0.00	
-9.450	0.026	-0.028	-58.0	-4019.3	29.39	0.00	
-9.794	0.025	-0.027	-49.1	-4037.7	29.39	0.00	
-9.950	0.024	-0.027	-46.8	-4045.1	29.39	0.00	
-10.450	0.023	-0.027	-39.5	-4066.7	29.40	0.00	
-10.854	0.022	-0.026	-34.0	-4081.5	29.40	0.00	
-11.450	0.020	-0.025	-26.2	-4099.4	29.41	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.018	-0.024	-14.5	-4119.7	29.41	0.00	
-13.144	0.016	-0.023	-7.2	-4127.1	29.42	0.00	
-13.450	0.016	-0.022	5.9	-4127.3	29.42	0.00	*
-14.160	0.014	-0.021	34.0	-4113.0	29.41	0.00	
-14.160	0.014	-0.021	34.0	-4113.0	34.25	0.00	
-14.450	0.014	-0.021	44.7	-4101.5	34.25	0.00	
-15.450	0.012	-0.019	78.1	-4039.7	34.23	0.00	
-16.450	0.010	-0.017	106.4	-3947.0	34.20	0.00	
-17.450	0.008	-0.016	130.1	-3828.4	34.17	0.00	
-18.450	0.007	-0.014	149.7	-3688.1	34.12	0.00	
-19.450	0.005	-0.013	165.4	-3530.3	34.07	0.00	
-20.450	0.004	-0.011	177.8	-3358.4	34.02	0.00	
-21.450	0.003	-0.010	187.2	-3175.7	33.96	0.00	
-21.704	0.003	-0.010	189.1	-3127.9	33.95	0.00	
-22.450	0.002	-0.009	193.6	-2985.1	33.90	0.00	
-23.450	0.001	-0.008	197.7	-2789.3	33.84	0.00	
-24.450	0.001	-0.007	199.8	-2590.4	33.78	0.00	
-25.450	0.000	-0.006	200.4	-2390.1	33.72	0.00	
-26.450	-0.001	-0.005	199.6	-2190.0	33.65	0.00	
-27.450	-0.001	-0.004	197.6	-1991.4	33.59	0.00	
-28.450	-0.001	-0.003	194.7	-1795.1	33.53	0.00	
-29.450	-0.002	-0.002	191.1	-1602.2	33.47	0.00	
-30.384	-0.002	-0.002	187.2	-1425.5	33.41	0.00	
-30.450	-0.002	-0.002	186.4	-1413.2	33.41	0.00	
-31.450	-0.002	-0.001	174.5	-1232.6	33.35	0.00	
-32.450	-0.002	-0.001	162.0	-1064.3	33.30	0.00	
-33.450	-0.002	0.000	148.9	-908.9	33.25	0.00	
-34.450	-0.002	0.000	135.8	-766.5	33.21	0.00	
-35.450	-0.002	0.000	122.7	-637.3	33.17	0.00	
-36.450	-0.002	0.001	109.8	-521.1	33.13	0.00	
-37.450	-0.002	0.001	97.3	-417.5	33.10	0.00	
-38.450	-0.002	0.001	85.4	-326.2	33.07	0.00	
-39.450	-0.002	0.001	74.1	-246.5	33.05	0.00	
-40.450	-0.002	0.001	63.4	-177.8	33.02	0.00	
-41.450	-0.001	0.001	53.5	-119.4	33.01	0.00	
-42.450	-0.001	0.001	44.4	-70.5	32.99	0.00	
-43.450	-0.001	0.001	36.2	-30.2	32.98	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.001	0.001	28.7	2.1	32.97	0.00	
-45.450	-0.001	0.001	22.0	27.4	32.98	0.00	
-46.450	-0.001	0.001	16.2	46.5	32.98	0.00	
-47.450	-0.001	0.001	11.2	60.1	32.99	0.00	
-48.450	-0.001	0.001	7.0	69.2	32.99	0.00	
-49.450	0.000	0.001	3.6	74.4	32.99	0.00	
-50.450	0.000	0.001	0.9	76.6	32.99	0.00	
-51.450	0.000	0.001	-1.0	76.5	32.99	0.00	
-52.450	0.000	0.001	-2.2	74.9	32.99	0.00	
-52.954	0.000	0.001	-2.5	73.7	32.99	0.00	
-53.450	0.000	0.001	-2.9	72.3	32.99	0.00	
-54.450	0.000	0.001	-2.4	69.5	32.99	0.00	
-54.660	0.000	0.001	-2.0	69.1	32.99	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.045	-0.036	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.25	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 69.1 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)
periphery n1 = 34 (number) IB1 = 357.98 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.711
maximum Rmax = 1472 (kN/number)
minimum Rmin = 1471 (kN/number)

4)Ord+Temp(low tide)

working force	vertical force	Vo	kN	53281.9
	horizontal force	Ho	kN	200.0
	moment	Mo	kN.m	3200.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.045

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	946	2115
2	2102	4700
3	1261	2820
4	1261	2820
5	5465	12220
6	5150	11516
7	13243	29612
8	36786	82256

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.045	-0.036	-200.0	-3200.0	31.00	0.00	
-4.450	0.041	-0.035	-180.2	-3390.0	31.06	0.00	
-5.450	0.038	-0.033	-162.0	-3560.9	31.10	0.00	
-6.450	0.035	-0.032	-145.3	-3714.5	31.14	0.00	
-6.704	0.034	-0.032	-141.3	-3750.9	31.15	0.00	
-7.450	0.032	-0.031	-116.4	-3846.9	31.18	0.00	
-8.450	0.029	-0.029	-85.7	-3947.7	31.21	0.00	
-9.450	0.026	-0.028	-58.0	-4019.3	31.23	0.00	
-9.794	0.025	-0.027	-49.1	-4037.7	31.23	0.00	
-9.950	0.024	-0.027	-46.8	-4045.1	31.23	0.00	
-10.450	0.023	-0.027	-39.5	-4066.7	31.24	0.00	
-10.854	0.022	-0.026	-34.0	-4081.5	31.24	0.00	
-11.450	0.020	-0.025	-26.2	-4099.4	31.25	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.018	-0.024	-14.5	-4119.7	31.25	0.00	
-13.144	0.016	-0.023	-7.2	-4127.1	31.25	0.00	
-13.450	0.016	-0.022	5.9	-4127.3	31.25	0.00	*
-14.160	0.014	-0.021	34.0	-4113.0	31.25	0.00	
-14.160	0.014	-0.021	34.0	-4113.0	36.40	0.00	
-14.450	0.014	-0.021	44.7	-4101.5	36.39	0.00	
-15.450	0.012	-0.019	78.1	-4039.7	36.37	0.00	
-16.450	0.010	-0.017	106.4	-3947.0	36.34	0.00	
-17.450	0.008	-0.016	130.1	-3828.4	36.31	0.00	
-18.450	0.007	-0.014	149.7	-3688.1	36.26	0.00	
-19.450	0.005	-0.013	165.4	-3530.3	36.21	0.00	
-20.450	0.004	-0.011	177.8	-3358.4	36.16	0.00	
-21.450	0.003	-0.010	187.2	-3175.7	36.10	0.00	
-21.704	0.003	-0.010	189.1	-3127.9	36.09	0.00	
-22.450	0.002	-0.009	193.6	-2985.1	36.04	0.00	
-23.450	0.001	-0.008	197.7	-2789.3	35.98	0.00	
-24.450	0.001	-0.007	199.8	-2590.4	35.92	0.00	
-25.450	0.000	-0.006	200.4	-2390.1	35.86	0.00	
-26.450	-0.001	-0.005	199.6	-2190.0	35.79	0.00	
-27.450	-0.001	-0.004	197.6	-1991.4	35.73	0.00	
-28.450	-0.001	-0.003	194.7	-1795.1	35.67	0.00	
-29.450	-0.002	-0.002	191.1	-1602.2	35.61	0.00	
-30.384	-0.002	-0.002	187.2	-1425.5	35.55	0.00	
-30.450	-0.002	-0.002	186.4	-1413.2	35.55	0.00	
-31.450	-0.002	-0.001	174.5	-1232.6	35.49	0.00	
-32.450	-0.002	-0.001	162.0	-1064.3	35.44	0.00	
-33.450	-0.002	0.000	148.9	-908.9	35.39	0.00	
-34.450	-0.002	0.000	135.8	-766.5	35.35	0.00	
-35.450	-0.002	0.000	122.7	-637.3	35.31	0.00	
-36.450	-0.002	0.001	109.8	-521.1	35.27	0.00	
-37.450	-0.002	0.001	97.3	-417.5	35.24	0.00	
-38.450	-0.002	0.001	85.4	-326.2	35.21	0.00	
-39.450	-0.002	0.001	74.1	-246.5	35.19	0.00	
-40.450	-0.002	0.001	63.4	-177.8	35.16	0.00	
-41.450	-0.001	0.001	53.5	-119.4	35.15	0.00	
-42.450	-0.001	0.001	44.4	-70.5	35.13	0.00	
-43.450	-0.001	0.001	36.2	-30.2	35.12	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.001	0.001	28.7	2.1	35.11	0.00	
-45.450	-0.001	0.001	22.0	27.4	35.12	0.00	
-46.450	-0.001	0.001	16.2	46.5	35.12	0.00	
-47.450	-0.001	0.001	11.2	60.1	35.13	0.00	
-48.450	-0.001	0.001	7.0	69.2	35.13	0.00	
-49.450	0.000	0.001	3.6	74.4	35.13	0.00	
-50.450	0.000	0.001	0.9	76.6	35.13	0.00	
-51.450	0.000	0.001	-1.0	76.5	35.13	0.00	
-52.450	0.000	0.001	-2.2	74.9	35.13	0.00	
-52.954	0.000	0.001	-2.5	73.7	35.13	0.00	
-53.450	0.000	0.001	-2.9	72.3	35.13	0.00	
-54.450	0.000	0.001	-2.4	69.5	35.13	0.00	
-54.660	0.000	0.001	-2.0	69.1	35.13	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.045	-0.036	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	36.40	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 69.1 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)

periphery	n1 = 34 (number)	IB1 =	357.98 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 3.711
maximum Rmax = 1568 (kN/number)
minimum Rmin = 1566 (kN/number)

5)Wind+Temp

working force	vertical force	Vo	kN	49225.8
	horizontal force	Ho	kN	400.0
	moment	Mo	kN.m	5900.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.087

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	946	2115
2	2102	4700
3	1261	2820
4	1261	2820
5	5465	12220
6	5150	11516
7	13243	29612
8	36786	82256

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.087	-0.068	-400.0	-5900.0	29.44	0.00	
-4.450	0.080	-0.066	-361.9	-6280.7	29.54	0.00	
-5.450	0.073	-0.064	-326.9	-6624.8	29.63	0.00	
-6.450	0.067	-0.061	-294.7	-6935.4	29.71	0.00	
-6.704	0.066	-0.061	-287.0	-7009.2	29.73	0.00	
-7.450	0.061	-0.059	-238.9	-7205.2	29.79	0.00	
-8.450	0.055	-0.056	-179.6	-7414.0	29.84	0.00	
-9.450	0.050	-0.054	-126.1	-7566.4	29.88	0.00	
-9.794	0.048	-0.053	-109.0	-7606.8	29.89	0.00	
-9.950	0.047	-0.052	-104.4	-7623.4	29.90	0.00	
-10.450	0.045	-0.051	-90.4	-7672.1	29.91	0.00	
-10.854	0.043	-0.050	-79.6	-7706.4	29.92	0.00	
-11.450	0.040	-0.048	-64.6	-7749.4	29.93	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.035	-0.045	-41.8	-7802.4	29.95	0.00	
-13.144	0.032	-0.044	-27.6	-7826.4	29.95	0.00	
-13.450	0.031	-0.043	-2.3	-7830.9	29.96	0.00	*
-14.160	0.028	-0.041	52.5	-7812.8	29.95	0.00	
-14.160	0.028	-0.041	52.5	-7812.8	34.88	0.00	
-14.450	0.027	-0.040	73.3	-7794.6	34.87	0.00	
-15.450	0.023	-0.037	138.3	-7687.9	34.84	0.00	
-16.450	0.019	-0.034	193.6	-7521.2	34.79	0.00	
-17.450	0.016	-0.031	240.1	-7303.6	34.72	0.00	
-18.450	0.013	-0.028	278.5	-7043.7	34.64	0.00	
-19.450	0.010	-0.025	309.6	-6749.1	34.55	0.00	
-20.450	0.008	-0.022	334.1	-6426.7	34.45	0.00	
-21.450	0.006	-0.020	352.8	-6082.8	34.34	0.00	
-21.704	0.006	-0.019	356.7	-5992.7	34.31	0.00	
-22.450	0.004	-0.017	365.8	-5723.1	34.23	0.00	
-23.450	0.003	-0.015	374.3	-5352.7	34.11	0.00	
-24.450	0.001	-0.013	379.0	-4975.7	33.99	0.00	
-25.450	0.000	-0.011	380.6	-4595.7	33.87	0.00	
-26.450	-0.001	-0.009	379.6	-4215.4	33.76	0.00	
-27.450	-0.002	-0.007	376.2	-3837.3	33.64	0.00	
-28.450	-0.002	-0.006	371.0	-3463.5	33.52	0.00	
-29.450	-0.003	-0.005	364.4	-3095.7	33.40	0.00	
-30.384	-0.003	-0.003	357.2	-2758.6	33.30	0.00	
-30.450	-0.003	-0.003	355.8	-2735.1	33.29	0.00	
-31.450	-0.004	-0.002	333.7	-2390.2	33.18	0.00	
-32.450	-0.004	-0.001	310.1	-2068.2	33.08	0.00	
-33.450	-0.004	-0.001	285.7	-1770.2	32.99	0.00	
-34.450	-0.004	0.000	260.9	-1496.9	32.90	0.00	
-35.450	-0.004	0.001	236.1	-1248.5	32.83	0.00	
-36.450	-0.004	0.001	211.7	-1024.7	32.76	0.00	
-37.450	-0.004	0.001	188.0	-824.9	32.69	0.00	
-38.450	-0.003	0.002	165.3	-648.4	32.64	0.00	
-39.450	-0.003	0.002	143.6	-494.0	32.59	0.00	
-40.450	-0.003	0.002	123.3	-360.7	32.55	0.00	
-41.450	-0.003	0.002	104.4	-246.9	32.51	0.00	
-42.450	-0.003	0.002	87.0	-151.4	32.48	0.00	
-43.450	-0.002	0.002	71.0	-72.5	32.46	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.002	0.002	56.7	-8.8	32.44	0.00	
-45.450	-0.002	0.002	43.9	41.4	32.45	0.00	
-46.450	-0.002	0.002	32.7	79.5	32.46	0.00	
-47.450	-0.001	0.002	23.0	107.2	32.47	0.00	
-48.450	-0.001	0.002	14.8	126.0	32.48	0.00	
-49.450	-0.001	0.002	8.2	137.4	32.48	0.00	
-50.450	-0.001	0.002	3.0	142.9	32.48	0.00	
-51.450	0.000	0.002	-0.8	143.8	32.48	0.00	
-52.450	0.000	0.002	-3.2	141.7	32.48	0.00	
-52.954	0.000	0.002	-3.9	139.9	32.48	0.00	
-53.450	0.000	0.002	-4.9	137.7	32.48	0.00	
-54.450	0.000	0.002	-4.1	133.0	32.48	0.00	
-54.660	0.000	0.002	-3.5	132.2	32.48	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.087	-0.068	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.88	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 132.2 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)

periphery	n1 = 34 (number)	IB1 = 357.98 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 3.711
maximum Rmax = 1449 (kN/number)
minimum Rmin = 1446 (kN/number)

6)Ord+Collision

working force	vertical force	Vo	kN	50032.6
	horizontal force	Ho	kN	3200.0
	moment	Mo	kN.m	23800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.530

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	946	2115
2	2102	4700
3	1261	2820
4	1261	2820
5	5465	12220
6	5150	11516
7	13243	29612
8	36786	82256

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.530	-0.384	-3200.0	-23800.0	34.71	0.00	
-4.450	0.493	-0.375	-2965.8	-26881.4	35.53	0.00	
-5.450	0.456	-0.365	-2748.7	-29737.3	36.30	0.00	
-6.450	0.420	-0.354	-2548.3	-32384.4	37.01	0.00	
-6.704	0.411	-0.351	-2500.1	-33025.5	37.19	0.00	
-7.450	0.385	-0.342	-2198.2	-34776.7	37.66	0.00	
-8.450	0.351	-0.330	-1823.8	-36784.9	38.20	0.00	
-9.450	0.319	-0.316	-1483.0	-38435.5	38.64	0.00	
-9.794	0.308	-0.312	-1373.3	-38926.7	38.77	0.00	
-9.950	0.303	-0.310	-1344.1	-39138.7	38.83	0.00	
-10.450	0.288	-0.303	-1253.9	-39788.0	39.00	0.00	
-10.854	0.276	-0.297	-1184.4	-40280.4	39.14	0.00	
-11.450	0.258	-0.289	-1087.3	-40957.1	39.32	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.230	-0.274	-938.2	-41968.4	39.59	0.00	
-13.144	0.212	-0.264	-844.7	-42586.6	39.76	0.00	
-13.450	0.204	-0.259	-676.7	-42819.2	39.82	0.00	
-14.160	0.185	-0.248	-311.4	-43168.0	39.91	0.00	
-14.160	0.185	-0.248	-311.4	-43168.0	46.47	0.00	
-14.450	0.178	-0.243	-171.8	-43237.9	46.50	0.00	*
-15.450	0.155	-0.226	268.7	-43184.3	46.48	0.00	
-16.450	0.133	-0.208	649.5	-42720.5	46.33	0.00	
-17.450	0.113	-0.191	975.2	-41903.8	46.08	0.00	
-18.450	0.095	-0.174	1250.3	-40787.0	45.73	0.00	
-19.450	0.078	-0.158	1479.4	-39418.5	45.30	0.00	
-20.450	0.063	-0.142	1666.8	-37842.0	44.81	0.00	
-21.450	0.050	-0.127	1816.7	-36097.3	44.26	0.00	
-21.704	0.047	-0.123	1849.2	-35631.7	44.12	0.00	
-22.450	0.038	-0.112	1928.1	-34221.7	43.67	0.00	
-23.450	0.028	-0.099	2009.7	-32250.6	43.06	0.00	
-24.450	0.018	-0.086	2066.6	-30210.6	42.42	0.00	
-25.450	0.010	-0.074	2101.9	-28124.7	41.77	0.00	
-26.450	0.003	-0.063	2118.8	-26012.9	41.11	0.00	
-27.450	-0.002	-0.053	2119.9	-23892.3	40.44	0.00	
-28.450	-0.007	-0.044	2107.8	-21777.4	39.78	0.00	
-29.450	-0.011	-0.035	2084.8	-19680.3	39.13	0.00	
-30.384	-0.014	-0.028	2055.3	-17746.3	38.52	0.00	
-30.450	-0.014	-0.028	2049.3	-17610.9	38.48	0.00	
-31.450	-0.017	-0.021	1949.8	-15610.0	37.85	0.00	
-32.450	-0.018	-0.015	1837.0	-13715.7	37.26	0.00	
-33.450	-0.020	-0.010	1714.5	-11939.3	36.70	0.00	
-34.450	-0.020	-0.005	1585.9	-10288.7	36.19	0.00	
-35.450	-0.021	-0.001	1454.1	-8768.5	35.71	0.00	
-36.450	-0.021	0.002	1321.4	-7380.8	35.28	0.00	
-37.450	-0.020	0.005	1190.1	-6125.2	34.88	0.00	
-38.450	-0.020	0.007	1061.9	-4999.5	34.53	0.00	
-39.450	-0.019	0.009	938.2	-3999.9	34.22	0.00	
-40.450	-0.018	0.010	820.3	-3121.2	33.94	0.00	
-41.450	-0.017	0.012	709.0	-2357.1	33.71	0.00	
-42.450	-0.016	0.012	605.2	-1700.6	33.50	0.00	
-43.450	-0.014	0.013	509.2	-1144.1	33.33	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.013	0.013	421.5	-679.5	33.18	0.00	
-45.450	-0.012	0.014	342.4	-298.2	33.06	0.00	
-46.450	-0.010	0.014	271.9	8.1	32.97	0.00	
-47.450	-0.009	0.014	210.0	248.4	33.05	0.00	
-48.450	-0.008	0.013	156.9	431.1	33.10	0.00	
-49.450	-0.006	0.013	112.3	565.0	33.14	0.00	
-50.450	-0.005	0.013	76.1	658.5	33.17	0.00	
-51.450	-0.004	0.013	48.3	720.0	33.19	0.00	
-52.450	-0.002	0.012	28.5	757.7	33.20	0.00	
-52.954	-0.002	0.012	21.5	770.2	33.21	0.00	
-53.450	-0.001	0.012	7.9	777.3	33.21	0.00	
-54.450	0.000	0.012	-3.7	777.6	33.21	0.00	
-54.660	0.000	0.012	-3.5	776.8	33.21	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.530	-0.384	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	46.50	-14.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 776.8 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)
periphery n1 = 34 (number) IB1 = 357.98 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.711
maximum Rmax = 1480 (kN/number)
minimum Rmin = 1463 (kN/number)

7)Earthquake

working force	vertical force	Vo	kN	46820.6
	horizontal force	Ho	kN	10800.0
	moment	Mo	kN.m	123800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	2.065
	calculation displacement	Del.	cm	2.059

convergence rate (Del.1 - Del.) / Del.1 = 0.31 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1892	2944
2	1400	2178
3	840	1307
4	1680	2614
5	10931	17008
6	10300	16026
7	26486	41211
8	73572	114474

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	2.059	-1.591	-10800.0	-123800.0	59.78	0.00	
-4.450	1.902	-1.546	-9537.9	-133960.6	62.51	0.00	
-5.450	1.750	-1.498	-8374.4	-142908.7	64.92	0.00	
-6.450	1.603	-1.446	-7306.3	-150741.2	67.02	0.00	
-6.704	1.566	-1.433	-7049.8	-152564.3	67.51	0.00	
-7.450	1.461	-1.392	-6517.4	-157622.5	68.87	0.00	
-8.450	1.324	-1.336	-5860.9	-163806.3	70.53	0.00	
-9.450	1.194	-1.277	-5267.4	-169365.4	72.03	0.00	
-9.794	1.150	-1.257	-5077.3	-171144.5	72.51	0.00	
-9.950	1.130	-1.247	-5027.0	-171932.6	72.72	0.00	
-10.450	1.069	-1.217	-4871.4	-174406.8	73.38	0.00	
-10.854	1.020	-1.192	-4752.0	-176350.5	73.91	0.00	
-11.450	0.950	-1.155	-4419.7	-179082.5	74.64	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-12.450	0.838	-1.092	-3914.1	-183244.2	75.76	0.00	
-13.144	0.764	-1.047	-3599.7	-185849.7	76.46	0.00	
-13.450	0.732	-1.027	-2757.1	-186821.4	76.72	0.00	
-14.160	0.661	-0.980	-937.3	-188121.9	77.07	0.00	
-14.160	0.661	-0.980	-937.3	-188121.9	89.71	0.00	
-14.450	0.633	-0.958	-246.9	-188292.9	89.76	0.00	*
-15.450	0.541	-0.881	1910.9	-187432.7	89.49	0.00	
-16.450	0.456	-0.805	3744.2	-184579.3	88.60	0.00	
-17.450	0.380	-0.731	5280.9	-180043.2	87.18	0.00	
-18.450	0.310	-0.658	6548.6	-174107.2	85.32	0.00	
-19.450	0.248	-0.589	7573.7	-167026.9	83.11	0.00	
-20.450	0.192	-0.522	8382.0	-159032.0	80.61	0.00	
-21.450	0.143	-0.459	8997.9	-150327.1	77.88	0.00	
-21.704	0.132	-0.443	9126.5	-148025.0	77.16	0.00	
-22.450	0.100	-0.399	9426.3	-141099.8	75.00	0.00	
-23.450	0.063	-0.344	9708.6	-131521.5	72.00	0.00	
-24.450	0.031	-0.292	9871.5	-121722.3	68.93	0.00	
-25.450	0.005	-0.244	9933.0	-111812.3	65.83	0.00	
-26.450	-0.018	-0.201	9909.5	-101884.6	62.73	0.00	
-27.450	-0.036	-0.161	9816.2	-92016.6	59.64	0.00	
-28.450	-0.050	-0.126	9666.8	-82271.0	56.59	0.00	
-29.450	-0.061	-0.094	9473.7	-72697.6	53.60	0.00	
-30.384	-0.068	-0.068	9263.5	-63945.4	50.86	0.00	
-30.450	-0.069	-0.066	9223.1	-63335.4	50.67	0.00	
-31.450	-0.074	-0.042	8582.9	-54428.4	47.88	0.00	
-32.450	-0.077	-0.022	7904.6	-46182.3	45.30	0.00	
-33.450	-0.079	-0.005	7206.7	-38625.7	42.94	0.00	
-34.450	-0.078	0.010	6504.5	-31770.3	40.79	0.00	
-35.450	-0.077	0.022	5810.9	-25613.8	38.87	0.00	
-36.450	-0.074	0.031	5136.3	-20142.3	37.15	0.00	
-37.450	-0.071	0.038	4489.0	-15332.2	35.65	0.00	
-38.450	-0.067	0.043	3875.6	-11152.9	34.34	0.00	
-39.450	-0.062	0.047	3300.8	-7568.1	33.22	0.00	
-40.450	-0.057	0.050	2768.0	-4537.3	32.27	0.00	
-41.450	-0.052	0.051	2279.5	-2017.3	31.48	0.00	
-42.450	-0.047	0.051	1836.5	36.9	30.86	0.00	
-43.450	-0.042	0.051	1439.2	1670.9	31.37	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-44.450	-0.037	0.050	1087.5	2930.5	31.77	0.00	
-45.450	-0.032	0.049	780.4	3860.8	32.06	0.00	
-46.450	-0.027	0.047	516.7	4505.7	32.26	0.00	
-47.450	-0.023	0.045	294.9	4908.1	32.39	0.00	
-48.450	-0.018	0.043	113.3	5108.9	32.45	0.00	
-49.450	-0.014	0.041	-30.0	5147.4	32.46	0.00	
-50.450	-0.010	0.039	-136.8	5061.0	32.43	0.00	
-51.450	-0.006	0.037	-208.9	4885.4	32.38	0.00	
-52.450	-0.003	0.035	-248.2	4654.2	32.31	0.00	
-52.954	-0.001	0.034	-256.1	4526.8	32.27	0.00	
-53.450	0.001	0.033	-257.0	4398.7	32.23	0.00	
-54.450	0.004	0.031	-198.1	4164.5	32.15	0.00	
-54.660	0.005	0.031	-175.8	4125.1	32.14	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	2.059	-1.591	5.000

maximum stress

	Sig.(N/mm^2)	elevation(m)
periphery sheet pile (SKY400)	89.76	-14.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 4125.1 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)

periphery n1 = 34 (number) IB1 = 357.98 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.711

maximum Rmax = 1420 (kN/number)
minimum Rmin = 1334 (kN/number)

(2)perpendicular direction

1)Oridinary(high tide)

working force	vertical force	Vo	kN	50032.6
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	6800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.029

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1142	2553
2	2538	5674
3	1523	3405
4	1523	3405
5	6598	14753
6	6217	13902
7	15987	35748
8	44408	99299

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-3.450	0.029	-0.018	0.0	-6800.0	29.67	0.00	*
-4.450	0.027	-0.017	6.2	-6796.9	29.67	0.00	
-5.450	0.026	-0.017	12.0	-6787.7	29.67	0.00	
-6.450	0.024	-0.016	17.5	-6773.0	29.66	0.00	
-6.704	0.023	-0.016	18.8	-6768.4	29.66	0.00	
-7.450	0.022	-0.016	27.1	-6751.2	29.66	0.00	
-8.450	0.021	-0.015	37.7	-6718.8	29.65	0.00	
-9.450	0.019	-0.015	47.4	-6676.1	29.64	0.00	
-9.794	0.019	-0.014	50.6	-6659.3	29.64	0.00	
-9.950	0.019	-0.014	51.5	-6651.3	29.64	0.00	
-10.450	0.018	-0.014	54.2	-6624.9	29.63	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-10.854	0.017	-0.014	56.2	-6602.6	29.63	0.00	
-11.450	0.016	-0.014	59.2	-6568.2	29.62	0.00	
-12.450	0.015	-0.013	63.8	-6506.6	29.61	0.00	
-13.144	0.014	-0.013	66.8	-6461.3	29.60	0.00	
-13.450	0.014	-0.012	72.3	-6440.0	29.60	0.00	
-14.160	0.013	-0.012	84.4	-6384.4	29.59	0.00	
-14.160	0.013	-0.012	84.4	-6384.4	34.46	0.00	
-14.450	0.013	-0.012	89.1	-6359.2	34.45	0.00	
-15.450	0.011	-0.011	104.4	-6262.3	34.43	0.00	
-16.450	0.010	-0.011	118.3	-6150.9	34.40	0.00	
-17.450	0.009	-0.010	130.8	-6026.2	34.37	0.00	
-18.450	0.008	-0.010	142.0	-5889.7	34.34	0.00	
-19.450	0.007	-0.009	152.1	-5742.6	34.31	0.00	
-20.450	0.007	-0.008	160.9	-5586.0	34.27	0.00	
-21.450	0.006	-0.008	168.8	-5421.1	34.23	0.00	
-21.704	0.006	-0.008	170.6	-5378.0	34.22	0.00	
-22.450	0.005	-0.007	175.3	-5248.9	34.19	0.00	
-23.450	0.004	-0.007	180.8	-5070.8	34.15	0.00	
-24.450	0.004	-0.006	185.5	-4887.6	34.11	0.00	
-25.450	0.003	-0.006	189.5	-4700.0	34.06	0.00	
-26.450	0.002	-0.005	192.7	-4508.9	34.02	0.00	
-27.450	0.002	-0.005	195.3	-4314.8	33.97	0.00	
-28.450	0.001	-0.005	197.3	-4118.5	33.93	0.00	
-29.450	0.001	-0.004	198.7	-3920.5	33.88	0.00	
-30.384	0.001	-0.004	199.5	-3734.5	33.84	0.00	
-30.450	0.001	-0.004	199.7	-3721.3	33.84	0.00	
-31.450	0.000	-0.004	200.8	-3521.0	33.79	0.00	
-32.450	0.000	-0.003	200.9	-3320.1	33.74	0.00	
-33.450	0.000	-0.003	199.9	-3119.6	33.69	0.00	
-34.450	-0.001	-0.003	198.1	-2920.5	33.65	0.00	
-35.450	-0.001	-0.002	195.5	-2723.6	33.60	0.00	
-36.450	-0.001	-0.002	192.2	-2529.7	33.56	0.00	
-37.450	-0.001	-0.002	188.2	-2339.5	33.51	0.00	
-38.450	-0.002	-0.002	183.6	-2153.5	33.47	0.00	
-39.450	-0.002	-0.001	178.6	-1972.4	33.43	0.00	
-40.450	-0.002	-0.001	173.1	-1796.5	33.39	0.00	
-41.450	-0.002	-0.001	167.3	-1626.2	33.35	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-42.450	-0.002	-0.001	161.1	-1462.0	33.31	0.00	
-43.450	-0.002	-0.001	154.6	-1304.1	33.27	0.00	
-44.450	-0.002	-0.001	147.9	-1152.8	33.24	0.00	
-45.450	-0.002	-0.001	141.0	-1008.4	33.20	0.00	
-46.450	-0.002	0.000	133.9	-870.9	33.17	0.00	
-47.450	-0.002	0.000	126.7	-740.6	33.14	0.00	
-48.450	-0.002	0.000	119.3	-617.6	33.11	0.00	
-49.450	-0.002	0.000	111.8	-502.0	33.08	0.00	
-50.450	-0.002	0.000	104.3	-394.0	33.06	0.00	
-51.450	-0.002	0.000	96.7	-293.5	33.04	0.00	
-52.450	-0.003	0.000	89.0	-200.6	33.01	0.00	
-52.954	-0.003	0.000	85.1	-156.8	33.00	0.00	
-53.450	-0.003	0.000	74.4	-117.2	33.00	0.00	
-54.450	-0.003	0.000	52.8	-53.6	32.98	0.00	
-54.660	-0.003	0.000	48.3	-42.9	32.98	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.029	-0.018	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.46	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -42.9 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 68.578 (m^4)
periphery n1 = 34 (number) IB1 = 1536.40 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 10.226
maximum Rmax = 1472 (kN/number)
minimum Rmin = 1471 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	53281.9
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	6800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.029

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1142	2553
2	2538	5674
3	1523	3405
4	1523	3405
5	6598	14753
6	6217	13902
7	15987	35748
8	44408	99299

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.029	-0.018	0.0	-6800.0	31.51	0.00	*
-4.450	0.027	-0.017	6.2	-6796.9	31.51	0.00	
-5.450	0.026	-0.017	12.0	-6787.7	31.50	0.00	
-6.450	0.024	-0.016	17.5	-6773.0	31.50	0.00	
-6.704	0.023	-0.016	18.8	-6768.4	31.50	0.00	
-7.450	0.022	-0.016	27.1	-6751.2	31.50	0.00	
-8.450	0.021	-0.015	37.7	-6718.8	31.49	0.00	
-9.450	0.019	-0.015	47.4	-6676.1	31.48	0.00	
-9.794	0.019	-0.014	50.6	-6659.3	31.48	0.00	
-9.950	0.019	-0.014	51.5	-6651.3	31.48	0.00	
-10.450	0.018	-0.014	54.2	-6624.9	31.47	0.00	
-10.854	0.017	-0.014	56.2	-6602.6	31.47	0.00	
-11.450	0.016	-0.014	59.2	-6568.2	31.46	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.015	-0.013	63.8	-6506.6	31.45	0.00	
-13.144	0.014	-0.013	66.8	-6461.3	31.44	0.00	
-13.450	0.014	-0.012	72.3	-6440.0	31.43	0.00	
-14.160	0.013	-0.012	84.4	-6384.4	31.42	0.00	
-14.160	0.013	-0.012	84.4	-6384.4	36.60	0.00	
-14.450	0.013	-0.012	89.1	-6359.2	36.59	0.00	
-15.450	0.011	-0.011	104.4	-6262.3	36.57	0.00	
-16.450	0.010	-0.011	118.3	-6150.9	36.54	0.00	
-17.450	0.009	-0.010	130.8	-6026.2	36.51	0.00	
-18.450	0.008	-0.010	142.0	-5889.7	36.48	0.00	
-19.450	0.007	-0.009	152.1	-5742.6	36.45	0.00	
-20.450	0.007	-0.008	160.9	-5586.0	36.41	0.00	
-21.450	0.006	-0.008	168.8	-5421.1	36.37	0.00	
-21.704	0.006	-0.008	170.6	-5378.0	36.36	0.00	
-22.450	0.005	-0.007	175.3	-5248.9	36.33	0.00	
-23.450	0.004	-0.007	180.8	-5070.8	36.29	0.00	
-24.450	0.004	-0.006	185.5	-4887.6	36.25	0.00	
-25.450	0.003	-0.006	189.5	-4700.0	36.20	0.00	
-26.450	0.002	-0.005	192.7	-4508.9	36.16	0.00	
-27.450	0.002	-0.005	195.3	-4314.8	36.11	0.00	
-28.450	0.001	-0.005	197.3	-4118.5	36.07	0.00	
-29.450	0.001	-0.004	198.7	-3920.5	36.02	0.00	
-30.384	0.001	-0.004	199.5	-3734.5	35.98	0.00	
-30.450	0.001	-0.004	199.7	-3721.3	35.98	0.00	
-31.450	0.000	-0.004	200.8	-3521.0	35.93	0.00	
-32.450	0.000	-0.003	200.9	-3320.1	35.88	0.00	
-33.450	0.000	-0.003	199.9	-3119.6	35.84	0.00	
-34.450	-0.001	-0.003	198.1	-2920.5	35.79	0.00	
-35.450	-0.001	-0.002	195.5	-2723.6	35.74	0.00	
-36.450	-0.001	-0.002	192.2	-2529.7	35.70	0.00	
-37.450	-0.001	-0.002	188.2	-2339.5	35.65	0.00	
-38.450	-0.002	-0.002	183.6	-2153.5	35.61	0.00	
-39.450	-0.002	-0.001	178.6	-1972.4	35.57	0.00	
-40.450	-0.002	-0.001	173.1	-1796.5	35.53	0.00	
-41.450	-0.002	-0.001	167.3	-1626.2	35.49	0.00	
-42.450	-0.002	-0.001	161.1	-1462.0	35.45	0.00	
-43.450	-0.002	-0.001	154.6	-1304.1	35.41	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.002	-0.001	147.9	-1152.8	35.38	0.00	
-45.450	-0.002	-0.001	141.0	-1008.4	35.34	0.00	
-46.450	-0.002	0.000	133.9	-870.9	35.31	0.00	
-47.450	-0.002	0.000	126.7	-740.6	35.28	0.00	
-48.450	-0.002	0.000	119.3	-617.6	35.25	0.00	
-49.450	-0.002	0.000	111.8	-502.0	35.23	0.00	
-50.450	-0.002	0.000	104.3	-394.0	35.20	0.00	
-51.450	-0.002	0.000	96.7	-293.5	35.18	0.00	
-52.450	-0.003	0.000	89.0	-200.6	35.16	0.00	
-52.954	-0.003	0.000	85.1	-156.8	35.15	0.00	
-53.450	-0.003	0.000	74.4	-117.2	35.14	0.00	
-54.450	-0.003	0.000	52.8	-53.6	35.12	0.00	
-54.660	-0.003	0.000	48.3	-42.9	35.12	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.029	-0.018	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	36.60	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -42.9 (kN.m)

Sum(ni*Aoi) = 1.518 (m^2)

Sum(IBi*Aoi) = 68.578 (m^4)

periphery	n1 = 34 (number)	IB1 = 1536.40 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 10.226

maximum Rmax = 1567 (kN/number)

minimum Rmin = 1567 (kN/number)

3)Wind

working force	vertical force	Vo	kN	49225.8
	horizontal force	Ho	kN	800.0
	moment	Mo	kN.m	20900.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.178

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1142	2553
2	2538	5674
3	1523	3405
4	1523	3405
5	6598	14753
6	6217	13902
7	15987	35748
8	44408	99299

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.178	-0.090	-800.0	-20900.0	32.04	0.00	
-4.450	0.169	-0.088	-761.8	-21680.7	32.19	0.00	
-5.450	0.160	-0.086	-725.5	-22424.3	32.34	0.00	
-6.450	0.152	-0.084	-691.2	-23132.4	32.48	0.00	
-6.704	0.150	-0.084	-682.7	-23306.9	32.52	0.00	
-7.450	0.144	-0.082	-629.2	-23796.1	32.62	0.00	
-8.450	0.136	-0.080	-560.9	-24390.9	32.74	0.00	
-9.450	0.128	-0.078	-496.6	-24919.3	32.84	0.00	
-9.794	0.125	-0.077	-475.3	-25086.5	32.88	0.00	
-9.950	0.124	-0.077	-469.6	-25160.2	32.89	0.00	
-10.450	0.120	-0.076	-451.8	-25390.5	32.94	0.00	
-10.854	0.117	-0.075	-437.7	-25570.2	32.97	0.00	
-11.450	0.112	-0.074	-417.7	-25825.0	33.02	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.105	-0.072	-385.7	-26226.6	33.10	0.00	
-13.144	0.100	-0.070	-364.8	-26486.9	33.16	0.00	
-13.450	0.098	-0.069	-326.2	-26592.7	33.18	0.00	
-14.160	0.093	-0.068	-239.9	-26793.4	33.22	0.00	
-14.160	0.093	-0.068	-239.9	-26793.4	38.68	0.00	
-14.450	0.091	-0.067	-205.8	-26858.0	38.70	0.00	
-15.450	0.085	-0.065	-94.0	-27007.2	38.73	0.00	
-16.450	0.078	-0.062	9.7	-27048.7	38.74	0.00	*
-17.450	0.072	-0.059	105.5	-26990.5	38.73	0.00	
-18.450	0.067	-0.057	193.7	-26840.3	38.69	0.00	
-19.450	0.061	-0.054	274.7	-26605.5	38.64	0.00	
-20.450	0.056	-0.052	348.9	-26293.1	38.56	0.00	
-21.450	0.051	-0.049	416.5	-25909.9	38.48	0.00	
-21.704	0.049	-0.048	432.6	-25802.1	38.45	0.00	
-22.450	0.046	-0.047	475.2	-25463.2	38.37	0.00	
-23.450	0.041	-0.044	527.5	-24961.4	38.25	0.00	
-24.450	0.037	-0.042	574.4	-24410.1	38.13	0.00	
-25.450	0.033	-0.039	616.4	-23814.2	37.99	0.00	
-26.450	0.029	-0.037	653.6	-23178.8	37.84	0.00	
-27.450	0.026	-0.035	686.4	-22508.4	37.68	0.00	
-28.450	0.022	-0.033	715.0	-21807.4	37.52	0.00	
-29.450	0.019	-0.031	739.7	-21079.7	37.35	0.00	
-30.384	0.016	-0.029	759.5	-20379.3	37.19	0.00	
-30.450	0.016	-0.029	762.8	-20329.1	37.17	0.00	
-31.450	0.013	-0.027	807.9	-19543.0	36.99	0.00	
-32.450	0.011	-0.025	844.9	-18715.9	36.80	0.00	
-33.450	0.008	-0.023	874.2	-17855.8	36.60	0.00	
-34.450	0.006	-0.021	896.3	-16970.0	36.39	0.00	
-35.450	0.004	-0.020	911.9	-16065.3	36.18	0.00	
-36.450	0.002	-0.018	921.3	-15148.3	35.97	0.00	
-37.450	0.000	-0.017	925.1	-14224.7	35.75	0.00	
-38.450	-0.001	-0.016	923.6	-13299.9	35.54	0.00	
-39.450	-0.003	-0.014	917.4	-12379.0	35.32	0.00	
-40.450	-0.004	-0.013	906.7	-11466.7	35.11	0.00	
-41.450	-0.005	-0.012	892.0	-10567.0	34.90	0.00	
-42.450	-0.007	-0.011	873.5	-9684.0	34.69	0.00	
-43.450	-0.008	-0.010	851.6	-8821.1	34.49	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.009	-0.009	826.5	-7981.8	34.30	0.00	
-45.450	-0.010	-0.009	798.6	-7169.0	34.11	0.00	
-46.450	-0.010	-0.008	767.9	-6385.6	33.92	0.00	
-47.450	-0.011	-0.007	734.8	-5634.0	33.75	0.00	
-48.450	-0.012	-0.007	699.3	-4916.8	33.58	0.00	
-49.450	-0.013	-0.007	661.8	-4236.1	33.42	0.00	
-50.450	-0.013	-0.006	622.2	-3594.0	33.27	0.00	
-51.450	-0.014	-0.006	580.7	-2992.4	33.13	0.00	
-52.450	-0.014	-0.006	537.4	-2433.2	33.00	0.00	
-52.954	-0.015	-0.005	514.9	-2168.0	32.94	0.00	
-53.450	-0.015	-0.005	452.4	-1928.0	32.89	0.00	
-54.450	-0.015	-0.005	322.8	-1540.1	32.80	0.00	
-54.660	-0.016	-0.005	295.1	-1475.2	32.78	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.178	-0.090	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	38.74	-16.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -1475.2 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 68.578 (m^4)
periphery n1 = 34 (number) IB1 = 1536.40 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 10.226
maximum Rmax = 1458 (kN/number)
minimum Rmin = 1438 (kN/number)

4)Ord+Collision

working force	vertical force	Vo	kN	50032.6
	horizontal force	Ho	kN	6400.0
	moment	Mo	kN.m	54300.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.941

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1142	2553
2	2538	5674
3	1523	3405
4	1523	3405
5	6598	14753
6	6217	13902
7	15987	35748
8	44408	99299

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.941	-0.417	-6400.0	-54300.0	39.19	0.00	
-4.450	0.900	-0.412	-6197.3	-60597.9	40.45	0.00	
-5.450	0.859	-0.407	-6003.7	-66697.7	41.67	0.00	
-6.450	0.819	-0.401	-5819.1	-72608.4	42.86	0.00	
-6.704	0.808	-0.400	-5773.6	-74080.6	43.15	0.00	
-7.450	0.779	-0.395	-5484.0	-78279.0	43.99	0.00	
-8.450	0.740	-0.388	-5112.7	-83575.8	45.05	0.00	
-9.450	0.701	-0.381	-4760.3	-88510.7	46.04	0.00	
-9.794	0.688	-0.379	-4643.4	-90128.1	46.37	0.00	
-9.950	0.682	-0.377	-4612.1	-90850.0	46.51	0.00	
-10.450	0.663	-0.374	-4513.3	-93131.3	46.97	0.00	
-10.854	0.648	-0.370	-4435.6	-94938.9	47.33	0.00	
-11.450	0.626	-0.366	-4324.1	-97549.1	47.85	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.590	-0.357	-4145.5	-101783.0	48.70	0.00	
-13.144	0.566	-0.351	-4027.8	-104618.9	49.27	0.00	
-13.450	0.555	-0.349	-3809.8	-105817.9	49.51	0.00	
-14.160	0.530	-0.342	-3319.8	-108347.6	50.02	0.00	
-14.160	0.530	-0.342	-3319.8	-108347.6	58.22	0.00	
-14.450	0.520	-0.339	-3126.0	-109282.1	58.44	0.00	
-15.450	0.487	-0.329	-2485.3	-112084.2	59.09	0.00	
-16.450	0.455	-0.318	-1886.5	-114266.7	59.60	0.00	
-17.450	0.424	-0.307	-1328.0	-115870.6	59.98	0.00	
-18.450	0.393	-0.295	-808.6	-116935.8	60.22	0.00	
-19.450	0.364	-0.284	-326.7	-117500.4	60.36	0.00	
-20.450	0.337	-0.273	119.0	-117601.3	60.38	0.00	*
-21.450	0.310	-0.261	530.0	-117273.9	60.30	0.00	
-21.704	0.303	-0.258	629.1	-117126.7	60.27	0.00	
-22.450	0.284	-0.250	891.8	-116558.3	60.14	0.00	
-23.450	0.260	-0.239	1217.8	-115501.1	59.89	0.00	
-24.450	0.237	-0.228	1515.3	-114132.2	59.57	0.00	
-25.450	0.214	-0.217	1785.4	-112479.6	59.18	0.00	
-26.450	0.193	-0.206	2029.6	-110569.9	58.74	0.00	
-27.450	0.173	-0.195	2249.1	-108428.5	58.24	0.00	
-28.450	0.154	-0.185	2445.2	-106079.5	57.69	0.00	
-29.450	0.136	-0.175	2619.1	-103545.5	57.10	0.00	
-30.384	0.120	-0.166	2762.6	-101030.8	56.52	0.00	
-30.450	0.119	-0.165	2787.0	-100847.7	56.47	0.00	
-31.450	0.103	-0.155	3129.5	-97885.3	55.78	0.00	
-32.450	0.088	-0.146	3424.2	-94604.6	55.02	0.00	
-33.450	0.074	-0.137	3673.8	-91052.0	54.19	0.00	
-34.450	0.061	-0.128	3881.2	-87271.1	53.31	0.00	
-35.450	0.048	-0.120	4049.0	-83302.8	52.38	0.00	
-36.450	0.037	-0.112	4179.8	-79185.5	51.42	0.00	
-37.450	0.026	-0.105	4275.9	-74954.8	50.44	0.00	
-38.450	0.016	-0.098	4339.8	-70644.4	49.43	0.00	
-39.450	0.006	-0.091	4373.5	-66285.3	48.42	0.00	
-40.450	-0.003	-0.085	4379.0	-61906.8	47.40	0.00	
-41.450	-0.011	-0.079	4358.4	-57536.0	46.38	0.00	
-42.450	-0.018	-0.074	4313.4	-53198.1	45.37	0.00	
-43.450	-0.026	-0.069	4245.6	-48916.8	44.37	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.032	-0.064	4156.5	-44714.0	43.39	0.00	
-45.450	-0.038	-0.060	4047.6	-40610.4	42.43	0.00	
-46.450	-0.044	-0.057	3920.1	-36625.0	41.50	0.00	
-47.450	-0.050	-0.053	3775.2	-32775.9	40.61	0.00	
-48.450	-0.055	-0.050	3613.9	-29080.0	39.75	0.00	
-49.450	-0.060	-0.048	3437.1	-25553.2	38.92	0.00	
-50.450	-0.064	-0.045	3245.7	-22210.6	38.14	0.00	
-51.450	-0.069	-0.043	3040.3	-19066.4	37.41	0.00	
-52.450	-0.073	-0.042	2821.6	-16134.4	36.73	0.00	
-52.954	-0.075	-0.041	2706.5	-14741.2	36.40	0.00	
-53.450	-0.077	-0.040	2383.1	-13478.6	36.11	0.00	
-54.450	-0.081	-0.039	1705.7	-11431.4	35.63	0.00	
-54.660	-0.082	-0.039	1559.1	-11088.5	35.55	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	0.941	-0.417	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	60.38	-20.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -11088.5 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 68.578 (m^4)
periphery n1 = 34 (number) IB1 = 1536.40 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 10.226
maximum Rmax = 1545 (kN/number)
minimum Rmin = 1398 (kN/number)

5)Earthquake

working force	vertical force	Vo	kN	46820.6
	horizontal force	Ho	kN	10800.0
	moment	Mo	kN.m	146700.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.529
	calculation displacement	Del.	cm	1.522

convergence rate (Del.1 - Del.) / Del.1 = 0.48 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	2284	4130
2	1690	3056
3	1014	1834
4	2028	3667
5	13195	23861
6	12434	22484
7	31974	57817
8	88816	160602

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	1.522	-0.772	-10800.0	-146700.0	55.88	0.00	
-4.450	1.445	-0.760	-10271.9	-157233.7	58.00	0.00	
-5.450	1.370	-0.746	-9770.8	-167252.7	60.00	0.00	
-6.450	1.296	-0.732	-9296.2	-176784.0	61.91	0.00	
-6.704	1.277	-0.728	-9179.9	-179130.5	62.38	0.00	
-7.450	1.224	-0.717	-8934.1	-185886.3	63.74	0.00	
-8.450	1.153	-0.701	-8621.1	-194662.4	65.50	0.00	
-9.450	1.083	-0.684	-8326.6	-203134.7	67.19	0.00	
-9.794	1.060	-0.679	-8229.5	-205982.3	67.76	0.00	
-9.950	1.049	-0.676	-8203.5	-207264.1	68.02	0.00	
-10.450	1.016	-0.667	-8121.9	-211345.3	68.84	0.00	
-10.854	0.989	-0.660	-8057.8	-214613.5	69.49	0.00	
-11.450	0.950	-0.649	-7875.2	-219361.2	70.44	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-12.450	0.886	-0.631	-7585.0	-227089.6	71.99	0.00	
-13.144	0.843	-0.618	-7395.4	-232287.3	73.04	0.00	
-13.450	0.824	-0.612	-6870.9	-234469.7	73.47	0.00	
-14.160	0.781	-0.598	-5699.2	-238928.4	74.37	0.00	
-14.160	0.781	-0.598	-5699.2	-238928.4	86.54	0.00	
-14.450	0.764	-0.591	-5238.5	-240514.1	86.91	0.00	
-15.450	0.706	-0.568	-3727.7	-244987.3	87.95	0.00	
-16.450	0.650	-0.544	-2333.6	-248008.4	88.66	0.00	
-17.450	0.597	-0.520	-1051.3	-249691.7	89.05	0.00	
-18.450	0.546	-0.495	124.2	-250146.6	89.16	0.00	*
-19.450	0.498	-0.471	1197.7	-249477.4	89.00	0.00	
-20.450	0.452	-0.447	2174.2	-247783.6	88.61	0.00	
-21.450	0.408	-0.423	3058.8	-245159.6	87.99	0.00	
-21.704	0.398	-0.417	3269.4	-244355.8	87.81	0.00	
-22.450	0.367	-0.400	3822.4	-241707.8	87.19	0.00	
-23.450	0.328	-0.377	4496.4	-237542.1	86.22	0.00	
-24.450	0.292	-0.354	5097.4	-232739.3	85.10	0.00	
-25.450	0.258	-0.332	5629.8	-227370.1	83.85	0.00	
-26.450	0.226	-0.310	6097.9	-221501.1	82.48	0.00	
-27.450	0.196	-0.289	6505.9	-215194.4	81.01	0.00	
-28.450	0.168	-0.268	6857.9	-208508.0	79.45	0.00	
-29.450	0.142	-0.248	7157.9	-201496.0	77.82	0.00	
-30.384	0.120	-0.231	7394.5	-194696.8	76.23	0.00	
-30.450	0.118	-0.229	7433.6	-194207.5	76.12	0.00	
-31.450	0.096	-0.211	7966.9	-186498.1	74.32	0.00	
-32.450	0.076	-0.193	8395.0	-178308.7	72.41	0.00	
-33.450	0.057	-0.176	8726.7	-169740.2	70.41	0.00	
-34.450	0.041	-0.160	8970.5	-160884.6	68.35	0.00	
-35.450	0.025	-0.145	9134.2	-151825.9	66.24	0.00	
-36.450	0.012	-0.131	9225.5	-142640.3	64.10	0.00	
-37.450	-0.001	-0.118	9251.4	-133396.7	61.94	0.00	
-38.450	-0.012	-0.105	9218.6	-124157.0	59.79	0.00	
-39.450	-0.022	-0.094	9133.3	-114976.9	57.65	0.00	
-40.450	-0.031	-0.083	9001.3	-105905.9	55.54	0.00	
-41.450	-0.039	-0.073	8827.8	-96988.2	53.46	0.00	
-42.450	-0.045	-0.064	8617.8	-88262.5	51.42	0.00	
-43.450	-0.052	-0.056	8375.7	-79763.3	49.44	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.450	-0.057	-0.049	8105.6	-71520.4	47.52	0.00	
-45.450	-0.061	-0.042	7811.2	-63560.1	45.67	0.00	
-46.450	-0.065	-0.037	7495.6	-55905.0	43.88	0.00	
-47.450	-0.069	-0.031	7161.8	-48574.9	42.17	0.00	
-48.450	-0.072	-0.027	6812.3	-41586.6	40.54	0.00	
-49.450	-0.074	-0.023	6449.3	-34954.8	39.00	0.00	
-50.450	-0.076	-0.020	6074.5	-28692.0	37.54	0.00	
-51.450	-0.078	-0.018	5689.6	-22809.2	36.17	0.00	
-52.450	-0.080	-0.016	5295.8	-17315.8	34.89	0.00	
-52.954	-0.081	-0.015	5094.2	-14697.4	34.28	0.00	
-53.450	-0.081	-0.014	4538.0	-12308.4	33.72	0.00	
-54.450	-0.083	-0.014	3401.8	-8336.9	32.79	0.00	
-54.660	-0.083	-0.013	3160.8	-7647.9	32.63	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.450	1.522	-0.772	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	89.16	-18.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

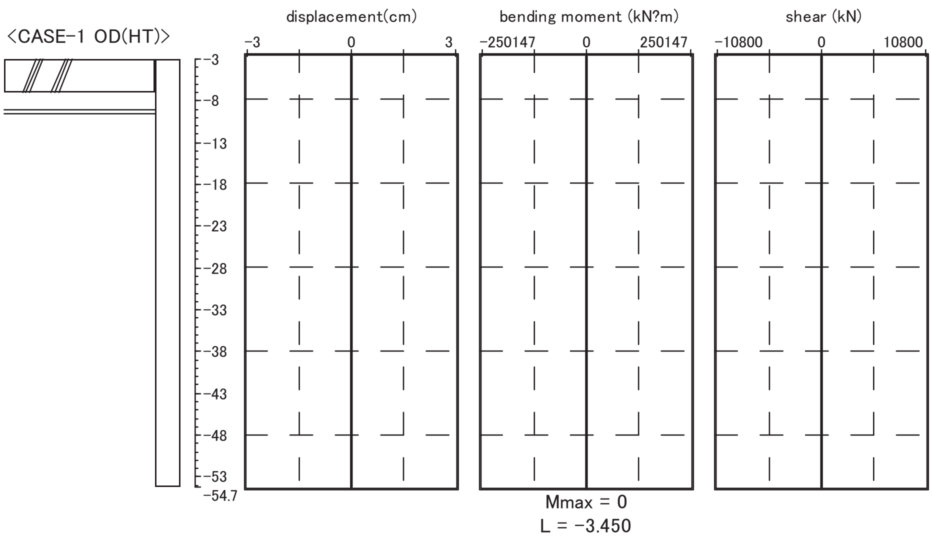
vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

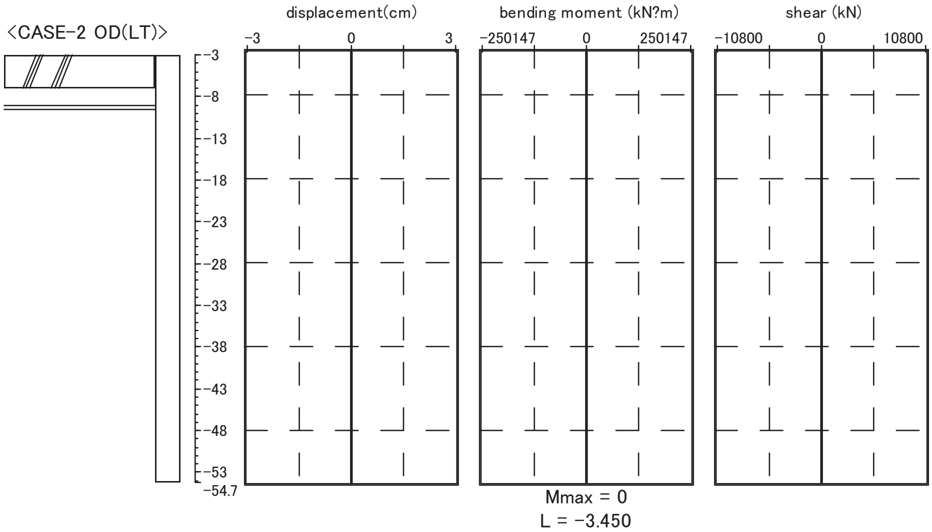
```
MB             =     -7647.9 (kN.m)
Sum(ni*Aoi)  =       1.518 (m²)
Sum(IBi*Aoi) =      68.578 (m⁴)
      periphery          n1  =  34 (number)   IB1 =       1536.40 (m²)   Ao1 =  0.0446 (m²/number)
      separation wall    n1  =   0 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0000 (m²/number)
      intermediate drive n1  =   0 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0000 (m²/number)
      x =  10.226
 maximum   Rmax =   1428 (kN/number)
 minimum   Rmin =   1326 (kN/number)
```


1.11 displacement / member force diagram

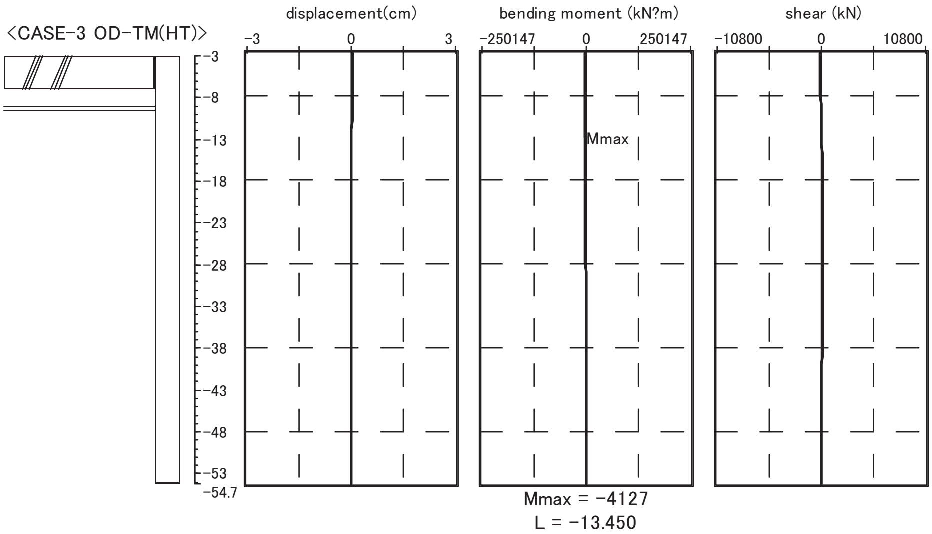
bridge axis direction



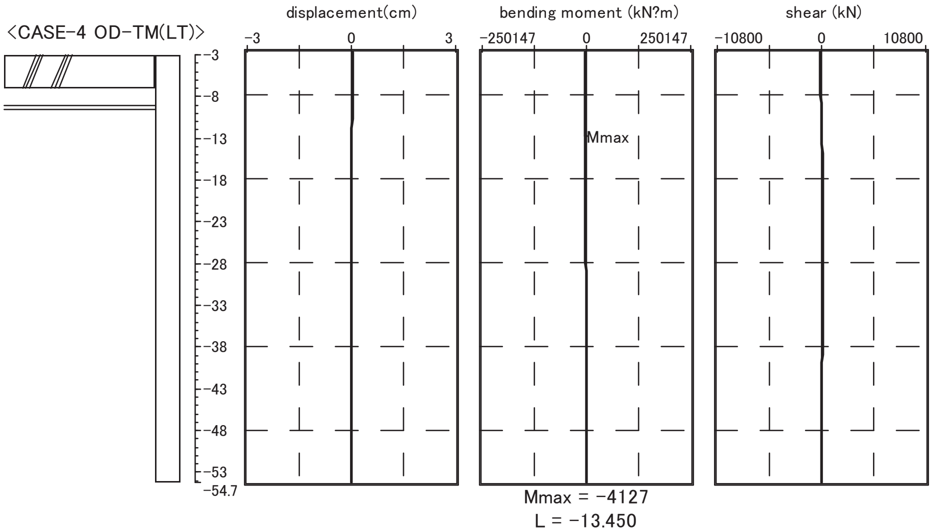
<CASE-2 OD(LT)>



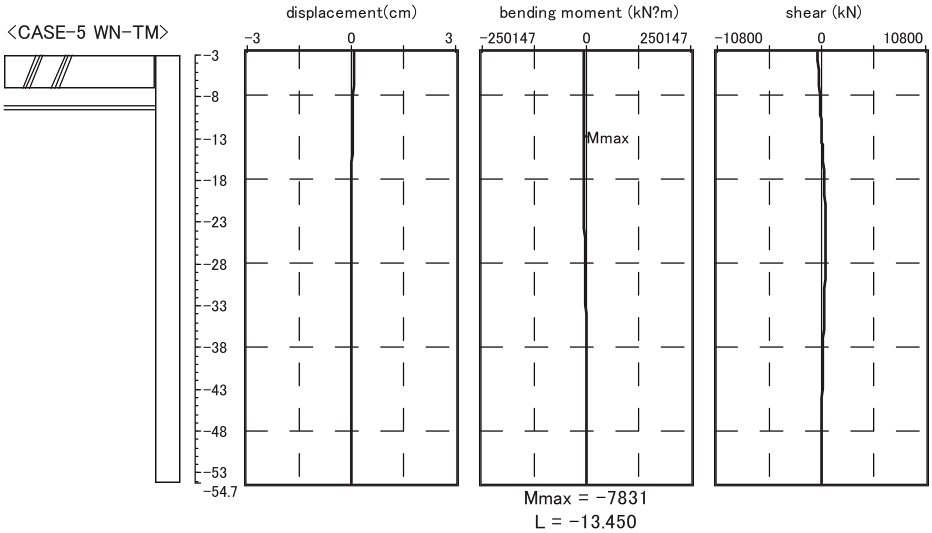
<CASE-3 OD-TM(HT)>

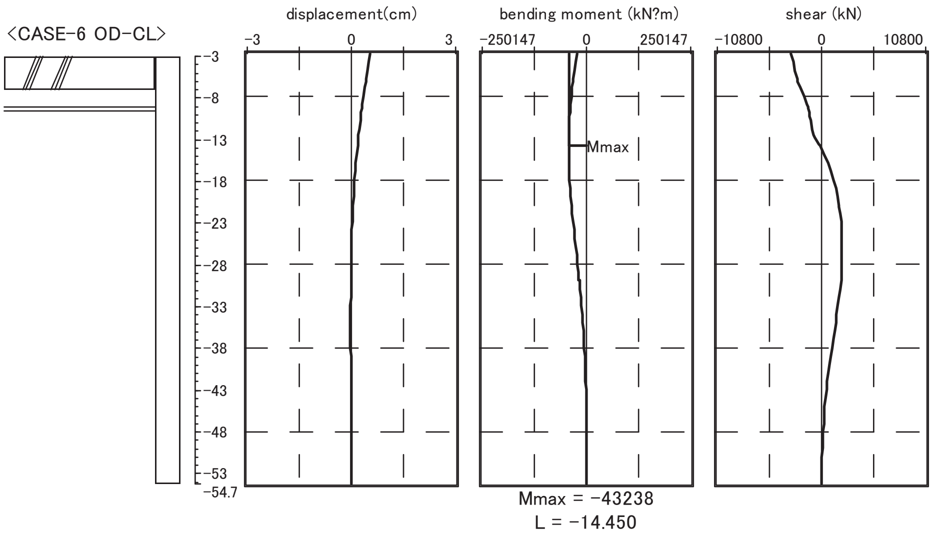


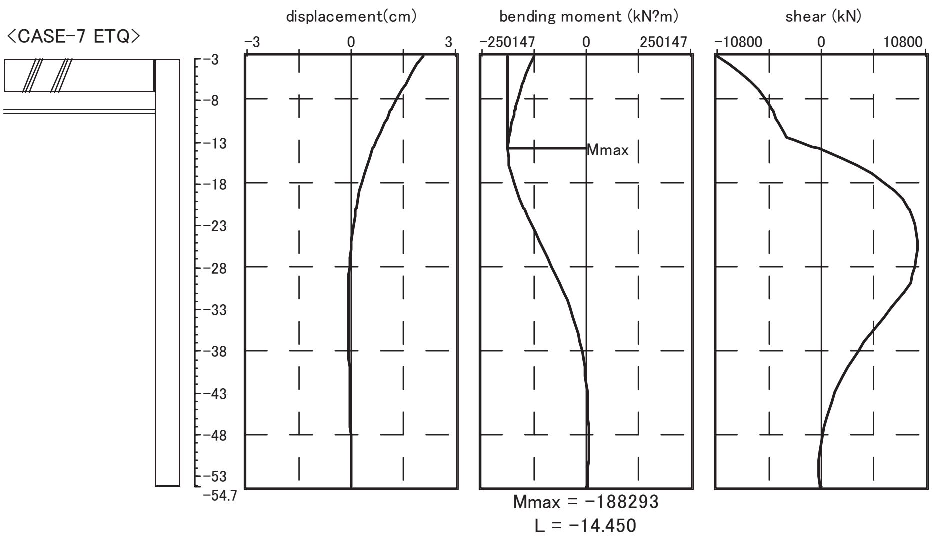
<CASE-4 OD-TM(LT)>



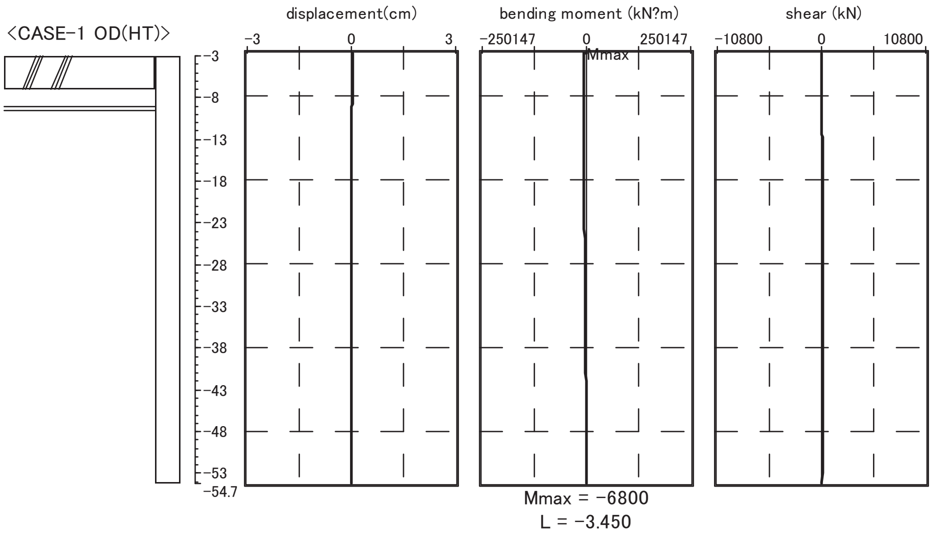
<CASE-5 WN-TM>

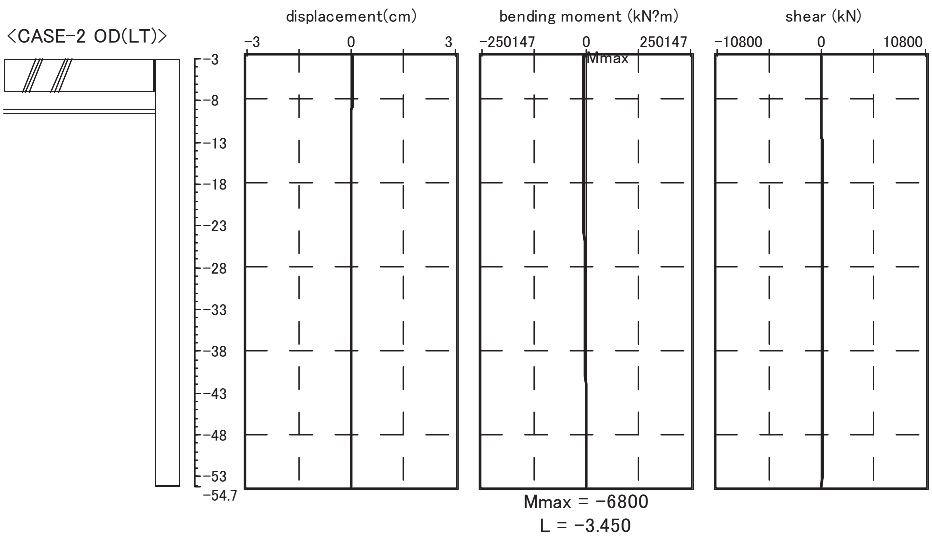



<CASE-6 OD-CL>
displacement(cm)
bending moment (kN?m)
shear (kN)
Mmax
Mmax = −43238
L = −14.450

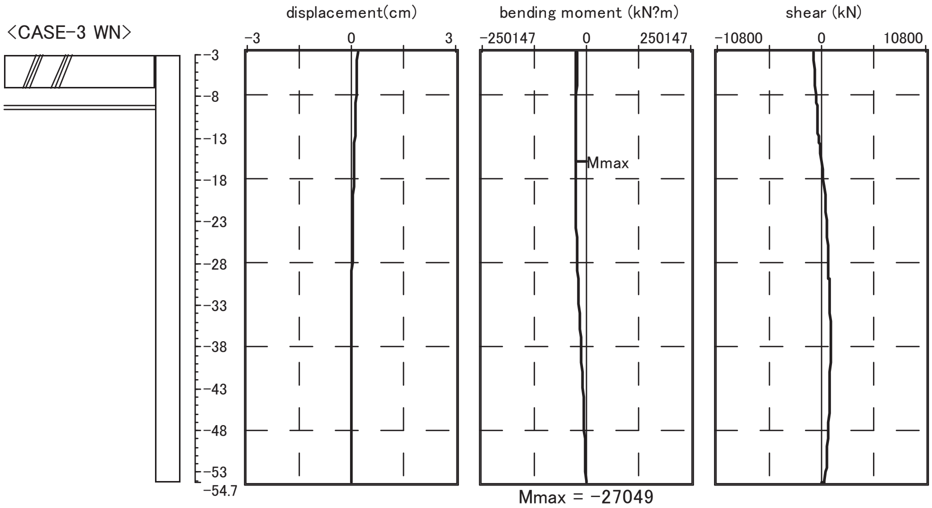

<CASE-7 ETQ>
displacement(cm)
bending moment (kN?m)
shear (kN)
Mmax
Mmax = −188293
L = −14.450

perpendicular direction



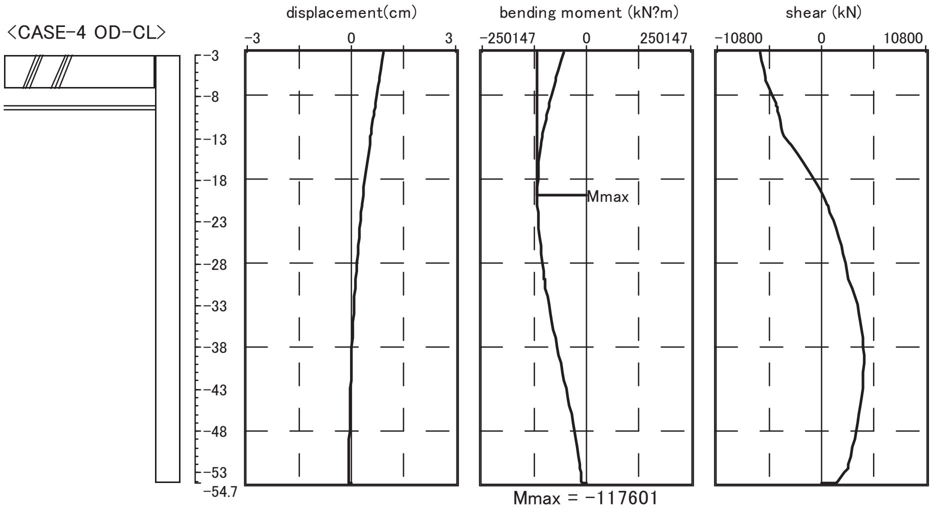


<CASE-3 WN>

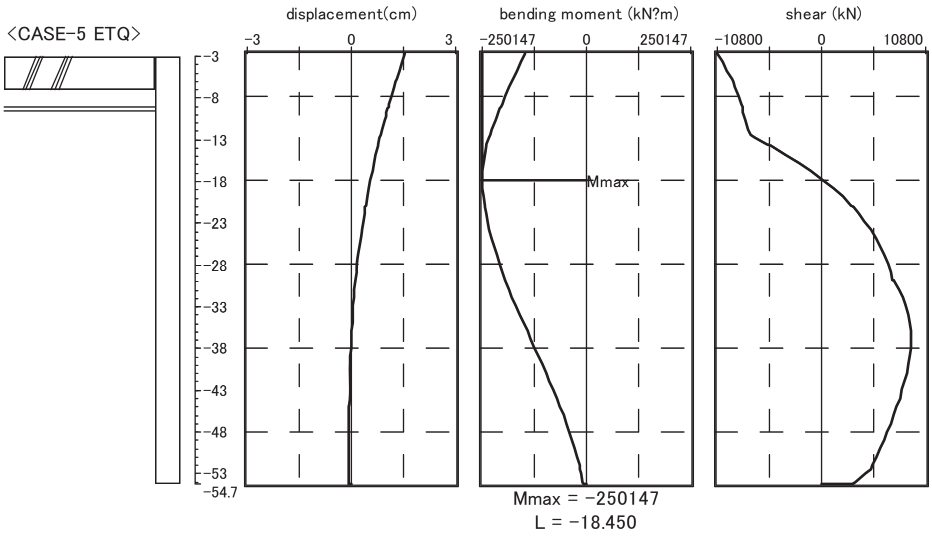


Mmax = -27049
L = -16.450

<CASE-4 OD-CL>

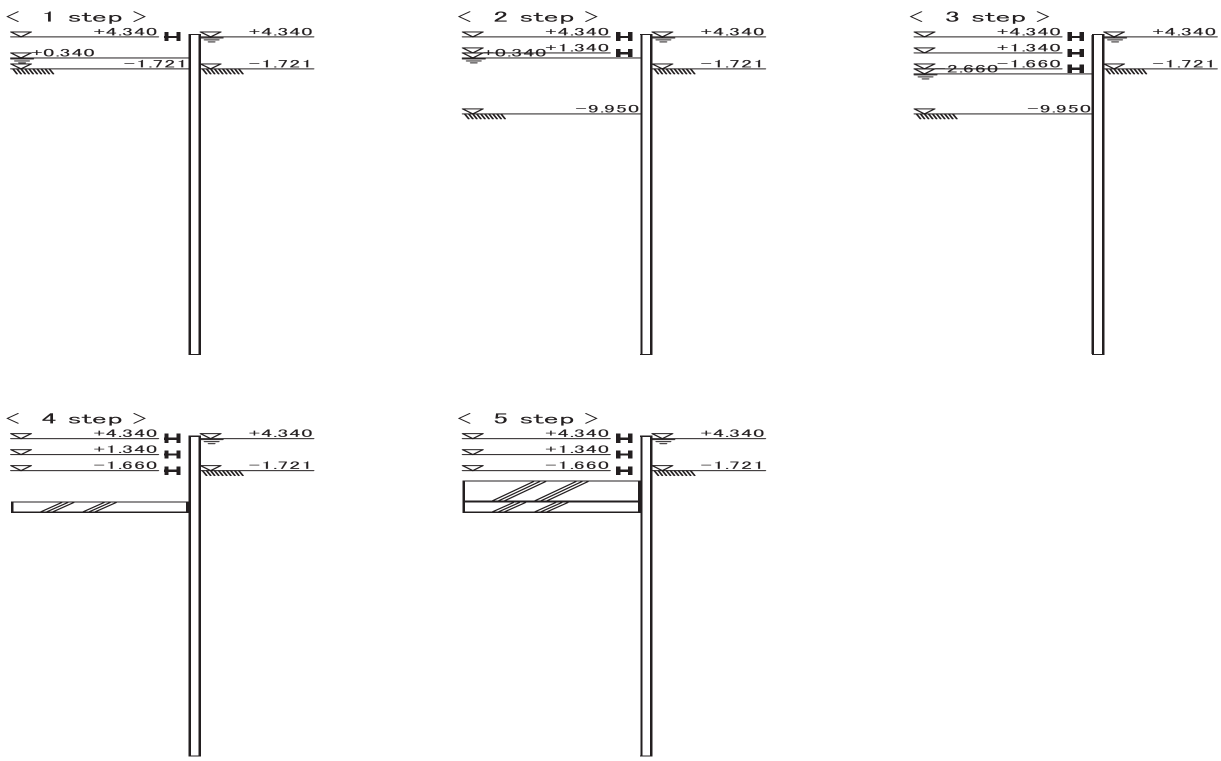


Mmax = -117601
L = -20.450



2 coffering calculation

2.1 construction step diagram



2.2 section properties

steel pipe pile body external diameter Phi.1200.0 (mm)
errosion allowance external side = 0.0 (mm) internal side = 0.0 (mm)

No	L (m)	bridge axis direction		perpendicular direction		material
		I(cm⁴/m)	Z(cm³/m)	I(cm⁴/m)	Z(cm³/m)	
1	7.000	633569.6	10559.5	633569.6	10559.5	SKY400
2	12.000	720452.4	12007.5	720452.4	12007.5	SKY400
3	40.500	633569.6	10559.5	633569.6	10559.5	SKY400
Sig.= 59.500 (m)						

2.3 soil condition

current ground surface elevation -1.721 (m)
riverside water table elevation +4.340 (m)
boundary condition of steel pipe sheet pile tip :free

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m³)		c (kN/m²)	Phi. Deg.	elastic assing (*)
				Gam.	Gam.'			
1	cohesv	4.983	1.0	17.5	7.5	10.0	0.0	0
2	cohesv	3.090	3.0	17.5	7.5	15.0	0.0	0
3	sandy	1.060	3.0	17.5	8.5	0.0	28.0	0
4	sandy	2.290	3.0	17.5	8.5	0.0	28.0	0
5	sandy	8.560	13.0	17.0	8.0	0.0	33.0	0
6	cohesv	8.680	7.0	17.5	7.5	42.0	0.0	0
7	cohesv	22.570	18.0	18.0	8.0	108.0	0.0	0
8	sandy	1.706	50.0	19.0	10.0	0.0	35.0	0

(*)0:if subgrade reaction> upper limit of subgrade reaction plastic area, 1: always elastic area

horizontal modulus of subgrade reaction kH (kN/m³)

No	bridge axis direction		perpendicular direction		step
	KH1	KH2	KH1	KH2	
1	865	865	865	865	0
2	1922	1922	1922	1922	0
3	1153	1153	1153	1153	0
4	1153	1153	1153	1153	0
5	4998	4998	4998	4998	0
6	4710	4710	4710	4710	0
7	12110	12110	12110	12110	0
8	33639	33639	33639	33639	0

2.4 timbering, construction step

(1) timbering

row	installation level(m)	step No		support point condition (tensile)	H shaped steel		
		set	remove		arc part	linear part(wailing)	linear part(strut)
1	+4.340	1	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15
2	+1.340	2	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15
3	-1.660	3	0	invld	2H-350*350*12*19	2H-350*350*12*19	2H-350*350*12*19

(2)H shaped steel
1)linear
**wailing

row	H (cm)	B (cm)	A (cm²)	Aw (cm²)	Iy (cm⁴)	Zy (cm³)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

2) arc

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

(3) strut spacing/brace span

row	perpendicular direction	
	strut spacing L1(m)	brace span L2(m)
1	4.000	1.300
2	4.000	1.300
3	4.000	1.300

(4)construction step

step	excavation area(m)	inside water level(m)
1	-1.721	+0.340
2	-9.950	+0.340
3	-9.950	-2.660
4	-9.950	-9.950
5	-9.950	-9.950

footing concrete cast --- 4 step
pile capcast --- 5 step

2.5 arbitrary load

No	working elevation (m)	load type	working width (m)	load (kN,kN/m)		working step number	
				top end	bottom end	begin	end
1	+4.340	distributed	6.061	0.270	0.068	1	5

note: positive load is applied from back side, negative load is applied from excavation area side

2.6 support point spring

(1) spring constant of timbering

arc part

$$K = \frac{E*A1}{r^2} \quad (kN/m/m)$$

linear part

$$K = \frac{E*A2}{\frac{L1}{2}} * \frac{1}{L2} \quad (kN/m/m)$$

Here, E : Young's modulus of timbering = 2.00 * 10^8(kN/m^2)

A1 : sectional area of wailing(m^2)

A2 : sectional area of strut (m^2)

r : timbering radius in arc part (m)

L1 : strut length (m)

L2 : strut spacing (m)

1)bridge axis direction

linear part

row	A2 (cm^2)	L1 (m)	L2 (m)	K (kN/m/m)
1	118.40	5.921	4.000	1.9996E+005
2	118.40	5.921	4.000	1.9996E+005
3	343.80	5.871	4.000	5.8557E+005

arc part

row	A1 (cm^2)	r (m)	K (kN/m/m)
1	118.40	2.961	2.7016E+005
2	118.40	2.961	2.7016E+005
3	343.80	2.936	7.9789E+005

(2)footing concrete spring constant

$$K = \frac{Alp.*(\ Ec*Ac\ )}{\frac{B}{2}} \quad (kN/m/m)$$

where, Alp. : reduction coefficient of spring = 0.050

Ec : Young's modulus of concrete at bottom = 2.35 * 10^7(kN/m^2)

Ac : sectional area per unit width of footing concrete = 2.000 (m^2/m)

B : footing concrete width (m)

bridge axis direction B = 6.221

perpendicular direction B = 19.251

1)bridge axis direction

K = 7.5548E+005 (kN/m/m)

2)perpendicular direction

K = 2.4414E+005 (kN/m/m)

(4) using value

1)support point spring constant (kN/m/m)

	support point condition(tensile)	bridge axis direction	perpendicular direction
timbering 1row	invld	1.9996E+005	2.7016E+005
timbering 2row	invld	1.9996E+005	2.7016E+005
timbering 3row	invld	5.8557E+005	7.9789E+005
footing concrete	invld	7.5548E+005	2.4414E+005

2.7 side pressure

(1) active side pressure

sand soil

$$Pa = Ka(Gam.*h - pw1 + q) - 2c * \sqrt{Ka} + pw1$$

where, Pa : active side pressure (kN/m^2)

Ka : active earth pressure coefficient $Ka = \tan^2(45Deg.- Phi. / 2)$

q : surcharge load (kN/m^2) (including weight of water upper than ground surface)

Gam. : unit weight of wet soil (kN/m^3)

pw1 : backsides water pressure at depth h (kN/m^2)

h : depth from ground surface (m)

Phi. : internal friction angle of soil (Deg.)

c : cohesion of soil (kN/m^2)

------

h<=H

$$Pa = Ka1(Gam.*h + q)$$

h>H

$$Pa = Ka1(Gam.*H + q) + Ka2*Gam.(h - H)$$

where, Ka1,Ka2 : active earth pressure coefficient for cohesive soil

cohesive soil N value	Ka1		Ka2
	presumption equation	minimum	
8 <= N	0.5 - 0.010H	0.3	0.5
4 <= N < 8	0.6 - 0.010H	0.4	0.6
2 <= N < 4	0.7 - 0.025H	0.5	0.7
N < 2	0.8 - 0.025H	0.6	0.8

H : excavation depth

(2)passive side pressure

sand soil

$$Pp = Kp(Gam.*h - pw2 + q) + 2c* \sqrt{Kp} + pw2$$

$$Pp = Kp(Gam.*h + q) + 2c*\sqrt{Kp}$$

where, Pp : passive side pressure (kN/m^2)

Kp : passive earth pressure coefficient

$$Kp = \frac{\cos^2 Phi}{\left(1 - \sqrt{\sin(Phi - Del.)*\frac{\sin Phi}{\cos Del.}} \right)^2}$$

pw2 : water pressure on excavation side at depth h (kN/m^2)

Del. : friction angle between steel pipe sheet pile and soil (Deg.) (Del. = -Phi./3)

q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
(after concrete is casted to footing, includes weight of footing concrete and paving sand)

(3)at rest side pressure

use less value of either Po or Po'

1)before excavation

sand soil

Po = Ko(Gam.*h - pw1 + q) + pw1

cohesive soil

Po = ko(Gam.*h + q)

where, Po : side pressure at rest before excavation (kN/m²)

Ko : at rest side pressure coefficient

Ko = 1 - sinPhi.(sand soil)

cohesive soil

N value of cohesive soil	Ko
8 <= N	0.5
4 <= N < 8	0.6
2 <= N < 4	0.7
N < 2	0.8

q : surcharge load (kN/m²) (including weight of water upper than ground surface)

2)after excavation

sand soil

$$Po' = Ko(Gam.*h' - pw2 + q) + Ko*\frac{f*h'}{B} + pw2$$

cohesive soil

$$Po' = Ko(Gam.*h' + q) + Ko*\frac{f*h'}{B}$$

where, Po' : side pressure at rest after excavation (kN/m²)

h' : depth from excavation areah (m)

q : surcharge load (kN/m²) (including weight of water upper than ground surface)

(after concrete is casted to footing, includes weight of footing concrete and paving sand)

B : range of friction influence (m)

(let B=5.0m, if excavation width is less than 10m, then let excavation width 1/2)

f : friction force between steel pipe sheet pile and ground (kN/m²)

sand soil : 1 * N(<=50)

cohesive soil : 0.5 * c or 5 * N(<=100)

where, if N<=2 weak layer, then friction force is not considered

steel pipe sheet pile length L = 59.500 (m)

design water tableelevation +4.340 (m)

design ground elevation -1.721 (m)

(4)sum up

1) 1 step

excavation area elevation = -1.721 (m)

landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
3	-1.721 -6.704	4.983	48.49 118.25	40.61 127.81	16.49 86.25	32.00 32.00	24.12 41.56
4	-6.704 -9.794	3.090	103.47 141.32	137.81 191.89	75.47 118.54	28.00 22.78	62.34 73.35
5	-9.794 -10.854	1.060	163.20 176.67	321.68 361.21	137.41 152.77	25.79 23.90	184.27 208.44
6	-10.854 -13.144	2.290	176.67 205.77	361.21 446.61	152.77 185.96	23.90 19.81	208.44 260.65
7	-13.144 -20.207	7.063	200.10 285.31	553.96 866.47	178.72 285.31	21.38 0.00	375.24 581.17
8	-20.207 -21.704	1.497	285.31 303.36	866.47 932.69	285.31 307.89	0.00 0.00	581.17 624.80
9	-21.704 -24.347	2.643	243.62 271.37	450.03 496.29	243.62 271.37	0.00 0.00	206.41 224.91
10	-24.347 -30.384	6.037	271.37 334.76	496.29 601.93	271.37 334.76	0.00 0.00	224.91 267.17
11	-30.384 -52.954	22.570	278.97 482.10	733.93 1140.19	278.97 482.10	0.00 0.00	454.96 658.09
12	-52.954 -54.660	1.706	678.97 700.19	2526.90 2629.37	739.78 763.39	0.00 0.00	1787.12 1865.98

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00
3	-1.721 -6.704	4.983	48.49 118.25	40.61 127.81	16.49 86.25	32.00 32.00	24.12 41.56
4	-6.704 -9.794	3.090	103.47 141.32	137.81 191.89	75.47 116.57	28.00 24.75	62.34 75.32
5	-9.794 -10.854	1.060	163.20 176.67	321.68 361.21	135.92 151.08	27.28 25.59	185.76 210.13
6	-10.854 -13.144	2.290	176.67 205.77	361.21 446.61	151.08 183.82	25.59 21.95	210.13 262.79

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
7	-13.144 -20.207	7.063	200.10 285.31	553.96 866.47	176.88 278.39	23.22 6.91	377.08 588.08
8	-20.207 -21.704	1.497	285.31 303.36	866.47 932.69	278.39 299.90	6.91 3.46	588.08 632.79
9	-21.704 -24.347	2.643	243.62 271.37	450.03 496.29	236.96 271.37	6.66 0.00	213.07 224.91
10	-24.347 -30.384	6.037	271.37 334.76	496.29 601.93	271.37 334.76	0.00 0.00	224.91 267.17
11	-30.384 -52.954	22.570	278.97 482.10	733.93 1140.19	278.97 482.10	0.00 0.00	454.96 658.09
12	-52.954 -54.660	1.706	678.97 700.19	2526.90 2629.37	739.78 763.39	0.00 0.00	1787.12 1865.98

2) 2 step

excavation area elevation = -9.950 (m)

landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00
3	-1.721 -6.704	4.983	36.37 88.69	20.61 70.44	20.61 70.44	15.76 18.25	0.00 0.00
4	-6.704 -9.477	2.773	73.91 98.17	70.44 98.17	70.44 98.17	3.47 0.00	0.00 0.00
5	-9.477 -9.794	0.317	98.17 100.94	98.17 101.34	98.17 101.34	0.00 0.00	0.00 0.00
6	-9.794 -9.950	0.156	163.20 165.18	101.34 102.90	101.34 102.90	61.86 62.28	0.00 0.00
7	-9.950 -10.854	0.904	165.18 176.67	102.90 136.61	102.90 116.00	62.28 60.67	0.00 20.61
8	-10.854 -13.144	2.290	176.67 205.77	136.61 222.01	116.00 149.18	60.67 56.59	20.61 72.83
9	-13.144 -21.704	8.560	200.10 303.36	252.03 630.77	147.15 276.33	52.95 27.03	104.88 354.44
10	-21.704 -26.859	5.155	226.78 280.90	388.32 478.52	205.90 280.90	20.88 0.00	182.41 197.62
11	-26.859 -30.384	3.525	280.90 317.92	478.52 540.22	280.90 332.20	0.00 0.00	197.62 208.01
12	-30.384 -30.630	0.246	262.13 264.34	672.22 676.63	276.83 281.18	0.00 0.00	395.38 395.46
13	-30.630 -31.070	0.441	264.34 268.31	676.63 684.57	281.18 285.14	0.00 0.00	395.46 399.43
14	-31.070 -34.189	3.118	268.31 296.37	684.57 740.70	285.14 313.21	0.00 0.00	399.43 427.49
15	-34.189 -52.954	18.765	296.37 465.26	740.70 1078.47	313.21 482.10	0.00 0.00	427.49 596.38

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
16	-52.954 -54.660	1.706	678.97 700.19	2183.58 2286.05	739.78 763.39	0.00 0.00	1443.80 1522.66

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00
3	-1.721 -6.704	4.983	36.37 88.69	20.61 70.44	20.61 70.44	15.76 18.25	0.00 0.00
4	-6.704 -9.477	2.773	73.91 98.17	70.44 98.17	70.44 98.17	3.47 0.00	0.00 0.00
5	-9.477 -9.794	0.317	98.17 100.94	98.17 101.34	98.17 101.34	0.00 0.00	0.00 0.00
6	-9.794 -9.950	0.156	163.20 165.18	101.34 102.90	101.34 102.90	61.86 62.28	0.00 0.00
7	-9.950 -10.854	0.904	165.18 176.67	102.90 136.61	102.90 115.82	62.28 60.85	0.00 20.79
8	-10.854 -13.144	2.290	176.67 205.77	136.61 222.01	115.82 148.57	60.85 57.21	20.79 73.45
9	-13.144 -21.704	8.560	200.10 303.36	252.03 630.77	146.62 269.64	53.48 33.72	105.41 361.12
10	-21.704 -26.859	5.155	226.78 280.90	388.32 478.52	197.09 264.20	29.69 16.70	191.22 214.32
11	-26.859 -30.384	3.525	280.90 317.92	478.52 540.22	264.20 310.11	16.70 7.82	214.32 230.11
12	-30.384 -30.630	0.246	262.13 264.34	672.22 676.63	258.42 261.96	3.71 2.38	413.79 414.68
13	-30.630 -31.070	0.441	264.34 268.31	676.63 684.57	261.96 268.31	2.38 0.00	414.68 416.26
14	-31.070 -34.189	3.118	268.31 296.37	684.57 740.70	268.31 313.21	0.00 0.00	416.26 427.49
15	-34.189 -52.954	18.765	296.37 465.26	740.70 1078.47	313.21 482.10	0.00 0.00	427.49 596.38

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
16	-52.954 -54.660	1.706	678.97 700.19	2183.58 2286.05	739.78 763.39	0.00 0.00	1443.80 1522.66

3) 3 step

excavation area elevation = -9.950 (m)

landside water table elevation = -2.660 (m)

before footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -2.660	0.939	36.37 46.23	0.00 0.00	0.00 0.00	36.37 46.23	0.00 0.00
3	-2.660 -6.704	4.044	46.23 88.69	0.00 40.44	0.00 40.44	46.23 48.25	0.00 0.00
4	-6.704 -9.794	3.090	73.91 100.94	40.44 71.34	40.44 71.34	33.47 29.60	0.00 0.00
5	-9.794 -9.950	0.156	163.20 165.18	71.34 72.90	71.34 72.90	91.86 92.28	0.00 0.00
6	-9.950 -10.854	0.904	165.18 176.67	72.90 106.61	72.90 86.00	92.28 90.67	0.00 20.61
7	-10.854 -13.144	2.290	176.67 205.77	106.61 192.01	86.00 119.18	90.67 86.59	20.61 72.83
8	-13.144 -21.704	8.560	200.10 303.36	222.03 600.77	117.15 246.33	82.95 57.03	104.88 354.44
9	-21.704 -30.384	8.680	226.78 317.92	358.32 510.21	187.90 314.20	38.88 3.72	170.41 196.01
10	-30.384 -30.418	0.034	262.13 262.43	642.22 642.82	261.83 262.43	0.29 0.00	380.38 380.39
11	-30.418 -32.358	1.940	262.43 279.89	642.82 677.74	262.43 296.73	0.00 0.00	380.39 381.01
12	-32.358 -33.848	1.491	279.89 293.31	677.74 704.57	296.73 310.14	0.00 0.00	381.01 394.43
13	-33.848 -36.966	3.118	293.31 321.37	704.57 760.70	310.14 338.21	0.00 0.00	394.43 422.49
14	-36.966 -52.954	15.988	321.37 465.26	760.70 1048.47	338.21 482.10	0.00 0.00	422.49 566.38
15	-52.954 -54.660	1.706	678.97 700.19	2016.69 2119.16	739.78 763.39	0.00 0.00	1276.91 1355.78

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -2.660	0.939	36.37 46.23	0.00 0.00	0.00 0.00	36.37 46.23	0.00 0.00
3	-2.660 -6.704	4.044	46.23 88.69	0.00 40.44	0.00 40.44	46.23 48.25	0.00 0.00
4	-6.704 -9.794	3.090	73.91 100.94	40.44 71.34	40.44 71.34	33.47 29.60	0.00 0.00
5	-9.794 -9.950	0.156	163.20 165.18	71.34 72.90	71.34 72.90	91.86 92.28	0.00 0.00
6	-9.950 -10.854	0.904	165.18 176.67	72.90 106.61	72.90 85.82	92.28 90.85	0.00 20.79
7	-10.854 -13.144	2.290	176.67 205.77	106.61 192.01	85.82 118.57	90.85 87.21	20.79 73.45
8	-13.144 -21.704	8.560	200.10 303.36	222.03 600.77	116.62 239.64	83.48 63.72	105.41 361.12
9	-21.704 -30.384	8.680	226.78 317.92	358.32 510.21	179.09 292.11	47.69 25.82	179.22 218.11
10	-30.384 -30.418	0.034	262.13 262.43	642.22 642.82	243.42 243.91	18.71 18.52	398.79 398.92
11	-30.418 -32.358	1.940	262.43 279.89	642.82 677.74	243.91 271.84	18.52 8.05	398.92 405.90
12	-32.358 -33.848	1.491	279.89 293.31	677.74 704.57	271.84 293.31	8.05 0.00	405.90 411.26
13	-33.848 -36.966	3.118	293.31 321.37	704.57 760.70	293.31 338.21	0.00 0.00	411.26 422.49
14	-36.966 -52.954	15.988	321.37 465.26	760.70 1048.47	338.21 482.10	0.00 0.00	422.49 566.38
15	-52.954 -54.660	1.706	678.97 700.19	2016.69 2119.16	739.78 763.39	0.00 0.00	1276.91 1355.78

4) 4 step

excavation area elevation = -9.950 (m)

landside water table elevation = -9.950 (m)

after footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.55	148.74 147.12	96.37 116.98
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.55 62.73	147.12 143.04	116.98 169.20
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	58.37 187.54	141.73 115.82	242.42 491.98
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	162.76 289.06	64.02 28.86	153.65 179.25
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	240.88 284.15	21.24 0.00	359.43 360.21
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	284.15 318.45	0.00 0.00	360.21 360.83
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	318.45 345.06	0.00 0.00	360.83 387.44
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	345.06 373.12	0.00 0.00	387.44 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.37	148.74 147.30	96.37 117.15
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.37 62.11	147.30 143.66	117.15 169.81
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	57.84 180.86	142.26 122.50	242.95 498.66
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	153.95 266.97	72.83 50.96	162.46 201.35
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	222.47 257.71	39.66 26.44	377.84 386.65
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	257.71 285.65	26.44 15.97	386.65 393.64
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	285.65 328.22	15.97 0.00	393.64 404.28
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	328.22 373.12	0.00 0.00	404.28 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

5) 5 step

excavation area elevation = -9.950 (m)
landside water table elevation = -9.950 (m)

after footing concrete cast, after pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.55	148.74 147.12	96.37 116.98
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.55 62.73	147.12 143.04	116.98 169.20
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	58.37 187.54	141.73 115.82	242.42 491.98
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	162.76 289.06	64.02 28.86	153.65 179.25
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	240.88 284.15	21.24 0.00	359.43 360.21
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	284.15 318.45	0.00 0.00	360.21 360.83
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	318.45 345.06	0.00 0.00	360.83 387.44
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	345.06 373.12	0.00 0.00	387.44 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.37	148.74 147.30	96.37 117.15
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.37 62.11	147.30 143.66	117.15 169.81
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	57.84 180.86	142.26 122.50	242.95 498.66
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	153.95 266.97	72.83 50.96	162.46 201.35
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	222.47 257.71	39.66 26.44	377.84 386.65
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	257.71 285.65	26.44 15.97	386.65 393.64
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	285.65 328.22	15.97 0.00	393.64 404.28
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	328.22 373.12	0.00 0.00	404.28 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

2.8 side pressure detail output

(1)construction step [1]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -1.721	2.061	----	----	----	----
3	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
4	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
5	sandy	-9.794 -10.854	1.060	17.5	0.0	28.00	3.0
6	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
7	sandy	-13.144 -20.207	7.063	17.0	0.0	33.00	13.0
8	sandy	-20.207 -21.704	1.497	17.0	0.0	33.00	13.0
9	cohesv	-21.704 -24.347	2.643	17.5	42.0	0.00	7.0
10	cohesv	-24.347 -30.384	6.037	17.5	42.0	0.00	7.0
11	cohesv	-30.384 -52.954	22.570	18.0	108.0	0.00	18.0
12	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00
2	----	+0.340 -1.721	2.061	0.00 0.00	-------- --------	40.00 60.61	------- -------	------- -------	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	0.000 87.202	-------- --------	0.8000 0.8000	0.8000 0.8000	48.49 118.25	48.49 118.25

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	87.202 141.277	-------- --------	0.7000 0.7000	0.7000 0.7000	103.47 141.32	103.47 141.32
5	sandy	-9.794 -10.854	1.060	201.89 220.44	0.000 0.000	141.34 151.94	0.3610 0.3610	------- -------	21.86 24.73	163.20 176.67
6	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
7	sandy	-13.144 -20.207	7.063	260.51 380.59	0.000 0.000	174.84 245.47	0.2948 0.2948	------- -------	25.26 39.83	200.10 285.31
8	sandy	-20.207 -21.704	1.497	380.59 406.03	0.000 0.000	245.47 260.44	0.2948 0.2948	------- -------	39.83 42.92	285.31 303.36
9	cohesv	-21.704 -24.347	2.643	406.03 452.28	345.423 391.668	-------- --------	0.6000 0.6000	0.6000 0.6000	243.62 271.37	243.62 271.37
10	cohesv	-24.347 -30.384	6.037	452.28 557.93	391.668 497.323	-------- --------	0.6000 0.6000	0.6000 0.6000	271.37 334.76	271.37 334.76
11	cohesv	-30.384 -52.954	22.570	557.93 964.19	497.323 903.582	-------- --------	0.5000 0.5000	0.5000 0.5000	278.97 482.10	278.97 482.10
12	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

Pa1 = Ka1*$\left\{ \text{Sum.}\left((\text{Gam.*h})\right) + q - \text{pw1} \right\}$ - 2 * c * $\sqrt{\text{Ka1}}$ (sand soil)

Pa = Pa1 + pw1 (sand soil)

Pa = Pa1 = Ka1*$\left\{ \text{Sum.(Gam.*H)} + q \right\}$ + Ka2*$\left\{ \text{Sum.}\left(\text{Gam.(h - H)}\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	----	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	20.61 107.81	-------- --------	1.0000 1.0000	40.61 127.81	40.61 127.81
4	cohesv	-6.704 -9.794	3.090	107.81 161.89	-------- --------	1.0000 1.0000	137.81 191.89	137.81 191.89
5	sandy	-9.794 -10.854	1.060	161.89 180.44	101.34 111.94	3.6391 3.6391	220.34 249.27	321.68 361.21

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
6	sandy	-10.854 -13.144	2.290	180.44 220.51	111.94 134.84	3.6391 3.6391	249.27 311.77	361.21 446.61
7	sandy	-13.144 -20.207	7.063	220.51 340.59	134.84 205.47	4.8921 4.8921	419.12 661.00	553.96 866.47
8	sandy	-20.207 -21.704	1.497	340.59 366.03	205.47 220.44	4.8921 4.8921	661.00 712.25	866.47 932.69
9	cohesv	-21.704 -24.347	2.643	366.03 412.28	-------- --------	1.0000 1.0000	450.03 496.28	450.03 496.28
10	cohesv	-24.347 -30.384	6.037	412.28 517.93	-------- --------	1.0000 1.0000	496.28 601.93	496.28 601.93
11	cohesv	-30.384 -52.954	22.570	517.93 924.19	-------- --------	1.0000 1.0000	733.93 1140.19	733.93 1140.19
12	sandy	-52.954 -54.660	1.706	924.19 956.61	572.94 590.00	5.5628 5.5628	1953.96 2039.37	2526.90 2629.37

Pp1 = Kp * $\left\{ \text{Sum.}\left((\text{Gam.*h})\right) + q - \text{pw2} \right\}$ + 2*c*$\sqrt{\text{Kp}}$ (sand soil)

Pp = Pp1 + pw2 (sand soil)

Pp = Pp1 - Kp*$\left\{ \text{Sum.}\left((\text{Gam.*h})\right) + q \right\}$ + 2*c*$\sqrt{\text{kp}}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	40.00 60.61	0.0000 0.0000	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
5	sandy	-9.794 -10.854	1.060	201.89 220.44	141.34 151.94	0.5305 0.5305	32.12 36.34	173.46 188.28
6	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
7	sandy	-13.144 -20.207	7.063	260.51 380.59	174.84 245.47	0.4554 0.4554	39.01 61.53	213.85 307.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
8	sandy	-20.207 -21.704	1.497	380.59 406.03	245.47 260.44	0.4554 0.4554	61.53 66.30	307.00 326.74
9	cohesv	-21.704 -24.347	2.643	406.03 452.28	-------- --------	0.6000 0.6000	243.62 271.37	243.62 271.37
10	cohesv	-24.347 -30.384	6.037	452.28 557.93	-------- --------	0.6000 0.6000	271.37 334.76	271.37 334.76
11	cohesv	-30.384 -52.954	22.570	557.93 964.19	-------- --------	0.5000 0.5000	278.97 482.10	278.97 482.10
12	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	20.61 107.81	-------- --------	0.00	0.00 0.00	0.8000 0.8000	16.49 86.25	16.49 86.25
4	cohesv	-6.704 -9.794	3.090	107.81 161.89	-------- --------	7.50	0.00 23.17	0.7000 0.7000	75.47 118.54	75.47 118.54
5	sandy	-9.794 -10.854	1.060	161.89 180.44	101.34 111.94	3.00	23.17 26.35	0.5305 0.5305	36.07 40.83	137.41 152.77
6	sandy	-10.854 -13.144	2.290	180.44 220.51	111.94 134.84	3.00	26.35 33.22	0.5305 0.5305	40.83 51.12	152.77 185.96
7	sandy	-13.144 -20.207	7.063	220.51 340.59	134.84 205.47	13.00	33.22 125.05	0.4554 0.4554	43.88 79.83	178.72 285.31
8	sandy	-20.207 -21.704	1.497	340.59 366.03	205.47 220.44	13.00	125.05 144.51	0.4554 0.4554	79.83 87.45	285.31 307.89

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
9	cohesv	-21.704 -24.347	2.643	366.03 412.28	-------- --------	21.00	144.51 200.00	0.6000 0.6000	247.49 285.94	247.49 285.94
10	cohesv	-24.347 -30.384	6.037	412.28 517.93	-------- --------	21.00	200.00 326.79	0.6000 0.6000	285.94 373.79	285.94 373.79
11	cohesv	-30.384 -52.954	22.570	517.93 924.19	-------- --------	54.00	326.79 1545.56	0.5000 0.5000	311.49 710.53	311.49 710.53
12	sandy	-52.954 -54.660	1.706	924.19 956.61	572.94 590.00	50.00	1545.56 1630.86	0.4264 0.4264	361.66 379.90	934.60 969.90

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	20.61 107.81	-------- --------	0.00	0.00 0.00	0.8000 0.8000	16.49 86.25	16.49 86.25
4	cohesv	-6.704 -9.794	3.090	107.81 161.89	-------- --------	7.50	0.00 23.17	0.7000 0.7000	75.47 116.57	75.47 116.57
5	sandy	-9.794 -10.854	1.060	161.89 180.44	101.34 111.94	3.00	23.17 26.35	0.5305 0.5305	34.58 39.14	135.92 151.08
6	sandy	-10.854 -13.144	2.290	180.44 220.51	111.94 134.84	3.00	26.35 33.22	0.5305 0.5305	39.14 48.98	151.08 183.82
7	sandy	-13.144 -20.207	7.063	220.51 340.59	134.84 205.47	13.00	33.22 125.05	0.4554 0.4554	42.04 72.91	176.88 278.39
8	sandy	-20.207 -21.704	1.497	340.59 366.03	205.47 220.44	13.00	125.05 144.51	0.4554 0.4554	72.91 79.46	278.39 299.90

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
9	cohesv	-21.704 -24.347	2.643	366.03 412.28	-------- --------	21.00	144.51 200.00	0.6000 0.6000	236.96 271.37	236.96 271.37
10	cohesv	-24.347 -30.384	6.037	412.28 517.93	-------- --------	21.00	200.00 326.79	0.6000 0.6000	271.37 349.97	271.37 349.97
11	cohesv	-30.384 -52.954	22.570	517.93 924.19	-------- --------	54.00	326.79 1545.56	0.5000 0.5000	291.64 616.65	291.64 616.65
12	sandy	-52.954 -54.660	1.706	924.19 956.61	572.94 590.00	50.00	1545.56 1630.86	0.4264 0.4264	281.60 295.42	854.54 885.42

friction force B7027influence range B = 5.000 (m)

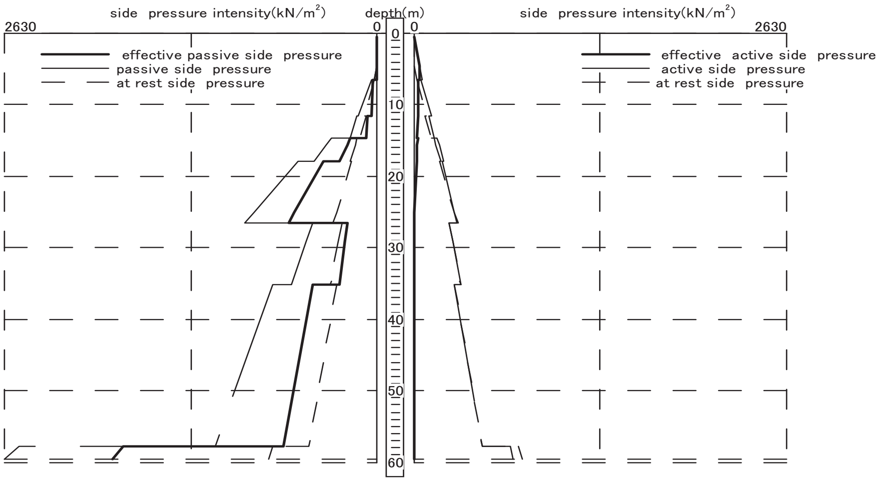
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

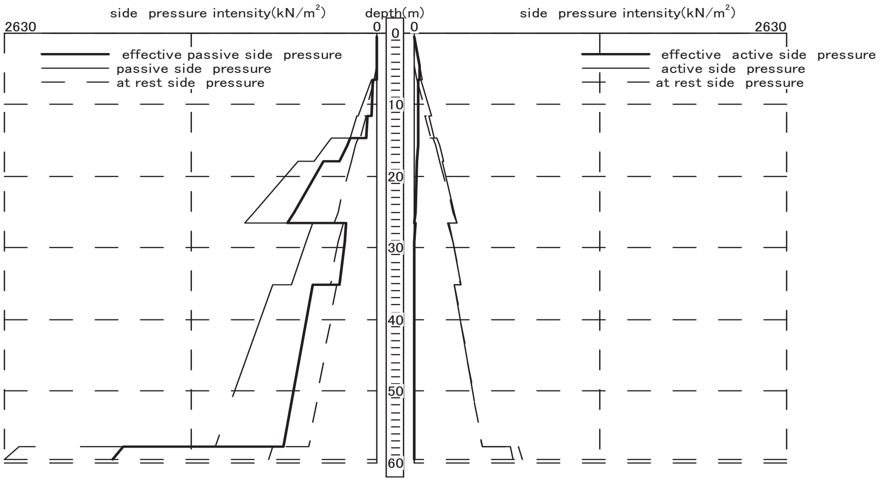
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(2)construction step [2]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -1.721	2.061	----	----	----	----
3	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
4	cohesv	-6.704 -9.477	2.773	17.5	15.0	0.00	3.0
5	cohesv	-9.477 -9.794	0.317	17.5	15.0	0.00	3.0
6	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
7	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
8	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
9	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
10	cohesv	-21.704 -26.859	5.155	17.5	42.0	0.00	7.0
11	cohesv	-26.859 -30.384	3.525	17.5	42.0	0.00	7.0
12	cohesv	-30.384 -30.630	0.246	18.0	108.0	0.00	18.0
13	cohesv	-30.630 -31.070	0.441	18.0	108.0	0.00	18.0
14	cohesv	-31.070 -34.189	3.118	18.0	108.0	0.00	18.0
15	cohesv	-34.189 -52.954	18.765	18.0	108.0	0.00	18.0
16	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00
2	----	+0.340 -1.721	2.061	0.00 0.00	-------- --------	40.00 60.61	------- -------	------- -------	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 88.69	36.37 88.69
4	cohesv	-6.704 -9.477	2.773	147.81 196.34	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 98.17	73.91 98.17
5	cohesv	-9.477 -9.794	0.317	196.34 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	98.17 100.94	98.17 100.94
6	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
7	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
8	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
9	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
10	cohesv	-21.704 -26.859	5.155	406.03 496.24	201.415 291.620	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 280.90	226.78 280.90
11	cohesv	-26.859 -30.384	3.525	496.24 557.93	291.620 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	280.90 317.92	280.90 317.92
12	cohesv	-30.384 -30.630	0.246	557.93 562.35	353.315 357.735	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 264.34	262.13 264.34
13	cohesv	-30.630 -31.070	0.441	562.35 570.29	357.735 365.670	-------- --------	0.4177 0.4177	0.5000 0.5000	264.34 268.31	264.34 268.31
14	cohesv	-31.070 -34.189	3.118	570.29 626.41	365.670 421.797	-------- --------	0.4177 0.4177	0.5000 0.5000	268.31 296.37	268.31 296.37
15	cohesv	-34.189 -52.954	18.765	626.41 964.19	421.797 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	296.37 465.26	296.37 465.26
16	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1*\left\{ Sum.(Gam.*H) + q \right\} + Ka2*\left\{ Sum.\left(Gam.(h - H)\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	----	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	20.61 70.44
4	cohesv	-6.704 -9.477	2.773	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	70.44 98.17
5	cohesv	-9.477 -9.794	0.317	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	98.17 101.34
6	sandy	-9.794 -9.950	0.156	0.00 0.00	101.34 102.90	0.0000 0.0000	0.00 0.00	101.34 102.90
7	sandy	-9.950 -10.854	0.904	102.90 118.72	102.90 111.94	3.6391 3.6391	0.00 24.67	102.90 136.61
8	sandy	-10.854 -13.144	2.290	118.72 158.80	111.94 134.84	3.6391 3.6391	24.67 87.17	136.61 222.01
9	sandy	-13.144 -21.704	8.560	158.80 304.32	134.84 220.44	4.8921 4.8921	117.19 410.32	252.03 630.77
10	cohesv	-21.704 -26.859	5.155	304.32 394.52	-------- --------	1.0000 1.0000	388.32 478.52	388.32 478.52
11	cohesv	-26.859 -30.384	3.525	394.52 456.21	-------- --------	1.0000 1.0000	478.52 540.22	478.52 540.22
12	cohesv	-30.384 -30.630	0.246	456.21 460.63	-------- --------	1.0000 1.0000	672.22 676.63	672.22 676.63
13	cohesv	-30.630 -31.070	0.441	460.63 468.57	-------- --------	1.0000 1.0000	676.63 684.57	676.63 684.57
14	cohesv	-31.070 -34.189	3.118	468.57 524.70	-------- --------	1.0000 1.0000	684.57 740.70	684.57 740.70
15	cohesv	-34.189 -52.954	18.765	524.70 862.47	-------- --------	1.0000 1.0000	740.70 1078.47	740.70 1078.47
16	sandy	-52.954 -54.660	1.706	862.47 894.89	572.94 590.00	5.5628 5.5628	1610.64 1696.05	2183.58 2286.05

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{Kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	40.00 60.61	0.0000 0.0000	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
4	cohesv	-6.704 -9.477	2.773	147.81 196.34	-------- --------	0.7000 0.7000	103.47 137.44	103.47 137.44
5	cohesv	-9.477 -9.794	0.317	196.34 201.89	-------- --------	0.7000 0.7000	137.44 141.32	137.44 141.32
6	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
7	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
8	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
9	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
10	cohesv	-21.704 -26.859	5.155	406.03 496.24	-------- --------	0.6000 0.6000	243.62 297.74	243.62 297.74
11	cohesv	-26.859 -30.384	3.525	496.24 557.93	-------- --------	0.6000 0.6000	297.74 334.76	297.74 334.76
12	cohesv	-30.384 -30.630	0.246	557.93 562.35	-------- --------	0.5000 0.5000	278.97 281.18	278.97 281.18
13	cohesv	-30.630 -31.070	0.441	562.35 570.29	-------- --------	0.5000 0.5000	281.18 285.14	281.18 285.14
14	cohesv	-31.070 -34.189	3.118	570.29 626.41	-------- --------	0.5000 0.5000	285.14 313.21	285.14 313.21
15	cohesv	-34.189 -52.954	18.765	626.41 964.19	-------- --------	0.5000 0.5000	313.21 482.10	313.21 482.10
16	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	20.61 70.44
4	cohesv	-6.704 -9.477	2.773	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	70.44 98.17
5	cohesv	-9.477 -9.794	0.317	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	98.17 101.34
6	sandy	-9.794 -9.950	0.156	0.00 0.00	101.34 102.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	101.34 102.90
7	sandy	-9.950 -10.854	0.904	102.90 118.72	102.90 111.94	3.00	0.00 2.71	0.5305 0.5305	0.00 4.06	102.90 116.00
8	sandy	-10.854 -13.144	2.290	118.72 158.80	111.94 134.84	3.00	2.71 9.58	0.5305 0.5305	4.06 14.34	116.00 149.18
9	sandy	-13.144 -21.704	8.560	158.80 304.32	134.84 220.44	13.00	9.58 120.86	0.4554 0.4554	12.31 55.89	147.15 276.33
10	cohesv	-21.704 -26.859	5.155	304.32 394.52	-------- --------	21.00	120.86 229.11	0.6000 0.6000	205.90 280.90	205.90 280.90
11	cohesv	-26.859 -30.384	3.525	394.52 456.21	-------- --------	21.00	229.11 303.14	0.6000 0.6000	280.90 332.20	280.90 332.20
12	cohesv	-30.384 -30.630	0.246	456.21 460.63	-------- --------	54.00	303.14 316.40	0.5000 0.5000	276.83 281.18	276.83 281.18
13	cohesv	-30.630 -31.070	0.441	460.63 468.57	-------- --------	54.00	316.40 340.21	0.5000 0.5000	281.18 288.97	281.18 288.97
14	cohesv	-31.070 -34.189	3.118	468.57 524.70	-------- --------	54.00	340.21 508.59	0.5000 0.5000	288.97 344.10	288.97 344.10
15	cohesv	-34.189 -52.954	18.765	524.70 862.47	-------- --------	54.00	508.59 1521.92	0.5000 0.5000	344.10 675.87	344.10 675.87

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
16	sandy	-52.954 -54.660	1.706	862.47 894.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	332.10 350.34	905.04 940.34

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	20.61 70.44
4	cohesv	-6.704 -9.477	2.773	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	70.44 98.17
5	cohesv	-9.477 -9.794	0.317	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	98.17 101.34
6	sandy	-9.794 -9.950	0.156	0.00 0.00	101.34 102.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	101.34 102.90
7	sandy	-9.950 -10.854	0.904	102.90 118.72	102.90 111.94	3.00	0.00 2.71	0.5305 0.5305	0.00 3.88	102.90 115.82
8	sandy	-10.854 -13.144	2.290	118.72 158.80	111.94 134.84	3.00	2.71 9.58	0.5305 0.5305	3.88 13.73	115.82 148.57
9	sandy	-13.144 -21.704	8.560	158.80 304.32	134.84 220.44	13.00	9.58 120.86	0.4554 0.4554	11.78 49.20	146.62 269.64
10	cohesv	-21.704 -26.859	5.155	304.32 394.52	-------- --------	21.00	120.86 229.11	0.6000 0.6000	197.09 264.20	197.09 264.20
11	cohesv	-26.859 -30.384	3.525	394.52 456.21	-------- --------	21.00	229.11 303.14	0.6000 0.6000	264.20 310.11	264.20 310.11

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
12	cohesv	-30.384 -30.630	0.246	456.21 460.63	-------- --------	54.00	303.14 316.40	0.5000 0.5000	258.42 261.96	258.42 261.96
13	cohesv	-30.630 -31.070	0.441	460.63 468.57	-------- --------	54.00	316.40 340.21	0.5000 0.5000	261.96 268.31	261.96 268.31
14	cohesv	-31.070 -34.189	3.118	468.57 524.70	-------- --------	54.00	340.21 508.59	0.5000 0.5000	268.31 313.21	268.31 313.21
15	cohesv	-34.189 -52.954	18.765	524.70 862.47	-------- --------	54.00	508.59 1521.92	0.5000 0.5000	313.21 583.43	313.21 583.43
16	sandy	-52.954 -54.660	1.706	862.47 894.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	253.26 267.08	826.20 857.08

friction force B7027influence range B = 5.000 (m)

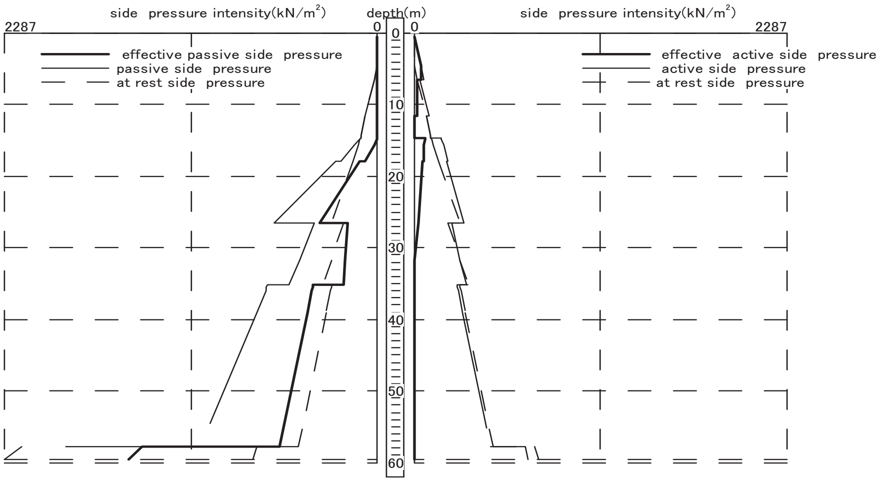
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



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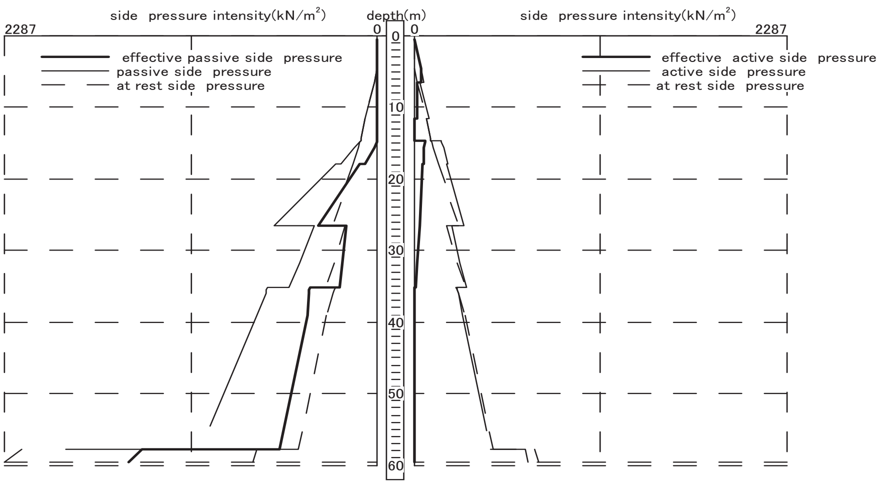
perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(3)construction step [3]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -1.721	6.061	----	----	----	----
2	cohesv	-1.721 -2.660	0.939	17.5	10.0	0.00	1.0
3	cohesv	-2.660 -6.704	4.044	17.5	10.0	0.00	1.0
4	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
5	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
6	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
7	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
8	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
9	cohesv	-21.704 -30.384	8.680	17.5	42.0	0.00	7.0
10	cohesv	-30.384 -30.418	0.034	18.0	108.0	0.00	18.0
11	cohesv	-30.418 -32.358	1.940	18.0	108.0	0.00	18.0
12	cohesv	-32.358 -33.848	1.491	18.0	108.0	0.00	18.0
13	cohesv	-33.848 -36.966	3.118	18.0	108.0	0.00	18.0
14	cohesv	-36.966 -52.954	15.988	18.0	108.0	0.00	18.0
15	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	-------- --------	0.00 60.61	------- -------	------- -------	0.00 0.00	0.00 60.61
2	cohesv	-1.721 -2.660	0.939	60.61 77.04	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 46.23	36.37 46.23
3	cohesv	-2.660 -6.704	4.044	77.04 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	46.23 88.69	46.23 88.69
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 100.94	73.91 100.94
5	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
6	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
7	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
8	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
9	cohesv	-21.704 -30.384	8.680	406.03 557.93	201.415 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 317.92	226.78 317.92
10	cohesv	-30.384 -30.418	0.034	557.93 558.54	353.315 353.923	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 262.43	262.13 262.43
11	cohesv	-30.418 -32.358	1.940	558.54 593.46	353.923 388.841	-------- --------	0.4177 0.4177	0.5000 0.5000	262.43 279.89	262.43 279.89
12	cohesv	-32.358 -33.848	1.491	593.46 620.29	388.841 415.670	-------- --------	0.4177 0.4177	0.5000 0.5000	279.89 293.31	279.89 293.31
13	cohesv	-33.848 -36.966	3.118	620.29 676.41	415.670 471.797	-------- --------	0.4177 0.4177	0.5000 0.5000	293.31 321.37	293.31 321.37
14	cohesv	-36.966 -52.954	15.988	676.41 964.19	471.797 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	321.37 465.26	321.37 465.26
15	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -2.660	0.939	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-2.660 -6.704	4.044	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 40.44
4	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	40.44 71.34
5	sandy	-9.794 -9.950	0.156	0.00 0.00	71.34 72.90	0.0000 0.0000	0.00 0.00	71.34 72.90
6	sandy	-9.950 -10.854	0.904	72.90 88.72	72.90 81.94	3.6391 3.6391	0.00 24.67	72.90 106.61
7	sandy	-10.854 -13.144	2.290	88.72 128.80	81.94 104.84	3.6391 3.6391	24.67 87.17	106.61 192.01
8	sandy	-13.144 -21.704	8.560	128.80 274.32	104.84 190.44	4.8921 4.8921	117.19 410.32	222.03 600.77
9	cohesv	-21.704 -30.384	8.680	274.32 426.21	-------- --------	1.0000 1.0000	358.32 510.21	358.32 510.21
10	cohesv	-30.384 -30.418	0.034	426.21 426.82	-------- --------	1.0000 1.0000	642.22 642.82	642.22 642.82
11	cohesv	-30.418 -32.358	1.940	426.82 461.74	-------- --------	1.0000 1.0000	642.82 677.74	642.82 677.74
12	cohesv	-32.358 -33.848	1.491	461.74 488.57	-------- --------	1.0000 1.0000	677.74 704.57	677.74 704.57
13	cohesv	-33.848 -36.966	3.118	488.57 544.70	-------- --------	1.0000 1.0000	704.57 760.70	704.57 760.70
14	cohesv	-36.966 -52.954	15.988	544.70 832.47	-------- --------	1.0000 1.0000	760.70 1048.47	760.70 1048.47
15	sandy	-52.954 -54.660	1.706	832.47 864.89	572.94 590.00	5.5628 5.5628	1443.75 1529.16	2016.69 2119.16

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 60.61	0.0000 0.0000	0.00 0.00	0.00 60.61
2	cohesv	-1.721 -2.660	0.939	60.61 77.04	-------- --------	0.8000 0.8000	48.49 61.63	48.49 61.63
3	cohesv	-2.660 -6.704	4.044	77.04 147.81	-------- --------	0.8000 0.8000	61.63 118.25	61.63 118.25
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
5	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
6	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
7	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
8	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
9	cohesv	-21.704 -30.384	8.680	406.03 557.93	-------- --------	0.6000 0.6000	243.62 334.76	243.62 334.76
10	cohesv	-30.384 -30.418	0.034	557.93 558.54	-------- --------	0.5000 0.5000	278.97 279.27	278.97 279.27
11	cohesv	-30.418 -32.358	1.940	558.54 593.46	-------- --------	0.5000 0.5000	279.27 296.73	279.27 296.73
12	cohesv	-32.358 -33.848	1.491	593.46 620.29	-------- --------	0.5000 0.5000	296.73 310.14	296.73 310.14
13	cohesv	-33.848 -36.966	3.118	620.29 676.41	-------- --------	0.5000 0.5000	310.14 338.21	310.14 338.21
14	cohesv	-36.966 -52.954	15.988	676.41 964.19	-------- --------	0.5000 0.5000	338.21 482.10	338.21 482.10
15	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (sand soil)

$Po = Po1 + pw1$ (sand soil)

$Po = Po1 = Ko * \left\{ Sum.(Gam.*h) + q \right\}$ (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -2.660	0.939	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-2.660 -6.704	4.044	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 40.44
4	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	40.44 71.34
5	sandy	-9.794 -9.950	0.156	0.00 0.00	71.34 72.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	71.34 72.90
6	sandy	-9.950 -10.854	0.904	72.90 88.72	72.90 81.94	3.00	0.00 2.71	0.5305 0.5305	0.00 4.06	72.90 86.00
7	sandy	-10.854 -13.144	2.290	88.72 128.80	81.94 104.84	3.00	2.71 9.58	0.5305 0.5305	4.06 14.34	86.00 119.18
8	sandy	-13.144 -21.704	8.560	128.80 274.32	104.84 190.44	13.00	9.58 120.86	0.4554 0.4554	12.31 55.89	117.15 246.33
9	cohesv	-21.704 -30.384	8.680	274.32 426.21	-------- --------	21.00	120.86 303.14	0.6000 0.6000	187.90 314.20	187.90 314.20
10	cohesv	-30.384 -30.418	0.034	426.21 426.82	-------- --------	54.00	303.14 304.97	0.5000 0.5000	261.83 262.43	261.83 262.43
11	cohesv	-30.418 -32.358	1.940	426.82 461.74	-------- --------	54.00	304.97 409.72	0.5000 0.5000	262.43 296.73	262.43 296.73
12	cohesv	-32.358 -33.848	1.491	461.74 488.57	-------- --------	54.00	409.72 490.21	0.5000 0.5000	296.73 323.08	296.73 323.08
13	cohesv	-33.848 -36.966	3.118	488.57 544.70	-------- --------	54.00	490.21 658.59	0.5000 0.5000	323.08 378.21	323.08 378.21
14	cohesv	-36.966 -52.954	15.988	544.70 832.47	-------- --------	54.00	658.59 1521.92	0.5000 0.5000	378.21 660.87	378.21 660.87

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
15	sandy	-52.954 -54.660	1.706	832.47 864.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	319.31 337.55	892.25 927.55

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -2.660	0.939	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-2.660 -6.704	4.044	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 40.44
4	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	40.44 71.34
5	sandy	-9.794 -9.950	0.156	0.00 0.00	71.34 72.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	71.34 72.90
6	sandy	-9.950 -10.854	0.904	72.90 88.72	72.90 81.94	3.00	0.00 2.71	0.5305 0.5305	0.00 3.88	72.90 85.82
7	sandy	-10.854 -13.144	2.290	88.72 128.80	81.94 104.84	3.00	2.71 9.58	0.5305 0.5305	3.88 13.73	85.82 118.57
8	sandy	-13.144 -21.704	8.560	128.80 274.32	104.84 190.44	13.00	9.58 120.86	0.4554 0.4554	11.78 49.20	116.62 239.64
9	cohesv	-21.704 -30.384	8.680	274.32 426.21	-------- --------	21.00	120.86 303.14	0.6000 0.6000	179.09 292.11	179.09 292.11
10	cohesv	-30.384 -30.418	0.034	426.21 426.82	-------- --------	54.00	303.14 304.97	0.5000 0.5000	243.42 243.91	243.42 243.91
11	cohesv	-30.418 -32.358	1.940	426.82 461.74	-------- --------	54.00	304.97 409.72	0.5000 0.5000	243.91 271.84	243.91 271.84

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
12	cohesv	-32.358 -33.848	1.491	461.74 488.57	-------- --------	54.00	409.72 490.21	0.5000 0.5000	271.84 293.31	271.84 293.31
13	cohesv	-33.848 -36.966	3.118	488.57 544.70	-------- --------	54.00	490.21 658.59	0.5000 0.5000	293.31 338.21	293.31 338.21
14	cohesv	-36.966 -52.954	15.988	544.70 832.47	-------- --------	54.00	658.59 1521.92	0.5000 0.5000	338.21 568.43	338.21 568.43
15	sandy	-52.954 -54.660	1.706	832.47 864.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	240.47 254.29	813.41 844.29

friction force B7027influence range B = 5.000 (m)

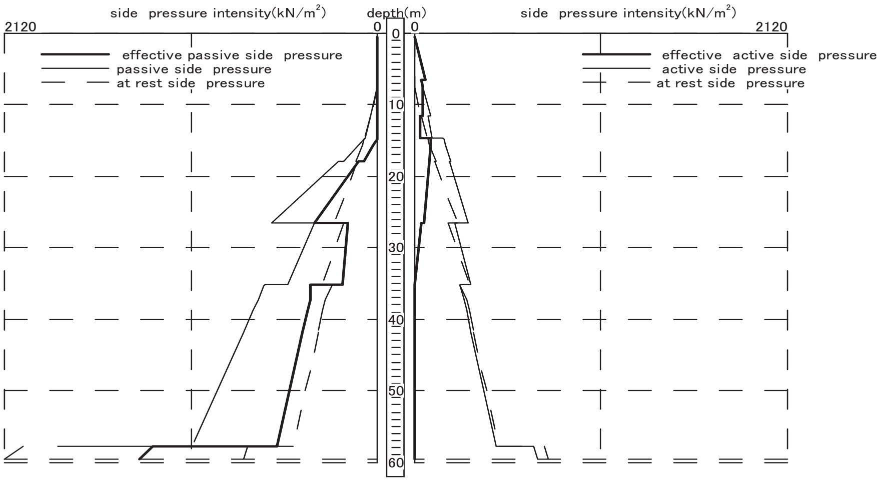
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

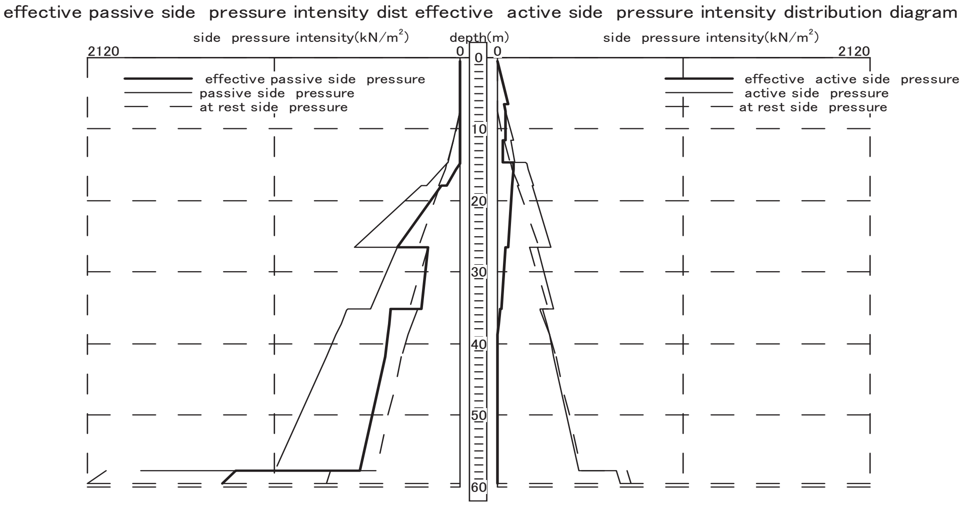
Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction



(4)construction step [4]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -1.721	6.061	----	----	----	----
2	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
3	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
4	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
5	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
6	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
7	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
8	cohesv	-21.704 -30.384	8.680	17.5	42.0	0.00	7.0
9	cohesv	-30.384 -32.831	2.447	18.0	108.0	0.00	18.0
10	cohesv	-32.831 -34.771	1.940	18.0	108.0	0.00	18.0
11	cohesv	-34.771 -37.728	2.957	18.0	108.0	0.00	18.0
12	cohesv	-37.728 -40.846	3.118	18.0	108.0	0.00	18.0
13	cohesv	-40.846 -52.954	12.108	18.0	108.0	0.00	18.0
14	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	-------- --------	0.00 60.61	------- -------	------- -------	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 88.69	36.37 88.69
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 100.94	73.91 100.94
4	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
5	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
6	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
7	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	201.415 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 317.92	226.78 317.92
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	353.315 397.368	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 284.15	262.13 284.15
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	397.368 432.285	-------- --------	0.4177 0.4177	0.5000 0.5000	284.15 301.61	284.15 301.61
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	432.285 485.504	-------- --------	0.4177 0.4177	0.5000 0.5000	301.61 328.22	301.61 328.22
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	485.504 541.630	-------- --------	0.4177 0.4177	0.5000 0.5000	328.22 356.29	328.22 356.29
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	541.630 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	356.29 465.26	356.29 465.26
14	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

Pa1 = Ka1*$\left\{ \text{Sum.}\left((\text{Gam.*h})\right) + q - \text{pw1} \right\}$ - 2 * c * $\sqrt{\text{Ka1}}$ (sand soil)

Pa = Pa1 + pw1 (sand soil)

Pa = Pa1 = Ka1*$\left\{ \text{Sum.(Gam.*H)} + q \right\}$ + Ka2*$\left\{ \text{Sum.}\left(\text{Gam.(h - H)}\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.6391 3.6391	112.81 137.48	112.81 146.52
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.6391 3.6391	137.48 199.99	146.52 231.93
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	4.8921 4.8921	268.85 561.98	300.79 679.52
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	1.0000 1.0000	316.42 468.32	316.42 468.32
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	1.0000 1.0000	600.32 644.37	600.32 644.37
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	1.0000 1.0000	644.37 679.29	644.37 679.29
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	1.0000 1.0000	679.29 732.50	679.29 732.50
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	1.0000 1.0000	732.50 788.63	732.50 788.63
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	1.0000 1.0000	788.63 1006.57	788.63 1006.57
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	5.5628 5.5628	1210.67 1296.08	1783.61 1886.08

Pp1 = Kp * $\left\{ \text{Sum.}\left((\text{Gam.*h})\right) + q - \text{pw2} \right\}$ + 2*c*$\sqrt{\text{Kp}}$ (sand soil)

Pp = Pp1 + pw2 (sand soil)

Pp = Pp1 - Kp*$\left\{ \text{Sum.}\left((\text{Gam.*h})\right) + q \right\}$ + 2*c*$\sqrt{\text{kp}}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 60.61	0.0000 0.0000	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
4	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
5	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
6	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
7	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	-------- --------	0.6000 0.6000	243.62 334.76	243.62 334.76
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	-------- --------	0.5000 0.5000	278.97 300.99	278.97 300.99
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	-------- --------	0.5000 0.5000	300.99 318.45	300.99 318.45
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	-------- --------	0.5000 0.5000	318.45 345.06	318.45 345.06
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	-------- --------	0.5000 0.5000	345.06 373.12	345.06 373.12
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	-------- --------	0.5000 0.5000	373.12 482.10	373.12 482.10
14	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.51	16.45 29.55
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.51 30.79	29.55 62.73
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	26.43 70.00	58.37 187.54
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	162.76 289.06	162.76 289.06
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	240.88 284.15	240.88 284.15
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	284.15 318.45	284.15 318.45
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	318.45 370.72	318.45 370.72
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	370.72 425.85	370.72 425.85
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	425.85 639.92	425.85 639.92
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	301.44 319.68	874.38 909.68

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.33	16.45 29.37
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.33 30.17	29.37 62.11
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	25.90 63.32	57.84 180.86
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	153.95 266.97	153.95 266.97
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	222.47 257.71	222.47 257.71
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	257.71 285.65	257.71 285.65
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	285.65 328.22	285.65 328.22
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	328.22 373.12	328.22 373.12
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	373.12 547.48	373.12 547.48
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	222.60 236.42	795.54 826.42

friction force B7027influence range B = 5.000 (m)

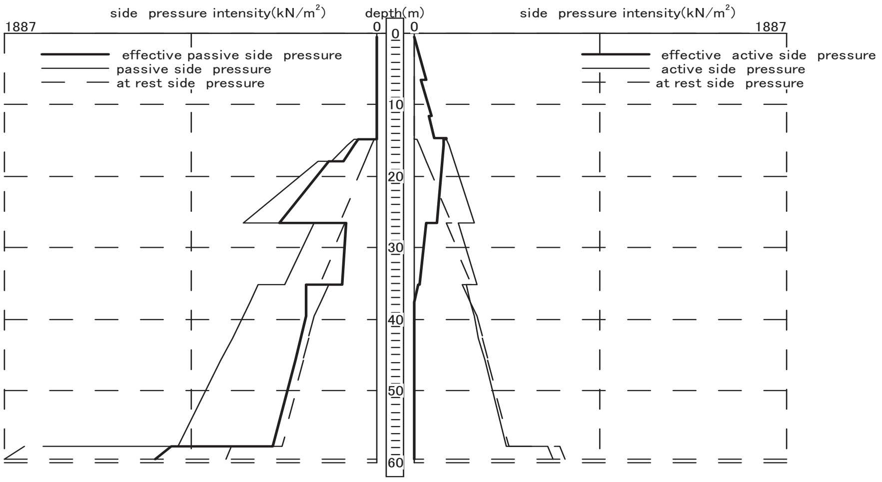
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

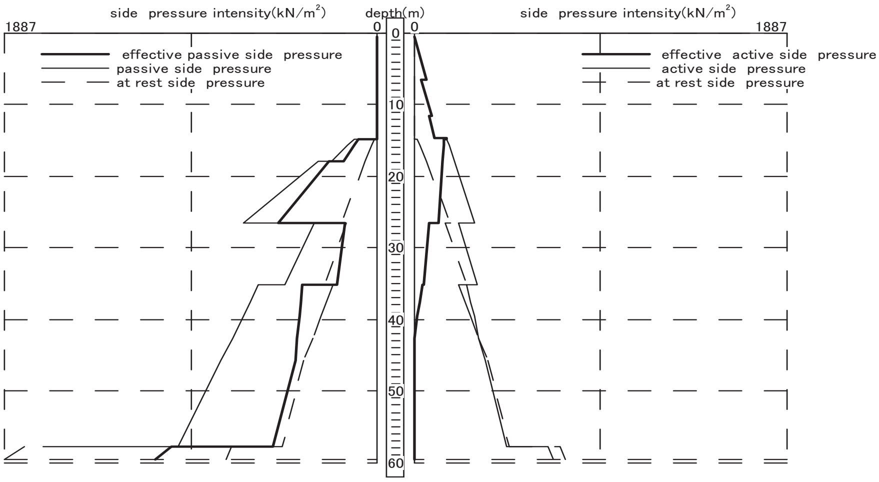
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(5)construction step [5]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -1.721	6.061	----	----	----	----
2	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
3	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
4	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
5	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
6	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
7	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
8	cohesv	-21.704 -30.384	8.680	17.5	42.0	0.00	7.0
9	cohesv	-30.384 -32.831	2.447	18.0	108.0	0.00	18.0
10	cohesv	-32.831 -34.771	1.940	18.0	108.0	0.00	18.0
11	cohesv	-34.771 -37.728	2.957	18.0	108.0	0.00	18.0
12	cohesv	-37.728 -40.846	3.118	18.0	108.0	0.00	18.0
13	cohesv	-40.846 -52.954	12.108	18.0	108.0	0.00	18.0
14	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	-------- --------	0.00 60.61	------- -------	------- -------	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 88.69	36.37 88.69
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 100.94	73.91 100.94
4	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
5	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
6	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
7	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	201.415 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 317.92	226.78 317.92
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	353.315 397.368	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 284.15	262.13 284.15
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	397.368 432.285	-------- --------	0.4177 0.4177	0.5000 0.5000	284.15 301.61	284.15 301.61
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	432.285 485.504	-------- --------	0.4177 0.4177	0.5000 0.5000	301.61 328.22	301.61 328.22
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	485.504 541.630	-------- --------	0.4177 0.4177	0.5000 0.5000	328.22 356.29	328.22 356.29
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	541.630 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	356.29 465.26	356.29 465.26
14	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

$$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \quad \text{(sand soil)}$$

$$Pa = Pa1 + pw1 \quad \text{(sand soil)}$$

$$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\} \quad \text{(cohesive soil)}$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.6391 3.6391	112.81 137.48	112.81 146.52
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.6391 3.6391	137.48 199.99	146.52 231.93
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	4.8921 4.8921	268.85 561.98	300.79 679.52
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	1.0000 1.0000	316.42 468.32	316.42 468.32
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	1.0000 1.0000	600.32 644.37	600.32 644.37
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	1.0000 1.0000	644.37 679.29	644.37 679.29
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	1.0000 1.0000	679.29 732.50	679.29 732.50
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	1.0000 1.0000	732.50 788.63	732.50 788.63
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	1.0000 1.0000	788.63 1006.57	788.63 1006.57
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	5.5628 5.5628	1210.67 1296.08	1783.61 1886.08

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \quad \text{(sand soil)}$$

$$Pp = Pp1 + pw2 \quad \text{(sand soil)}$$

$$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp} \quad \text{(cohesive soil)}$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 60.61	0.0000 0.0000	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
4	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
5	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
6	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
7	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	-------- --------	0.6000 0.6000	243.62 334.76	243.62 334.76
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	-------- --------	0.5000 0.5000	278.97 300.99	278.97 300.99
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	-------- --------	0.5000 0.5000	300.99 318.45	300.99 318.45
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	-------- --------	0.5000 0.5000	318.45 345.06	318.45 345.06
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	-------- --------	0.5000 0.5000	345.06 373.12	345.06 373.12
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	-------- --------	0.5000 0.5000	373.12 482.10	373.12 482.10
14	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.51	16.45 29.55
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.51 30.79	29.55 62.73
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	26.43 70.00	58.37 187.54
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	162.76 289.06	162.76 289.06
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	240.88 284.15	240.88 284.15
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	284.15 318.45	284.15 318.45
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	318.45 370.72	318.45 370.72
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	370.72 425.85	370.72 425.85
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	425.85 639.92	425.85 639.92
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	301.44 319.68	874.38 909.68

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.33	16.45 29.37
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.33 30.17	29.37 62.11
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	25.90 63.32	57.84 180.86
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	153.95 266.97	153.95 266.97
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	222.47 257.71	222.47 257.71
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	257.71 285.65	257.71 285.65
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	285.65 328.22	285.65 328.22
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	328.22 373.12	328.22 373.12
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	373.12 547.48	373.12 547.48
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	222.60 236.42	795.54 826.42

friction force B7027influence range B = 5.000 (m)

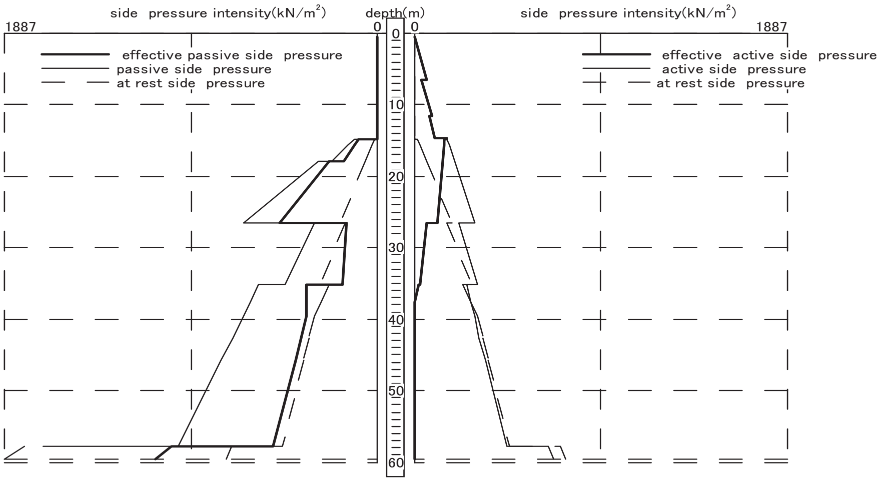
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

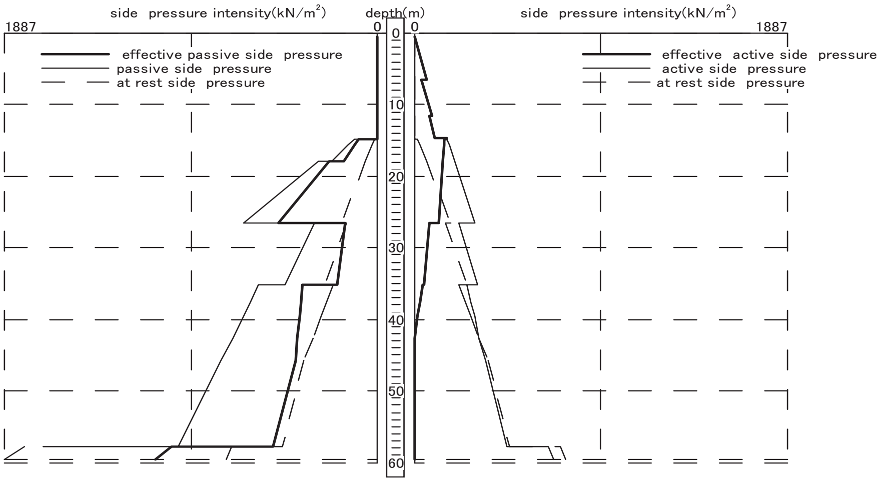
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



2.9 calculation result table

1)bridge axis direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	1.866	2.665	3.599	3.809
	accrue location	Lm	m	-5.160	-7.160	-9.160	-10.854
displace coffer displace part	max bending moment	Mmax	kN.m	637.0	623.0	418.0	382.0
		Sig.	N/mm²	60.37	51.89	34.80	31.81
		Lm	m	-1.721	-3.450	-3.450	-3.450
	SKY400	M	kN.m	637.0	570.0	418.0	382.0
		Sig.max	N/mm²	60.37	53.96	34.80	31.81
		Lm	m	-1.721	-2.160	-3.450	-3.450
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	614.0	651.0	965.0	804.0
		Sig.	N/mm²	51.13	54.21	80.35	66.97
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY400	M	kN.m	614.0	651.0	965.0	804.0
		Sig.max	N/mm²	51.13	54.21	80.35	66.97
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	164.6	75.2	25.6	30.2
		2nd row	kN/m	------	147.0	52.0	56.8
		3rd row	kN/m	------	------	405.6	353.1
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	0.0	487.1

note)Lm shows elevation

item			unit	the5step
displace ment	max displacement	Del.max	cm	3.811
	accrue location	Lm	m	-10.854
displace coffer displace part	max bending moment	Mmax	kN.m	389.0
		Sig.	N/mm²	32.42
		Lm	m	-3.450
	SKY400	M	kN.m	389.0
		Sig.max	N/mm²	32.42
		Lm	m	-3.450
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
displace celler displace part	max bending moment	Mmax	kN.m	806.0
		Sig.	N/mm²	67.16
		Lm	m	-11.160
	SKY400	M	kN.m	806.0
		Sig.max	N/mm²	67.16
		Lm	m	-11.160
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
(SKY400)		Sig.a	N/mm²	210.00
(SKY490)		Sig.a	N/mm²	------

support point reaction force	timbering reaction	1st row	kN/m	30.4
		2nd row	kN/m	57.8
		3rd row	kN/m	353.6
		4th row	kN/m	------
		5th row	kN/m	------
		6th row	kN/m	------
		7th row	kN/m	------
		8th row	kN/m	------
		9th row	kN/m	------
		10th row	kN/m	------
	footing concrete reaction		kN/m	491.9

note)Lm shows elevation

2)perpendicular direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	1.905	2.658	3.578	3.918
	accrue location	Lm	m	-5.160	-7.450	-9.160	-11.160
displace coffer displace part	max bending moment	Mmax	kN.m	637.0	611.0	388.0	322.0
		Sig.	N/mm²	60.32	50.85	32.28	26.82
		Lm	m	-1.721	-3.450	-3.450	-3.450
	SKY400	M	kN.m	637.0	558.0	388.0	322.0
		Sig.max	N/mm²	60.32	52.82	32.28	26.82
		Lm	m	-1.721	-2.160	-3.450	-3.450
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	614.0	638.0	942.0	833.0
		Sig.	N/mm²	51.10	53.10	78.41	69.36
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY400	M	kN.m	614.0	638.0	942.0	833.0
		Sig.max	N/mm²	51.10	53.10	78.41	69.36
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	164.5	71.7	31.9	30.7
		2nd row	kN/m	------	150.0	28.7	19.2
		3rd row	kN/m	------	------	423.9	418.1
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	0.0	440.1

note)Lm shows elevation

item			unit	the5step
displace ment	max displacement	Del.max	cm	3.920
	accrue location	Lm	m	-11.160
displace coffer displace part	max bending moment	Mmax	kN.m	330.0
		Sig.	N/mm²	27.50
		Lm	m	-3.450
	SKY400	M	kN.m	330.0
		Sig.max	N/mm²	27.50
		Lm	m	-3.450
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
displace celler displace part	max bending moment	Mmax	kN.m	836.0
		Sig.	N/mm²	69.59
		Lm	m	-11.160
	SKY400	M	kN.m	836.0
		Sig.max	N/mm²	69.59
		Lm	m	-11.160
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
(SKY400)		Sig.a	N/mm²	210.00
(SKY490)		Sig.a	N/mm²	------

support point reaction force	timbering reaction	1st row	kN/m	30.8
		2nd row	kN/m	20.3
		3rd row	kN/m	419.2
		4th row	kN/m	------
		5th row	kN/m	------
		6th row	kN/m	------
		7th row	kN/m	------
		8th row	kN/m	------
		9th row	kN/m	------
		10th row	kN/m	------
	footing concrete reaction		kN/m	442.2

note)Lm shows elevation

2.10 detail output

(1)bridge axis direction 1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.083	3.308	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.082	3.308	0.0	0.0	0.00	0.0	0.0	
164.6										
	+4.340	0.3	0.082	3.308	0.0	164.6	0.00	0.0	0.0	
	+3.840	5.3	0.247	3.292	82.1	163.2	7.77	0.0	0.0	
	+2.840	15.2	0.571	3.163	241.0	153.0	22.82	0.0	0.0	
	+1.840	25.2	0.876	2.915	384.7	132.8	36.43	0.0	0.0	
	+1.340	30.2	1.018	2.751	447.8	118.9	42.40	0.0	0.0	
	+0.840	35.2	1.151	2.563	503.2	102.6	47.66	0.0	0.0	
	+0.340	40.1	1.274	2.355	550.0	83.8	52.08	0.0	0.0	
	-0.160	40.1	1.386	2.130	586.8	63.7	55.57	0.0	0.0	
	-1.160	40.1	1.575	1.647	630.5	23.6	59.71	0.0	0.0	
	-1.660	40.1	1.651	1.397	637.3	3.6	60.35	0.0	0.0	
	-1.721	32.0	1.660	1.366	637.5	1.1	60.37	14.4	24.1	
	-2.160	32.0	1.715	1.145	636.3	-6.5	60.26	14.8	25.7	
	-2.160	32.0	1.715	1.145	636.3	-6.5	52.99	14.8	25.7	
	-3.160	32.0	1.807	0.708	621.3	-23.2	51.75	15.6	29.2	
	-3.450	32.0	1.826	0.584	613.9	-28.0	51.13	15.8	30.2	
	-4.160	32.0	1.857	0.287	590.0	-39.4	49.14	16.1	32.7	
	-5.160	32.0	1.866	-0.107	542.7	-55.2	45.20	16.1	36.2	
	-6.160	32.0	1.837	-0.463	479.5	-71.2	39.94	15.9	39.7	
	-6.704	28.0	1.807	-0.636	438.4	-80.0	36.51	34.7	62.3	
	-7.160	27.2	1.775	-0.769	402.6	-76.9	33.53	34.1	64.0	
	-7.450	26.7	1.751	-0.848	380.6	-74.9	31.70	33.7	65.0	
	-8.160	25.5	1.685	-1.023	329.2	-70.0	27.41	32.4	67.5	
	-8.450	25.1	1.654	-1.087	309.2	-68.0	25.75	31.8	68.6	
	-9.160	23.9	1.572	-1.228	262.5	-63.4	21.86	30.2	71.1	
	-9.794	25.8	1.490	-1.335	223.6	-59.5	18.62	17.2	184.3	
	-10.160	25.1	1.441	-1.389	201.2	-62.6	16.76	16.6	192.6	
	-10.854	23.9	1.341	-1.475	155.7	-68.5	12.97	15.5	208.4	
	-11.160	23.4	1.295	-1.506	134.4	-71.1	11.19	14.9	215.4	
	-11.450	22.8	1.251	-1.531	113.4	-73.5	9.44	14.4	222.0	
	-12.160	21.6	1.141	-1.573	59.1	-79.5	4.92	13.2	238.2	
	-13.144	21.4	0.985	-1.586	-23.2	-87.8	1.94	49.2	375.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-13.160	21.3	0.983	-1.586	-24.6	-87.4	2.05	49.1	375.7	
	-14.160	18.3	0.826	-1.541	-98.9	-62.0	8.24	41.3	404.9	
	-14.160	18.3	0.826	-1.541	-98.9	-62.0	9.37	41.3	404.9	
	-15.160	15.3	0.676	-1.442	-150.2	-41.3	14.22	33.8	434.0	
	-16.160	12.3	0.539	-1.309	-182.9	-24.8	17.32	26.9	463.2	
	-17.160	9.2	0.415	-1.157	-200.9	-11.7	19.02	20.7	492.3	
	-18.160	6.2	0.307	-0.995	-207.3	-1.4	19.63	15.4	521.5	
	-19.160	3.2	0.216	-0.832	-204.4	6.9	19.36	10.8	550.6	
	-20.160	0.1	0.141	-0.675	-193.9	14.1	18.36	7.0	579.8	
	-20.207	0.0	0.138	-0.667	-193.2	14.4	18.30	6.9	581.2	
	-21.160	0.0	0.081	-0.528	-176.8	19.6	16.75	4.0	608.9	
	-21.704	0.0	0.054	-0.454	-165.7	21.4	15.69	2.5	206.4	
	-22.160	0.0	0.035	-0.397	-155.7	22.3	14.74	1.6	209.6	
	-23.160	0.0	0.001	-0.283	-132.8	23.1	12.58	0.0	216.6	
	-24.160	0.0	-0.022	-0.187	-109.9	22.6	10.41	0.0	223.6	
	-24.347	0.0	-0.026	-0.171	-105.7	22.4	10.01	0.0	224.9	
	-25.160	0.0	-0.037	-0.109	-88.0	21.1	8.33	0.0	230.6	
	-26.160	0.0	-0.045	-0.048	-67.8	19.2	6.42	0.0	237.6	
	-27.160	0.0	-0.047	-0.001	-49.7	17.0	4.71	0.0	244.6	
	-28.160	0.0	-0.046	0.031	-33.8	14.8	3.20	0.0	251.6	
	-29.160	0.0	-0.041	0.052	-20.0	12.8	1.90	0.0	258.6	
	-30.160	0.0	-0.035	0.063	-8.2	10.9	0.78	0.0	265.6	
	-30.384	0.0	-0.034	0.065	-5.8	10.6	0.55	0.0	455.0	
	-31.160	0.0	-0.029	0.066	1.2	7.6	0.12	0.0	461.9	
	-32.160	0.0	-0.022	0.062	7.3	4.5	0.69	0.0	470.9	
	-33.160	0.0	-0.016	0.055	10.5	2.2	1.00	0.0	479.9	
	-34.160	0.0	-0.011	0.046	11.8	0.5	1.12	0.0	488.9	
	-35.160	0.0	-0.007	0.037	11.7	-0.6	1.11	0.0	497.9	
	-36.160	0.0	-0.004	0.028	10.8	-1.3	1.02	0.0	506.9	
	-37.160	0.0	-0.002	0.020	9.3	-1.6	0.88	0.0	515.9	
	-38.160	0.0	0.000	0.013	7.6	-1.7	0.72	0.0	524.9	
	-39.160	0.0	0.001	0.008	5.9	-1.6	0.56	0.1	533.9	
	-40.160	0.0	0.002	0.004	4.4	-1.4	0.42	0.2	542.9	
	-41.160	0.0	0.002	0.001	3.1	-1.2	0.29	0.2	551.9	
	-42.160	0.0	0.002	-0.001	2.0	-1.0	0.19	0.2	560.9	
	-43.160	0.0	0.002	-0.002	1.1	-0.7	0.10	0.2	569.9	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-44.160	0.0	0.002	-0.003	0.5	-0.5	0.04	0.2	578.9	
	-45.160	0.0	0.001	-0.003	0.0	-0.4	0.00	0.2	587.9	
	-46.160	0.0	0.001	-0.003	-0.2	-0.2	0.02	0.1	596.9	
	-47.160	0.0	0.001	-0.002	-0.4	-0.1	0.04	0.1	605.9	
	-48.160	0.0	0.001	-0.002	-0.5	0.0	0.04	0.1	614.9	
	-49.160	0.0	0.000	-0.002	-0.4	0.0	0.04	0.0	623.9	
	-50.160	0.0	0.000	-0.001	-0.4	0.1	0.03	0.0	632.9	
	-51.160	0.0	0.000	-0.001	-0.3	0.1	0.03	0.0	641.9	
	-52.160	0.0	0.000	-0.001	-0.2	0.1	0.02	0.0	650.9	
	-52.954	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1787.1	
	-53.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1796.6	
	-54.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1842.9	
	-54.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1866.0	

(2)bridge axis direction 2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.142	3.596	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.038	3.596	0.0	0.0	0.00	0.0	0.0	
75.2										
	+4.340	0.3	0.038	3.596	0.0	75.2	0.00	0.0	0.0	
	+3.840	5.3	0.217	3.589	37.3	73.8	3.54	0.0	0.0	
	+2.840	15.2	0.574	3.531	106.8	63.5	10.12	0.0	0.0	
	+1.840	25.2	0.922	3.424	161.1	43.3	15.26	0.0	0.0	
	+1.340	30.2	1.091	3.357	179.4	29.5	16.99	0.0	0.0	
147.0										
	+1.340	30.2	1.091	3.357	179.4	176.6	16.99	0.0	0.0	
	+0.840	35.2	1.257	3.269	263.7	160.2	24.98	0.0	0.0	
	+0.340	40.1	1.418	3.150	339.2	141.4	32.13	0.0	0.0	
	-0.160	40.1	1.572	3.003	404.9	121.3	38.35	0.0	0.0	
	-1.160	40.1	1.855	2.640	506.2	81.2	47.94	0.0	0.0	
	-1.660	40.1	1.981	2.433	541.8	61.2	51.31	0.0	0.0	
	-1.721	15.8	1.996	2.407	545.5	58.8	51.66	0.0	0.0	
	-2.160	16.0	2.098	2.214	569.7	51.8	53.96	0.0	0.0	
	-2.160	16.0	2.098	2.214	569.7	51.8	47.45	0.0	0.0	
	-3.160	16.5	2.299	1.802	613.5	35.6	51.09	0.0	0.0	
	-3.450	16.6	2.349	1.678	623.1	30.8	51.89	0.0	0.0	
	-4.160	17.0	2.457	1.366	640.7	18.8	53.36	0.0	0.0	
	-5.160	17.5	2.572	0.917	651.0	1.6	54.21	0.0	0.0	
	-6.160	18.0	2.641	0.467	643.7	-16.1	53.61	0.0	0.0	
	-6.704	3.5	2.660	0.226	632.3	-26.0	52.66	0.0	0.0	
	-7.160	2.9	2.665	0.028	620.1	-27.4	51.64	0.0	0.0	
	-7.450	2.5	2.664	-0.096	612.1	-28.2	50.97	0.0	0.0	
	-8.160	1.6	2.647	-0.393	591.5	-29.7	49.26	0.0	0.0	
	-8.450	1.3	2.634	-0.511	582.8	-30.1	48.53	0.0	0.0	
	-9.160	0.4	2.587	-0.793	561.2	-30.7	46.73	0.0	0.0	
	-9.477	0.0	2.560	-0.915	551.4	-30.8	45.92	0.0	0.0	
	-9.794	61.9	2.529	-1.036	541.6	-30.8	45.11	0.0	0.0	
	-9.950	62.3	2.513	-1.094	536.1	-40.5	44.65	0.0	0.0	
	-9.950	62.3	2.513	-1.094	536.1	-40.5	44.65	0.0	0.0	*
	-10.160	61.9	2.489	-1.171	526.3	-53.0	43.83	4.8	4.8	*
	-10.854	60.7	2.399	-1.414	477.1	-86.7	39.73	20.6	20.6	*

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-11.142	60.2	2.357	-1.507	450.6	-97.2	37.52	27.2	27.2	*
	-11.142	60.2	2.357	-1.507	450.6	-97.2	37.52	27.2	27.2	
	-11.160	60.1	2.354	-1.512	448.8	-97.8	37.38	27.1	27.6	
	-11.450	59.6	2.309	-1.600	419.0	-107.4	34.90	26.6	34.2	
	-12.160	58.3	2.189	-1.786	334.5	-130.8	27.86	25.2	50.4	
	-13.144	52.9	2.003	-1.967	189.7	-163.6	15.79	100.1	104.9	
	-13.160	52.9	2.000	-1.969	187.0	-162.8	15.58	100.0	105.3	
	-14.160	49.9	1.798	-2.048	46.6	-119.3	3.88	89.9	134.5	
	-14.160	49.9	1.798	-2.048	46.6	-119.3	4.41	89.9	134.5	
	-15.160	46.8	1.593	-2.042	-53.9	-82.9	5.10	79.6	163.7	
	-16.160	43.8	1.392	-1.971	-121.5	-53.6	11.51	69.6	192.8	
	-17.160	40.8	1.201	-1.857	-163.4	-31.2	15.47	60.0	222.0	
	-18.160	37.8	1.022	-1.718	-186.0	-15.0	17.61	51.1	251.1	
	-19.160	34.7	0.857	-1.567	-195.2	-4.3	18.48	42.8	280.3	
	-20.160	31.7	0.708	-1.412	-196.2	1.5	18.58	35.4	309.4	
	-21.160	28.7	0.575	-1.259	-193.5	3.3	18.33	28.7	338.6	
	-21.704	20.9	0.509	-1.176	-191.8	2.9	18.16	24.0	182.4	
	-22.160	19.0	0.456	-1.107	-190.2	4.1	18.01	21.5	183.8	
	-23.160	15.0	0.353	-0.959	-185.0	6.1	17.52	16.6	186.7	
	-24.160	10.9	0.265	-0.816	-178.1	7.7	16.87	12.5	189.7	
	-25.160	6.9	0.190	-0.678	-169.6	9.4	16.06	8.9	192.6	
	-26.160	2.8	0.129	-0.548	-159.0	12.0	15.06	6.1	195.6	
	-26.859	0.0	0.093	-0.463	-149.8	14.6	14.18	4.4	197.6	
	-27.160	0.0	0.080	-0.428	-145.1	15.9	13.75	3.8	198.5	
	-28.160	0.0	0.043	-0.320	-127.7	18.7	12.09	2.0	201.5	
	-29.160	0.0	0.015	-0.227	-108.2	20.0	10.25	0.7	204.4	
	-30.160	0.0	-0.003	-0.150	-88.0	20.3	8.33	0.0	207.4	
	-30.384	0.0	-0.007	-0.134	-83.4	20.2	7.90	0.0	395.4	
	-30.630	0.0	-0.010	-0.119	-78.5	20.0	7.43	0.0	395.5	
	-31.070	0.0	-0.014	-0.093	-69.8	19.4	6.61	0.0	399.4	
	-31.160	0.0	-0.015	-0.088	-68.1	19.2	6.45	0.0	400.2	
	-32.160	0.0	-0.021	-0.042	-50.0	16.9	4.73	0.0	409.2	
	-33.160	0.0	-0.024	-0.009	-34.4	14.1	3.26	0.0	418.2	
	-34.160	0.0	-0.024	0.013	-21.7	11.3	2.06	0.0	427.2	
	-34.189	0.0	-0.024	0.014	-21.4	11.2	2.03	0.0	427.5	
	-35.160	0.0	-0.022	0.026	-11.8	8.5	1.12	0.0	436.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-36.160	0.0	-0.019	0.033	-4.6	6.1	0.43	0.0	445.2	
	-37.160	0.0	-0.015	0.034	0.4	4.0	0.04	0.0	454.2	
	-38.160	0.0	-0.012	0.033	3.6	2.4	0.34	0.0	463.2	
	-39.160	0.0	-0.009	0.029	5.4	1.2	0.51	0.0	472.2	
	-40.160	0.0	-0.006	0.024	6.1	0.3	0.58	0.0	481.2	
	-41.160	0.0	-0.004	0.019	6.1	-0.3	0.58	0.0	490.2	
	-42.160	0.0	-0.002	0.015	5.6	-0.6	0.53	0.0	499.2	
	-43.160	0.0	-0.001	0.011	4.9	-0.8	0.46	0.0	508.2	
	-44.160	0.0	0.000	0.007	4.0	-0.9	0.38	0.0	517.2	
	-45.160	0.0	0.001	0.004	3.1	-0.8	0.30	0.1	526.2	
	-46.160	0.0	0.001	0.002	2.4	-0.7	0.22	0.1	535.2	
	-47.160	0.0	0.001	0.001	1.7	-0.6	0.16	0.1	544.2	
	-48.160	0.0	0.001	-0.001	1.1	-0.5	0.11	0.1	553.2	
	-49.160	0.0	0.001	-0.001	0.7	-0.4	0.07	0.1	562.2	
	-50.160	0.0	0.001	-0.002	0.4	-0.3	0.04	0.1	571.2	
	-51.160	0.0	0.001	-0.002	0.2	-0.2	0.02	0.1	580.2	
	-52.160	0.0	0.000	-0.002	0.1	-0.1	0.01	0.1	589.2	
	-52.954	0.0	0.000	-0.002	0.0	-0.1	0.00	0.1	1443.8	
	-53.160	0.0	0.000	-0.002	0.0	0.0	0.00	0.1	1453.3	
	-54.160	0.0	0.000	-0.002	0.0	0.0	0.00	0.0	1499.5	
	-54.660	0.0	0.000	-0.002	0.0	0.0	0.00	0.0	1522.7	

*showing plastic

(3)bridge axis direction 3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.160	3.462	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.013	3.462	0.0	0.0	0.00	0.0	0.0	
25.6										
	+4.340	0.3	0.013	3.462	0.0	25.6	0.00	0.0	0.0	
	+3.840	5.3	0.186	3.459	12.6	24.2	1.19	0.0	0.0	
	+2.840	15.2	0.531	3.441	32.5	14.0	3.08	0.0	0.0	
	+1.840	25.2	0.874	3.412	37.2	-6.2	3.53	0.0	0.0	
	+1.340	30.2	1.044	3.398	30.8	-20.0	2.92	0.0	0.0	
52.0										
	+1.340	30.2	1.044	3.398	30.8	32.0	2.92	0.0	0.0	
	+0.840	35.2	1.213	3.383	42.8	15.6	4.05	0.0	0.0	
	-0.160	45.1	1.550	3.348	39.2	-24.5	3.71	0.0	0.0	
	-1.160	55.1	1.884	3.333	-9.5	-74.6	0.90	0.0	0.0	
	-1.660	60.1	2.051	3.346	-53.9	-103.4	5.11	0.0	0.0	
405.6										
	-1.660	60.1	2.051	3.346	-53.9	302.2	5.11	0.0	0.0	
	-1.721	36.4	2.071	3.348	-35.6	298.5	3.37	0.0	0.0	
	-2.160	41.0	2.218	3.338	91.8	281.5	8.69	0.0	0.0	
	-2.160	41.0	2.218	3.338	91.8	281.5	7.64	0.0	0.0	
	-2.660	46.2	2.384	3.282	227.2	259.7	18.92	0.0	0.0	
	-3.160	46.5	2.545	3.181	351.3	236.5	29.25	0.0	0.0	
	-3.450	46.6	2.637	3.104	417.9	223.0	34.80	0.0	0.0	
	-4.160	47.0	2.849	2.861	564.5	189.8	47.01	0.0	0.0	
	-5.160	47.5	3.113	2.409	730.7	142.6	60.85	0.0	0.0	
	-6.160	48.0	3.327	1.858	849.5	94.9	70.75	0.0	0.0	
	-6.704	33.5	3.419	1.528	894.0	68.7	74.45	0.0	0.0	
	-7.160	32.9	3.483	1.241	921.8	53.6	76.77	0.0	0.0	
	-7.450	32.5	3.516	1.054	936.0	44.1	77.95	0.0	0.0	
	-8.160	31.6	3.574	0.586	959.2	21.3	79.88	0.0	0.0	
	-8.450	31.3	3.588	0.392	964.0	12.2	80.28	0.0	0.0	
	-9.160	30.4	3.599	-0.083	964.8	-9.7	80.35	0.0	0.0	
	-9.794	91.9	3.581	-0.506	952.6	-28.8	79.34	0.0	0.0	
	-9.950	92.3	3.572	-0.609	947.0	-43.1	78.87	0.0	0.0	
	-9.950	92.3	3.572	-0.609	947.0	-43.1	78.87	0.0	0.0	*
	-10.160	91.9	3.558	-0.746	936.0	-62.0	77.95	4.8	4.8	*

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	90.7	3.491	-1.183	873.4	-116.5	72.73	20.6	20.6	*
	-11.160	90.1	3.452	-1.365	834.6	-136.8	69.50	27.6	27.6	*
	-11.450	89.6	3.410	-1.528	792.4	-153.9	65.99	34.2	34.2	*
	-11.656	89.2	3.377	-1.639	759.5	-164.8	63.25	38.9	38.9	*
	-11.656	89.2	3.377	-1.639	759.5	-164.8	63.25	38.9	38.9	
	-12.160	88.3	3.288	-1.890	670.1	-190.1	55.81	37.9	50.4	
	-13.144	86.6	3.082	-2.278	458.5	-240.0	38.18	35.5	72.8	
	-13.144	82.9	3.082	-2.278	458.5	-240.0	38.18	104.9	104.9	*
	-13.160	82.9	3.078	-2.283	454.6	-239.7	37.86	105.3	105.3	*
	-14.160	79.9	2.837	-2.519	231.5	-201.1	19.28	134.5	134.5	*
	-14.160	79.9	2.837	-2.519	231.5	-201.1	21.93	134.5	134.5	*
	-14.331	79.4	2.793	-2.548	198.1	-191.4	18.76	139.5	139.5	*
	-14.331	79.4	2.793	-2.548	198.1	-191.4	18.76	139.6	139.5	
	-15.160	76.8	2.578	-2.630	59.1	-144.8	5.60	128.9	163.7	
	-16.160	73.8	2.315	-2.626	-61.3	-97.8	5.81	115.7	192.8	
	-17.160	70.8	2.056	-2.544	-139.9	-61.0	13.25	102.7	222.0	
	-18.160	67.8	1.807	-2.413	-186.5	-33.8	17.66	90.3	251.1	
	-19.160	64.7	1.574	-2.255	-210.5	-15.6	19.93	78.7	280.3	
	-20.160	61.7	1.357	-2.085	-220.4	-5.6	20.87	67.8	309.4	
	-21.160	58.7	1.157	-1.909	-224.2	-3.1	21.23	57.8	338.6	
	-21.704	38.9	1.056	-1.813	-226.2	-4.5	21.42	49.7	170.4	
	-22.160	37.0	0.975	-1.731	-227.2	0.0	21.51	45.9	171.8	
	-23.160	33.0	0.811	-1.553	-223.4	7.0	21.15	38.2	174.7	
	-24.160	28.9	0.664	-1.380	-214.3	10.7	20.29	31.3	177.7	
	-25.160	24.9	0.535	-1.215	-202.8	12.0	19.20	25.2	180.6	
	-26.160	20.8	0.421	-1.060	-190.9	11.5	18.08	19.8	183.6	
	-27.160	16.8	0.322	-0.914	-180.0	10.2	17.05	15.2	186.5	
	-28.160	12.7	0.238	-0.775	-170.7	8.6	16.16	11.2	189.5	
	-29.160	8.7	0.167	-0.644	-162.8	7.3	15.41	7.9	192.4	
	-30.160	4.6	0.109	-0.518	-155.6	7.1	14.74	5.1	195.4	
	-30.384	0.3	0.098	-0.491	-154.0	7.3	14.58	11.8	380.4	
	-30.418	0.0	0.096	-0.487	-153.7	7.7	14.56	11.6	380.4	
	-31.160	0.0	0.063	-0.399	-145.2	14.8	13.75	7.7	380.6	
	-32.160	0.0	0.029	-0.291	-127.3	20.3	12.06	3.5	380.9	
	-32.358	0.0	0.023	-0.271	-123.3	20.9	11.67	2.8	381.0	
	-33.160	0.0	0.004	-0.199	-105.9	22.2	10.03	0.5	388.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-33.848	0.0	-0.007	-0.145	-90.6	22.0	8.58	0.0	394.4	
	-34.160	0.0	-0.012	-0.124	-83.8	21.7	7.93	0.0	397.2	
	-35.160	0.0	-0.021	-0.066	-63.0	19.7	5.97	0.0	406.2	
	-36.160	0.0	-0.025	-0.024	-44.7	16.8	4.24	0.0	415.2	
	-36.966	0.0	-0.026	0.000	-32.2	14.3	3.05	0.0	422.5	
	-37.160	0.0	-0.026	0.005	-29.5	13.7	2.79	0.0	424.2	
	-38.160	0.0	-0.025	0.023	-17.4	10.6	1.64	0.0	433.2	
	-39.160	0.0	-0.022	0.033	-8.2	7.8	0.78	0.0	442.2	
	-40.160	0.0	-0.018	0.037	-1.7	5.4	0.16	0.0	451.2	
	-41.160	0.0	-0.014	0.037	2.6	3.4	0.25	0.0	460.2	
	-42.160	0.0	-0.011	0.033	5.2	1.8	0.49	0.0	469.2	
	-43.160	0.0	-0.008	0.029	6.5	0.7	0.61	0.0	478.2	
	-44.160	0.0	-0.005	0.023	6.8	-0.1	0.64	0.0	487.2	
	-45.160	0.0	-0.003	0.018	6.4	-0.6	0.61	0.0	496.2	
	-46.160	0.0	-0.002	0.013	5.7	-0.8	0.54	0.0	505.2	
	-47.160	0.0	0.000	0.009	4.8	-1.0	0.45	0.0	514.2	
	-48.160	0.0	0.000	0.006	3.8	-1.0	0.36	0.0	523.2	
	-49.160	0.0	0.001	0.003	2.9	-0.9	0.27	0.1	532.2	
	-50.160	0.0	0.001	0.001	2.1	-0.8	0.20	0.1	541.2	
	-51.160	0.0	0.001	0.000	1.3	-0.7	0.13	0.1	550.2	
	-52.160	0.0	0.001	-0.001	0.7	-0.5	0.07	0.1	559.2	
	-52.954	0.0	0.001	-0.001	0.4	-0.4	0.03	0.3	1276.9	
	-53.160	0.0	0.001	-0.001	0.3	-0.4	0.03	0.3	1286.4	
	-54.160	0.0	0.001	-0.001	0.0	-0.1	0.00	0.2	1332.7	
	-54.660	0.0	0.001	-0.001	0.0	0.0	0.00	0.2	1355.8	

*showing plastic

(4)bridge axis direction   4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.158	3.468	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.015	3.468	0.0	0.0	0.00	0.0	0.0	
30.2										
	+4.340	0.3	0.015	3.468	0.0	30.2	0.00	0.0	0.0	
	+3.840	5.3	0.188	3.465	14.9	28.8	1.41	0.0	0.0	
	+2.840	15.2	0.534	3.442	39.4	18.6	3.73	0.0	0.0	
	+1.840	25.2	0.876	3.406	48.7	-1.6	4.61	0.0	0.0	
	+1.340	30.2	1.046	3.388	44.6	-15.5	4.22	0.0	0.0	
56.8										
	+1.340	30.2	1.046	3.388	44.6	41.4	4.22	0.0	0.0	
	+0.840	35.2	1.215	3.367	61.3	25.0	5.80	0.0	0.0	
	-0.160	45.1	1.549	3.313	67.1	-15.1	6.35	0.0	0.0	
	-1.160	55.1	1.878	3.273	27.8	-65.2	2.63	0.0	0.0	
	-1.660	60.1	2.042	3.269	-11.9	-94.0	1.13	0.0	0.0	
353.1										
	-1.660	60.1	2.042	3.269	-11.9	259.1	1.13	0.0	0.0	
	-1.721	36.4	2.062	3.269	3.8	255.4	0.36	0.0	0.0	
	-2.160	41.0	2.205	3.249	112.3	238.4	10.63	0.0	0.0	
	-2.160	41.0	2.205	3.249	112.3	238.4	9.35	0.0	0.0	
	-3.160	51.5	2.523	3.093	328.5	192.2	27.35	0.0	0.0	
	-3.450	54.5	2.612	3.022	382.0	176.8	31.81	0.0	0.0	
	-4.160	62.0	2.819	2.805	493.2	135.5	41.07	0.0	0.0	
	-5.160	72.5	3.081	2.423	595.9	68.3	49.63	0.0	0.0	
	-6.160	83.0	3.302	1.995	626.2	-9.5	52.15	0.0	0.0	
	-6.704	73.9	3.404	1.761	608.5	-56.2	50.68	0.0	0.0	
	-7.160	77.9	3.480	1.573	575.1	-90.8	47.89	0.0	0.0	
	-7.450	80.4	3.524	1.460	545.4	-113.7	45.42	0.0	0.0	
	-8.160	86.6	3.619	1.215	505.3	-173.0	42.08	0.0	0.0	
	-8.450	89.2	3.653	1.131	511.8	-198.5	42.62	0.0	0.0	
487.1										
	-8.450	89.2	3.653	1.131	511.8	288.6	42.62	0.0	0.0	
	-9.160	95.4	3.725	0.892	582.2	223.1	48.48	0.0	0.0	
	-9.794	163.2	3.773	0.612	693.8	160.8	57.78	0.0	0.0	
	-9.950	148.7	3.782	0.535	716.9	135.2	59.70	43.6	96.4	
	-10.160	148.4	3.792	0.429	743.0	113.2	61.88	43.7	101.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	147.1	3.809	0.056	796.4	41.1	66.33	43.9	117.0	
	-11.160	146.6	3.808	-0.114	804.2	9.6	66.97	43.9	124.0	
	-11.450	146.1	3.803	-0.276	802.7	-20.1	66.85	43.8	130.6	
	-12.160	144.8	3.769	-0.664	762.7	-92.4	63.52	43.5	146.8	
	-13.144	141.7	3.680	-1.142	622.9	-191.7	51.87	183.9	242.4	
	-13.160	141.7	3.678	-1.149	619.8	-191.0	51.62	183.8	242.9	
	-14.160	138.7	3.543	-1.518	449.3	-150.6	37.42	177.1	272.0	
	-14.160	138.7	3.543	-1.518	449.3	-150.6	42.55	177.1	272.0	
	-15.160	135.6	3.376	-1.818	317.2	-114.7	30.04	168.7	301.2	
	-16.160	132.6	3.183	-2.027	218.0	-84.8	20.64	159.1	330.3	
	-17.160	129.6	2.973	-2.169	145.2	-62.0	13.75	148.6	359.5	
	-18.160	126.5	2.751	-2.261	91.4	-47.0	8.65	137.5	388.7	
	-19.160	123.5	2.522	-2.316	48.4	-40.3	4.59	126.0	417.8	
	-20.160	120.5	2.289	-2.338	8.0	-42.1	0.76	114.4	447.0	
	-21.160	117.5	2.055	-2.327	-38.6	-52.5	3.65	102.7	476.1	
	-21.704	64.0	1.929	-2.304	-69.5	-61.8	6.59	90.9	153.7	
	-22.160	62.2	1.825	-2.274	-95.0	-50.3	9.00	85.9	155.0	
	-23.160	58.1	1.601	-2.182	-134.5	-29.8	12.74	75.4	157.9	
	-24.160	54.1	1.389	-2.066	-156.6	-15.5	14.83	65.4	160.9	
	-25.160	50.0	1.189	-1.938	-167.3	-6.9	15.85	56.0	163.8	
	-26.160	46.0	1.001	-1.804	-172.0	-3.3	16.29	47.2	166.8	
	-27.160	41.9	0.828	-1.667	-175.5	-4.2	16.62	39.0	169.7	
	-28.160	37.9	0.668	-1.526	-181.8	-9.0	17.22	31.5	172.7	
	-29.160	33.8	0.523	-1.378	-194.4	-16.8	18.41	24.6	175.6	
	-30.160	29.8	0.393	-1.217	-216.2	-27.1	20.48	18.5	178.6	
	-30.384	21.2	0.366	-1.178	-222.6	-29.7	21.08	44.3	359.4	
	-31.160	14.5	0.280	-1.036	-239.0	-13.2	22.64	33.9	359.7	
	-32.160	5.8	0.186	-0.845	-243.1	4.6	23.02	22.5	360.0	
	-32.831	0.0	0.134	-0.717	-236.3	15.6	22.38	16.2	360.2	
	-33.160	0.0	0.111	-0.657	-230.3	20.5	21.81	13.5	360.3	
	-34.160	0.0	0.054	-0.485	-204.3	30.3	19.35	6.6	360.6	
	-34.771	0.0	0.028	-0.391	-184.8	33.3	17.50	3.3	360.8	
	-35.160	0.0	0.013	-0.336	-171.6	34.3	16.25	1.6	364.3	
	-36.160	0.0	-0.014	-0.214	-137.1	34.1	12.99	0.0	373.3	
	-37.160	0.0	-0.030	-0.119	-104.2	31.4	9.87	0.0	382.3	
	-37.728	0.0	-0.036	-0.076	-87.1	29.1	8.24	0.0	387.4	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-38.160	0.0	-0.039	-0.049	-74.9	27.1	7.09	0.0	391.3	
	-39.160	0.0	-0.041	0.000	-50.2	22.3	4.75	0.0	400.3	
	-40.160	0.0	-0.039	0.032	-30.3	17.4	2.87	0.0	409.3	
	-40.846	0.0	-0.036	0.045	-19.5	14.3	1.85	0.0	415.5	
	-41.160	0.0	-0.035	0.049	-15.2	12.9	1.44	0.0	418.3	
	-42.160	0.0	-0.029	0.057	-4.3	9.0	0.41	0.0	427.3	
	-43.160	0.0	-0.024	0.057	3.0	5.8	0.29	0.0	436.3	
	-44.160	0.0	-0.018	0.053	7.5	3.3	0.71	0.0	445.3	
	-45.160	0.0	-0.013	0.046	9.8	1.4	0.92	0.0	454.3	
	-46.160	0.0	-0.009	0.038	10.4	0.0	0.99	0.0	463.3	
	-47.160	0.0	-0.006	0.030	9.9	-0.9	0.94	0.0	472.3	
	-48.160	0.0	-0.003	0.022	8.8	-1.4	0.83	0.0	481.3	
	-49.160	0.0	-0.001	0.016	7.2	-1.7	0.68	0.0	490.3	
	-50.160	0.0	0.000	0.011	5.5	-1.7	0.52	0.0	499.3	
	-51.160	0.0	0.001	0.007	3.8	-1.6	0.36	0.1	508.3	
	-52.160	0.0	0.002	0.005	2.3	-1.5	0.21	0.2	517.3	
	-52.954	0.0	0.002	0.004	1.2	-1.3	0.11	0.7	1043.8	
	-53.160	0.0	0.002	0.004	0.9	-1.2	0.09	0.7	1053.4	
	-54.160	0.0	0.002	0.003	0.1	-0.4	0.01	0.8	1099.6	
	-54.660	0.0	0.003	0.003	0.0	0.0	0.00	0.9	1122.7	

bending moment at support of footing concrete is reduced value

(5)bridge axis direction 5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.158	3.469	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.015	3.469	0.0	0.0	0.00	0.0	0.0	
30.4										
	+4.340	0.3	0.015	3.469	0.0	30.4	0.00	0.0	0.0	
	+3.840	5.3	0.189	3.466	15.0	29.0	1.42	0.0	0.0	
	+2.840	15.2	0.534	3.444	39.7	18.8	3.76	0.0	0.0	
	+1.840	25.2	0.877	3.407	49.2	-1.4	4.66	0.0	0.0	
	+1.340	30.2	1.047	3.389	45.2	-15.2	4.28	0.0	0.0	
57.8										
	+1.340	30.2	1.047	3.389	45.2	42.6	4.28	0.0	0.0	
	+0.840	35.2	1.216	3.367	62.5	26.2	5.92	0.0	0.0	
	-0.160	45.1	1.550	3.312	69.5	-13.9	6.58	0.0	0.0	
	-1.160	55.1	1.879	3.269	31.4	-64.0	2.97	0.0	0.0	
	-1.660	60.1	2.042	3.264	-7.7	-92.8	0.73	0.0	0.0	
353.6										
	-1.660	60.1	2.042	3.264	-7.7	260.8	0.73	0.0	0.0	
	-1.721	36.4	2.062	3.264	8.1	257.2	0.76	0.0	0.0	
	-2.160	41.0	2.205	3.242	117.3	240.2	11.11	0.0	0.0	
	-2.160	41.0	2.205	3.242	117.3	240.2	9.77	0.0	0.0	
	-3.160	51.5	2.522	3.082	335.3	194.0	27.92	0.0	0.0	
	-3.450	261249.0	2.611	3.009	389.3	178.6	32.42	0.0	0.0	
	-4.160	281973.4	2.817	2.791	490.8	95.9	40.88	0.0	0.0	
	-5.160	308183.3	3.078	2.422	574.4	56.9	47.83	0.0	0.0	
	-6.160	330299.4	3.300	2.012	618.4	45.2	51.50	0.0	0.0	
	-6.704	340501.4	3.403	1.777	616.7	-43.1	51.36	0.0	0.0	
	-7.160	348101.9	3.480	1.587	585.1	-90.5	48.73	0.0	0.0	
	-7.450	80.4	3.524	1.472	554.5	-119.1	46.18	0.0	0.0	
	-8.160	86.6	3.619	1.223	511.2	-178.4	42.57	0.0	0.0	
	-8.450	89.2	3.653	1.138	516.7	-203.9	43.03	0.0	0.0	
491.9										
	-8.450	89.2	3.653	1.138	516.7	288.0	43.03	0.0	0.0	
	-9.160	95.4	3.726	0.897	585.6	222.5	48.77	0.0	0.0	
	-9.794	163.2	3.775	0.616	696.8	160.3	58.03	0.0	0.0	
	-9.950	148.7	3.784	0.539	719.8	134.7	59.95	43.6	96.4	
	-10.160	148.4	3.794	0.432	745.8	112.6	62.11	43.7	101.2	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	147.1	3.811	0.058	798.9	40.5	66.53	43.9	117.0	
	-11.160	146.6	3.810	-0.112	806.4	9.1	67.16	43.9	124.0	
	-11.450	146.1	3.804	-0.275	804.8	-20.6	67.02	43.9	130.6	
	-12.160	144.8	3.771	-0.663	764.4	-92.9	63.66	43.5	146.8	
	-13.144	141.7	3.681	-1.143	624.1	-192.2	51.98	184.0	242.4	
	-13.160	141.7	3.680	-1.150	621.0	-191.5	51.72	183.9	242.9	
	-14.160	138.7	3.545	-1.519	450.1	-151.0	37.49	177.2	272.0	
	-14.160	138.7	3.545	-1.519	450.1	-151.0	42.63	177.2	272.0	
	-15.160	135.6	3.377	-1.820	317.6	-115.0	30.08	168.8	301.2	
	-16.160	132.6	3.184	-2.029	218.2	-85.0	20.66	159.1	330.3	
	-17.160	129.6	2.974	-2.171	145.2	-62.2	13.75	148.6	359.5	
	-18.160	126.5	2.752	-2.263	91.2	-47.1	8.64	137.5	388.7	
	-19.160	123.5	2.522	-2.318	48.2	-40.3	4.56	126.1	417.8	
	-20.160	120.5	2.289	-2.340	7.7	-42.1	0.73	114.4	447.0	
	-21.160	117.5	2.055	-2.328	-38.9	-52.5	3.68	102.7	476.1	
	-21.704	64.0	1.929	-2.305	-69.9	-61.8	6.61	90.9	153.7	
	-22.160	62.2	1.825	-2.275	-95.3	-50.2	9.03	86.0	155.0	
	-23.160	58.1	1.602	-2.183	-134.8	-29.7	12.76	75.4	157.9	
	-24.160	54.1	1.389	-2.067	-156.9	-15.4	14.86	65.4	160.9	
	-25.160	50.0	1.189	-1.939	-167.6	-6.8	15.87	56.0	163.8	
	-26.160	46.0	1.001	-1.804	-172.2	-3.3	16.31	47.2	166.8	
	-27.160	41.9	0.828	-1.667	-175.6	-4.2	16.63	39.0	169.7	
	-28.160	37.9	0.668	-1.526	-181.9	-8.9	17.23	31.5	172.7	
	-29.160	33.8	0.523	-1.378	-194.5	-16.8	18.42	24.6	175.6	
	-30.160	29.8	0.393	-1.217	-216.3	-27.1	20.48	18.5	178.6	
	-30.384	21.2	0.366	-1.178	-222.6	-29.6	21.08	44.3	359.4	
	-31.160	14.5	0.280	-1.036	-239.1	-13.2	22.64	33.9	359.7	
	-32.160	5.8	0.186	-0.845	-243.1	4.7	23.03	22.5	360.0	
	-32.831	0.0	0.134	-0.717	-236.3	15.6	22.38	16.2	360.2	
	-33.160	0.0	0.111	-0.657	-230.3	20.5	21.81	13.5	360.3	
	-34.160	0.0	0.054	-0.485	-204.3	30.3	19.35	6.6	360.6	
	-34.771	0.0	0.028	-0.391	-184.8	33.3	17.50	3.3	360.8	
	-35.160	0.0	0.013	-0.336	-171.6	34.3	16.25	1.6	364.3	
	-36.160	0.0	-0.014	-0.214	-137.1	34.1	12.99	0.0	373.3	
	-37.160	0.0	-0.030	-0.119	-104.2	31.4	9.87	0.0	382.3	
	-37.728	0.0	-0.036	-0.076	-87.0	29.1	8.24	0.0	387.4	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-38.160	0.0	-0.039	-0.049	-74.9	27.1	7.09	0.0	391.3	
	-39.160	0.0	-0.041	0.000	-50.2	22.3	4.75	0.0	400.3	
	-40.160	0.0	-0.039	0.032	-30.3	17.4	2.87	0.0	409.3	
	-40.846	0.0	-0.036	0.045	-19.5	14.3	1.84	0.0	415.5	
	-41.160	0.0	-0.035	0.049	-15.2	12.9	1.44	0.0	418.3	
	-42.160	0.0	-0.029	0.057	-4.3	9.0	0.41	0.0	427.3	
	-43.160	0.0	-0.024	0.057	3.0	5.8	0.29	0.0	436.3	
	-44.160	0.0	-0.018	0.053	7.5	3.3	0.71	0.0	445.3	
	-45.160	0.0	-0.013	0.046	9.8	1.4	0.92	0.0	454.3	
	-46.160	0.0	-0.009	0.038	10.4	0.0	0.99	0.0	463.3	
	-47.160	0.0	-0.006	0.030	9.9	-0.9	0.94	0.0	472.3	
	-48.160	0.0	-0.003	0.022	8.8	-1.4	0.83	0.0	481.3	
	-49.160	0.0	-0.001	0.016	7.2	-1.7	0.68	0.0	490.3	
	-50.160	0.0	0.000	0.011	5.5	-1.7	0.52	0.0	499.3	
	-51.160	0.0	0.001	0.007	3.8	-1.6	0.36	0.1	508.3	
	-52.160	0.0	0.002	0.005	2.3	-1.5	0.21	0.2	517.3	
	-52.954	0.0	0.002	0.004	1.2	-1.3	0.11	0.7	1043.8	
	-53.160	0.0	0.002	0.004	0.9	-1.2	0.09	0.7	1053.4	
	-54.160	0.0	0.002	0.003	0.1	-0.4	0.01	0.8	1099.6	
	-54.660	0.0	0.003	0.003	0.0	0.0	0.00	0.9	1122.7	

bending moment at support of footing concrete is reduced value

(6)perpendicular direction 1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.108	3.372	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.061	3.372	0.0	0.0	0.00	0.0	0.0	
164.5										
	+4.340	0.3	0.061	3.372	0.0	164.5	0.00	0.0	0.0	
	+3.840	5.3	0.229	3.355	82.0	163.1	7.77	0.0	0.0	
	+2.840	15.2	0.559	3.227	240.9	152.9	22.81	0.0	0.0	
	+1.840	25.2	0.871	2.979	384.5	132.7	36.41	0.0	0.0	
	+1.340	30.2	1.016	2.815	447.5	118.9	42.38	0.0	0.0	
	+0.840	35.2	1.152	2.627	503.0	102.5	47.63	0.0	0.0	
	+0.340	40.1	1.278	2.419	549.6	83.7	52.05	0.0	0.0	
	-0.160	40.1	1.393	2.194	586.5	63.7	55.54	0.0	0.0	
	-1.160	40.1	1.589	1.712	630.1	23.5	59.67	0.0	0.0	
	-1.660	40.1	1.668	1.462	636.8	3.5	60.31	0.0	0.0	
	-1.721	32.0	1.677	1.431	637.0	1.1	60.32	14.5	24.1	
	-2.160	32.0	1.735	1.210	635.8	-6.5	60.21	15.0	25.7	
	-2.160	32.0	1.735	1.210	635.8	-6.5	52.95	15.0	25.7	
	-3.160	32.0	1.834	0.773	620.9	-23.0	51.71	15.9	29.2	
	-3.450	32.0	1.855	0.649	613.6	-27.7	51.10	16.0	30.2	
	-4.160	32.0	1.890	0.352	589.9	-38.9	49.13	16.4	32.7	
	-5.160	32.0	1.905	-0.042	543.3	-54.4	45.24	16.5	36.2	
	-6.160	32.0	1.883	-0.398	481.0	-70.0	40.06	16.3	39.7	
	-6.704	28.0	1.857	-0.572	440.6	-78.6	36.69	35.7	62.3	
	-7.160	27.5	1.827	-0.706	405.5	-75.2	33.77	35.1	64.3	
	-7.450	27.2	1.806	-0.786	384.1	-73.0	31.98	34.7	65.5	
	-8.160	26.5	1.744	-0.963	334.1	-67.8	27.83	33.5	68.5	
	-8.450	26.2	1.715	-1.028	314.7	-65.8	26.21	33.0	69.7	
	-9.160	25.4	1.637	-1.172	269.7	-61.2	22.46	31.5	72.7	
	-9.794	27.3	1.559	-1.282	232.1	-57.6	19.33	18.0	185.8	
	-10.160	26.7	1.511	-1.338	210.3	-61.0	17.52	17.4	194.2	
	-10.854	25.6	1.415	-1.429	165.8	-67.5	13.80	16.3	210.1	
	-11.160	25.1	1.370	-1.462	144.7	-70.3	12.05	15.8	217.2	
	-11.450	24.6	1.327	-1.489	123.9	-73.0	10.32	15.3	223.8	
	-12.160	23.5	1.220	-1.537	69.7	-79.7	5.81	14.1	240.2	
	-13.144	23.2	1.067	-1.557	-13.3	-89.1	1.11	53.3	377.1	
	-13.160	23.2	1.065	-1.556	-14.7	-88.6	1.22	53.2	377.6	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-14.160	20.9	0.911	-1.519	-89.2	-61.3	7.43	45.5	407.4	
	-14.160	20.9	0.911	-1.519	-89.2	-61.3	8.44	45.5	407.4	
	-15.160	18.6	0.763	-1.427	-139.0	-39.2	13.16	38.1	437.3	
	-16.160	16.3	0.626	-1.305	-169.2	-21.9	16.02	31.3	467.2	
	-17.160	13.9	0.503	-1.164	-184.3	-8.9	17.45	25.1	497.0	
	-18.160	11.6	0.394	-1.017	-188.1	0.6	17.82	19.7	526.9	
	-19.160	9.3	0.299	-0.869	-183.9	7.4	17.42	15.0	556.8	
	-20.160	7.0	0.219	-0.728	-174.0	12.1	16.48	11.0	586.7	
	-20.207	6.9	0.216	-0.721	-173.5	12.3	16.43	10.8	588.1	
	-21.160	4.7	0.153	-0.596	-160.1	15.5	15.17	7.7	616.5	
	-21.704	6.7	0.123	-0.529	-151.3	17.0	14.33	5.8	213.1	
	-22.160	5.5	0.100	-0.476	-143.6	16.6	13.60	4.7	215.1	
	-23.160	3.0	0.058	-0.369	-127.3	16.1	12.06	2.7	219.6	
	-24.160	0.5	0.026	-0.275	-111.2	16.2	10.53	1.2	224.1	
	-24.347	0.0	0.021	-0.259	-108.2	16.4	10.24	1.0	224.9	
	-25.160	0.0	0.002	-0.194	-94.6	16.8	8.96	0.1	230.6	
	-26.160	0.0	-0.014	-0.126	-77.9	16.5	7.38	0.0	237.6	
	-27.160	0.0	-0.023	-0.071	-61.8	15.6	5.85	0.0	244.6	
	-28.160	0.0	-0.028	-0.028	-46.7	14.4	4.42	0.0	251.6	
	-29.160	0.0	-0.029	0.003	-33.0	13.1	3.12	0.0	258.6	
	-30.160	0.0	-0.028	0.025	-20.6	11.7	1.95	0.0	265.6	
	-30.384	0.0	-0.027	0.028	-18.0	11.4	1.70	0.0	455.0	
	-31.160	0.0	-0.025	0.036	-10.1	9.0	0.96	0.0	461.9	
	-32.160	0.0	-0.021	0.041	-2.5	6.2	0.24	0.0	470.9	
	-33.160	0.0	-0.017	0.041	2.5	4.0	0.24	0.0	479.9	
	-34.160	0.0	-0.013	0.038	5.6	2.2	0.53	0.0	488.9	
	-35.160	0.0	-0.009	0.033	7.1	0.9	0.67	0.0	497.9	
	-36.160	0.0	-0.006	0.027	7.5	0.0	0.71	0.0	506.9	
	-37.160	0.0	-0.004	0.021	7.2	-0.6	0.68	0.0	515.9	
	-38.160	0.0	-0.002	0.016	6.4	-0.9	0.61	0.0	524.9	
	-39.160	0.0	-0.001	0.011	5.4	-1.1	0.51	0.0	533.9	
	-40.160	0.0	0.000	0.007	4.4	-1.1	0.41	0.0	542.9	
	-41.160	0.0	0.001	0.004	3.3	-1.0	0.32	0.1	551.9	
	-42.160	0.0	0.001	0.002	2.4	-0.9	0.23	0.1	560.9	
	-43.160	0.0	0.001	0.000	1.6	-0.7	0.15	0.2	569.9	
	-44.160	0.0	0.001	-0.001	1.0	-0.5	0.10	0.2	578.9	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-45.160	0.0	0.001	-0.001	0.5	-0.4	0.05	0.1	587.9	
	-46.160	0.0	0.001	-0.002	0.2	-0.3	0.02	0.1	596.9	
	-47.160	0.0	0.001	-0.002	0.0	-0.2	0.00	0.1	605.9	
	-48.160	0.0	0.001	-0.002	-0.2	-0.1	0.02	0.1	614.9	
	-49.160	0.0	0.000	-0.002	-0.2	0.0	0.02	0.1	623.9	
	-50.160	0.0	0.000	-0.001	-0.2	0.0	0.02	0.0	632.9	
	-51.160	0.0	0.000	-0.001	-0.2	0.0	0.02	0.0	641.9	
	-52.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	650.9	
	-52.954	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1787.1	
	-53.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1796.6	
	-54.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1842.9	
	-54.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1866.0	

(7)perpendicular direction 2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.152	3.561	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.027	3.561	0.0	0.0	0.00	0.0	0.0	
71.7										
	+4.340	0.3	0.027	3.561	0.0	71.7	0.00	0.0	0.0	
	+3.840	5.3	0.204	3.554	35.6	70.3	3.37	0.0	0.0	
	+2.840	15.2	0.558	3.499	101.7	60.1	9.63	0.0	0.0	
	+1.840	25.2	0.903	3.398	152.5	39.9	14.44	0.0	0.0	
	+1.340	30.2	1.071	3.334	169.1	26.1	16.01	0.0	0.0	
150.0										
	+1.340	30.2	1.071	3.334	169.1	176.1	16.01	0.0	0.0	
	+0.840	35.2	1.236	3.251	253.2	159.8	23.97	0.0	0.0	
	+0.340	40.1	1.396	3.135	328.4	140.9	31.10	0.0	0.0	
	-0.160	40.1	1.549	2.993	393.9	120.9	37.30	0.0	0.0	
	-1.160	40.1	1.831	2.639	494.7	80.8	46.85	0.0	0.0	
	-1.660	40.1	1.958	2.437	530.1	60.7	50.20	0.0	0.0	
	-1.721	15.8	1.973	2.411	533.7	58.3	50.55	0.0	0.0	
	-2.160	16.0	2.075	2.222	557.8	51.3	52.82	0.0	0.0	
	-2.160	16.0	2.075	2.222	557.8	51.3	46.45	0.0	0.0	
	-3.160	16.5	2.277	1.819	601.1	35.1	50.06	0.0	0.0	
	-3.450	16.6	2.328	1.697	610.5	30.3	50.85	0.0	0.0	
	-4.160	17.0	2.438	1.392	627.8	18.4	52.29	0.0	0.0	
	-5.160	17.5	2.555	0.951	637.6	1.2	53.10	0.0	0.0	
	-6.160	18.0	2.628	0.511	630.0	-16.6	52.46	0.0	0.0	
	-6.704	3.5	2.649	0.275	618.3	-26.4	51.49	0.0	0.0	
	-7.160	2.9	2.657	0.081	605.9	-27.9	50.46	0.0	0.0	
	-7.450	2.5	2.658	-0.040	597.7	-28.7	49.78	0.0	0.0	
	-8.160	1.6	2.645	-0.329	576.8	-30.1	48.03	0.0	0.0	
	-8.450	1.3	2.634	-0.445	568.0	-30.6	47.30	0.0	0.0	
	-9.160	0.4	2.592	-0.719	546.0	-31.2	45.47	0.0	0.0	
	-9.477	0.0	2.568	-0.838	536.1	-31.2	44.65	0.0	0.0	
	-9.794	61.9	2.539	-0.955	526.2	-31.2	43.82	0.0	0.0	
	-9.950	62.3	2.524	-1.012	520.6	-40.9	43.36	0.0	0.0	
	-9.950	62.3	2.524	-1.012	520.6	-40.9	43.36	0.0	0.0	*
	-10.160	61.9	2.502	-1.087	510.7	-53.5	42.53	4.8	4.8	*
	-10.854	60.8	2.418	-1.322	461.2	-87.2	38.41	20.8	20.8	*

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-11.143	60.4	2.378	-1.412	434.4	-97.7	36.18	27.4	27.4	*
	-11.143	60.4	2.378	-1.412	434.4	-97.7	36.18	27.4	27.4	
	-11.160	60.4	2.376	-1.417	432.8	-98.3	36.04	27.4	27.8	
	-11.450	59.9	2.334	-1.501	402.9	-107.8	33.55	26.9	34.5	
	-12.160	58.8	2.221	-1.679	318.0	-131.3	26.48	25.6	50.8	
	-13.144	53.5	2.046	-1.849	172.6	-164.1	14.38	102.3	105.4	
	-13.160	53.4	2.043	-1.851	170.0	-163.4	14.16	102.1	105.9	
	-14.160	51.1	1.854	-1.917	29.8	-118.2	2.48	92.7	135.8	
	-14.160	51.1	1.854	-1.917	29.8	-118.2	2.82	92.7	135.8	
	-15.160	48.8	1.663	-1.899	-68.9	-80.3	6.52	83.1	165.6	
	-16.160	46.5	1.476	-1.818	-133.2	-49.6	12.62	73.8	195.5	
	-17.160	44.2	1.300	-1.696	-170.3	-25.6	16.13	65.0	225.4	
	-18.160	41.9	1.138	-1.554	-186.6	-7.8	17.67	56.9	255.3	
	-19.160	39.6	0.990	-1.406	-187.8	4.5	17.78	49.5	285.1	
	-20.160	37.3	0.856	-1.260	-179.1	12.2	16.96	42.8	315.0	
	-21.160	35.0	0.737	-1.125	-164.8	15.8	15.60	36.8	344.9	
	-21.704	29.7	0.678	-1.056	-156.0	16.4	14.77	31.9	191.2	
	-22.160	28.5	0.631	-1.001	-148.3	17.1	14.04	29.7	193.3	
	-23.160	26.0	0.537	-0.891	-130.9	17.3	12.40	25.3	197.7	
	-24.160	23.5	0.453	-0.794	-114.2	15.8	10.82	21.3	202.2	
	-25.160	21.0	0.377	-0.710	-99.7	13.1	9.44	17.8	206.7	
	-26.160	18.5	0.310	-0.636	-88.3	9.5	8.37	14.6	211.2	
	-26.859	16.7	0.267	-0.589	-82.7	6.7	7.83	12.6	214.3	
	-27.160	15.9	0.250	-0.569	-80.8	5.5	7.65	11.8	215.7	
	-28.160	13.4	0.196	-0.507	-77.4	1.3	7.33	9.2	220.1	
	-29.160	10.9	0.149	-0.446	-78.2	-2.8	7.40	7.0	224.6	
	-30.160	8.4	0.107	-0.383	-82.8	-6.4	7.84	5.0	229.1	
	-30.384	3.7	0.099	-0.368	-84.3	-7.2	7.99	11.9	413.8	
	-30.630	2.4	0.090	-0.352	-85.9	-5.1	8.13	10.9	414.7	
	-31.070	0.0	0.075	-0.321	-87.3	-1.2	8.26	9.1	416.3	
	-31.160	0.0	0.072	-0.315	-87.3	-0.4	8.27	8.7	416.6	
	-32.160	0.0	0.044	-0.247	-84.0	6.5	7.96	5.3	420.2	
	-33.160	0.0	0.022	-0.184	-75.3	10.5	7.13	2.7	423.8	
	-34.160	0.0	0.007	-0.129	-63.8	12.2	6.04	0.8	427.4	
	-34.189	0.0	0.007	-0.128	-63.4	12.2	6.01	0.8	427.5	
	-35.160	0.0	-0.004	-0.084	-51.4	12.4	4.87	0.0	436.2	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	0.0	-0.010	-0.048	-39.4	11.5	3.73	0.0	445.2	
	-37.160	0.0	-0.014	-0.021	-28.6	10.0	2.71	0.0	454.2	
	-38.160	0.0	-0.015	-0.002	-19.4	8.3	1.84	0.0	463.2	
	-39.160	0.0	-0.014	0.010	-12.0	6.5	1.14	0.0	472.2	
	-40.160	0.0	-0.013	0.017	-6.3	4.9	0.59	0.0	481.2	
	-41.160	0.0	-0.011	0.020	-2.1	3.5	0.20	0.0	490.2	
	-42.160	0.0	-0.009	0.021	0.7	2.3	0.07	0.0	499.2	
	-43.160	0.0	-0.007	0.019	2.5	1.3	0.24	0.0	508.2	
	-44.160	0.0	-0.005	0.017	3.4	0.6	0.33	0.0	517.2	
	-45.160	0.0	-0.003	0.014	3.8	0.1	0.36	0.0	526.2	
	-46.160	0.0	-0.002	0.011	3.7	-0.2	0.35	0.0	535.2	
	-47.160	0.0	-0.001	0.008	3.3	-0.5	0.31	0.0	544.2	
	-48.160	0.0	0.000	0.006	2.8	-0.6	0.27	0.0	553.2	
	-49.160	0.0	0.000	0.004	2.2	-0.6	0.21	0.0	562.2	
	-50.160	0.0	0.000	0.002	1.7	-0.6	0.16	0.0	571.2	
	-51.160	0.0	0.001	0.001	1.1	-0.5	0.11	0.1	580.2	
	-52.160	0.0	0.001	0.001	0.7	-0.4	0.06	0.1	589.2	
	-52.954	0.0	0.001	0.000	0.3	-0.4	0.03	0.2	1443.8	
	-53.160	0.0	0.001	0.000	0.3	-0.3	0.02	0.2	1453.3	
	-54.160	0.0	0.001	0.000	0.0	-0.1	0.00	0.2	1499.5	
	-54.660	0.0	0.001	0.000	0.0	0.0	0.00	0.2	1522.7	

*showing plastic

(8)perpendicular direction   3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.159	3.414	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.012	3.414	0.0	0.0	0.00	0.0	0.0	
31.9										
	+4.340	0.3	0.012	3.414	0.0	31.9	0.00	0.0	0.0	
	+3.840	5.3	0.182	3.410	15.7	30.5	1.49	0.0	0.0	
	+2.840	15.2	0.522	3.387	41.9	20.3	3.97	0.0	0.0	
	+1.840	25.2	0.859	3.348	52.9	0.0	5.01	0.0	0.0	
	+1.340	30.2	1.026	3.328	49.5	-13.8	4.69	0.0	0.0	
28.7										
	+1.340	30.2	1.026	3.328	49.5	14.9	4.69	0.0	0.0	
	+0.840	35.2	1.192	3.307	53.0	-1.5	5.02	0.0	0.0	
	-0.160	45.1	1.521	3.271	32.3	-41.6	3.06	0.0	0.0	
	-1.160	55.1	1.847	3.268	-33.5	-91.7	3.17	0.0	0.0	
	-1.660	60.1	2.011	3.291	-86.5	-120.5	8.19	0.0	0.0	
423.9										
	-1.660	60.1	2.011	3.291	-86.5	303.4	8.19	0.0	0.0	
	-1.721	36.4	2.031	3.295	-68.1	299.7	6.44	0.0	0.0	
	-2.160	41.0	2.176	3.296	59.9	282.7	5.67	0.0	0.0	
	-2.160	41.0	2.176	3.296	59.9	282.7	4.99	0.0	0.0	
	-2.660	46.2	2.340	3.252	195.9	260.9	16.31	0.0	0.0	
	-3.160	46.5	2.501	3.162	320.6	237.8	26.70	0.0	0.0	
	-3.450	46.6	2.591	3.090	387.6	224.3	32.28	0.0	0.0	
	-4.160	47.0	2.803	2.862	535.0	191.0	44.56	0.0	0.0	
	-5.160	47.5	3.069	2.430	702.5	143.8	58.50	0.0	0.0	
	-6.160	48.0	3.286	1.898	822.5	96.1	68.50	0.0	0.0	
	-6.704	33.5	3.380	1.579	867.6	69.9	72.26	0.0	0.0	
	-7.160	32.9	3.446	1.299	896.1	54.8	74.63	0.0	0.0	
	-7.450	32.5	3.481	1.117	910.6	45.3	75.83	0.0	0.0	
	-8.160	31.6	3.544	0.662	934.6	22.5	77.84	0.0	0.0	
	-8.450	31.3	3.561	0.474	939.8	13.4	78.27	0.0	0.0	
	-9.160	30.4	3.578	0.009	941.5	-8.5	78.41	0.0	0.0	
	-9.794	91.9	3.565	-0.403	930.1	-27.5	77.46	0.0	0.0	
	-9.950	92.3	3.558	-0.503	924.6	-41.9	77.01	0.0	0.0	
	-9.950	92.3	3.558	-0.503	924.6	-41.9	77.01	0.0	0.0	*
	-10.160	91.9	3.546	-0.637	913.8	-60.7	76.11	4.8	4.8	*

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-10.854	90.8	3.487	-1.064	852.1	-115.3	70.96	20.8	20.8	*
	-11.160	90.4	3.452	-1.241	813.7	-135.6	67.76	27.8	27.8	*
	-11.450	89.9	3.414	-1.401	771.8	-152.7	64.28	34.5	34.5	*
	-11.646	89.6	3.385	-1.504	740.8	-163.1	61.70	39.0	39.0	*
	-11.646	89.6	3.385	-1.504	740.8	-163.1	61.70	39.0	39.0	
	-12.160	88.8	3.301	-1.752	650.4	-189.1	54.16	38.1	50.8	
	-13.144	87.2	3.109	-2.127	439.7	-239.2	36.62	35.9	73.4	
	-13.144	83.5	3.109	-2.127	439.7	-239.2	36.62	105.4	105.4	*
	-13.160	83.4	3.106	-2.132	435.9	-238.9	36.30	105.9	105.9	*
	-14.160	81.1	2.880	-2.355	213.6	-200.3	17.79	135.8	135.8	*
	-14.160	81.1	2.880	-2.355	213.6	-200.3	20.23	135.8	135.8	*
	-14.353	80.7	2.835	-2.385	176.0	-189.2	16.67	141.5	141.5	*
	-14.353	80.7	2.835	-2.385	176.0	-189.2	16.67	141.7	141.5	
	-15.160	78.8	2.639	-2.452	42.3	-143.2	4.01	131.9	165.6	
	-16.160	76.5	2.394	-2.436	-75.9	-95.1	7.19	119.6	195.5	
	-17.160	74.2	2.154	-2.344	-151.1	-56.8	14.31	107.7	225.4	
	-18.160	71.9	1.926	-2.206	-192.7	-28.0	18.25	96.3	255.3	
	-19.160	69.6	1.714	-2.046	-210.0	-7.8	19.88	85.6	285.1	
	-20.160	67.3	1.517	-1.879	-211.1	4.4	19.99	75.8	315.0	
	-21.160	65.0	1.338	-1.715	-203.5	9.5	19.28	66.9	344.9	
	-21.704	47.7	1.247	-1.629	-198.2	9.6	18.77	58.7	179.2	
	-22.160	46.5	1.174	-1.559	-192.8	14.2	18.26	55.3	181.3	
	-23.160	44.0	1.026	-1.413	-175.0	20.6	16.58	48.3	185.7	
	-24.160	41.5	0.891	-1.283	-152.9	22.9	14.48	42.0	190.2	
	-25.160	39.0	0.768	-1.172	-130.4	21.7	12.34	36.2	194.7	
	-26.160	36.5	0.656	-1.077	-110.5	17.5	10.47	30.9	199.2	
	-27.160	33.9	0.552	-0.996	-96.2	10.7	9.11	26.0	203.7	
	-28.160	31.4	0.457	-0.923	-89.8	1.8	8.51	21.5	208.1	
	-29.160	28.9	0.368	-0.851	-93.3	-9.0	8.84	17.3	212.6	
	-30.160	26.4	0.286	-0.773	-108.4	-21.3	10.26	13.5	217.1	
	-30.384	18.7	0.269	-0.753	-113.4	-24.2	10.74	32.6	398.8	
	-30.418	18.5	0.267	-0.750	-114.3	-23.7	10.82	32.3	398.9	
	-31.160	14.5	0.214	-0.679	-128.3	-14.4	12.15	25.9	401.6	
	-32.160	9.1	0.151	-0.573	-137.5	-4.2	13.02	18.3	405.2	
	-32.358	8.0	0.140	-0.552	-138.1	-2.5	13.08	17.0	405.9	
	-33.160	3.7	0.099	-0.464	-137.3	4.4	13.00	12.0	408.8	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-33.848	0.0	0.070	-0.391	-132.3	10.1	12.53	8.5	411.3	
	-34.160	0.0	0.058	-0.359	-128.8	12.5	12.20	7.1	412.4	
	-35.160	0.0	0.027	-0.263	-113.4	17.6	10.74	3.3	416.0	
	-36.160	0.0	0.005	-0.180	-94.6	19.5	8.96	0.6	419.6	
	-36.966	0.0	-0.007	-0.125	-78.9	19.4	7.47	0.0	422.5	
	-37.160	0.0	-0.009	-0.114	-75.1	19.2	7.11	0.0	424.2	
	-38.160	0.0	-0.018	-0.062	-56.7	17.5	5.37	0.0	433.2	
	-39.160	0.0	-0.022	-0.023	-40.4	15.0	3.83	0.0	442.2	
	-40.160	0.0	-0.023	0.003	-26.8	12.2	2.54	0.0	451.2	
	-41.160	0.0	-0.022	0.020	-15.9	9.5	1.51	0.0	460.2	
	-42.160	0.0	-0.019	0.029	-7.7	7.0	0.73	0.0	469.2	
	-43.160	0.0	-0.016	0.032	-1.8	4.8	0.17	0.0	478.2	
	-44.160	0.0	-0.013	0.032	2.1	3.0	0.20	0.0	487.2	
	-45.160	0.0	-0.010	0.029	4.4	1.7	0.42	0.0	496.2	
	-46.160	0.0	-0.007	0.025	5.5	0.6	0.52	0.0	505.2	
	-47.160	0.0	-0.005	0.021	5.7	-0.1	0.54	0.0	514.2	
	-48.160	0.0	-0.003	0.016	5.4	-0.6	0.51	0.0	523.2	
	-49.160	0.0	-0.002	0.012	4.6	-0.9	0.43	0.0	532.2	
	-50.160	0.0	-0.001	0.009	3.6	-1.0	0.34	0.0	541.2	
	-51.160	0.0	0.000	0.007	2.6	-1.0	0.24	0.0	550.2	
	-52.160	0.0	0.001	0.005	1.6	-1.0	0.15	0.1	559.2	
	-52.954	0.0	0.001	0.004	0.8	-0.9	0.08	0.4	1276.9	
	-53.160	0.0	0.001	0.004	0.6	-0.8	0.06	0.4	1286.4	
	-54.160	0.0	0.002	0.004	0.1	-0.3	0.01	0.6	1332.7	
	-54.660	0.0	0.002	0.004	0.0	0.0	0.00	0.6	1355.8	

*showing plastic

(9)perpendicular direction   4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.159	3.402	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.011	3.402	0.0	0.0	0.00	0.0	0.0	
30.7										
	+4.340	0.3	0.011	3.402	0.0	30.7	0.00	0.0	0.0	
	+3.840	5.3	0.181	3.399	15.1	29.3	1.43	0.0	0.0	
	+2.840	15.2	0.520	3.376	40.1	19.1	3.80	0.0	0.0	
	+1.840	25.2	0.856	3.340	50.0	-1.1	4.73	0.0	0.0	
	+1.340	30.2	1.023	3.320	46.0	-15.0	4.36	0.0	0.0	
19.2										
	+1.340	30.2	1.023	3.320	46.0	4.3	4.36	0.0	0.0	
	+0.840	35.2	1.188	3.302	44.2	-12.1	4.18	0.0	0.0	
	-0.160	45.1	1.517	3.277	12.9	-52.2	1.22	0.0	0.0	
	-1.160	55.1	1.845	3.294	-63.6	-102.3	6.02	0.0	0.0	
	-1.660	60.1	2.011	3.330	-121.8	-131.1	11.54	0.0	0.0	
418.1										
	-1.660	60.1	2.011	3.330	-121.8	287.0	11.54	0.0	0.0	
	-1.721	36.4	2.031	3.335	-104.4	283.3	9.89	0.0	0.0	
	-2.160	41.0	2.178	3.350	16.3	266.4	1.54	0.0	0.0	
	-2.160	41.0	2.178	3.350	16.3	266.4	1.36	0.0	0.0	
	-3.160	51.5	2.509	3.252	260.4	220.1	21.69	0.0	0.0	
	-3.450	54.5	2.603	3.193	322.0	204.8	26.82	0.0	0.0	
	-4.160	62.0	2.823	3.001	453.1	163.4	37.73	0.0	0.0	
	-5.160	72.5	3.106	2.637	583.7	96.2	48.61	0.0	0.0	
	-6.160	83.0	3.348	2.208	641.9	18.5	53.46	0.0	0.0	
	-6.704	73.9	3.462	1.965	639.4	-28.2	53.25	0.0	0.0	
	-7.160	77.9	3.547	1.765	618.7	-62.9	51.52	0.0	0.0	
	-7.450	80.4	3.596	1.643	597.1	-85.8	49.73	0.0	0.0	
	-8.160	86.6	3.703	1.367	570.9	-145.1	47.54	0.0	0.0	
	-8.450	89.2	3.741	1.268	579.7	-170.6	48.28	0.0	0.0	
440.1										
	-8.450	89.2	3.741	1.268	579.7	269.4	48.28	0.0	0.0	
	-9.160	95.4	3.822	0.993	647.2	203.9	53.90	0.0	0.0	
	-9.794	163.2	3.875	0.687	747.7	141.7	62.27	0.0	0.0	
	-9.950	148.7	3.885	0.605	767.8	116.1	63.94	44.8	96.4	
	-10.160	148.4	3.897	0.491	789.9	94.3	65.78	44.9	101.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	147.3	3.917	0.099	830.5	23.0	69.17	45.2	117.2	
	-11.160	146.8	3.918	-0.078	832.8	-8.2	69.36	45.2	124.2	
	-11.450	146.4	3.913	-0.245	826.1	-37.6	68.80	45.1	130.9	
	-12.160	145.2	3.882	-0.641	774.0	-109.2	64.46	44.8	147.2	
	-13.144	142.3	3.794	-1.122	618.0	-207.7	51.47	189.6	242.9	
	-13.160	142.2	3.792	-1.129	614.7	-207.0	51.19	189.5	243.4	
	-14.160	139.9	3.660	-1.489	430.8	-161.7	35.87	182.9	273.3	
	-14.160	139.9	3.660	-1.489	430.8	-161.7	40.79	182.9	273.3	
	-15.160	137.6	3.496	-1.771	289.7	-121.5	27.43	174.7	303.2	
	-16.160	135.3	3.309	-1.956	185.7	-87.8	17.58	165.4	333.0	
	-17.160	133.0	3.107	-2.072	111.6	-61.5	10.57	155.3	362.9	
	-18.160	130.7	2.896	-2.138	59.9	-43.3	5.67	144.8	392.8	
	-19.160	128.4	2.681	-2.170	22.2	-33.5	2.10	134.0	422.7	
	-20.160	126.1	2.463	-2.175	-9.9	-32.1	0.93	123.1	452.5	
	-21.160	123.8	2.247	-2.154	-44.9	-39.4	4.25	112.3	482.4	
	-21.704	72.8	2.130	-2.130	-68.2	-46.9	6.46	100.3	162.5	
	-22.160	71.7	2.034	-2.101	-86.9	-35.1	8.23	95.8	164.5	
	-23.160	69.2	1.827	-2.022	-111.1	-14.6	10.52	86.1	169.0	
	-24.160	66.6	1.630	-1.930	-118.5	-1.2	11.22	76.7	173.5	
	-25.160	64.1	1.441	-1.838	-115.6	5.7	10.95	67.9	177.9	
	-26.160	61.6	1.262	-1.749	-109.0	6.5	10.33	59.4	182.4	
	-27.160	59.1	1.091	-1.665	-104.6	1.5	9.90	51.4	186.9	
	-28.160	56.6	0.929	-1.582	-107.7	-8.7	10.20	43.7	191.4	
	-29.160	54.0	0.775	-1.492	-123.7	-24.0	11.72	36.5	195.9	
	-30.160	51.5	0.631	-1.382	-157.2	-43.7	14.88	29.7	200.3	
	-30.384	39.7	0.601	-1.353	-167.5	-48.6	15.86	72.7	377.8	
	-31.160	35.5	0.500	-1.241	-196.1	-26.2	18.57	60.5	380.6	
	-32.160	30.1	0.384	-1.079	-211.3	-5.6	20.01	46.5	384.2	
	-32.831	26.4	0.315	-0.967	-211.7	3.8	20.05	38.2	386.7	
	-33.160	24.7	0.284	-0.912	-209.8	7.3	19.87	34.4	387.8	
	-34.160	19.3	0.201	-0.750	-198.5	14.6	18.80	24.4	391.4	
	-34.771	16.0	0.158	-0.657	-188.7	17.1	17.87	19.2	393.6	
	-35.160	13.9	0.134	-0.600	-181.9	18.1	17.22	16.2	395.0	
	-36.160	8.5	0.081	-0.464	-162.8	19.8	15.42	9.8	398.6	
	-37.160	3.1	0.040	-0.343	-142.3	21.3	13.48	4.9	402.2	
	-37.728	0.0	0.023	-0.282	-129.9	22.5	12.30	2.7	404.3	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-38.160	0.0	0.011	-0.240	-119.9	23.4	11.36	1.4	405.8	
	-39.160	0.0	-0.008	-0.155	-96.2	23.5	9.12	0.0	409.4	
	-40.160	0.0	-0.020	-0.088	-73.5	21.8	6.96	0.0	413.0	
	-40.846	0.0	-0.025	-0.052	-59.2	19.9	5.60	0.0	415.5	
	-41.160	0.0	-0.026	-0.038	-53.1	18.9	5.03	0.0	418.3	
	-42.160	0.0	-0.028	-0.003	-35.8	15.6	3.39	0.0	427.3	
	-43.160	0.0	-0.027	0.020	-22.0	12.2	2.08	0.0	436.3	
	-44.160	0.0	-0.025	0.032	-11.4	9.0	1.08	0.0	445.3	
	-45.160	0.0	-0.021	0.038	-3.8	6.3	0.36	0.0	454.3	
	-46.160	0.0	-0.017	0.039	1.3	3.9	0.12	0.0	463.3	
	-47.160	0.0	-0.013	0.037	4.3	2.1	0.41	0.0	472.3	
	-48.160	0.0	-0.010	0.033	5.7	0.7	0.54	0.0	481.3	
	-49.160	0.0	-0.007	0.028	5.8	-0.3	0.55	0.0	490.3	
	-50.160	0.0	-0.004	0.024	5.2	-1.0	0.49	0.0	499.3	
	-51.160	0.0	-0.002	0.020	4.0	-1.3	0.38	0.0	508.3	
	-52.160	0.0	0.000	0.017	2.6	-1.5	0.25	0.0	517.3	
	-52.954	0.0	0.001	0.016	1.4	-1.4	0.14	0.4	1043.8	
	-53.160	0.0	0.001	0.016	1.1	-1.3	0.11	0.5	1053.4	
	-54.160	0.0	0.003	0.015	0.1	-0.6	0.01	1.0	1099.6	
	-54.660	0.0	0.004	0.015	0.0	0.0	0.00	1.3	1122.7	

bending moment at support of footing concrete is reduced value

(10)perpendicular direction 5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.159	3.403	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.011	3.403	0.0	0.0	0.00	0.0	0.0	
30.8										
	+4.340	0.3	0.011	3.403	0.0	30.8	0.00	0.0	0.0	
	+3.840	5.3	0.182	3.400	15.2	29.4	1.44	0.0	0.0	
	+2.840	15.2	0.521	3.378	40.3	19.2	3.82	0.0	0.0	
	+1.840	25.2	0.857	3.341	50.2	-1.0	4.76	0.0	0.0	
	+1.340	30.2	1.023	3.321	46.4	-14.8	4.39	0.0	0.0	
20.3										
	+1.340	30.2	1.023	3.321	46.4	5.5	4.39	0.0	0.0	
	+0.840	35.2	1.189	3.303	45.1	-10.9	4.28	0.0	0.0	
	-0.160	45.1	1.518	3.277	15.0	-51.0	1.43	0.0	0.0	
	-1.160	55.1	1.845	3.291	-60.2	-101.1	5.70	0.0	0.0	
	-1.660	60.1	2.011	3.326	-117.8	-129.9	11.16	0.0	0.0	
419.2										
	-1.660	60.1	2.011	3.326	-117.8	289.3	11.16	0.0	0.0	
	-1.721	36.4	2.031	3.331	-100.3	285.6	9.50	0.0	0.0	
	-2.160	41.0	2.178	3.344	21.5	268.7	2.03	0.0	0.0	
	-2.160	41.0	2.178	3.344	21.5	268.7	1.79	0.0	0.0	
	-3.160	51.5	2.508	3.241	267.9	222.4	22.31	0.0	0.0	
	-3.450	260338.8	2.602	3.181	330.2	207.1	27.50	0.0	0.0	
	-4.160	282373.4	2.821	2.987	451.9	124.4	37.63	0.0	0.0	
	-5.160	310650.8	3.103	2.635	562.2	81.3	46.82	0.0	0.0	
	-6.160	334919.1	3.346	2.224	632.3	71.9	52.66	0.0	0.0	
	-6.704	346258.3	3.460	1.982	645.4	-15.7	53.75	0.0	0.0	
	-7.160	354764.7	3.546	1.780	626.6	-61.5	52.18	0.0	0.0	
	-7.450	80.4	3.596	1.656	604.6	-88.6	50.35	0.0	0.0	
	-8.160	86.6	3.703	1.377	576.6	-147.9	48.02	0.0	0.0	
	-8.450	89.2	3.742	1.277	584.9	-173.4	48.71	0.0	0.0	
442.2										
	-8.450	89.2	3.742	1.277	584.9	268.8	48.71	0.0	0.0	
	-9.160	95.4	3.823	1.000	651.4	203.2	54.25	0.0	0.0	
	-9.794	163.2	3.877	0.692	751.4	141.0	62.58	0.0	0.0	
	-9.950	148.7	3.887	0.609	771.4	115.4	64.24	44.8	96.4	
	-10.160	148.4	3.899	0.495	793.4	93.6	66.07	45.0	101.2	

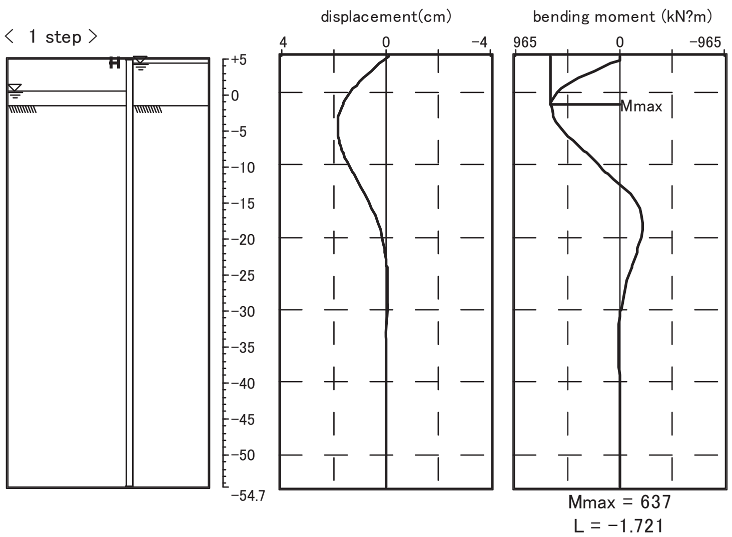
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-10.854	147.3	3.920	0.102	833.5	22.3	69.42	45.2	117.2	
	-11.160	146.8	3.920	-0.076	835.6	-8.9	69.59	45.2	124.2	
	-11.450	146.4	3.915	-0.243	828.7	-38.3	69.02	45.2	130.9	
	-12.160	145.2	3.884	-0.641	776.1	-109.8	64.64	44.8	147.2	
	-13.144	142.3	3.796	-1.123	619.6	-208.3	51.60	189.7	242.9	
	-13.160	142.2	3.794	-1.130	616.2	-207.6	51.32	189.6	243.4	
	-14.160	139.9	3.662	-1.491	431.7	-162.1	35.96	183.0	273.3	
	-14.160	139.9	3.662	-1.491	431.7	-162.1	40.89	183.0	273.3	
	-15.160	137.6	3.498	-1.773	290.2	-121.9	27.49	174.8	303.2	
	-16.160	135.3	3.311	-1.959	185.9	-88.1	17.60	165.5	333.0	
	-17.160	133.0	3.109	-2.074	111.6	-61.7	10.57	155.4	362.9	
	-18.160	130.7	2.898	-2.141	59.7	-43.5	5.65	144.8	392.8	
	-19.160	128.4	2.682	-2.172	21.9	-33.5	2.07	134.0	422.7	
	-20.160	126.1	2.464	-2.177	-10.2	-32.2	0.97	123.2	452.5	
	-21.160	123.8	2.247	-2.155	-45.3	-39.4	4.29	112.3	482.4	
	-21.704	72.8	2.131	-2.131	-68.6	-46.8	6.50	100.3	162.5	
	-22.160	71.7	2.034	-2.103	-87.3	-35.1	8.26	95.8	164.5	
	-23.160	69.2	1.828	-2.023	-111.5	-14.6	10.56	86.1	169.0	
	-24.160	66.6	1.630	-1.931	-118.8	-1.1	11.25	76.8	173.5	
	-25.160	64.1	1.441	-1.838	-115.9	5.8	10.98	67.9	177.9	
	-26.160	61.6	1.262	-1.749	-109.3	6.5	10.35	59.4	182.4	
	-27.160	59.1	1.091	-1.665	-104.8	1.6	9.92	51.4	186.9	
	-28.160	56.6	0.929	-1.582	-107.9	-8.7	10.22	43.7	191.4	
	-29.160	54.0	0.775	-1.492	-123.8	-23.9	11.73	36.5	195.9	
	-30.160	51.5	0.631	-1.382	-157.2	-43.6	14.89	29.7	200.3	
	-30.384	39.7	0.601	-1.353	-167.6	-48.6	15.87	72.7	377.8	
	-31.160	35.5	0.500	-1.241	-196.2	-26.1	18.58	60.5	380.6	
	-32.160	30.1	0.384	-1.079	-211.3	-5.6	20.01	46.5	384.2	
	-32.831	26.4	0.315	-0.967	-211.7	3.8	20.05	38.1	386.7	
	-33.160	24.7	0.284	-0.912	-209.8	7.3	19.87	34.4	387.8	
	-34.160	19.3	0.201	-0.750	-198.5	14.6	18.80	24.4	391.4	
	-34.771	16.0	0.158	-0.657	-188.7	17.1	17.87	19.1	393.6	
	-35.160	13.9	0.134	-0.600	-181.9	18.2	17.22	16.2	395.0	
	-36.160	8.5	0.081	-0.464	-162.8	19.8	15.42	9.8	398.6	
	-37.160	3.1	0.040	-0.343	-142.3	21.3	13.48	4.9	402.2	
	-37.728	0.0	0.023	-0.282	-129.9	22.5	12.30	2.7	404.3	

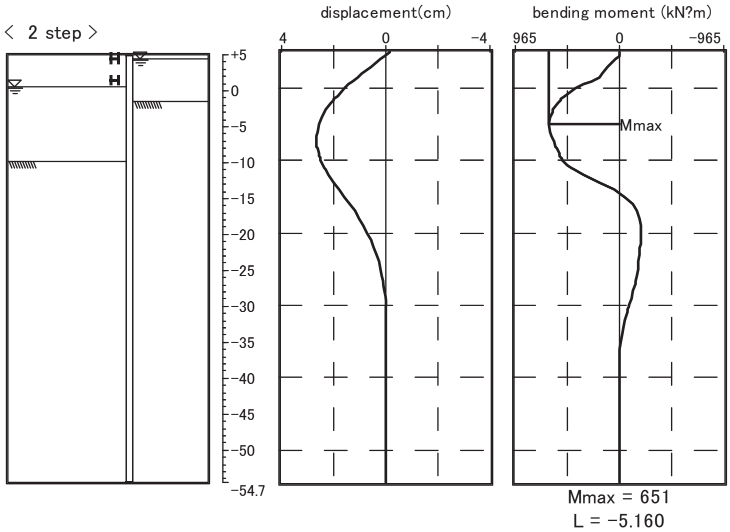
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-38.160	0.0	0.011	-0.240	-119.9	23.4	11.36	1.4	405.8	
	-39.160	0.0	-0.008	-0.154	-96.2	23.5	9.11	0.0	409.4	
	-40.160	0.0	-0.020	-0.088	-73.5	21.8	6.96	0.0	413.0	
	-40.846	0.0	-0.025	-0.052	-59.2	19.9	5.60	0.0	415.5	
	-41.160	0.0	-0.026	-0.038	-53.1	18.9	5.03	0.0	418.3	
	-42.160	0.0	-0.028	-0.003	-35.8	15.6	3.39	0.0	427.3	
	-43.160	0.0	-0.027	0.020	-21.9	12.2	2.08	0.0	436.3	
	-44.160	0.0	-0.025	0.032	-11.4	9.0	1.08	0.0	445.3	
	-45.160	0.0	-0.021	0.038	-3.8	6.3	0.36	0.0	454.3	
	-46.160	0.0	-0.017	0.039	1.3	3.9	0.12	0.0	463.3	
	-47.160	0.0	-0.013	0.037	4.3	2.1	0.41	0.0	472.3	
	-48.160	0.0	-0.010	0.033	5.7	0.7	0.54	0.0	481.3	
	-49.160	0.0	-0.007	0.028	5.8	-0.3	0.55	0.0	490.3	
	-50.160	0.0	-0.004	0.024	5.2	-1.0	0.49	0.0	499.3	
	-51.160	0.0	-0.002	0.020	4.0	-1.3	0.38	0.0	508.3	
	-52.160	0.0	0.000	0.017	2.6	-1.5	0.25	0.0	517.3	
	-52.954	0.0	0.001	0.016	1.4	-1.4	0.14	0.4	1043.8	
	-53.160	0.0	0.001	0.016	1.1	-1.3	0.11	0.5	1053.4	
	-54.160	0.0	0.003	0.015	0.1	-0.6	0.01	1.0	1099.6	
	-54.660	0.0	0.004	0.015	0.0	0.0	0.00	1.3	1122.7	

bending moment at support of footing concrete is reduced value

2.11 displacement / member force diagram

bridge axis direction

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bending moment (kN?m)
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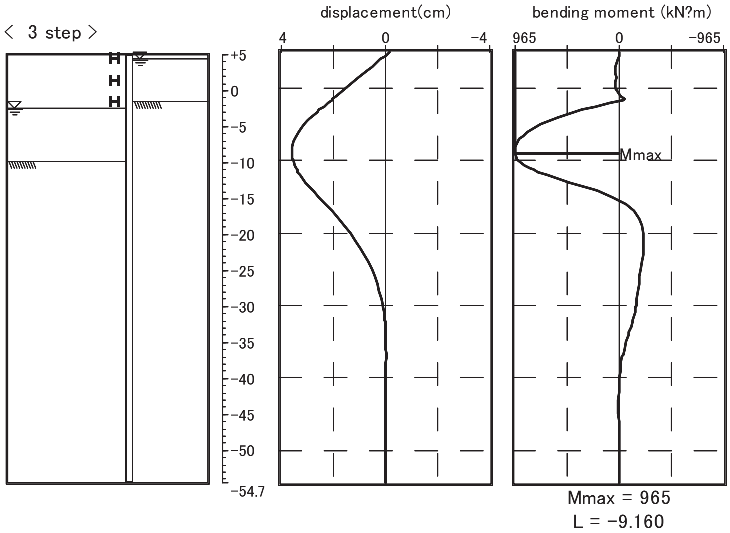
0
-4
965
0
-965
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-54.7
Mmax
Mmax = 651
L = -5.160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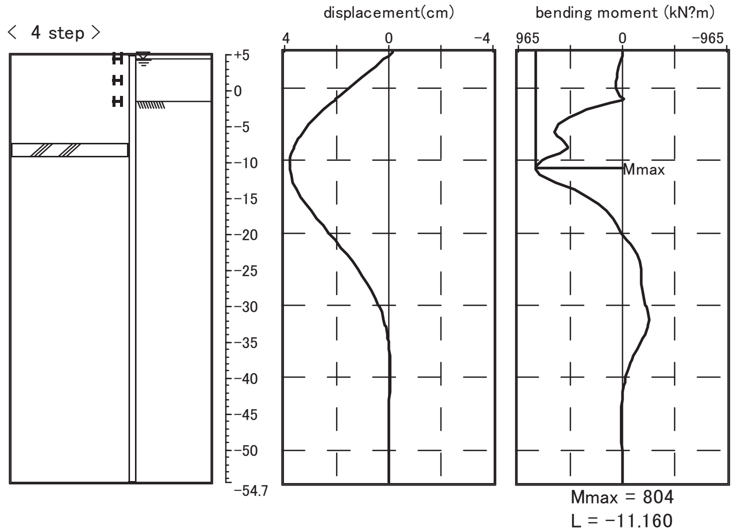
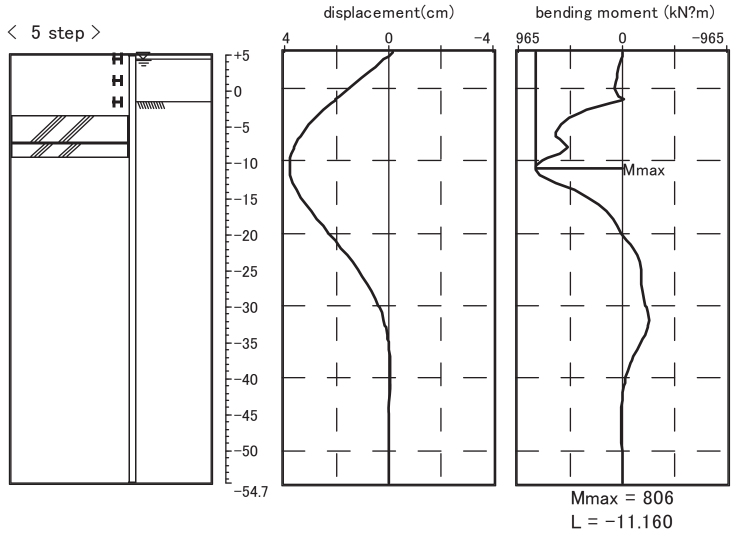
displacement(cm)
bending moment (kN?m)
4
0
-4
965
0
-965
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-54.7
Mmax
Mmax = 965
L = -9.160

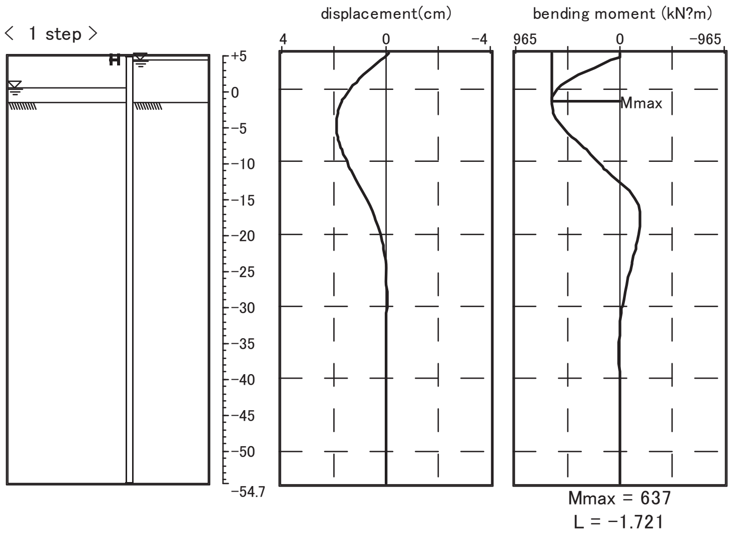


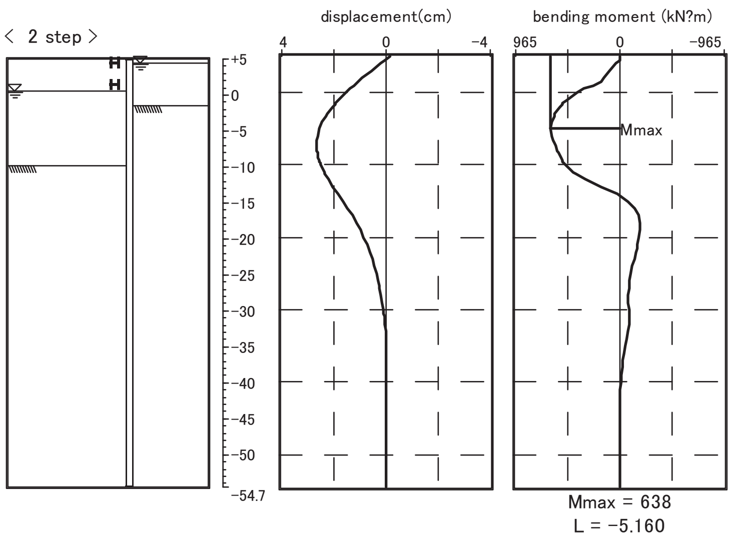
< 4 step >
displacement(cm)
4
0
-4
bending moment (kN?m)
965
0
-965
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-54.7
Mmax
Mmax = 804
L = -11.160

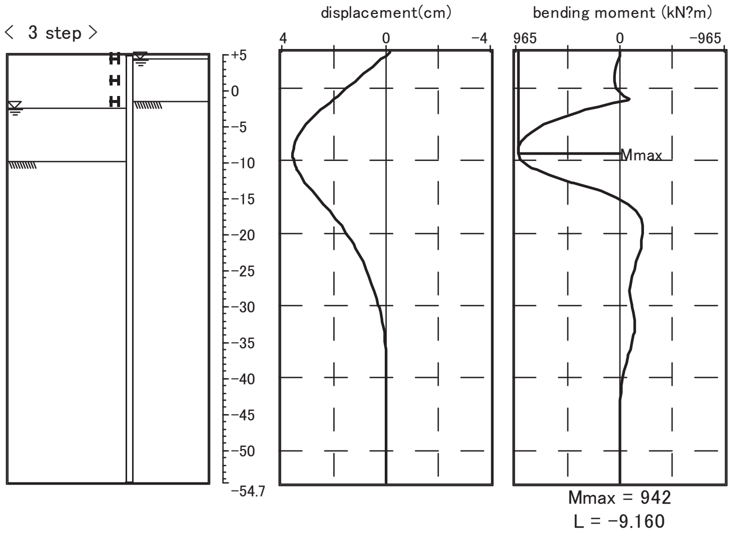


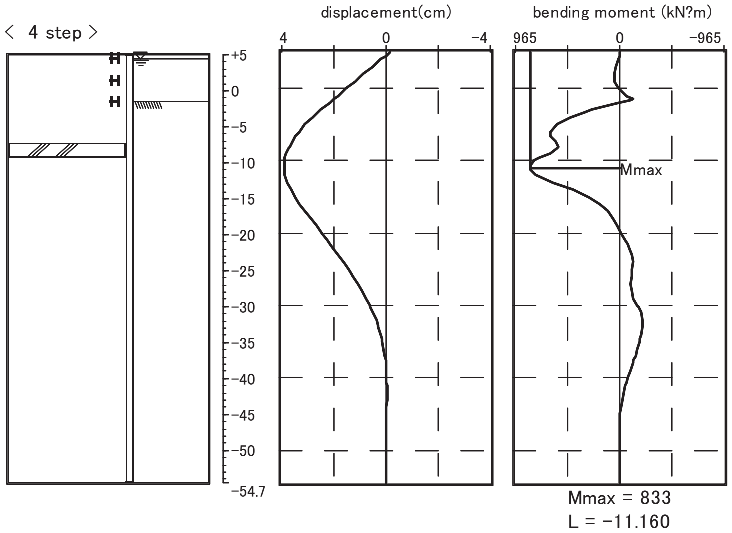
< 5 step >
displacement(cm)
4
0
-4
bending moment (kN?m)
965
0
-965
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-54.7
Mmax
Mmax = 806
L = -11.160

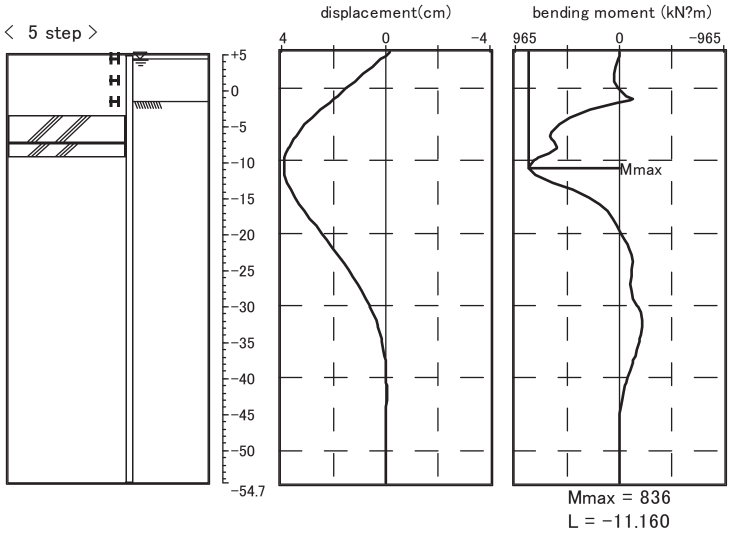
perpendicular direction






< 3 step >
displacement(cm)
bending moment (kN?m)
4
0
−4
965
0
−965
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−54.7
Mmax
Mmax = 942
L = −9.160


< 4 step >
displacement(cm)
bending moment (kN?m)
4
0
−4
965
0
−965
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−54.7
Mmax
Mmax = 833
L = −11.160



2.12 check timbering

(1) section performance

1)bridge axis direction (linear)

**wailing

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

2)perpendicular direction (arc)

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

(2) maximum timbering reaction Rmax (kN/m)

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
1	H-300*300*10*15	164.61	H-300*300*10*15	164.53
2	H-300*300*10*15	147.05	H-300*300*10*15	150.04
3	2H-350*350*12*19	202.79	2H-350*350*12*19	211.94

note)double timbering is 1/2 value

(3)arc part

1)check of ring buckling

about buckling of arc wailing, following equation to calculate allowable timbering reaction in considertaion of ring buckling safety is checked

$$Ra = \frac{2*E*Iy}{r^3} >= R1max$$

where, Ra : allowable timbering reaction (N/mm)

E : Young's modulus of wailing = 2.00 * 10^5(N/mm^2)

Iy : moment of inertia of wailing(mm^4)

r : radius of circular timbering (mm)

R1max : maximum timbering reaction (N/mm) ------ perpendicular direction(arc part)

row	section	r (cm)	Iy (cm^4)	Ra (kN/m)	R1max (kN/m)	judge
1	H-300*300*10*15	296.06	20200	3113.70	164.53	OK
2	H-300*300*10*15	296.06	20200	3113.70	150.04	OK
3	2H-350*350*12*19	293.56	39800	6292.99	211.94	OK

2)wailing stress check

arc wailing may be calculated as an axial compression member under uniformly distributed pressure

Acutually, irregular shape of timbering and precision to cast steel pipe sheet pile (actual observation, radius in oval part about 1 to 2%), because imbalanced pressure induced moment is observed,

for safety, following procedure is taken to consider influence of ovalization in principle

stress working at wailing is given by the following equation.

$$Sig.s = \frac{N}{A} + \frac{M1 + M2}{Z} <= Sig.sa$$

where, Sig.s : stress of wailing(N/mm^2)

Sig.sa : allowable stress of wailing (N/mm^2)

A : sectional area of wailing (mm^2)

Z : section coefficient of wailing (mm^3)

N : axial force (N) = R1max * r

R1max : maximum timbering reaction (N/mm)

r : radius of wailing (mm)

M1 : bending moment in consideration of ovalization (N.mm) = R1max * r^2* Del.

Del. : ovalization rate, 2% wailing radius is supposed to be standard.

M2 : support point bending moment in linear part (N.mm) = (R2max.L1^2) / 12

R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)

L1 : effective span in linear part of wailing (mm)

row	section	A (cm^2)	Z (cm^3)	R1max (kN/m)	R2max (kN/m)	r (cm)
1	H-300*300*10*15	118.40	1350	164.53	164.61	296.06
2	H-300*300*10*15	118.40	1350	150.04	147.05	296.06
3	2H-350*350*12*19	171.90	2280	211.94	202.79	293.56

row	L1 (m)	N (kN)	M1 (kN.m)	M2 (kN.m)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	judge
1	2.700	487.1	28.8	100.0	136.58	210.00	OK
2	2.700	444.2	26.3	89.3	123.17	210.00	OK
3	2.700	622.2	36.5	123.2	106.25	210.00	OK

(4)linear part

1)check of wailing

wailing in linear part is a member which receives both axial compressive force and bending moment together are supposed to be checked using the following equation
besides, as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy * \left(1 - \frac{Sig.c}{Sig.eay}\right)} \le 1.0 \quad \text{--- check1}$$

$$Sig.c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} \le Sig.cal \quad \text{--- check2}$$

where, Sig.c : compressive stress by axial force acting on check section (N/mm^2)
Sig.bcy : bending compressive stress by bending moment about strong axis (N/mm^2)
Sig.caz : about weak axis allowable axial direction compressive stress (N/mm^2)

$$\frac{L5}{rz} \le 18 : Sig.caz = 210.0$$

$$18 < \frac{L5}{rz} \le 92 : Sig.caz = 1.5*\left\{140.0 - 0.82\left(\frac{L5}{rz} - 18\right)\right\}$$

$$92 < \frac{L5}{rz} \quad : Sig.caz = \frac{1.5*1,200,000}{6700 + \left(\frac{L5}{rz}\right)^2}$$

L5 : about weak axis effective buckling length (mm)
rz : about weak axis section second radius (mm)
Sig.bagy : without considering local tbuckling, allowable bending compressive stress about strong axis (N/mm^2)

$$\frac{L2}{b} \le 4.5 \quad : Sig.bagy = 210.0$$

$$4.5 < \frac{L2}{b} \le 30 \quad : Sig.bagy = 1.5*\left\{140.0 - 2.4\left(\frac{L2}{b} - 4.5\right)\right\}$$

L2 : distance between fixed flange (mm)
b : compressive flange width (mm)
Sig.cal : allowable stress for local buckling of protrusion under compressive force (N/mm^2)
(= 210.0 (N/mm^2))

Sig.eay : Euler buckling stress about strong axis(N/mm^2) = $\frac{1,200,000}{\left(\frac{L4}{ry}\right)^2}$

L4 : effective buckling length about strong axis (mm)
ry : section second radius about strong axis (mm)

a)stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} \le 1.0$$

$N = R1max*r + Del.N$

$$M = \frac{R2max*L1^2}{8}$$

$$sc = \frac{N}{A}, \quad sbcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \quad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, R1max : maximum timbering reaction (N/mm) perpendicular direction(arc part)
R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)
N : axial force (N)
L : maximum strut spacing (mm)
L' : brace setting length (mm)
L1 : effective buckling length (mm) = L - L'
L2 : distance between fixed flange (mm)
L4 : effective buckling length about strong axis (mm)
L5 : effective buckling length about weak axis (mm)

row	section	A (cm^2)	Z (cm^3)	r (cm)	L (m)	L' (m)	L1 (m)	L2 (m)	L4 (m)	L5 (m)
1	H-300*300*10*15	118.40	1350	296.06	4.000	1.300	2.700	2.700	2.700	2.700
2	H-300*300*10*15	118.40	1350	296.06	4.000	1.300	2.700	2.700	2.700	2.700
3	2H-350*350*12*19	171.90	2280	293.56	4.000	1.300	2.700	2.700	2.700	2.700

row	L5/rz	Sig.caz (N/mm²)	L2/b	Sig.bagy (N/mm²)	L4/ry (m)	Sig.eay (N/mm²)
1	35.76	188.15	9.00	193.80	20.61	2824.86
2	35.76	188.15	9.00	193.80	20.61	2824.86
3	30.37	194.78	7.71	198.43	17.76	3803.13

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	164.53	164.61	637.10	150.00	53.81	111.11
2	150.04	147.05	594.21	134.00	50.19	99.26
3	211.94	202.79	772.17	184.79	44.92	81.05

row	Alp.	Beta	Alp.+Beta	judgement
1	0.286	0.584	0.870	OK
2	0.267	0.521	0.788	OK
3	0.231	0.413	0.644	OK

b)stability check2

$$\text{Sig..c} + \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}} \le \text{Sig.cal}$$

$$\text{Gam.} = \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	53.81	111.11	2824.86	113.27	167.08	210.00	OK
2	50.19	99.26	2824.86	101.05	151.24	210.00	OK
3	44.92	81.05	3803.13	82.02	126.94	210.00	OK

c) check of shear stress

$$\text{Smax} = \frac{\text{R2max*L1}}{2}$$

$$\text{Tau.s} = \frac{\text{Smax}}{\text{Aw}} \le \text{Tau.sa}$$

where, Smax : maximum shear force (N)
Aw : web sectional area (mm^2)
Tau.s : accrue shear stress (N/mm^2)
Tau.sa : allowable shear stress (N/mm^2)

row	R2max (kN/m)	L1 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	164.61	2.700	222.22	27.00	82.30	120.00	OK
2	147.05	2.700	198.52	27.00	73.52	120.00	OK
3	202.79	2.700	273.76	37.44	73.12	120.00	OK

2) check of strut

strut is a member which receives both axial compression force and bending moment with wailing likewise check. vertical load working at strut is sume of strut dead weight+surcharge load (w = 5.0 kN/m) as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

a) stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0$$

$$N = R2max*L1 + Del.N$$

$$M = \frac{w*L3^2}{8}$$

$$Sig.c = \frac{N}{A}, \quad Sig.bcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \quad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, L1 : axial force sharing width of strut (mm)
L2 : distance between fixed flange (mm)
L3 : strut bending span (mm)
L4 : effective buckling length about strong axis (mm)
L5 : effective buckling length about weak axis (mm)

row	section	A (cm2)	Z (cm3)	L1 (m)	L2 (m)	L3 (m)	L4 (m)	L5 (m)
1	H-300*300*10*15	118.40	1350	4.000	3.021	5.621	5.621	3.021
2	H-300*300*10*15	118.40	1350	4.000	3.021	5.621	5.621	3.021
3	2H-350*350*12*19	171.90	2280	4.000	2.921	5.521	5.521	2.921

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	40.01	182.92	10.07	189.95	42.91	651.77
2	40.01	182.92	10.07	189.95	42.91	651.77
3	32.86	191.73	8.35	196.16	36.32	909.56

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	164.53	164.61	808.43	19.75	68.28	14.63
2	150.04	147.05	738.19	19.75	62.35	14.63
3	211.94	202.79	961.15	19.05	55.91	8.36

row	Alp.	Beta	Alp.+Beta	judgement
1	0.373	0.086	0.459	OK
2	0.341	0.085	0.426	OK
3	0.292	0.045	0.337	OK

b)stability check2

$$Sig..c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} <= Sig.cal$$

$$Gam. = \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	68.28	14.63	651.77	16.34	84.62	210.00	OK
2	62.35	14.63	651.77	16.17	78.52	210.00	OK
3	55.91	8.36	909.56	8.90	64.82	210.00	OK

c) check of shear stress

$$Smax = \frac{5.0*L3}{2}$$

$$Tau.s = \frac{Smax}{Aw} <= Tau.sa$$

row	L3 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	5.621	14.05	27.00	5.20	120.00	OK
2	5.621	14.05	27.00	5.20	120.00	OK

row	L3 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
3	5.521	13.80	37.44	3.69	120.00	OK

3)check of brace beam

brace beam is a member which receives only axial compression force from wailing and use the following equation are supposed to be checked

$$Sig.c = \frac{N}{A} \le Sig.caz$$

$$N = \frac{(L1 + L2)*R2max}{2*cosTheta}$$

where, L : brace length (mm)
L1 : brace setting length (mm)
L2 : strut spacing - 2 * brace span (mm)
Theta : brace setting angle (Deg.)

row	section	A (cm2)	Theta (Deg.)	L (m)	L1 (m)	L2 (m)
1	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400
2	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400
3	2H-350*350*12*19	171.90	45.0	1.838	1.300	1.400

row	L/rz	R2max (kN/m)	N (kN)	Sig.c (N/mm2)	Sig.caz (N/mm2)	judgement
1	24.35	164.61	314.26	26.54	202.19	OK
2	24.35	147.05	280.74	23.71	202.19	OK
3	20.68	202.79	387.16	22.52	206.70	OK

2.13 check of embedment length

current ground surface elevation   -1.721 (m)
riverside water table elevation   +4.340 (m)
steel pipe sheet pile length   59.500 (m)

(1)final excavation time   (4 step)
observing strut   elevation = -1.660 (m)
coffered landside excavation area elevation = -9.950 (m)
coffered landside water table   elevation = -9.950 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	-1.660 -1.721	0.061	------- -------	0.00 0.00	60.00 60.61
2	-1.721 -4.388	2.667	------- -------	0.00 0.00	60.61 87.28
3	-4.388 -6.704	2.316	------- -------	0.00 17.37	87.28 110.44
4	-6.704 -9.794	3.090	------- -------	7.37 30.55	110.44 141.34
5	-9.794 -9.950	0.156	------- -------	21.86 22.34	141.34 142.90
6	-9.950 -10.854	0.904	0.00 21.28	22.34 25.11	142.90 128.19
7	-10.854 -13.144	2.290	21.28 75.20	25.11 32.14	128.19 90.92
8	-13.144 -18.731	5.587	92.09 243.71	26.24 39.42	90.92 0.00

active earth pressure /water pressure Pa = 1821.0   (kN/m)
ya =   8.259 (m)
Ma =   15039 (kN.m/m)
passive earth pressure   Pp = 1058.2   (kN/m)
yp =   14.212 (m)
Mp =   15039 (kN.m/m)
balanced depth   Z =   8.781 (m)   (elevation = -18.731 (m))
embedment length   D = 10.537 (m)   (elevation = -20.487 (m))

required sheet pile length   L = 25.327 (m)

(2)before installation of the lower strut   (2 step)
observing strut   elevation = +1.340 (m)
coffered landside excavation area elevation = -9.950 (m)
coffered landside water table   elevation = +0.340 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	+1.340 +0.340	1.000	------- -------	0.00 0.00	30.00 40.00
2	+0.340 -1.721	2.061	------- -------	0.00 0.00	40.00 8.51
3	-1.721 -4.388	2.667	------- -------	0.00 0.00	8.51 6.77
4	-4.388 -6.704	2.316	------- -------	0.00 17.37	6.77 5.25
5	-6.704 -9.794	3.090	------- -------	7.37 30.55	5.25 3.24
6	-9.794 -9.950	0.156	------- -------	21.86 22.34	3.24 3.14
7	-9.950 -10.854	0.904	0.00 21.28	22.34 25.11	3.14 2.55
8	-10.854 -13.144	2.290	21.28 75.20	25.11 32.14	2.55 1.05
9	-13.144 -14.755	1.611	92.09 135.81	26.24 30.04	1.05 0.00

active earth pressure /water pressure Pa = 551.4   (kN/m)
ya =   8.031 (m)
Ma =   4428 (kN.m/m)
passive earth pressure   Pp = 303.7   (kN/m)
yp =   14.581 (m)
Mp =   4428 (kN.m/m)
balanced depth   Z =   4.805 (m)   (elevation = -14.755 (m))
embedment length   D =   5.766 (m)   (elevation = -15.716 (m))
required sheet pile length   L = 20.556 (m)

3 composite stress calculation

3.1 maximum stress table

(1)bridge axis direction

1) material :SKY400

Case	load name	accrue location(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	Sig.a(N/mm^2)
1	Oridinary(high tide)	-11.160	28.31	66.97	95.28	140.00
2	Oridinary(low tide)	-11.160	30.14	66.97	97.12	140.00
3	Ord+Temp(high tide)	-11.160	29.41	66.97	96.38	161.00
4	Ord+Temp(low tide)	-11.160	31.24	66.97	98.22	161.00
5	Wind+Temp	-11.160	29.93	66.97	96.90	189.00
6	Ord+Collision	-11.160	39.23	66.97	106.20	210.00
7	Earthquake	-11.450	74.64	66.85	141.49	210.00

(2)perpendicular direction

1) material :SKY400

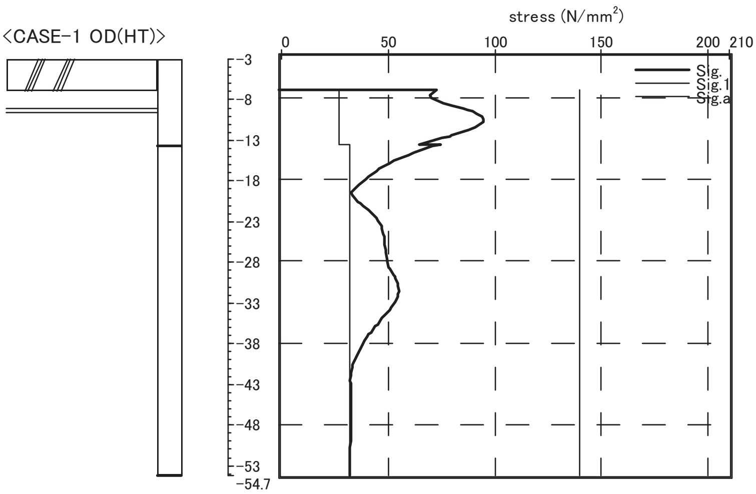
Case	load name	accrue location(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	Sig.a(N/mm^2)
1	Oridinary(high tide)	-11.160	29.63	69.36	98.98	140.00
2	Oridinary(low tide)	-11.160	31.46	69.36	100.82	140.00
3	Wind	-11.160	33.00	69.36	102.35	175.00
4	Ord+Collision	-11.160	47.60	69.36	116.95	210.00
5	Earthquake	-11.160	69.98	69.36	139.34	210.00

occurence location shows elevation
Sig.1 : stress after completion by design external force
Sig.2 : resultant stress(4 step)
Sig.max: composite stress
Sig.a : allowabe stress of steel pipe sheet pile

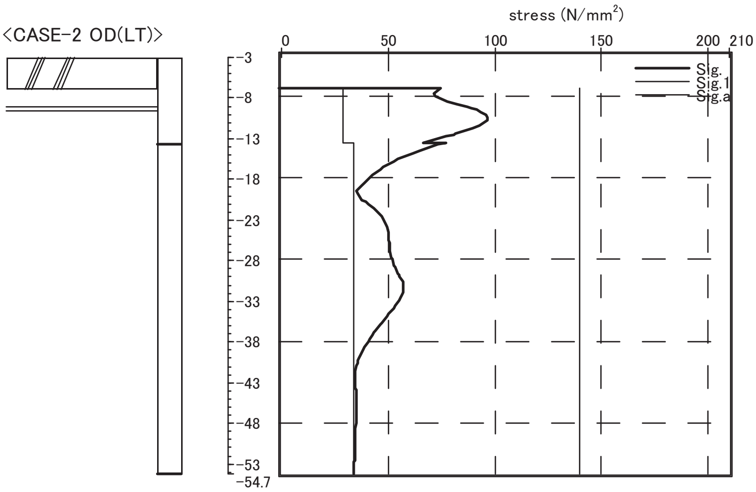
3.2 stress distribution diagram

(1)bridge axis direction

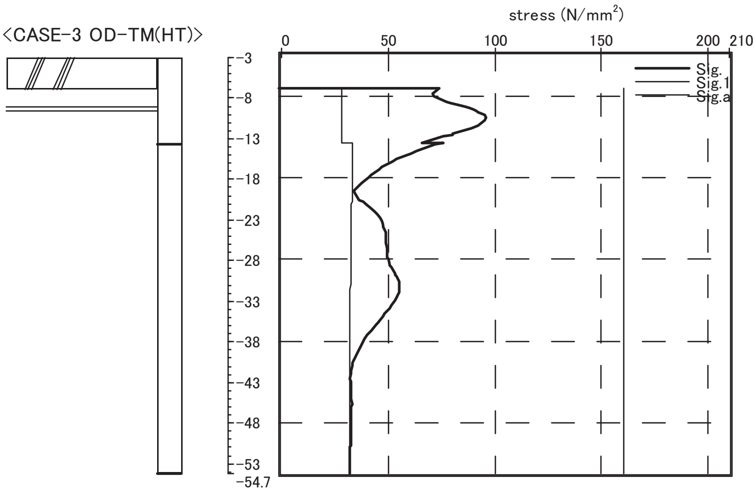
<CASE-1 OD(HT)>



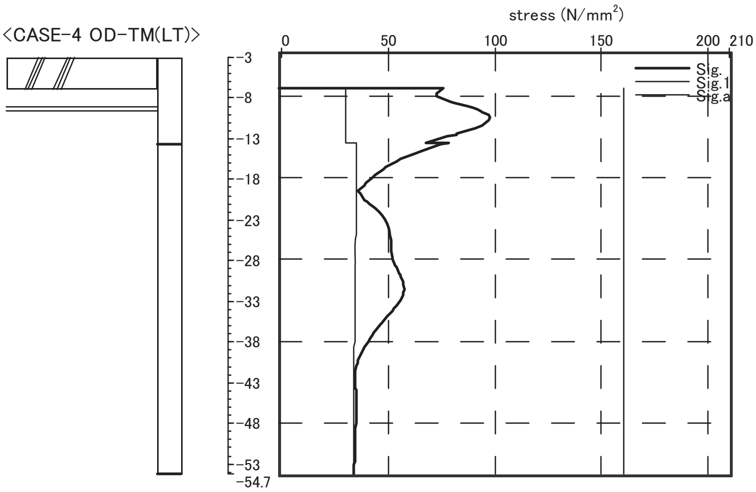
<CASE-2 OD(LT)>



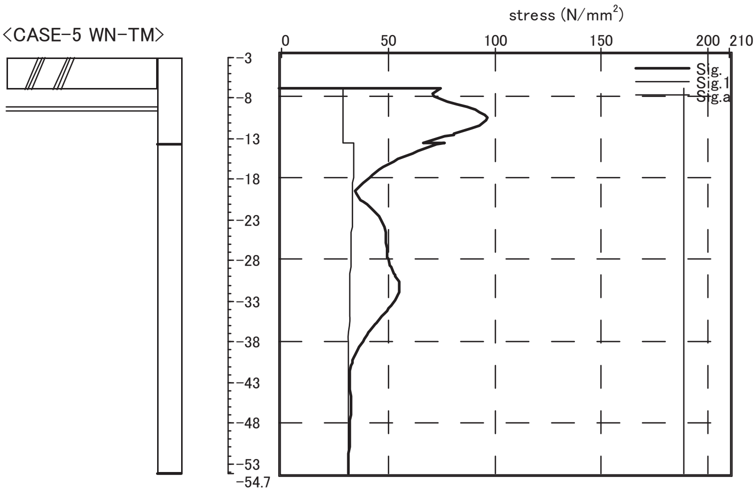
<CASE-3 OD-TM(HT)>



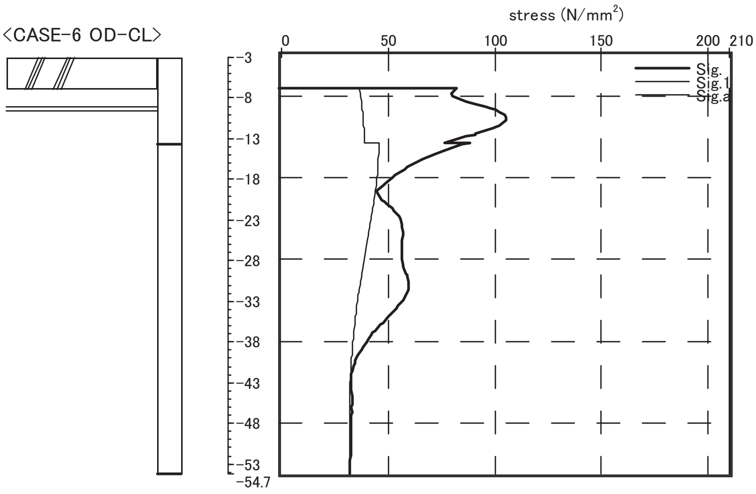
<CASE-4 OD-TM(LT)>



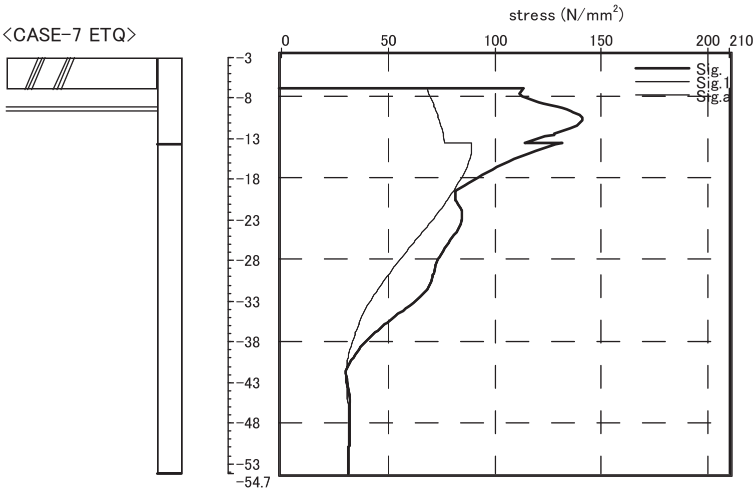
<CASE-5 WN-TM>



<CASE-6 OD-CL>

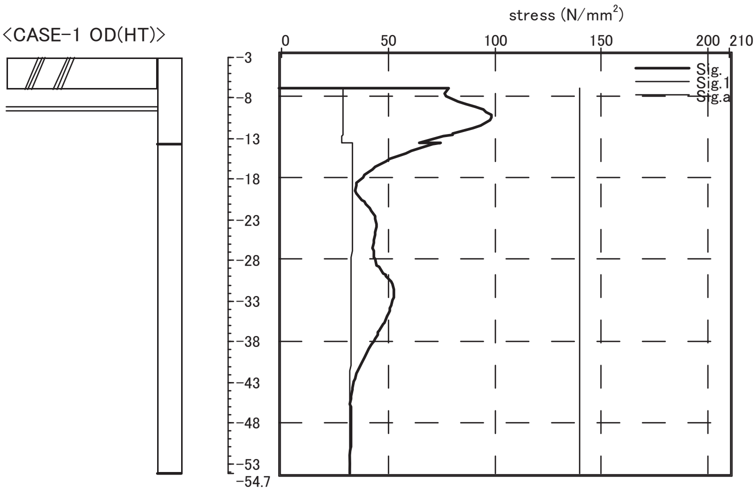


<CASE-7 ETQ>

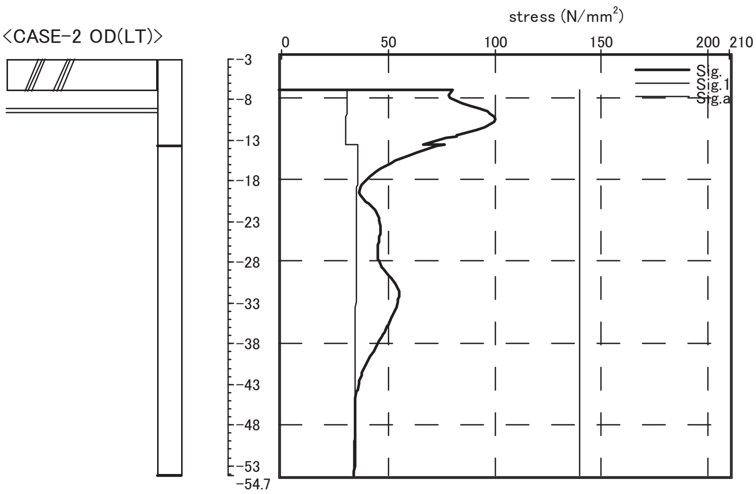


(2)perpendicular direction

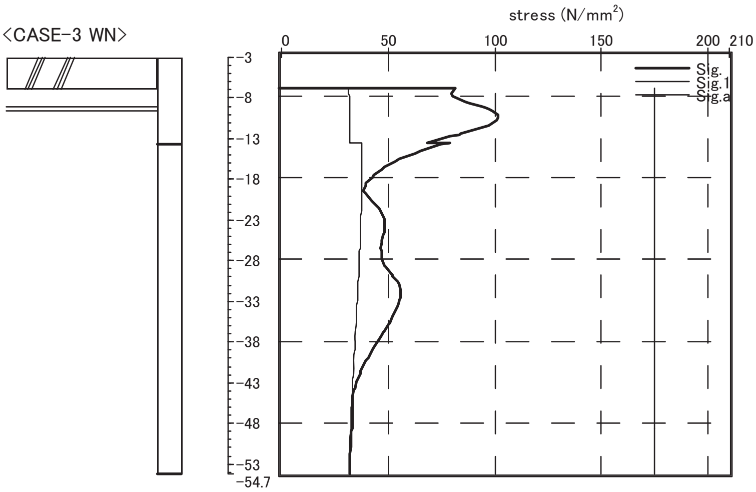
<CASE-1 OD(HT)>



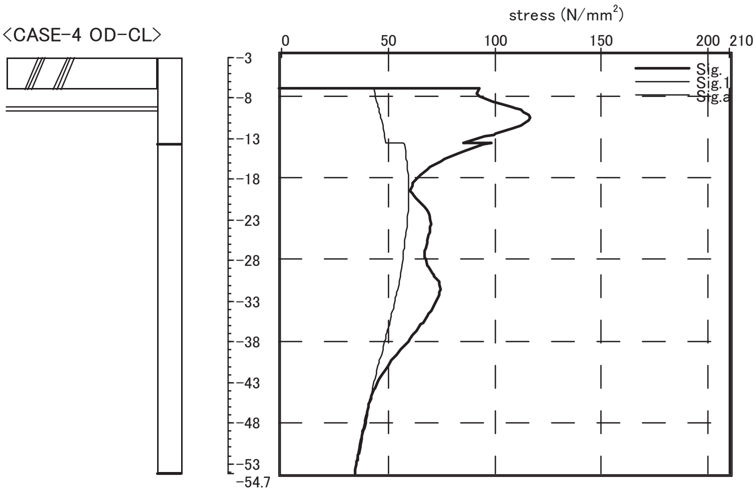
<CASE-2 OD(LT)>



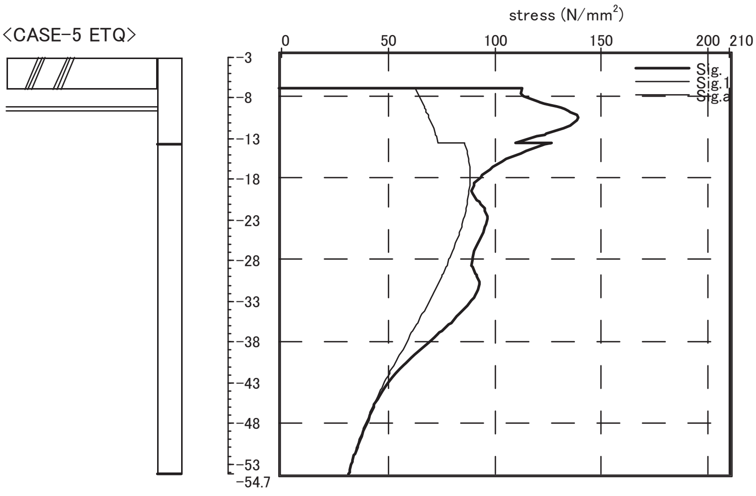
<CASE-3 WN>



<CASE-4 OD-CL>



〈CASE-5 ETQ〉



3.3 detail output

(1)bridge axis direction

1)Oridinary(high tide)

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-7.450	28.31	45.42	73.73	
-8.160	28.31	42.08	70.39	
-8.450	28.31	42.62	70.93	
-9.160	28.31	48.48	76.79	
-9.450	28.31	52.74	81.04	
-9.794	28.31	57.78	86.09	
-9.950	28.31	59.70	88.01	
-10.160	28.31	61.88	90.18	
-10.450	28.31	63.74	92.04	
-10.854	28.31	66.33	94.63	
-11.160	28.31	66.97	95.28	**
-11.450	28.31	66.85	95.15	
-12.160	28.31	63.52	91.82	
-12.450	28.31	60.09	88.39	
-13.144	28.31	51.87	80.18	
-13.160	28.31	51.62	79.93	
-13.450	28.31	47.50	75.81	
-14.160	28.31	37.42	65.73	
-14.160	32.97	42.55	75.52	
-14.450	32.97	38.92	71.89	
-15.160	32.97	30.04	63.00	
-15.450	32.97	27.31	60.28	
-16.160	32.97	20.64	53.61	
-16.450	32.97	18.64	51.61	
-17.160	32.97	13.75	46.72	
-17.450	32.97	12.27	45.24	
-18.160	32.97	8.65	41.62	
-18.450	32.97	7.47	40.44	
-19.160	32.97	4.59	37.55	
-19.450	32.97	3.48	36.44	
-20.160	32.97	0.76	33.72	
-20.450	32.97	1.60	34.56	
-21.160	32.97	3.65	36.62	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-21.450	32.97	5.22	38.18	
-21.704	32.97	6.59	39.55	
-22.160	32.97	9.00	41.97	
-22.450	32.97	10.08	43.05	
-23.160	32.97	12.74	45.70	
-23.450	32.97	13.34	46.31	
-24.160	32.97	14.83	47.80	
-24.450	32.97	15.12	48.09	
-25.160	32.97	15.85	48.81	
-25.450	32.97	15.97	48.94	
-26.160	32.97	16.29	49.26	
-26.450	32.97	16.39	49.35	
-27.160	32.97	16.62	49.58	
-27.450	32.97	16.79	49.76	
-28.160	32.97	17.22	50.18	
-28.450	32.97	17.56	50.53	
-29.160	32.97	18.41	51.38	
-29.450	32.97	19.01	51.98	
-30.160	32.97	20.48	53.44	
-30.384	32.97	21.08	54.05	
-30.450	32.97	21.21	54.18	
-31.160	32.97	22.64	55.61	
-31.450	32.97	22.75	55.72	
-32.160	32.97	23.02	55.99	
-32.450	32.97	22.74	55.71	
-32.831	32.97	22.38	55.35	
-33.160	32.97	21.81	54.78	
-33.450	32.97	21.10	54.07	
-34.160	32.97	19.35	52.32	
-34.450	32.97	18.47	51.44	
-34.771	32.97	17.50	50.47	
-35.160	32.97	16.25	49.22	
-35.450	32.97	15.31	48.27	
-36.160	32.97	12.99	45.96	
-36.450	32.97	12.08	45.05	
-37.160	32.97	9.87	42.84	
-37.450	32.97	9.04	42.01	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-37.728	32.97	8.24	41.21	
-38.160	32.97	7.09	40.06	
-38.450	32.97	6.41	39.38	
-39.160	32.97	4.75	37.72	
-39.450	32.97	4.21	37.17	
-40.160	32.97	2.87	35.84	
-40.450	32.97	2.44	35.41	
-40.846	32.97	1.85	34.81	
-41.160	32.97	1.44	34.41	
-41.450	32.97	1.14	34.11	
-42.160	32.97	0.41	33.38	
-42.450	32.97	0.37	33.34	
-43.160	32.97	0.29	33.26	
-43.450	32.97	0.41	33.38	
-44.160	32.97	0.71	33.68	
-44.450	32.97	0.77	33.74	
-45.160	32.97	0.92	33.89	
-45.450	32.97	0.94	33.91	
-46.160	32.97	0.99	33.95	
-46.450	32.97	0.97	33.94	
-47.160	32.97	0.94	33.91	
-47.450	32.97	0.91	33.88	
-48.160	32.97	0.83	33.80	
-48.450	32.97	0.79	33.76	
-49.160	32.97	0.68	33.65	
-49.450	32.97	0.64	33.61	
-50.160	32.97	0.52	33.49	
-50.450	32.97	0.48	33.44	
-51.160	32.97	0.36	33.33	
-51.450	32.97	0.32	33.29	
-52.160	32.97	0.21	33.18	
-52.450	32.97	0.18	33.14	
-52.954	32.97	0.11	33.08	
-53.160	32.97	0.09	33.05	
-53.450	32.97	0.06	33.03	
-54.160	32.97	0.01	32.98	
-54.450	32.97	0.00	32.97	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.97	0.00	32.97	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

2)Oridinary(low tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	30.14	45.42	75.57	
-8.160	30.14	42.08	72.22	
-8.450	30.14	42.62	72.77	
-9.160	30.14	48.48	78.63	
-9.450	30.14	52.74	82.88	
-9.794	30.14	57.78	87.92	
-9.950	30.14	59.70	89.85	
-10.160	30.14	61.88	92.02	
-10.450	30.14	63.74	93.88	
-10.854	30.14	66.33	96.47	
-11.160	30.14	66.97	97.12	**
-11.450	30.14	66.85	96.99	
-12.160	30.14	63.52	93.66	
-12.450	30.14	60.09	90.23	
-13.144	30.14	51.87	82.02	
-13.160	30.14	51.62	81.76	
-13.450	30.14	47.50	77.65	
-14.160	30.14	37.42	67.57	
-14.160	35.11	42.55	77.66	
-14.450	35.11	38.92	74.03	
-15.160	35.11	30.04	65.14	
-15.450	35.11	27.31	62.42	
-16.160	35.11	20.64	55.75	
-16.450	35.11	18.64	53.75	
-17.160	35.11	13.75	48.86	
-17.450	35.11	12.27	47.38	
-18.160	35.11	8.65	43.76	
-18.450	35.11	7.47	42.58	
-19.160	35.11	4.59	39.69	
-19.450	35.11	3.48	38.58	
-20.160	35.11	0.76	35.87	
-20.450	35.11	1.60	36.70	
-21.160	35.11	3.65	38.76	
-21.450	35.11	5.22	40.32	
-21.704	35.11	6.59	41.69	
-22.160	35.11	9.00	44.11	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	35.11	10.08	45.19	
-23.160	35.11	12.74	47.85	
-23.450	35.11	13.34	48.45	
-24.160	35.11	14.83	49.94	
-24.450	35.11	15.12	50.23	
-25.160	35.11	15.85	50.95	
-25.450	35.11	15.97	51.08	
-26.160	35.11	16.29	51.40	
-26.450	35.11	16.39	51.49	
-27.160	35.11	16.62	51.73	
-27.450	35.11	16.79	51.90	
-28.160	35.11	17.22	52.32	
-28.450	35.11	17.56	52.67	
-29.160	35.11	18.41	53.52	
-29.450	35.11	19.01	54.12	
-30.160	35.11	20.48	55.59	
-30.384	35.11	21.08	56.19	
-30.450	35.11	21.21	56.32	
-31.160	35.11	22.64	57.75	
-31.450	35.11	22.75	57.86	
-32.160	35.11	23.02	58.13	
-32.450	35.11	22.74	57.85	
-32.831	35.11	22.38	57.49	
-33.160	35.11	21.81	56.92	
-33.450	35.11	21.10	56.21	
-34.160	35.11	19.35	54.46	
-34.450	35.11	18.47	53.58	
-34.771	35.11	17.50	52.61	
-35.160	35.11	16.25	51.36	
-35.450	35.11	15.31	50.42	
-36.160	35.11	12.99	48.10	
-36.450	35.11	12.08	47.19	
-37.160	35.11	9.87	44.98	
-37.450	35.11	9.04	44.15	
-37.728	35.11	8.24	43.35	
-38.160	35.11	7.09	42.20	
-38.450	35.11	6.41	41.52	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	35.11	4.75	39.86	
-39.450	35.11	4.21	39.32	
-40.160	35.11	2.87	37.98	
-40.450	35.11	2.44	37.55	
-40.846	35.11	1.85	36.95	
-41.160	35.11	1.44	36.55	
-41.450	35.11	1.14	36.25	
-42.160	35.11	0.41	35.52	
-42.450	35.11	0.37	35.48	
-43.160	35.11	0.29	35.40	
-43.450	35.11	0.41	35.52	
-44.160	35.11	0.71	35.82	
-44.450	35.11	0.77	35.88	
-45.160	35.11	0.92	36.03	
-45.450	35.11	0.94	36.05	
-46.160	35.11	0.99	36.09	
-46.450	35.11	0.97	36.08	
-47.160	35.11	0.94	36.05	
-47.450	35.11	0.91	36.02	
-48.160	35.11	0.83	35.94	
-48.450	35.11	0.79	35.90	
-49.160	35.11	0.68	35.79	
-49.450	35.11	0.64	35.75	
-50.160	35.11	0.52	35.63	
-50.450	35.11	0.48	35.59	
-51.160	35.11	0.36	35.47	
-51.450	35.11	0.32	35.43	
-52.160	35.11	0.21	35.32	
-52.450	35.11	0.18	35.29	
-52.954	35.11	0.11	35.22	
-53.160	35.11	0.09	35.19	
-53.450	35.11	0.06	35.17	
-54.160	35.11	0.01	35.12	
-54.450	35.11	0.00	35.11	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	35.11	0.00	35.11	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

3)Ord+Temp(high tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	29.34	45.42	74.76	
-8.160	29.36	42.08	71.44	
-8.450	29.37	42.62	71.99	
-9.160	29.38	48.48	77.86	
-9.450	29.39	52.74	82.12	
-9.794	29.39	57.78	87.17	
-9.950	29.39	59.70	89.10	
-10.160	29.40	61.88	91.27	
-10.450	29.40	63.74	93.14	
-10.854	29.40	66.33	95.73	
-11.160	29.41	66.97	96.38	**
-11.450	29.41	66.85	96.25	
-12.160	29.41	63.52	92.93	
-12.450	29.41	60.09	89.50	
-13.144	29.42	51.87	81.29	
-13.160	29.42	51.62	81.03	
-13.450	29.42	47.50	76.92	
-14.160	29.41	37.42	66.83	
-14.160	34.25	42.55	76.81	
-14.450	34.25	38.92	73.17	
-15.160	34.24	30.04	64.27	
-15.450	34.23	27.31	61.54	
-16.160	34.21	20.64	54.85	
-16.450	34.20	18.64	52.85	
-17.160	34.18	13.75	47.93	
-17.450	34.17	12.27	46.44	
-18.160	34.13	8.65	42.79	
-18.450	34.12	7.47	41.59	
-19.160	34.09	4.59	38.67	
-19.450	34.07	3.48	37.55	
-20.160	34.03	0.76	34.79	
-20.450	34.02	1.60	35.61	
-21.160	33.98	3.65	37.63	
-21.450	33.96	5.22	39.18	
-21.704	33.95	6.59	40.53	
-22.160	33.92	9.00	42.92	

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elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-22.450	33.90	10.08	43.98	
-23.160	33.86	12.74	46.59	
-23.450	33.84	13.34	47.18	
-24.160	33.80	14.83	48.63	
-24.450	33.78	15.12	48.90	
-25.160	33.73	15.85	49.58	
-25.450	33.72	15.97	49.69	
-26.160	33.67	16.29	49.96	
-26.450	33.65	16.39	50.04	
-27.160	33.61	16.62	50.23	
-27.450	33.59	16.79	50.38	
-28.160	33.55	17.22	50.76	
-28.450	33.53	17.56	51.09	
-29.160	33.49	18.41	51.90	
-29.450	33.47	19.01	52.48	
-30.160	33.43	20.48	53.90	
-30.384	33.41	21.08	54.49	
-30.450	33.41	21.21	54.62	
-31.160	33.37	22.64	56.01	
-31.450	33.35	22.75	56.10	
-32.160	33.32	23.02	56.34	
-32.450	33.30	22.74	56.05	
-32.831	33.28	22.38	55.66	
-33.160	33.27	21.81	55.08	
-33.450	33.25	21.10	54.35	
-34.160	33.22	19.35	52.57	
-34.450	33.21	18.47	51.68	
-34.771	33.19	17.50	50.69	
-35.160	33.18	16.25	49.43	
-35.450	33.17	15.31	48.47	
-36.160	33.14	12.99	46.13	
-36.450	33.13	12.08	45.21	
-37.160	33.11	9.87	42.98	
-37.450	33.10	9.04	42.14	
-37.728	33.09	8.24	41.33	
-38.160	33.08	7.09	40.17	
-38.450	33.07	6.41	39.48	

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elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-39.160	33.05	4.75	37.80	
-39.450	33.05	4.21	37.25	
-40.160	33.03	2.87	35.90	
-40.450	33.02	2.44	35.46	
-40.846	33.02	1.85	34.86	
-41.160	33.01	1.44	34.45	
-41.450	33.01	1.14	34.15	
-42.160	32.99	0.41	33.40	
-42.450	32.99	0.37	33.36	
-43.160	32.98	0.29	33.27	
-43.450	32.98	0.41	33.39	
-44.160	32.97	0.71	33.68	
-44.450	32.97	0.77	33.74	
-45.160	32.97	0.92	33.90	
-45.450	32.98	0.94	33.92	
-46.160	32.98	0.99	33.97	
-46.450	32.98	0.97	33.95	
-47.160	32.99	0.94	33.93	
-47.450	32.99	0.91	33.90	
-48.160	32.99	0.83	33.82	
-48.450	32.99	0.79	33.78	
-49.160	32.99	0.68	33.67	
-49.450	32.99	0.64	33.63	
-50.160	32.99	0.52	33.51	
-50.450	32.99	0.48	33.47	
-51.160	32.99	0.36	33.35	
-51.450	32.99	0.32	33.31	
-52.160	32.99	0.21	33.21	
-52.450	32.99	0.18	33.17	
-52.954	32.99	0.11	33.10	
-53.160	32.99	0.09	33.08	
-53.450	32.99	0.06	33.05	
-54.160	32.99	0.01	33.00	
-54.450	32.99	0.00	32.99	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.99	0.00	32.99	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4)Ord+Temp(low tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	31.18	45.42	76.60	
-8.160	31.20	42.08	73.28	
-8.450	31.21	42.62	73.83	
-9.160	31.22	48.48	79.70	
-9.450	31.23	52.74	83.96	
-9.794	31.23	57.78	89.01	
-9.950	31.23	59.70	90.94	
-10.160	31.23	61.88	93.11	
-10.450	31.24	63.74	94.97	
-10.854	31.24	66.33	97.57	
-11.160	31.24	66.97	98.22	**
-11.450	31.25	66.85	98.09	
-12.160	31.25	63.52	94.77	
-12.450	31.25	60.09	91.34	
-13.144	31.25	51.87	83.13	
-13.160	31.25	51.62	82.87	
-13.450	31.25	47.50	78.76	
-14.160	31.25	37.42	68.67	
-14.160	36.40	42.55	78.95	
-14.450	36.39	38.92	75.32	
-15.160	36.38	30.04	66.41	
-15.450	36.37	27.31	63.68	
-16.160	36.35	20.64	56.99	
-16.450	36.34	18.64	54.99	
-17.160	36.32	13.75	50.07	
-17.450	36.31	12.27	48.58	
-18.160	36.28	8.65	44.93	
-18.450	36.26	7.47	43.74	
-19.160	36.23	4.59	40.81	
-19.450	36.21	3.48	39.69	
-20.160	36.18	0.76	36.93	
-20.450	36.16	1.60	37.76	
-21.160	36.12	3.65	39.77	
-21.450	36.10	5.22	41.32	
-21.704	36.09	6.59	42.67	
-22.160	36.06	9.00	45.06	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-22.450	36.04	10.08	46.13	
-23.160	36.00	12.74	48.74	
-23.450	35.98	13.34	49.33	
-24.160	35.94	14.83	50.77	
-24.450	35.92	15.12	51.04	
-25.160	35.87	15.85	51.72	
-25.450	35.86	15.97	51.83	
-26.160	35.81	16.29	52.10	
-26.450	35.79	16.39	52.18	
-27.160	35.75	16.62	52.37	
-27.450	35.73	16.79	52.52	
-28.160	35.69	17.22	52.90	
-28.450	35.67	17.56	53.23	
-29.160	35.63	18.41	54.04	
-29.450	35.61	19.01	54.62	
-30.160	35.57	20.48	56.04	
-30.384	35.55	21.08	56.63	
-30.450	35.55	21.21	56.76	
-31.160	35.51	22.64	58.15	
-31.450	35.49	22.75	58.24	
-32.160	35.46	23.02	58.48	
-32.450	35.44	22.74	58.19	
-32.831	35.42	22.38	57.80	
-33.160	35.41	21.81	57.22	
-33.450	35.39	21.10	56.49	
-34.160	35.36	19.35	54.71	
-34.450	35.35	18.47	53.82	
-34.771	35.34	17.50	52.84	
-35.160	35.32	16.25	51.57	
-35.450	35.31	15.31	50.61	
-36.160	35.28	12.99	48.27	
-36.450	35.27	12.08	47.36	
-37.160	35.25	9.87	45.12	
-37.450	35.24	9.04	44.28	
-37.728	35.23	8.24	43.48	
-38.160	35.22	7.09	42.31	
-38.450	35.21	6.41	41.63	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-39.160	35.19	4.75	39.94	
-39.450	35.19	4.21	39.39	
-40.160	35.17	2.87	38.04	
-40.450	35.16	2.44	37.60	
-40.846	35.16	1.85	37.00	
-41.160	35.15	1.44	36.59	
-41.450	35.15	1.14	36.29	
-42.160	35.14	0.41	35.54	
-42.450	35.13	0.37	35.50	
-43.160	35.12	0.29	35.41	
-43.450	35.12	0.41	35.53	
-44.160	35.11	0.71	35.82	
-44.450	35.11	0.77	35.88	
-45.160	35.12	0.92	36.04	
-45.450	35.12	0.94	36.06	
-46.160	35.12	0.99	36.11	
-46.450	35.12	0.97	36.10	
-47.160	35.13	0.94	36.07	
-47.450	35.13	0.91	36.04	
-48.160	35.13	0.83	35.96	
-48.450	35.13	0.79	35.92	
-49.160	35.13	0.68	35.82	
-49.450	35.13	0.64	35.77	
-50.160	35.13	0.52	35.66	
-50.450	35.13	0.48	35.61	
-51.160	35.13	0.36	35.50	
-51.450	35.13	0.32	35.45	
-52.160	35.13	0.21	35.35	
-52.450	35.13	0.18	35.31	
-52.954	35.13	0.11	35.24	
-53.160	35.13	0.09	35.22	
-53.450	35.13	0.06	35.20	
-54.160	35.13	0.01	35.14	
-54.450	35.13	0.00	35.13	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	35.13	0.00	35.13	

* :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

5)Wind+Temp

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	29.79	45.42	75.21	
-8.160	29.83	42.08	71.91	
-8.450	29.84	42.62	72.47	
-9.160	29.87	48.48	78.36	
-9.450	29.88	52.74	82.62	
-9.794	29.89	57.78	87.68	
-9.950	29.90	59.70	89.60	
-10.160	29.90	61.88	91.78	
-10.450	29.91	63.74	93.65	
-10.854	29.92	66.33	96.25	
-11.160	29.93	66.97	96.90	**
-11.450	29.93	66.85	96.78	
-12.160	29.94	63.52	93.46	
-12.450	29.95	60.09	90.03	
-13.144	29.95	51.87	81.83	
-13.160	29.95	51.62	81.57	
-13.450	29.96	47.50	77.46	
-14.160	29.95	37.42	67.37	
-14.160	34.88	42.55	77.43	
-14.450	34.87	38.92	73.80	
-15.160	34.85	30.04	64.89	
-15.450	34.84	27.31	62.15	
-16.160	34.80	20.64	55.45	
-16.450	34.79	18.64	53.43	
-17.160	34.74	13.75	48.49	
-17.450	34.72	12.27	46.99	
-18.160	34.66	8.65	43.32	
-18.450	34.64	7.47	42.11	
-19.160	34.57	4.59	39.16	
-19.450	34.55	3.48	38.02	
-20.160	34.48	0.76	35.23	
-20.450	34.45	1.60	36.04	
-21.160	34.37	3.65	38.02	
-21.450	34.34	5.22	39.56	
-21.704	34.31	6.59	40.90	
-22.160	34.26	9.00	43.26	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	34.23	10.08	44.31	
-23.160	34.14	12.74	46.88	
-23.450	34.11	13.34	47.45	
-24.160	34.03	14.83	48.86	
-24.450	33.99	15.12	49.12	
-25.160	33.91	15.85	49.75	
-25.450	33.87	15.97	49.85	
-26.160	33.79	16.29	50.08	
-26.450	33.76	16.39	50.14	
-27.160	33.67	16.62	50.29	
-27.450	33.64	16.79	50.43	
-28.160	33.55	17.22	50.77	
-28.450	33.52	17.56	51.08	
-29.160	33.44	18.41	51.85	
-29.450	33.40	19.01	52.42	
-30.160	33.32	20.48	53.80	
-30.384	33.30	21.08	54.38	
-30.450	33.29	21.21	54.50	
-31.160	33.22	22.64	55.85	
-31.450	33.18	22.75	55.93	
-32.160	33.11	23.02	56.14	
-32.450	33.08	22.74	55.83	
-32.831	33.05	22.38	55.43	
-33.160	33.02	21.81	54.83	
-33.450	32.99	21.10	54.09	
-34.160	32.93	19.35	52.28	
-34.450	32.90	18.47	51.38	
-34.771	32.88	17.50	50.38	
-35.160	32.85	16.25	49.10	
-35.450	32.83	15.31	48.13	
-36.160	32.78	12.99	45.77	
-36.450	32.76	12.08	44.84	
-37.160	32.71	9.87	42.58	
-37.450	32.69	9.04	41.73	
-37.728	32.68	8.24	40.92	
-38.160	32.66	7.09	39.75	
-38.450	32.64	6.41	39.05	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	32.60	4.75	37.36	
-39.450	32.59	4.21	36.80	
-40.160	32.56	2.87	35.44	
-40.450	32.55	2.44	34.99	
-40.846	32.54	1.85	34.38	
-41.160	32.52	1.44	33.97	
-41.450	32.51	1.14	33.66	
-42.160	32.49	0.41	32.90	
-42.450	32.48	0.37	32.86	
-43.160	32.47	0.29	32.75	
-43.450	32.46	0.41	32.87	
-44.160	32.44	0.71	33.16	
-44.450	32.44	0.77	33.21	
-45.160	32.45	0.92	33.37	
-45.450	32.45	0.94	33.39	
-46.160	32.46	0.99	33.44	
-46.450	32.46	0.97	33.43	
-47.160	32.47	0.94	33.41	
-47.450	32.47	0.91	33.38	
-48.160	32.47	0.83	33.30	
-48.450	32.48	0.79	33.26	
-49.160	32.48	0.68	33.16	
-49.450	32.48	0.64	33.12	
-50.160	32.48	0.52	33.00	
-50.450	32.48	0.48	32.96	
-51.160	32.48	0.36	32.84	
-51.450	32.48	0.32	32.80	
-52.160	32.48	0.21	32.70	
-52.450	32.48	0.18	32.66	
-52.954	32.48	0.11	32.59	
-53.160	32.48	0.09	32.57	
-53.450	32.48	0.06	32.54	
-54.160	32.48	0.01	32.49	
-54.450	32.48	0.00	32.48	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.48	0.00	32.48	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

6)Ord+Collision

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	37.66	45.42	83.08	
-8.160	38.04	42.08	80.12	
-8.450	38.20	42.62	80.82	
-9.160	38.51	48.48	87.00	
-9.450	38.64	52.74	91.38	
-9.794	38.77	57.78	96.55	
-9.950	38.83	59.70	98.53	
-10.160	38.90	61.88	100.78	
-10.450	39.00	63.74	102.74	
-10.854	39.14	66.33	105.47	
-11.160	39.23	66.97	106.20	**
-11.450	39.32	66.85	106.17	
-12.160	39.51	63.52	103.03	
-12.450	39.59	60.09	99.68	
-13.144	39.76	51.87	91.63	
-13.160	39.76	51.62	91.38	
-13.450	39.82	47.50	87.32	
-14.160	39.91	37.42	77.33	
-14.160	46.47	42.55	89.03	
-14.450	46.50	38.92	85.42	
-15.160	46.48	30.04	76.52	
-15.450	46.48	27.31	73.79	
-16.160	46.38	20.64	67.02	
-16.450	46.33	18.64	64.98	
-17.160	46.15	13.75	59.90	
-17.450	46.08	12.27	58.35	
-18.160	45.83	8.65	54.48	
-18.450	45.73	7.47	53.20	
-19.160	45.42	4.59	50.01	
-19.450	45.30	3.48	48.78	
-20.160	44.95	0.76	45.71	
-20.450	44.81	1.60	46.40	
-21.160	44.42	3.65	48.07	
-21.450	44.26	5.22	49.48	
-21.704	44.12	6.59	50.70	
-22.160	43.85	9.00	52.85	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	43.67	10.08	53.76	
-23.160	43.24	12.74	55.97	
-23.450	43.06	13.34	56.40	
-24.160	42.60	14.83	57.44	
-24.450	42.42	15.12	57.54	
-25.160	41.96	15.85	57.80	
-25.450	41.77	15.97	57.74	
-26.160	41.30	16.29	57.59	
-26.450	41.11	16.39	57.49	
-27.160	40.64	16.62	57.25	
-27.450	40.44	16.79	57.23	
-28.160	39.97	17.22	57.19	
-28.450	39.78	17.56	57.34	
-29.160	39.32	18.41	57.73	
-29.450	39.13	19.01	58.14	
-30.160	38.67	20.48	59.14	
-30.384	38.52	21.08	59.60	
-30.450	38.48	21.21	59.69	
-31.160	38.03	22.64	60.67	
-31.450	37.85	22.75	60.60	
-32.160	37.43	23.02	60.45	
-32.450	37.26	22.74	60.00	
-32.831	37.05	22.38	59.42	
-33.160	36.86	21.81	58.68	
-33.450	36.70	21.10	57.80	
-34.160	36.34	19.35	55.69	
-34.450	36.19	18.47	54.66	
-34.771	36.03	17.50	53.53	
-35.160	35.85	16.25	52.10	
-35.450	35.71	15.31	51.02	
-36.160	35.40	12.99	48.39	
-36.450	35.28	12.08	47.36	
-37.160	35.00	9.87	44.87	
-37.450	34.88	9.04	43.92	
-37.728	34.79	8.24	43.03	
-38.160	34.63	7.09	41.73	
-38.450	34.53	6.41	40.95	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	34.31	4.75	39.06	
-39.450	34.22	4.21	38.43	
-40.160	34.02	2.87	36.90	
-40.450	33.94	2.44	36.38	
-40.846	33.85	1.85	35.70	
-41.160	33.77	1.44	35.22	
-41.450	33.71	1.14	34.85	
-42.160	33.56	0.41	33.97	
-42.450	33.50	0.37	33.87	
-43.160	33.38	0.29	33.66	
-43.450	33.33	0.41	33.74	
-44.160	33.22	0.71	33.93	
-44.450	33.18	0.77	33.95	
-45.160	33.10	0.92	34.02	
-45.450	33.06	0.94	34.00	
-46.160	33.00	0.99	33.98	
-46.450	32.97	0.97	33.94	
-47.160	33.02	0.94	33.96	
-47.450	33.05	0.91	33.95	
-48.160	33.09	0.83	33.92	
-48.450	33.10	0.79	33.89	
-49.160	33.13	0.68	33.82	
-49.450	33.14	0.64	33.78	
-50.160	33.17	0.52	33.69	
-50.450	33.17	0.48	33.65	
-51.160	33.19	0.36	33.55	
-51.450	33.19	0.32	33.51	
-52.160	33.20	0.21	33.42	
-52.450	33.20	0.18	33.38	
-52.954	33.21	0.11	33.32	
-53.160	33.21	0.09	33.30	
-53.450	33.21	0.06	33.27	
-54.160	33.21	0.01	33.22	
-54.450	33.21	0.00	33.22	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	33.21	0.00	33.21	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

7)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	68.87	45.42	114.30	
-8.160	70.05	42.08	112.13	
-8.450	70.53	42.62	113.16	
-9.160	71.60	48.48	120.08	
-9.450	72.03	52.74	124.76	
-9.794	72.51	57.78	130.29	
-9.950	72.72	59.70	132.42	
-10.160	73.00	61.88	134.87	
-10.450	73.38	63.74	137.12	
-10.854	73.91	66.33	140.24	
-11.160	74.28	66.97	141.26	
-11.450	74.64	66.85	141.49	**
-12.160	75.44	63.52	138.95	
-12.450	75.76	60.09	135.85	
-13.144	76.46	51.87	128.34	
-13.160	76.48	51.62	128.09	
-13.450	76.72	47.50	124.22	
-14.160	77.07	37.42	114.49	
-14.160	89.71	42.55	132.26	
-14.450	89.76	38.92	128.69	
-15.160	89.57	30.04	119.61	
-15.450	89.49	27.31	116.80	
-16.160	88.86	20.64	109.50	
-16.450	88.60	18.64	107.24	
-17.160	87.59	13.75	101.34	
-17.450	87.18	12.27	99.45	
-18.160	85.86	8.65	94.51	
-18.450	85.32	7.47	92.80	
-19.160	83.75	4.59	88.34	
-19.450	83.11	3.48	86.58	
-20.160	81.33	0.76	82.09	
-20.450	80.61	1.60	82.20	
-21.160	78.67	3.65	82.33	
-21.450	77.88	5.22	83.10	
-21.704	77.16	6.59	83.75	
-22.160	75.84	9.00	84.84	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	75.00	10.08	85.08	
-23.160	72.87	12.74	85.61	
-23.450	72.00	13.34	85.34	
-24.160	69.82	14.83	84.65	
-24.450	68.93	15.12	84.06	
-25.160	66.73	15.85	82.58	
-25.450	65.83	15.97	81.81	
-26.160	63.63	16.29	79.92	
-26.450	62.73	16.39	79.11	
-27.160	60.54	16.62	77.15	
-27.450	59.64	16.79	76.43	
-28.160	57.48	17.22	74.69	
-28.450	56.59	17.56	74.15	
-29.160	54.46	18.41	72.88	
-29.450	53.60	19.01	72.61	
-30.160	51.51	20.48	71.99	
-30.384	50.86	21.08	71.94	
-30.450	50.67	21.21	71.88	
-31.160	48.69	22.64	71.33	
-31.450	47.88	22.75	70.63	
-32.160	46.05	23.02	69.07	
-32.450	45.30	22.74	68.04	
-32.831	44.40	22.38	66.78	
-33.160	43.62	21.81	65.43	
-33.450	42.94	21.10	64.04	
-34.160	41.41	19.35	60.77	
-34.450	40.79	18.47	59.26	
-34.771	40.17	17.50	57.67	
-35.160	39.42	16.25	55.68	
-35.450	38.87	15.31	54.17	
-36.160	37.65	12.99	50.64	
-36.450	37.15	12.08	49.24	
-37.160	36.08	9.87	45.96	
-37.450	35.65	9.04	44.69	
-37.728	35.29	8.24	43.53	
-38.160	34.72	7.09	41.81	
-38.450	34.34	6.41	40.76	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	33.54	4.75	38.30	
-39.450	33.22	4.21	37.43	
-40.160	32.55	2.87	35.42	
-40.450	32.27	2.44	34.71	
-40.846	31.96	1.85	33.80	
-41.160	31.71	1.44	33.15	
-41.450	31.48	1.14	32.62	
-42.160	31.04	0.41	31.45	
-42.450	30.86	0.37	31.24	
-43.160	31.23	0.29	31.51	
-43.450	31.37	0.41	31.78	
-44.160	31.65	0.71	32.37	
-44.450	31.77	0.77	32.54	
-45.160	31.97	0.92	32.90	
-45.450	32.06	0.94	33.00	
-46.160	32.20	0.99	33.19	
-46.450	32.26	0.97	33.23	
-47.160	32.35	0.94	33.29	
-47.450	32.39	0.91	33.30	
-48.160	32.43	0.83	33.26	
-48.450	32.45	0.79	33.24	
-49.160	32.46	0.68	33.14	
-49.450	32.46	0.64	33.10	
-50.160	32.44	0.52	32.97	
-50.450	32.43	0.48	32.91	
-51.160	32.40	0.36	32.76	
-51.450	32.38	0.32	32.70	
-52.160	32.33	0.21	32.54	
-52.450	32.31	0.18	32.48	
-52.954	32.27	0.11	32.38	
-53.160	32.25	0.09	32.34	
-53.450	32.23	0.06	32.29	
-54.160	32.18	0.01	32.19	
-54.450	32.15	0.00	32.16	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.14	0.00	32.14	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

(2)perpendicular direction

1)Oridinary(high tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	29.66	49.73	79.39	
-8.160	29.65	47.54	77.20	
-8.450	29.65	48.28	77.93	
-9.160	29.65	53.90	83.55	
-9.450	29.64	57.73	87.37	
-9.794	29.64	62.27	91.91	
-9.950	29.64	63.94	93.58	
-10.160	29.64	65.78	95.42	
-10.450	29.63	67.20	96.83	
-10.854	29.63	69.17	98.80	
-11.160	29.63	69.36	98.98	**
-11.450	29.62	68.80	98.42	
-12.160	29.61	64.46	94.07	
-12.450	29.61	60.63	90.24	
-13.144	29.60	51.47	81.07	
-13.160	29.60	51.19	80.79	
-13.450	29.60	46.75	76.35	
-14.160	29.59	35.87	65.46	
-14.160	34.46	40.79	75.25	
-14.450	34.45	36.92	71.37	
-15.160	34.43	27.43	61.87	
-15.450	34.43	24.58	59.01	
-16.160	34.41	17.58	51.99	
-16.450	34.40	15.55	49.95	
-17.160	34.38	10.57	44.95	
-17.450	34.37	9.15	43.52	
-18.160	34.35	5.67	40.02	
-18.450	34.34	4.64	38.98	
-19.160	34.32	2.10	36.42	
-19.450	34.31	1.77	36.07	
-20.160	34.28	0.93	35.22	
-20.450	34.27	1.90	36.17	
-21.160	34.24	4.25	38.50	
-21.450	34.23	5.43	39.66	
-21.704	34.22	6.46	40.68	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.160	34.20	8.23	42.43	
-22.450	34.19	8.89	43.08	
-23.160	34.16	10.52	44.69	
-23.450	34.15	10.73	44.88	
-24.160	34.12	11.22	45.34	
-24.450	34.11	11.14	45.25	
-25.160	34.08	10.95	45.03	
-25.450	34.06	10.77	44.83	
-26.160	34.03	10.33	44.36	
-26.450	34.02	10.20	44.22	
-27.160	33.99	9.90	43.89	
-27.450	33.97	9.99	43.96	
-28.160	33.94	10.20	44.15	
-28.450	33.93	10.64	44.57	
-29.160	33.90	11.72	45.61	
-29.450	33.88	12.63	46.52	
-30.160	33.85	14.88	48.73	
-30.384	33.84	15.86	49.70	
-30.450	33.84	16.09	49.93	
-31.160	33.80	18.57	52.37	
-31.450	33.79	18.99	52.78	
-32.160	33.76	20.01	53.76	
-32.450	33.74	20.02	53.77	
-32.831	33.72	20.05	53.77	
-33.160	33.71	19.87	53.58	
-33.450	33.69	19.56	53.25	
-34.160	33.66	18.80	52.46	
-34.450	33.65	18.36	52.01	
-34.771	33.63	17.87	51.51	
-35.160	33.62	17.22	50.84	
-35.450	33.60	16.70	50.30	
-36.160	33.57	15.42	48.99	
-36.450	33.56	14.86	48.41	
-37.160	33.53	13.48	47.00	
-37.450	33.51	12.88	46.39	
-37.728	33.50	12.30	45.80	
-38.160	33.48	11.36	44.84	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-38.450	33.47	10.71	44.18	
-39.160	33.44	9.12	42.55	
-39.450	33.43	8.49	41.92	
-40.160	33.40	6.96	40.36	
-40.450	33.39	6.39	39.77	
-40.846	33.37	5.60	38.97	
-41.160	33.36	5.03	38.39	
-41.450	33.35	4.55	37.90	
-42.160	33.32	3.39	36.71	
-42.450	33.31	3.01	36.32	
-43.160	33.28	2.08	35.36	
-43.450	33.27	1.79	35.06	
-44.160	33.25	1.08	34.32	
-44.450	33.24	0.87	34.10	
-45.160	33.21	0.36	33.57	
-45.450	33.20	0.29	33.49	
-46.160	33.18	0.12	33.30	
-46.450	33.17	0.21	33.38	
-47.160	33.15	0.41	33.56	
-47.450	33.14	0.44	33.59	
-48.160	33.12	0.54	33.66	
-48.450	33.11	0.54	33.65	
-49.160	33.09	0.55	33.65	
-49.450	33.08	0.54	33.62	
-50.160	33.07	0.49	33.56	
-50.450	33.06	0.46	33.52	
-51.160	33.04	0.38	33.42	
-51.450	33.04	0.34	33.38	
-52.160	33.02	0.25	33.27	
-52.450	33.01	0.21	33.22	
-52.954	33.00	0.14	33.14	
-53.160	33.00	0.11	33.11	
-53.450	33.00	0.08	33.08	
-54.160	32.98	0.01	33.00	
-54.450	32.98	0.01	32.99	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.98	0.00	32.98	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

2)Oridinary(low tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	31.50	49.73	81.23	
-8.160	31.49	47.54	79.04	
-8.450	31.49	48.28	79.77	
-9.160	31.48	53.90	85.39	
-9.450	31.48	57.73	89.21	
-9.794	31.48	62.27	93.75	
-9.950	31.48	63.94	95.42	
-10.160	31.47	65.78	97.26	
-10.450	31.47	67.20	98.67	
-10.854	31.47	69.17	100.63	
-11.160	31.46	69.36	100.82	**
-11.450	31.46	68.80	100.26	
-12.160	31.45	64.46	95.91	
-12.450	31.45	60.63	92.08	
-13.144	31.44	51.47	82.91	
-13.160	31.44	51.19	82.63	
-13.450	31.43	46.75	78.19	
-14.160	31.42	35.87	67.30	
-14.160	36.60	40.79	77.39	
-14.450	36.59	36.92	73.51	
-15.160	36.58	27.43	64.01	
-15.450	36.57	24.58	61.15	
-16.160	36.55	17.58	54.13	
-16.450	36.54	15.55	52.09	
-17.160	36.52	10.57	47.10	
-17.450	36.51	9.15	45.67	
-18.160	36.49	5.67	42.16	
-18.450	36.48	4.64	41.12	
-19.160	36.46	2.10	38.56	
-19.450	36.45	1.77	38.21	
-20.160	36.42	0.93	37.36	
-20.450	36.41	1.90	38.31	
-21.160	36.38	4.25	40.64	
-21.450	36.37	5.43	41.80	
-21.704	36.36	6.46	42.83	
-22.160	36.34	8.23	44.57	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	36.33	8.89	45.23	
-23.160	36.30	10.52	46.83	
-23.450	36.29	10.73	47.02	
-24.160	36.26	11.22	47.48	
-24.450	36.25	11.14	47.39	
-25.160	36.22	10.95	47.17	
-25.450	36.20	10.77	46.97	
-26.160	36.17	10.33	46.50	
-26.450	36.16	10.20	46.36	
-27.160	36.13	9.90	46.03	
-27.450	36.11	9.99	46.10	
-28.160	36.08	10.20	46.29	
-28.450	36.07	10.64	46.71	
-29.160	36.04	11.72	47.75	
-29.450	36.02	12.63	48.66	
-30.160	35.99	14.88	50.87	
-30.384	35.98	15.86	51.84	
-30.450	35.98	16.09	52.07	
-31.160	35.94	18.57	54.52	
-31.450	35.93	18.99	54.92	
-32.160	35.90	20.01	55.90	
-32.450	35.88	20.02	55.91	
-32.831	35.86	20.05	55.91	
-33.160	35.85	19.87	55.72	
-33.450	35.84	19.56	55.40	
-34.160	35.80	18.80	54.60	
-34.450	35.79	18.36	54.15	
-34.771	35.77	17.87	53.65	
-35.160	35.76	17.22	52.98	
-35.450	35.74	16.70	52.44	
-36.160	35.71	15.42	51.13	
-36.450	35.70	14.86	50.55	
-37.160	35.67	13.48	49.14	
-37.450	35.65	12.88	48.53	
-37.728	35.64	12.30	47.94	
-38.160	35.62	11.36	46.98	
-38.450	35.61	10.71	46.32	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	35.58	9.12	44.70	
-39.450	35.57	8.49	44.06	
-40.160	35.54	6.96	42.50	
-40.450	35.53	6.39	41.91	
-40.846	35.51	5.60	41.12	
-41.160	35.50	5.03	40.53	
-41.450	35.49	4.55	40.04	
-42.160	35.46	3.39	38.85	
-42.450	35.45	3.01	38.46	
-43.160	35.42	2.08	37.50	
-43.450	35.41	1.79	37.20	
-44.160	35.39	1.08	36.46	
-44.450	35.38	0.87	36.25	
-45.160	35.35	0.36	35.71	
-45.450	35.34	0.29	35.63	
-46.160	35.32	0.12	35.45	
-46.450	35.31	0.21	35.52	
-47.160	35.29	0.41	35.70	
-47.450	35.28	0.44	35.73	
-48.160	35.26	0.54	35.80	
-48.450	35.25	0.54	35.79	
-49.160	35.23	0.55	35.79	
-49.450	35.23	0.54	35.76	
-50.160	35.21	0.49	35.70	
-50.450	35.20	0.46	35.66	
-51.160	35.18	0.38	35.56	
-51.450	35.18	0.34	35.52	
-52.160	35.16	0.25	35.41	
-52.450	35.16	0.21	35.36	
-52.954	35.15	0.14	35.28	
-53.160	35.14	0.11	35.25	
-53.450	35.14	0.08	35.22	
-54.160	35.13	0.01	35.14	
-54.450	35.12	0.01	35.13	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	35.12	0.00	35.12	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

3)Wind

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	32.62	49.73	82.35	
-8.160	32.70	47.54	80.25	
-8.450	32.74	48.28	81.01	
-9.160	32.81	53.90	86.71	
-9.450	32.84	57.73	90.57	
-9.794	32.88	62.27	95.15	
-9.950	32.89	63.94	96.83	
-10.160	32.91	65.78	98.69	
-10.450	32.94	67.20	100.13	
-10.854	32.97	69.17	102.14	
-11.160	33.00	69.36	102.35	**
-11.450	33.02	68.80	101.83	
-12.160	33.08	64.46	97.54	
-12.450	33.10	60.63	93.74	
-13.144	33.16	51.47	84.63	
-13.160	33.16	51.19	84.35	
-13.450	33.18	46.75	79.93	
-14.160	33.22	35.87	69.09	
-14.160	38.68	40.79	79.48	
-14.450	38.70	36.92	75.62	
-15.160	38.72	27.43	66.16	
-15.450	38.73	24.58	63.31	
-16.160	38.74	17.58	56.32	
-16.450	38.74	15.55	54.29	
-17.160	38.73	10.57	49.30	
-17.450	38.73	9.15	47.88	
-18.160	38.70	5.67	44.38	
-18.450	38.69	4.64	43.33	
-19.160	38.65	2.10	40.76	
-19.450	38.64	1.77	40.40	
-20.160	38.59	0.93	39.52	
-20.450	38.56	1.90	40.46	
-21.160	38.50	4.25	42.75	
-21.450	38.48	5.43	43.91	
-21.704	38.45	6.46	44.91	
-22.160	38.40	8.23	46.63	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	38.37	8.89	47.26	
-23.160	38.29	10.52	48.81	
-23.450	38.25	10.73	48.98	
-24.160	38.16	11.22	49.38	
-24.450	38.13	11.14	49.27	
-25.160	38.03	10.95	48.98	
-25.450	37.99	10.77	48.76	
-26.160	37.88	10.33	48.21	
-26.450	37.84	10.20	48.04	
-27.160	37.73	9.90	47.63	
-27.450	37.68	9.99	47.67	
-28.160	37.57	10.20	47.77	
-28.450	37.52	10.64	48.16	
-29.160	37.40	11.72	49.11	
-29.450	37.35	12.63	49.98	
-30.160	37.23	14.88	52.11	
-30.384	37.19	15.86	53.05	
-30.450	37.17	16.09	53.27	
-31.160	37.04	18.57	55.62	
-31.450	36.99	18.99	55.98	
-32.160	36.85	20.01	56.86	
-32.450	36.80	20.02	56.82	
-32.831	36.72	20.05	56.77	
-33.160	36.66	19.87	56.53	
-33.450	36.60	19.56	56.16	
-34.160	36.45	18.80	55.25	
-34.450	36.39	18.36	54.75	
-34.771	36.32	17.87	54.20	
-35.160	36.24	17.22	53.47	
-35.450	36.18	16.70	52.88	
-36.160	36.03	15.42	51.45	
-36.450	35.97	14.86	50.82	
-37.160	35.81	13.48	49.29	
-37.450	35.75	12.88	48.63	
-37.728	35.69	12.30	47.99	
-38.160	35.60	11.36	46.96	
-38.450	35.54	10.71	46.24	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	35.38	9.12	44.50	
-39.450	35.32	8.49	43.81	
-40.160	35.17	6.96	42.13	
-40.450	35.11	6.39	41.49	
-40.846	35.03	5.60	40.63	
-41.160	34.96	5.03	39.99	
-41.450	34.90	4.55	39.45	
-42.160	34.75	3.39	38.15	
-42.450	34.69	3.01	37.71	
-43.160	34.55	2.08	36.63	
-43.450	34.49	1.79	36.28	
-44.160	34.35	1.08	35.43	
-44.450	34.30	0.87	35.16	
-45.160	34.16	0.36	34.52	
-45.450	34.11	0.29	34.40	
-46.160	33.98	0.12	34.10	
-46.450	33.92	0.21	34.13	
-47.160	33.80	0.41	34.21	
-47.450	33.75	0.44	34.19	
-48.160	33.63	0.54	34.17	
-48.450	33.58	0.54	34.12	
-49.160	33.47	0.55	34.02	
-49.450	33.42	0.54	33.96	
-50.160	33.32	0.49	33.81	
-50.450	33.27	0.46	33.73	
-51.160	33.17	0.38	33.55	
-51.450	33.13	0.34	33.47	
-52.160	33.04	0.25	33.29	
-52.450	33.00	0.21	33.21	
-52.954	32.94	0.14	33.08	
-53.160	32.92	0.11	33.03	
-53.450	32.89	0.08	32.97	
-54.160	32.82	0.01	32.84	
-54.450	32.80	0.01	32.80	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.78	0.00	32.78	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4)Ord+Collision

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	43.99	49.73	93.72	
-8.160	44.75	47.54	92.29	
-8.450	45.05	48.28	93.33	
-9.160	45.76	53.90	99.66	
-9.450	46.04	57.73	103.77	
-9.794	46.37	62.27	108.64	
-9.950	46.51	63.94	110.45	
-10.160	46.70	65.78	112.49	
-10.450	46.97	67.20	114.16	
-10.854	47.33	69.17	116.50	
-11.160	47.60	69.36	116.95	**
-11.450	47.85	68.80	116.65	
-12.160	48.46	64.46	112.91	
-12.450	48.70	60.63	109.33	
-13.144	49.27	51.47	100.74	
-13.160	49.28	51.19	100.48	
-13.450	49.51	46.75	96.26	
-14.160	50.02	35.87	85.89	
-14.160	58.22	40.79	99.02	
-14.450	58.44	36.92	95.36	
-15.160	58.90	27.43	86.34	
-15.450	59.09	24.58	83.67	
-16.160	59.45	17.58	77.04	
-16.450	59.60	15.55	75.15	
-17.160	59.87	10.57	70.44	
-17.450	59.98	9.15	69.13	
-18.160	60.15	5.67	65.82	
-18.450	60.22	4.64	64.86	
-19.160	60.32	2.10	62.42	
-19.450	60.36	1.77	62.12	
-20.160	60.37	0.93	61.31	
-20.450	60.38	1.90	62.28	
-21.160	60.32	4.25	64.58	
-21.450	60.30	5.43	65.73	
-21.704	60.27	6.46	66.73	
-22.160	60.19	8.23	68.41	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-22.450	60.14	8.89	69.03	
-23.160	59.96	10.52	70.49	
-23.450	59.89	10.73	70.61	
-24.160	59.66	11.22	70.88	
-24.450	59.57	11.14	70.71	
-25.160	59.30	10.95	70.25	
-25.450	59.18	10.77	69.96	
-26.160	58.87	10.33	69.20	
-26.450	58.74	10.20	68.94	
-27.160	58.39	9.90	68.29	
-27.450	58.24	9.99	68.23	
-28.160	57.85	10.20	68.06	
-28.450	57.69	10.64	68.34	
-29.160	57.27	11.72	68.99	
-29.450	57.10	12.63	69.74	
-30.160	56.66	14.88	71.54	
-30.384	56.52	15.86	72.38	
-30.450	56.47	16.09	72.57	
-31.160	55.98	18.57	74.56	
-31.450	55.78	18.99	74.77	
-32.160	55.24	20.01	75.25	
-32.450	55.02	20.02	75.04	
-32.831	54.70	20.05	74.75	
-33.160	54.43	19.87	74.30	
-33.450	54.19	19.56	73.75	
-34.160	53.56	18.80	72.36	
-34.450	53.31	18.36	71.67	
-34.771	53.01	17.87	70.89	
-35.160	52.65	17.22	69.88	
-35.450	52.38	16.70	69.09	
-36.160	51.70	15.42	67.12	
-36.450	51.42	14.86	66.28	
-37.160	50.72	13.48	64.20	
-37.450	50.44	12.88	63.31	
-37.728	50.16	12.30	62.46	
-38.160	49.73	11.36	61.08	
-38.450	49.43	10.71	60.14	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-39.160	48.71	9.12	57.83	
-39.450	48.42	8.49	56.91	
-40.160	47.69	6.96	54.65	
-40.450	47.40	6.39	53.78	
-40.846	46.99	5.60	52.60	
-41.160	46.67	5.03	51.70	
-41.450	46.38	4.55	50.93	
-42.160	45.66	3.39	49.05	
-42.450	45.37	3.01	48.38	
-43.160	44.66	2.08	46.74	
-43.450	44.37	1.79	46.16	
-44.160	43.67	1.08	44.75	
-44.450	43.39	0.87	44.26	
-45.160	42.71	0.36	43.07	
-45.450	42.43	0.29	42.72	
-46.160	41.77	0.12	41.90	
-46.450	41.50	0.21	41.71	
-47.160	40.87	0.41	41.27	
-47.450	40.61	0.44	41.05	
-48.160	40.00	0.54	40.53	
-48.450	39.75	0.54	40.29	
-49.160	39.16	0.55	39.72	
-49.450	38.92	0.54	39.46	
-50.160	38.37	0.49	38.86	
-50.450	38.14	0.46	38.60	
-51.160	37.62	0.38	38.00	
-51.450	37.41	0.34	37.75	
-52.160	36.93	0.25	37.17	
-52.450	36.73	0.21	36.93	
-52.954	36.40	0.14	36.54	
-53.160	36.28	0.11	36.39	
-53.450	36.11	0.08	36.19	
-54.160	35.77	0.01	35.78	
-54.450	35.63	0.01	35.64	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	35.55	0.00	35.55	

* :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

5)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	63.74	49.73	113.47	
-8.160	64.99	47.54	112.53	
-8.450	65.50	48.28	113.77	
-9.160	66.70	53.90	120.60	
-9.450	67.19	57.73	124.92	
-9.794	67.76	62.27	130.03	
-9.950	68.02	63.94	131.96	
-10.160	68.36	65.78	134.15	
-10.450	68.84	67.20	136.04	
-10.854	69.49	69.17	138.66	
-11.160	69.98	69.36	139.34	**
-11.450	70.44	68.80	139.25	
-12.160	71.54	64.46	136.00	
-12.450	71.99	60.63	132.62	
-13.144	73.04	51.47	124.51	
-13.160	73.06	51.19	124.25	
-13.450	73.47	46.75	120.22	
-14.160	74.37	35.87	110.24	
-14.160	86.54	40.79	127.34	
-14.450	86.91	36.92	123.83	
-15.160	87.65	27.43	115.09	
-15.450	87.95	24.58	112.53	
-16.160	88.45	17.58	106.04	
-16.450	88.66	15.55	104.21	
-17.160	88.94	10.57	99.51	
-17.450	89.05	9.15	98.20	
-18.160	89.13	5.67	94.80	
-18.450	89.16	4.64	93.79	
-19.160	89.05	2.10	91.15	
-19.450	89.00	1.77	90.77	
-20.160	88.72	0.93	89.65	
-20.450	88.61	1.90	90.50	
-21.160	88.17	4.25	92.42	
-21.450	87.99	5.43	93.43	
-21.704	87.81	6.46	94.27	
-22.160	87.43	8.23	95.66	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	87.19	8.89	96.08	
-23.160	86.50	10.52	97.02	
-23.450	86.22	10.73	96.94	
-24.160	85.42	11.22	96.64	
-24.450	85.10	11.14	96.24	
-25.160	84.21	10.95	95.16	
-25.450	83.85	10.77	94.62	
-26.160	82.88	10.33	93.20	
-26.450	82.48	10.20	92.68	
-27.160	81.44	9.90	91.34	
-27.450	81.01	9.99	91.00	
-28.160	79.90	10.20	90.11	
-28.450	79.45	10.64	90.09	
-29.160	78.29	11.72	90.01	
-29.450	77.82	12.63	90.45	
-30.160	76.61	14.88	91.50	
-30.384	76.23	15.86	92.09	
-30.450	76.12	16.09	92.21	
-31.160	74.84	18.57	93.41	
-31.450	74.32	18.99	93.31	
-32.160	72.97	20.01	92.97	
-32.450	72.41	20.02	92.44	
-32.831	71.65	20.05	91.70	
-33.160	70.99	19.87	90.87	
-33.450	70.41	19.56	89.97	
-34.160	68.95	18.80	87.75	
-34.450	68.35	18.36	86.71	
-34.771	67.67	17.87	85.55	
-35.160	66.85	17.22	84.08	
-35.450	66.24	16.70	82.94	
-36.160	64.72	15.42	80.14	
-36.450	64.10	14.86	78.95	
-37.160	62.57	13.48	76.05	
-37.450	61.94	12.88	74.82	
-37.728	61.35	12.30	73.65	
-38.160	60.41	11.36	71.77	
-38.450	59.79	10.71	70.50	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	58.27	9.12	67.39	
-39.450	57.65	8.49	66.14	
-40.160	56.15	6.96	63.11	
-40.450	55.54	6.39	61.92	
-40.846	54.71	5.60	60.32	
-41.160	54.06	5.03	59.09	
-41.450	53.46	4.55	58.01	
-42.160	52.01	3.39	55.41	
-42.450	51.42	3.01	54.44	
-43.160	50.02	2.08	52.10	
-43.450	49.44	1.79	51.23	
-44.160	48.08	1.08	49.16	
-44.450	47.52	0.87	48.39	
-45.160	46.20	0.36	46.56	
-45.450	45.67	0.29	45.95	
-46.160	44.40	0.12	44.52	
-46.450	43.88	0.21	44.09	
-47.160	42.67	0.41	43.08	
-47.450	42.17	0.44	42.62	
-48.160	41.02	0.54	41.55	
-48.450	40.54	0.54	41.09	
-49.160	39.45	0.55	40.00	
-49.450	39.00	0.54	39.53	
-50.160	37.96	0.49	38.45	
-50.450	37.54	0.46	38.00	
-51.160	36.57	0.38	36.95	
-51.450	36.17	0.34	36.51	
-52.160	35.26	0.25	35.50	
-52.450	34.89	0.21	35.09	
-52.954	34.28	0.14	34.41	
-53.160	34.05	0.11	34.15	
-53.450	33.72	0.08	33.80	
-54.160	33.06	0.01	33.08	
-54.450	32.79	0.01	32.80	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.63	0.00	32.63	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4 member calculation

4.1 calculation of pile cap

4.1.1 design condition

(1) calculation method : cantilever
(2) concrete design standard strength : Sig.ck = 24 (N/mm²)
(3) rebar in use : SD345(underwater member)
(4) shape dimension
pile cap thickness h = 4.000 (m)
1)bridge axis direction
span length L = 1.611 (m)
shear stress check location Ls = 1.611 (m) (distance from external edge of leg column)
center spacing of steel pipe sheet piles a = 1.4478 (m)
2)perpendicular direction
span length L = 2.176 (m)
shear stress check location Ls = 2.000 (m) (distance from external edge of leg column)
center spacing of steel pipe sheet piles a = 1.4478 (m)
(5) dead weight of pile cap and surcharge load
1)bridge axis direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m²)
1	OD(HT)	-1.721	3.180	70.97
2	OD(LT)	-1.721	-2.390	77.66
3	OD-TM(HT)	-1.721	3.180	70.97
4	OD-TM(LT)	-1.721	-2.390	77.66
5	WN-TM	-1.721	4.990	70.97
6	OD-CL	-1.721	3.180	70.97
7	ETQ	-1.721	0.290	70.97

2)perpendicular direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m²)
1	OD(HT)	-1.721	3.180	70.97
2	OD(LT)	-1.721	-2.390	77.66
3	WN	-1.721	4.990	70.97
4	OD-CL	-1.721	3.180	70.97

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m^2)
5	ETQ	-1.721	0.290	70.97

note: backfilling soil height , water table height is shown in elevation(crest of pile cap elevation = -3.450m)

4.1.2 external working force

pile cap is designed for external working force at bottom of pile cap

besides, in estimating vertical load, dead weight of pile cap upto celler part internal periphery and surcharge load are considered

(1) area of pile cap(let internal periphery sheet pile)

oval: $A1 = B^2 = PI /4 + B * (L-B)$

$= 6.221^2 * Pai/4 + 6.221*(19.251- 6.221) = 111.461$ (m^2)

(2)area of backfilling soil

$A2 = A1 - Ap = 66.891$ (m^2)

where, Ap:leg column cross sectional area = 44.57 (m^2)

(3)working force at leg column bottom

1)bridge axis direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	40500.0	0.0	0.0	0.0	0.0
2	OD(LT)	40500.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	40500.0	200.0	3200.0	800.0	4000.0
4	OD-TM(LT)	40500.0	200.0	3200.0	800.0	4000.0
5	WN-TM	40500.0	400.0	5900.0	1600.0	7500.0
6	OD-CL	40500.0	3200.0	23800.0	12800.0	36600.0
7	ETQ	36000.0	10800.0	123800.0	43200.0	167000.0

2)perpendicular direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	40500.0	0.0	6800.0	0.0	6800.0
2	OD(LT)	40500.0	0.0	6800.0	0.0	6800.0
3	WN	40500.0	800.0	20900.0	3200.0	24100.0

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
4	OD-CL	40500.0	6400.0	54300.0	25600.0	79900.0
5	ETQ	36000.0	10800.0	146700.0	43200.0	189900.0

(4) pile cap, backfilling soil

V1 = A1*{ h1*Gam.c + h2*(Gam.c - Gam.w) }

V2 = A2*{ h1'*Gam.t + h2'*(Gam.sat - Gam.w) }

V3 = Ap*hw*Gam.w

where, V1 : weight of pile cap (kN)

V2 : weight of backfilling soil (kN)

V3 : buoyancy working at column (kN)

h1 : pile cap thickness upper than water table(m)

h2 : pile cap thickness lower than water table(m)

h1' : backfilling soil thickness upper than water table(m)

h2' : backfilling soil thickness lower than water table(m)

Gam.c : pile cap concrete unit weight = 24.5 (kN/m^3)

Gam.w : unit weight of water =10.00 (kN/m^3)

Gam.t : unit weight of backfilling soil(wet) = 17.5 (kN/m^3)

Gam.sat: unit weight of backfilling soil(saturated) = 17.5 (kN/m^3)

hw : water table (m)(height from crest of pile cap)

h' : backfilling soil thickness (m)

H1 : pile cap and filling concrete inertia force (kN)

y : pile cap inertia force working gravity location height (m)

1)bridge axis direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	6.630	1.729	6464.71	867.40	2954.99	4377.12
2	OD(LT)	1.060	1.729	6464.71	1314.90	472.44	7307.17
3	OD-TM(HT)	6.630	1.729	6464.71	867.40	2954.99	4377.12
4	OD-TM(LT)	1.060	1.729	6464.71	1314.90	472.44	7307.17
5	WN-TM	8.440	1.729	6464.71	867.40	3761.71	3570.40
6	OD-CL	6.630	1.729	6464.71	867.40	2954.99	4377.12

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
7	ETQ	3.740	1.729	6464.71	867.40	1666.92	5665.19

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00
2	OD(LT)	0.00	0.000	0.00
3	OD-TM(HT)	0.00	0.000	0.00
4	OD-TM(LT)	0.00	0.000	0.00
5	WN-TM	0.00	0.000	0.00
6	OD-CL	0.00	0.000	0.00
7	ETQ	0.00	0.000	0.00

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	6.630	1.729	6464.71	867.40	2954.99	4377.12
2	OD(LT)	1.060	1.729	6464.71	1314.90	472.44	7307.17
3	WN	8.440	1.729	6464.71	867.40	3761.71	3570.40
4	OD-CL	6.630	1.729	6464.71	867.40	2954.99	4377.12
5	ETQ	3.740	1.729	6464.71	867.40	1666.92	5665.19

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00
2	OD(LT)	0.00	0.000	0.00
3	WN	0.00	0.000	0.00
4	OD-CL	0.00	0.000	0.00
5	ETQ	0.00	0.000	0.00

(5)external force sum up

Vo = V + V1 + V2 - V3 + V4

Ho = H + H1

Mo = M + H*y + H1*y = SumM + H1*y

where, V4: other load (kN)

1)bridge axis direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	44877.2	0.0	0.0
2	OD(LT)	0.0	47807.2	0.0	0.0
3	OD-TM(HT)	0.0	44877.2	200.0	4000.0
4	OD-TM(LT)	0.0	47807.2	200.0	4000.0
5	WN-TM	0.0	44070.4	400.0	7500.0
6	OD-CL	0.0	44877.2	3200.0	36600.0
7	ETQ	0.0	41665.2	10800.0	167000.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	44877.1	0.0	6800.0
2	OD(LT)	0.0	47807.2	0.0	6800.0
3	WN	0.0	44070.4	800.0	24100.0
4	OD-CL	0.0	44877.1	6400.0	79900.0
5	ETQ	0.0	41665.2	10800.0	189900.0

(6) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

	number ni (num)	sectional area Aoi (m^2/num)	IBi (m^2)	
			bridge axis direction	perpendicular direction
periphery sheet pile(1)	34	0.05199	357.98	1536.40
separation wall sheet pile(2)	--	------	----------	----------
intermediate driven pile (3)	--	------	----------	----------

1)bridge axis direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	OD(HT)	1320	1320	1.00
2	OD(LT)	1406	1406	1.00
3	OD-TM(HT)	1361	1278	1.15
4	OD-TM(LT)	1448	1365	1.15
5	WN-TM	1374	1218	1.35
6	OD-CL	1699	941	1.50
7	ETQ	2956	-506	1.50

2)perpendicular direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	OD(HT)	1365	1275	1.00
2	OD(LT)	1451	1361	1.00
3	WN	1457	1136	1.25
4	OD-CL	1852	788	1.50
5	ETQ	2489	-38	1.50

4.1.3 reaction

(1)bridge axis direction

No	load name	max vertical reaction (kN/number)	min vertical reaction (kN/number)	increment coeff.
1	Oridinary(high tide)	1320	1320	1.00
2	Oridinary(low tide)	1406	1406	1.00
3	Ord+Temp(high tide)	1361	1278	1.15
4	Ord+Temp(low tide)	1448	1365	1.15
5	Wind+Temp	1374	1218	1.35
6	Ord+Collision	1699	941	1.50
7	Earthquake	2956	-506	1.50

(2)perpendicular direction

No	load name	max vertical reaction (kN/number)	min vertical reaction (kN/number)	increment coeff.
1	Oridinary(high tide)	1365	1275	1.00
2	Oridinary(low tide)	1451	1361	1.00
3	Wind	1457	1136	1.25
4	Ord+Collision	1852	788	1.50
5	Earthquake	2489	-38	1.50

4.1.4 calculation of member force

(1)section of leg column bottom external edge

calculate cantilever with leg column bottom external edge as fixed end

$$MA = \frac{R}{Do'}*\left(L + \frac{Do}{2} \right) - \frac{w*L^2}{2} \quad (kN.m/m)$$

where, R : vertical reaction induced in steel pipe sheet pile (kN/number)

Do' : center spacing of steel pipe sheet piles (m)

L : distance from external edge of leg column bottom to steel pipe sheet pile side (m)

Do : periphery steel pipe pile body diameter (m)

w : dead weight of pile cap and surcharge load (kN/m^2)

(2)steel pipe sheet pile front section

$$QB = \frac{R}{Do'} \quad (kN/m)$$

(3)shear stress check section

$$S = \frac{R}{Do'} - w*(L - Ls) \quad (kN/m)$$

where, Ls:distance from external edge of leg column bottom to check location (m)

(4)member force sum up table

1)bridge axis direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	S (kN/m)
1	Oridinary(high tide)	1924	1924	912	912
2	Oridinary(low tide)	2047	2047	971	971
3	Ord+Temp(high tide)	1987	1860	940	940
4	Ord+Temp(low tide)	2110	1983	1000	1000
5	Wind+Temp	2006	1769	949	949
6	Ord+Collision	2503	1344	1174	1174
7	Earthquake	4423	-864	2042	2042

2)perpendicular direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	S (kN/m)
1	Oridinary(high tide)	2450	2276	943	930
2	Oridinary(low tide)	2599	2425	1002	989
3	Wind	2625	2010	1006	994
4	Ord+Collision	3382	1343	1279	1266
5	Earthquake	4605	-242	1719	1707

4.1.5 stress calculation

(1)bridge axis direction

b = 100.0 (cm)   h = 400.0 (cm)

rebar in use

lower tensile (As = 77.306 (cm^2))

1 row cover 150 (mm) D32 @ 203

2 row cover 300 (mm) D32 @ 208

upper tensile (As = 27.576 (cm^2))

1 row cover 150 (mm) D32 @ 288

			unit	OD(HT)	OD(LT)	OD-TM(HT)
bottom side ten sile	bending moment	MA	kN.m	1924.0	2047.0	1987.0
	required rebar amount	Asr	cm^2	34.296	36.555	30.722
	neutral axis	x	cm	82.7	82.7	82.7
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.33 72.84	1.41 77.50	1.37 75.24
	tensile resultant force required rebar amount	T As	kN cm^2	854.9 53.434	909.6 56.848	883.1 47.993
top side ten sile	bending moment	MA'	kN.m	1924.0	2047.0	1860.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	7.8	7.8	7.8
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	0.00 0.00
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	0.0 0.000
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	8.00 160.00	8.00 160.00	9.20 184.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	912.0 0.24 0.88	971.0 0.26 0.88	940.0 0.25 1.01
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	912.0 0.24 0.88	971.0 0.26 0.88	940.0 0.25 1.01
shear force to share by concrete		SC a	kN	3325.0	3325.0	3824.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.171	0.171	0.171
	allowable tensile stress	Sig.sa	N/mm^2	160.00	160.00	160.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height Ce = 0.661 : effective height d = 377.59 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 0.905 : tensile rebar percentage pt = 0.205 (%)
3) for shear span ratio increment coefficient Cdc = 6.400 : shear span a = 1.611 (m)

			unit	OD-TM(LT)	WN-TM	OD-CL
bottom side ten sile	bending moment	MA	kN.m	2110.0	2006.0	2503.0
	required rebar amount	Asr	cm^2	32.669	26.324	23.586
	neutral axis	x	cm	82.7	82.7	82.7
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.46 79.90	1.38 75.97	1.73 94.78
	tensile resultant force required rebar amount	T As	kN cm^2	937.7 50.963	891.6 41.278	1112.4 37.081
top side ten sile	bending moment	MA'	kN.m	1983.0	1769.0	1344.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	7.8	7.8	7.8
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	0.00 0.00
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	0.0 0.000
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	9.20 184.00	10.80 216.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1000.0 0.26 1.01	949.0 0.25 1.19	1174.0 0.31 1.34
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1000.0 0.26 1.01	949.0 0.25 1.19	1174.0 0.31 1.34
shear force to share by concrete		SC a	kN	3824.0	4489.0	5060.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.171	0.171	0.171
	allowable tensile stress	Sig.sa	N/mm^2	160.00	160.00	200.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height Ce = 0.661 : effective height d = 377.59 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 0.905 : tensile rebar percentage pt = 0.205 (%)
3) for shear span ratio increment coefficient Cdc = 6.400 : shear span a = 1.611 (m)

			unit	ETQ
bottom side ten sile	bending moment	MA	kN.m	4423.0
	required rebar amount	Asr	cm^2	42.301
	neutral axis	x	cm	82.7
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	3.05 167.49
	tensile resultant force required rebar amount	T As	kN cm^2	1965.7 65.524
top side ten sile	bending moment	MA'	kN.m	-864.0
	required rebar amount	Asr	cm^2	7.672
	neutral axis	x	cm	52.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.90 85.26
	tensile resultant force required rebar amount	T As	kN cm^2	384.1 12.802
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2042.0 0.54 1.34
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2042.0 0.54 1.34
shear force to share by concrete		SC a	kN	5060.0
rebar	shear force to share	Sh'	kN	0.0
	member axial direction spacing	s	cm	100.0
	reduction coefficient	Cds	----	0.171
	allowable tensile stress	Sig.sa	N/mm^2	200.00
	amount of rebar in use	Aw	cm^2	3.871
	required rebar amount	Awreq	cm^2	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc
1) correction coefficient about effective height Ce = 0.661 : effective height d = 377.59 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 0.905 : tensile rebar percentage pt = 0.205 (%)
3) for shear span ratio increment coefficient Cdc = 6.400 : shear span a = 1.611 (m)

(2)perpendicular direction
b = 100.0 (cm) h = 400.0 (cm)
rebar in use
lower tensile (As = 81.534 (cm^2))
1 row cover 118 (mm) D32 @ 189
2 row cover 268 (mm) D32 @ 201
upper tensile (As = 33.989 (cm^2))
1 row cover 120 (mm) D29 @ 189

			unit	OD(HT)	OD(LT)	WN
bottom side ten sile	bending moment	MA	kN.m	2450.0	2599.0	2625.0
	required rebar amount	Asr	cm^2	43.544	46.282	37.164
	neutral axis	x	cm	85.1	85.1	85.1
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.63 87.25	1.73 92.57	1.75 93.49
	tensile resultant force required rebar amount	T As	kN cm^2	1088.7 68.043	1155.1 72.193	1166.6 58.330
top side ten sile	bending moment	MA'	kN.m	2276.0	2425.0	2010.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	7.1	7.1	7.1
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	0.00 0.00
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	0.0 0.000
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	8.00 160.00	8.00 160.00	10.00 200.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	943.0 0.25 0.84	1002.0 0.26 0.84	1006.0 0.26 1.05
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	930.0 0.24 0.84	989.0 0.26 0.84	994.0 0.26 1.05
shear force to share by concrete		SC a	kN	3200.0	3200.0	4000.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.228	0.228	0.228
	allowable tensile stress	Sig.sa	N/mm^2	160.00	160.00	160.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height   Ce = 0.660 : effective height   d = 380.93 (cm)
2) correction coefficient about tensile rebar percentage   Cpt = 0.914 : tensile rebar percentage   pt = 0.214 (%)
3) for shear span ratio increment coefficient   Cdc = 6.058 : shear span   a = 2.176 (m)

			unit	OD-CL	ETQ
bottom side ten sile	bending moment	MA	kN.m	3382.0	4605.0
	required rebar amount	Asr	cm^2	31.793	43.660
	neutral axis	x	cm	85.1	85.1
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.26 120.47	3.07 164.02
	tensile resultant force required rebar amount	T As	kN cm^2	1503.3 50.110	2046.7 68.223
top side ten sile	bending moment	MA'	kN.m	1343.0	-242.0
	required rebar amount	Asr	cm^2	0.000	2.105
	neutral axis	x	cm	7.1	58.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.23 19.30
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	107.4 3.581
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1279.0 0.34 1.28	1719.0 0.45 1.28
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1266.0 0.33 1.28	1707.0 0.45 1.28
shear force to share by concrete		SC a	kN	4869.0	4869.0
rebar	shear force to share	Sh'	kN	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0
	reduction coefficient	Cds	----	0.228	0.228
	allowable tensile stress	Sig.sa	N/mm^2	200.00	200.00
	amount of rebar in use	Aw	cm^2	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height   Ce = 0.660 : effective height   d = 380.93 (cm)
2) correction coefficient about tensile rebar percentage   Cpt = 0.914 : tensile rebar percentage   pt = 0.214 (%)
3) for shear span ratio increment coefficient   Cdc = 6.058 : shear span   a = 2.176 (m)

(3) required thickness of pile cap

$$h >= 1.94*\sqrt[3]{\frac{kp*Lambda^4}{E}} = 1.056\ (m)$$

where, h : required thickness of pile cap(m)

kp : equivalent modulus of subgrade reaction (kN/m^3)

$$kp = \frac{Kv1*n1 + Kv2*n2 + Kv3*n3}{A}$$

Kv : axial direction spring constant of steel pipe sheet pile or intermediate driven single pile (kN/m)

$$Kv = a * \frac{Ap*Ep}{L}$$

Ap : pure cross sectional area of steel pipe sheet pile or intermediate driven single pile (m^2)

Ep : Young's modulus of steel pipe sheet pile or 1 center pick single pile (kN/m^2)

L : pile length (m)

a : correction coefficient

a = 0.014*(L/D) + 0.72

Kv1(periphery steel pipe sheet pile) = 2.7987E+005

Kv2(separation wall steel pipe sheet pile) = 0.0000E+000

Kv3(intermediate driven single pile) = 0.0000E+000

n1 : number of periphery steel pipe sheet pile = 34

n2 : number of separation wall steel pipe sheet pile = 0

n3 : number of intermediate driven single pile = 0

A : area of pile cap (m^2) = 140.0

E : Young's modulus of pile cap (kN/m^2) = $2.50 * 10^7$

Lambda : protrusion length of pile cap (m) = 2.78

(4) minimum rebar amount check

		Mu(kN.m)	Mc(kN.m)	1.7M(kN.m)	As(mm^2/m)	judge
bridge axis direction	lower tensile	9891	5103	7519	7731	OK
	upper tensile	3640	5103	1469	2758	OK
perpendicular direction	lower tensile	10516	5103	7829	8153	OK
	upper tensile	4515	5103	411	3399	OK

Note: 1)Mu>=Mc, 2)1.7M<=Mc, 3)As>=500(mm^2/m)

if either 1) or 2) and 3) are satisfied, it is OK

Note: 1.7M is the value against maximum moment in all cases.

4.2 calculation of pile cap / sheet pile joint part

4.2.1 design condition

(1) steel material in use :SS400,SM400

(2) rebar in use :SD345(underwater member)

(3) concrete design standard strength :Sig.ck = 24 (N/mm^2)

(4) material of steel pipe sheet pile :SKY400

(5) diameter of steel material main body :D = 1200.0 (mm)

(6) section coefficient of steel pipe pile body :Z = 15184.5 (cm^3)

(7) joint method :rebar stud welding method

4.2.2 reaction

(1)bridge axis direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Oridinary(high tide)	1320	0	1.00
2	Oridinary(low tide)	1406	0	1.00
3	Ord+Temp(high tide)	1361	6	1.15
4	Ord+Temp(low tide)	1448	6	1.15
5	Wind+Temp	1374	12	1.35
6	Ord+Collision	1686	94	1.50
7	Earthquake	2965	324	1.50

(2)perpendicular direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Oridinary(high tide)	1365	0	1.00
2	Oridinary(low tide)	1451	0	1.00
3	Wind	1457	24	1.25
4	Ord+Collision	1831	188	1.50
5	Earthquake	2495	324	1.50

4.2.3 rebar stud welding method

(1) design bending moment

Me = Rp*e

MFix = Sig.sa * Zo

where, Me : moment by eccentricity of reaction(kN.m)
MFix : constraining moment (kN.m)
Rp : vertical reaction per single steel pipe sheet pile(kN)
e : eccentricity (m) = 0.6000
Sig.sa: allowable stress of steel pipe sheet pile (kN/m^2) = 140.00 (N/mm^2)
Zo : section coefficient of steel pipe pile body (m^3) = 15184.5 (cm^3)

select bigger of either Me or MFix

(2) moment rebar design

1) tensile stress by moment

$$T1 = \frac{M}{h}$$

$$Sig.s1 = \frac{T1}{nb*Ab}$$

where, T1 : tensile force working at moment rebar row (N)
M : design moment (N.mm)
h : center spacing of moment rebar row (mm) = 2950.00
Sig.s1: moment rebar tensile stress (N/mm^2)
nb : number of moment rebar (number/ row) = 16
Ab : cross sectional area of single moment rebar (mm^2) = 387.1 (D22)

2)tensile stress by horizontal force

$$T2 = \frac{Ho}{n1}$$

$$Sig.s2 = \frac{T2}{2*nb*Ab}$$

where, T2 : horizontal tensile force working at moment rebar row (N)
Ho : horizontal force working at bottom of pile cap(N)
n1 : number of periphery steel pipe sheet pile
Sig.s2: moment rebar tensile stress (N/mm^2)

3)composite

Sig.s = Sig.s1 + Sig.s2 <= Sig.sa

where, Sig.sa: moment rebar allowable tensile stress (N/mm^2)

4)required number of rebar

$$nba >= \frac{2*T1 + T2}{2*Sig.sa*Ab}$$

where, nba: required number of moment rebar (rebar/ row)

(3) shear rebar design

1) shear stress

$$Tau_s = \frac{Rp}{ns*As} <= Tau.sa$$

where, Tau.s : shear rebar shear stress (N/mm^2)
Rp : vertical reaction per single steel pipe sheet pile (N)
ns : number of shear rebar = 56
As : cross sectional area of single shear rebar (mm^2) = 387.1 (D22)
Tau.sa: shear rebar allowable shear stress (N/mm^2)

2)required number of rebar

$$nsa >= \frac{Rp}{Tau.sa*As}$$

where, nsa: required number of shear rebar (number)

bridge axis direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	OD(HT)	1320.0	792	2126	2126	720.6	0.0
2	OD(LT)	1406.0	844	2126	2126	720.6	0.0
3	OD-TM(HT)	1361.0	817	2445	2445	828.7	6.0
4	OD-TM(LT)	1448.0	869	2445	2445	828.7	6.0
5	WN-TM	1374.0	824	2870	2870	972.8	12.0
6	OD-CL	1686.0	1012	3189	3189	1080.9	94.0
7	ETQ	2965.0	1779	3189	3189	1080.9	324.0

No	Sig.s1 (N/mm²)	Sig.s2 (N/mm²)	Sig.s (N/mm²)	Sig.sa (N/mm²)	nb nba (rebar/row)	Tau.s (N/mm²)	Tau.sa (N/mm²)	ns nsa (rebar)
1	116.35	0.00	116.35	160.00	16 >= 12	60.89	96.00	56 >= 36
2	116.35	0.00	116.35	160.00	16 >= 12	64.86	96.00	56 >= 38
3	133.80	0.48	134.29	184.00	16 >= 12	62.78	110.40	56 >= 32
4	133.80	0.48	134.29	184.00	16 >= 12	66.80	110.40	56 >= 34
5	157.07	0.97	158.04	216.00	16 >= 12	63.38	129.60	56 >= 28
6	174.52	7.59	182.11	300.00	16 >= 10	77.78	180.00	56 >= 25
7	174.52	26.16	200.68	300.00	16 >= 11	136.78	180.00	56 >= 43

perpendicular direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	OD(HT)	1365.0	819	2126	2126	720.6	0.0
2	OD(LT)	1451.0	871	2126	2126	720.6	0.0
3	WN	1457.0	874	2657	2657	900.8	24.0
4	OD-CL	1831.0	1099	3189	3189	1080.9	188.0
5	ETQ	2495.0	1497	3189	3189	1080.9	324.0

No	Sig.s1 (N/mm²)	Sig.s2 (N/mm²)	Sig.s (N/mm²)	Sig.sa (N/mm²)	nb nba (rebar/row)	Tau.s (N/mm²)	Tau.sa (N/mm²)	ns nsa (rebar)
1	116.35	0.00	116.35	160.00	16 >= 12	62.97	96.00	56 >= 37
2	116.35	0.00	116.35	160.00	16 >= 12	66.94	96.00	56 >= 40
3	145.44	1.94	147.37	200.00	16 >= 12	67.21	120.00	56 >= 32
4	174.52	15.18	189.70	300.00	16 >= 11	84.47	180.00	56 >= 27
5	174.52	26.16	200.68	300.00	16 >= 11	115.10	180.00	56 >= 36

4.3 calculation of pile head joint part

4.3.1 design condition

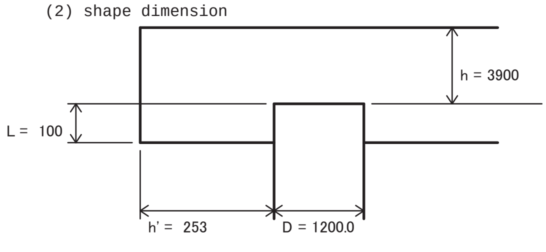
(1) design condition

1) joint method : method B

2) concrete design standard strength :Sig.ck = 24 (N/mm²)

3) rebar in use :SD345(underwater member)

(2) shape dimension



(3) pile head working force

1)bridge axis direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Oridinary(high tide)	1.00	0	0	0	0
2	Oridinary(low tide)	1.00	0	0	0	0
3	Ord+Temp(high tide)	1.15	0	0	0	0
4	Ord+Temp(low tide)	1.15	0	0	0	0
5	Wind+Temp	1.35	0	0	0	0
6	Ord+Collision	1.50	0	0	0	0
7	Earthquake	1.50	0	0	0	0

2)perpendicular direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Oridinary(high tide)	1.00	0	0	0	0
2	Oridinary(low tide)	1.00	0	0	0	0
3	Wind	1.25	0	0	0	0
4	Ord+Collision	1.50	0	0	0	0
5	Earthquake	1.50	0	0	0	0

4.3.2 pile head joint part stress calculation

(1) pile cap concrete vertical bearing stress

$$Sig.cv = \frac{PNmax}{Pai*D^2/4} <= Sig.ca$$

where, PNmax : axial direction maximum compressive force (N)
D : pile external diameter (mm) = 120.00 (cm)
Sig.ca : concrete allowable bearing stress (N/mm^2)

(2) punching shear stress at pile cap concrete

$$Tau_v = \frac{PNmax}{Pai*(D + h)*h} <= Tau_a$$

where, h : effective thickness of pile cap to resist vertical punching shear force (mm) = 390.0 (cm)
Tau.a: concrete allowable punching shear stress (N/mm^2)

1)bridge axis direction

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
1	Oridinary(high tide)	0	0.00	7.20	0.000	0.900
2	Oridinary(low tide)	0	0.00	7.20	0.000	0.900
3	Ord+Temp(high tide)	0	0.00	8.28	0.000	0.900
4	Ord+Temp(low tide)	0	0.00	8.28	0.000	0.900

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
5	Wind+Temp	0	0.00	9.72	0.000	0.900
6	Ord+Collision	0	0.00	10.80	0.000	0.900
7	Earthquake	0	0.00	10.80	0.000	0.900

2)perpendicular direction

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
1	Oridinary(high tide)	0	0.00	7.20	0.000	0.900
2	Oridinary(low tide)	0	0.00	7.20	0.000	0.900
3	Wind	0	0.00	9.00	0.000	0.900
4	Ord+Collision	0	0.00	10.80	0.000	0.900
5	Earthquake	0	0.00	10.80	0.000	0.900

(3) horizontal bearing stress at pile cap concrete

$$Sig.ch = \frac{PHmax}{D*I} <= Sig.ca$$

where, PHmax : axial orthogonal direction force (N)
I : pile embedment length (mm) = 10.0 (cm)
Sig.ca : concrete allowable bearing stress (N/mm^2)

1)bridge axis direction

No	load name	PHmax (kN)	Sig.ch (N/mm^2)	Sig.ca (N/mm^2)
1	Oridinary(high tide)	0	0.000	7.200
2	Oridinary(low tide)	0	0.000	7.200
3	Ord+Temp(high tide)	0	0.000	8.280
4	Ord+Temp(low tide)	0	0.000	8.280
5	Wind+Temp	0	0.000	9.720
6	Ord+Collision	0	0.000	10.800
7	Earthquake	0	0.000	10.800

2)perpendicular direction

No	load name	PHmax (kN)	Sig.ch (N/mm^2)	Sig.ca (N/mm^2)
1	Oridinary(high tide)	0	0.000	7.200
2	Oridinary(low tide)	0	0.000	7.200
3	Wind	0	0.000	9.000
4	Ord+Collision	0	0.000	10.800
5	Earthquake	0	0.000	10.800

4.3.3 pile head reinforcing rebar calculation

(1)calculation of imaginary rebar concrete section

sec	dia(cm)	cover(cm)	rebar	amount of used rebar(cm^2)
1row	160.00	26.0	D22 - 12 (@283)	46.452

1)bridge axis direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
1	OD(HT)	0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00
		0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00
2	OD(LT)	0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00
		0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00
3	OD-TM(HT)	0.0	0.0	0.000	30.88	0.00	9.20	0.00	184.00
		0.0	0.0	0.000	30.88	0.00	9.20	0.00	184.00
4	OD-TM(LT)	0.0	0.0	0.000	30.88	0.00	9.20	0.00	184.00
		0.0	0.0	0.000	30.88	0.00	9.20	0.00	184.00
5	WN-TM	0.0	0.0	0.000	30.88	0.00	10.80	0.00	216.00
		0.0	0.0	0.000	30.88	0.00	10.80	0.00	216.00
6	OD-CL	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
7	ETQ	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

2)perpendicular direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
1	OD(HT)	0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00
		0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00
2	OD(LT)	0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00
		0.0	0.0	0.000	30.88	0.00	8.00	0.00	160.00

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
3	WN	0.0	0.0	0.000	30.88	0.00	10.00	0.00	200.00
		0.0	0.0	0.000	30.88	0.00	10.00	0.00	200.00
4	OD-CL	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
5	ETQ	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

(2) pile head reinforcing rebar anchor length

$$Lo = \frac{Sig.sa}{4*Tau.oa} Phi = 687 \ (mm)$$

Lo : rebaranchor length (mm)
Sig.sa : rebar allowable tensile stress = 200.00 (N/mm^2)
Tau.oa : allowable rebar bond stress = 1.600 (N/mm^2)
Phi. : pile head reinforcing rebar diameter = 22 (mm)

embedment length L >= Lo + 10 * Phi. = 908 (mm)

assure L from center of rebar in bottom of pile cap

(3) welding length of pile head supplemental rebar welding part by shear stress

$$Tau_s = \frac{Sig.sa*Ast}{1.4*Lambda*Ls} \le Tau.sa$$

$$Ls = \frac{Sig.s*Ast}{1.4*Lambda*Tau_{sa}}$$

where, Tau.sa: allowable shear stress of fillet welding = 72.00 (N/mm^2)
Sig.sa: rebar allowable tensile stress(to estimate anchor length) = 200.00 (N/mm^2)
Ast : sectional area of sigle pile head supplemental rebar = 3.871 (cm^2)
Lambda : fleg length of fillet welding (cm)
Ls : fillet welding length

welding leg length Lambda (cm)	0.6	0.7	0.8	0.9
welding length Ls (cm)	12.8	11.0	9.6	8.5

5 foundation spring calculation

subgrade reaction constant value used in calculation of natural period
It is calculated by the analysis model used in horizontal capacity method. But the upper limit of the subgrade reaction is not considered.

(1)Layer data

	type sand	thick(m) Layer	Nvalue	usual time	in quakes	calculation natural period	
				Alp.*Eo (kN/m^2)	Alp.*Eo (kN/m^2)	dyna.het.coef ED(kN/m)	dyna.pois.rate NyuD
1	clay	3.254	1.0	3600	7200	34286	0.50
2	clay	3.090	3.0	8000	16000	71312	0.50
3	sandy	1.060	3.0	4800	9600	45643	0.50
4	sandy	2.290	3.0	4800	9600	45643	0.50
5	sandy	8.560	13.0	20800	41600	117855	0.50
6	clay	8.680	7.0	19600	39200	125458	0.50
7	clay	22.570	18.0	50400	100800	242205	0.50
8	sandy	1.706	50.0	140000	280000	323331	0.50

(2)modulus of subgrade reaction
1) foundation bottom spring

	vertical direction kv(kN/m^3)	horizontal direction shear ks(kN/m^3)
periphery sheet pile	381049	114315
separation wall sheet pile	----------	----------
intermediate driven pile	----------	----------

2) foundation front , side spring

usual time/ earthquake time kHo = Alp.*Eo/0.3
estimate natural period kHo = ED/0.3
foundation front horizontal direction kh = $Alp.k*kHo*(Be/0.3)^{(-3/4)}$ (kN/m^3)
foundation front vertical direction kSVB = $0.3*Alp.k*kHo*(Be/0.3)^{(-3/4)}$ (kN/m^3)
foundation side horizontal direction kSHD = $0.6*Alp.k*kHo*(De/0.3)^{(-3/4)}$ (kN/m^3)
foundation side vertical direction kSVD = $0.3*Alp.k*kHo*(De/0.3)^{(-3/4)}$ (kN/m^3)

where Alp.k : modulus of subgrade reaction correction coefficient (= 1.50)
Alp. : modulus of elasticity in ground (kN/m^2)
Eo : dynamic modulus of elasticity in ground (kN/m^2)
ED : dynamic modulus of elasticity in ground (kN/m^2)
Nu.D: dynamic Poisson's ratio
Be : equivalent loading width in orthogonal direction to external force, foundation width (m)
De : equivalent loading width in external force direction, foundation width (m)
both Be,De are values which 0.2*D is deducted in case of circular and oval shape (D:circular diameter (m))

usual time
1.bridge axis direction(Be = 19.92714, De = 6.89694)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	774	232	1029	514
2	-6.704 - -7.450	1719	516	2286	1143
3	-7.450 - -9.794	1719	516	2286	1143
4	-9.794 - -10.854	1031	309	1372	686
5	-10.854 - -13.144	1031	309	1372	686
6	-13.144 - -21.704	4470	1341	5943	2972
7	-21.704 - -30.384	4212	1264	5600	2800
8	-30.384 - -48.439	10831	3249	14401	7201
9	-48.439 - -52.954	10831	6498	14401	14401
10	-52.954 - -54.660	30085	18051	40003	40003

2.perpendicular direction(Be = 6.89694, De = 19.92714)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	1714	514	464	232
2	-6.704 - -7.450	3810	1143	1031	516
3	-7.450 - -9.794	3810	1143	1031	516
4	-9.794 - -10.854	2286	686	619	309
5	-10.854 - -13.144	2286	686	619	309
6	-13.144 - -21.704	9906	2972	2682	1341
7	-21.704 - -30.384	9334	2800	2527	1264
8	-30.384 - -48.439	24002	7201	6498	3249
9	-48.439 - -52.954	24002	14401	6498	6498
10	-52.954 - -54.660	66672	40003	18051	18051

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -48.439(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

earthquake time
1.bridge axis direction(Be = 19.92714, De = 6.89694)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	1547	464	2057	1029
2	-6.704 - -7.450	1145	343	1522	761
3	-7.450 - -9.794	1145	343	1522	761
4	-9.794 - -10.854	687	206	913	457
5	-10.854 - -13.144	1374	412	1827	913
6	-13.144 - -21.704	8940	2682	11887	5943
7	-21.704 - -30.384	8424	2527	11201	5600
8	-30.384 - -48.439	21661	6498	28803	14401
9	-48.439 - -52.954	21661	12997	28803	28803
10	-52.954 - -54.660	60171	36102	80007	80007

2.perpendicular direction(Be = 6.89694, De = 19.92714)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	3429	1029	928	464
2	-6.704 - -7.450	2537	761	687	343
3	-7.450 - -9.794	2537	761	687	343
4	-9.794 - -10.854	1522	457	412	206
5	-10.854 - -13.144	3045	913	824	412
6	-13.144 - -21.704	19811	5943	5364	2682
7	-21.704 - -30.384	18668	5600	5054	2527
8	-30.384 - -48.439	48004	14401	12997	6498
9	-48.439 - -52.954	48004	28803	12997	12997
10	-52.954 - -54.660	133345	80007	36102	36102

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -48.439(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

to estimate natural period
1.bridge axis direction(Be = 19.92714, De = 6.89694)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	7368	2210	9797	4898
2	-6.704 - -7.450	15325	4597	20377	10188
3	-7.450 - -9.794	15325	4597	20377	10188
4	-9.794 - -10.854	9808	2943	13042	6521
5	-10.854 - -13.144	9808	2943	13042	6521
6	-13.144 - -21.704	25327	7598	33676	16838
7	-21.704 - -30.384	26960	8088	35848	17924
8	-30.384 - -48.439	52049	15615	69207	34604
9	-48.439 - -52.954	52049	31229	69207	69207
10	-52.954 - -54.660	69482	41689	92388	92388

2.perpendicular direction(Be = 6.89694, De = 19.92714)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	16328	4898	4421	2210
2	-6.704 - -7.450	33961	10188	9195	4597
3	-7.450 - -9.794	33961	10188	9195	4597
4	-9.794 - -10.854	21737	6521	5885	2943
5	-10.854 - -13.144	21737	6521	5885	2943
6	-13.144 - -21.704	56126	16838	15196	7598
7	-21.704 - -30.384	59747	17924	16176	8088
8	-30.384 - -48.439	115346	34604	31229	15615
9	-48.439 - -52.954	115346	69207	31229	31229
10	-52.954 - -54.660	153981	92388	41689	41689

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -48.439(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

(3)joint pipe external diameter ,shear resistance of joint

joint pipe external diameter

- periphery :linear part = 0.1652 (m)
- periphery :curve part = 0.1652 (m)
- separation wall:Y direction = 0.1652 (m)
- separation wall:X direction = 0.1652 (m)

shear resistance of joint

- shear rigidity Gj = 1200000 (kN/m^2)
- shear capacity qju = 200 (kN/m)

(4) ground spring constant to estimate natural period

general equation

$$\begin{bmatrix} H \\ M \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del. \\ Theta \end{bmatrix}$$

hence

$$\begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}$$

$$\begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} = \begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}^{-1}$$

where Ho : unit horizontal force to apply at crest of foundation (kN)
- Mo : unit moment to apply at crest of foundation (kN.m)
- Del.oH : horizontal displacement at crest of foundation by Ho(m)
- $Theta_{oH}$: rotational angle at crest of foundation by Ho (rad)
- Del.oM : horizontal displacement at crest of foundation by Mo(m)
- $Theta_{oM}$: rotational angle at crest of foundation by Mo (rad)
- Ass : ground spring constant (kN/m)
- Asr : ground spring constant (kN/rad)
- Ars : ground spring constant (kN.m/m)
- Arr : ground spring constant (kN.m/rad)

usual time

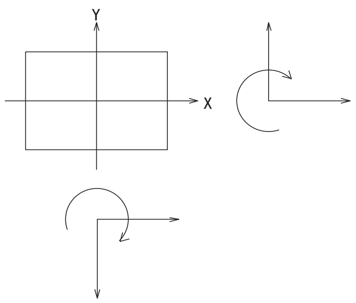
item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.6085E-001	8.6398E-002
ThetaoH	mrad	7.3638E-003	2.6922E-003
Del.oM	mm	7.3638E-002	2.6922E-002
ThetaoM	mrad	6.8044E-003	1.9235E-003
Ass	kN/m	1.2321E+006	2.0527E+006
Asr	kN/rad	-1.3334E+007	-2.8730E+007
Ars	kN.m/m	-1.3334E+007	-2.8730E+007
Arr	kN.m/rad	2.9127E+008	9.2201E+008

earthquake time

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.3127E-001	6.6386E-002
ThetaoH	mrad	6.4262E-003	2.1862E-003
Del.oM	mm	6.4262E-002	2.1862E-002
ThetaoM	mrad	6.3418E-003	1.7206E-003
Ass	kN/m	1.5117E+006	2.5902E+006
Asr	kN/rad	-1.5318E+007	-3.2911E+007
Ars	kN.m/m	-1.5318E+007	-3.2911E+007
Arr	kN.m/rad	3.1290E+008	9.9936E+008

to estimate natural period

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	3.7293E-002	2.1016E-002
ThetaoH	mrad	2.6494E-003	9.2951E-004
Del.oM	mm	2.6494E-002	9.2951E-003
ThetaoM	mrad	3.7700E-003	1.0243E-003
Ass	kN/m	5.3548E+006	7.9487E+006
Asr	kN/rad	-3.7631E+007	-7.2133E+007
Ars	kN.m/m	-3.7631E+007	-7.2133E+007
Arr	kN.m/rad	5.2971E+008	1.6309E+009



Y direction: bridge axis direction
X direction:perpendicular direction

3.3 DETAIL CALCULATION SHEET OF SPSP OF P6 (LOAD CASE-3)

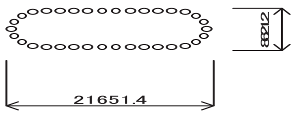
Load Case-3 is the case which considers:

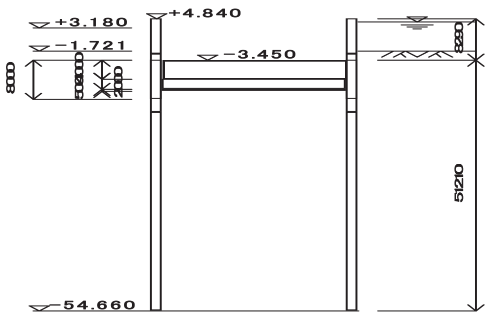
- with local scouring of 1/2 of maximum scouring depth, thus design elevation is set on the elevation of 1/2 of maximum scouring depth EL-3.64m.
- Load combinations of Extreme wind situation＋Effect of Temperature Change, Vessel Collision, Earthquake Condition

Contents

1 concrete body calculation

1.1 foundation shape dimension diagram





1.2 steel pipe sheet pile composing points

1)periphery sheet pile

external diameter = 1200.0(mm)
pile length = 59.500(m)
number = 34(number)

steel pipe thickness (mm)	length (m)	material
14.0	7.000	SKY400
16.0	12.000	SKY400
14.0	40.500	SKY400

1.3 ground condition

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m^3)		c (kN/m^2)	Phi. (angle)	modulus of elasticity Alp.*Eo(kN/m^2)		reduction coefficient		
				Gam.	Gam.'			usual	earthquake	DE	DE' Type1	DE' Type2
1	chsv	4.983	1.0	17.5	7.5	10.0	0.00	3600	7200	1.000	1.000	1.000
2	chsv	3.090	3.0	17.5	7.5	15.0	0.00	8000	16000	0.333	0.333	0.333
3	sand	1.060	3.0	17.5	8.5	0.0	28.00	4800	9600	0.333	0.333	0.333
4	sand	2.290	3.0	17.5	8.5	0.0	28.00	4800	9600	0.666	0.666	0.666
5	sand	8.560	13.0	17.0	8.0	0.0	33.00	20800	41600	1.000	1.000	1.000
6	chsv	8.680	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
7	chsv	22.570	18.0	18.0	8.0	108.0	0.00	50400	100800	1.000	1.000	1.000
8	sand	6.140	50.0	19.0	10.0	0.0	35.00	140000	280000	1.000	1.000	1.000

1.4 section properties

(1)section properties of steel pipe pile body

errosion margin external side = 2.0 (mm) internal side = 0.0 (mm)

1)periphery sheet pile Do = 1200(mm) number = 34

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
16.0	10.710	519.9	908031	15184	SKY400
14.0	40.500	446.4	782242	13081	SKY400

(2)sum of squared distance from centroid of steel pipe sheet to neutral axis of horizontal section of celler IB(m^2)

	bridge axis direction	perpendicular direction
periphery sheet pile	357.98	1536.40

(3)sum of moment of inertia in celler part I(m^4)

bridge axis direction I = SumIoi + Mu * Sum(Aoi * Yi^2)

perpendicular direction I = SumIoi + Mu * Sum(Aoi * Xi^2)

Mu : composite efficiency - 0.75

No	L(m)	bridge axis direction	perpendicular direction
1	10.710	14.266469	60.213367
2	40.500	12.250007	51.699783

foundation length = 51.210 (m)

(4)coordinates of cetroid of steel pipe sheet pile

1) periphery sheet pile

No	Y(m)	X(m)	number
1	3.7106	0.7239	4
2	3.7106	2.1717	4
3	3.7106	3.6195	4
4	3.7106	5.0673	4
5	3.7106	6.5151	4
6	0.0000	10.2257	2
7	1.4200	9.9432	4

No	Y(m)	X(m)	number
8	2.6238	9.1389	4
9	3.4281	7.9351	4

1.5 ground constant

(1) ground modulus of elasticity

layer No	usual time		earthquake time		
	layer thickness (m)	Alp.*Eo(kN/m^2)	layer thickness (m)	Alp.*Eo(kN/m^2)	DE
protrusion length	0.190	------	0.190	------	----
1	3.064	3600	3.064	7200	1.000
2	3.090	8000	3.090	16000	0.333
3	1.060	4800	1.060	9600	0.333
4	2.290	4800	2.290	9600	0.666
5	8.560	20800	8.560	41600	1.000
6	8.680	19600	8.680	39200	1.000
7	22.570	50400	22.570	100800	1.000
8	1.706	140000	1.706	280000	1.000

(2)vertical modulus of subgrade reaction

$$kv = \frac{1}{0.3} * Alp. * Eo * \left(\frac{Bv}{0.3}\right)^{-3/4}$$

where kv : vertical modulus of subgrade reaction (kN/m^3)

Alp.*Eo: ground modulus of elasticity (kN/m^2)

usual time = 140000

earthquake time = 280000

Bv : foundation equivalent loading width of foundation (m) -- external diameter of steel pipe sheet pile main body

	Bv (mm)	kv(kN/m^3)	
		usual	earthquake
periphery sheet pile	1200.0	164992	329983

(3)horizontal modulus of subgrade reaction

$$kH = \frac{1}{0.3} * Alp. * Eo * \left(\frac{BH}{0.3}\right)^{-3/4}$$

where kH : horizontal modulus of subgrade reaction (kN/m^3)

BH : equivalent loading width of foundation in orthogonal to load working direction (m)

$BH = \sqrt{D/Beta} <= \sqrt{De*Le}$

D : loading width of foundation in orthogonal to load working direction (m)

De : effective loading width of foundation in orthogonal to load working direction (m)

1/Beta : ground depth to relate with horizontal resistance, less than foundation length (m)

Beta : characteristic value of foundation(m^{-1})

$$Beta = \sqrt[4]{\frac{kH*D}{4*E*I}}$$

E : Young's modulus of foundation = 2.00 * 10^8(kN/m^2)

I : moment of inertia of foundation (m^4)

Le : effective embedment depth of foundation(m)

$$kH1 = (1 + Alp.H)*kH*\left(\frac{y}{yo}\right)^{-1/2}$$

where kH1 : in case of considering strain-dependance, standard modulus of subgrade reaction in horizontal direction (kN/m^3) (assuming y = yo, standard value)

Alp.H : shear subgrade reaction on celler part side in horizontal direction and resistance of internal soil increment coefficient including sharing etc (= 1.00)

y : horizontal displacemen of foundation on design ground surfacet (m)

yo : standard displacement (m)

	bridge axis direction		perpendicular direction	
	usual time	earthquake time	usual time	earthquake time
I (cm^4)	1.4266E+009		6.0213E+009	
D (cm)	2165.14		862.12	
Beta(cm^{-1})	0.000434	0.000434	0.000285	0.000285
1/Beta(cm)	2304.4	2304.4	3503.9	3503.9
average Alp.*Eo (N/cm^2)	1421.1	1421.1	2334.7	2334.7
BH, $\sqrt{De*Le}$ (cm)	2233.7 < 3323.6	2233.7 < 3323.6	1738.0 < 2097.3	1738.0 < 2097.3

layer No	layer thickness (m)		Alp.*Eo(kN/m²)		bridge axis direction kH1(kN/m³)		perpendicular direction kH1(kN/m³)	
	usual	earthquake	usual	earthquake	usual	in earthquake	usual	in earthquake
protrusion length	0.190	0.190	------	------	------	------	------	------
1	3.064	3.064	3600	7200	947	1894	1143	2286
2	3.090	3.090	8000	16000	2104	1401	2540	1691
3	1.060	1.060	4800	9600	1262	841	1524	1015
4	2.290	2.290	4800	9600	1262	1682	1524	2030
5	8.560	8.560	20800	41600	5471	10942	6603	13207
6	8.680	8.680	19600	39200	5155	10310	6222	12445
7	22.570	22.570	50400	100800	13256	26512	16001	32001
8	1.706	1.706	140000	280000	36823	73645	44446	88892

horizontal modulus of subgrade reaction(using value)(kN/m³)

layer No	layer thickness (m)		bridge axis direction		perpendicular direction	
	usual time	in quakes	usual time	in quakes	usual time	in quakes
protrusion length	0.190	0.190	------	------	------	------
1	3.064	3.064	947	1894	1143	2286
2	3.090	3.090	2104	1401	2540	1691
3	1.060	1.060	1262	841	1524	1015
4	2.290	2.290	1262	1682	1524	2030
5	8.560	8.560	5471	10942	6603	13207
6	8.680	8.680	5155	10310	6222	12445
7	22.570	22.570	13256	26512	16001	32001
8	1.706	1.706	36823	73645	44446	88892

(4)horizontal direction shear modulus of subgrade reaction at bottom of celler

ks = 0.3 * kv

where ks :horizontal direction shear modulus of subgrade reaction at bottom of celler (kN/m³)

	usual time	in quakes
periphery sheet pile	49497	98995

(5)spring constant at bottom of celler

1)vertical spring constant

$Kv = \sum_{i=1}^{3}((ni*kvi*A1i))$ (kN/m)

where A1i : close sectional area of steel pipe sheet pile and intermediate driven single pile (m²)

periphery sheet pile		separation wall sheet pile		intermediate driven pile		Kv (kN/m)	
A11(m²)	n1(number)	A12(m²)	n2(number)	A13(m²)	n3(number)	usual time	earthquake time
1.1310	34	0.0000	0	0.0000	0	6.3444E+006	1.2689E+007

2) shear spring constant

$Ks = \sum_{i=1}^{2}((ni*ksi*A1i))$ (kN/m)

usual time	in quakes
1.9033E+006	3.8067E+006

3)rotational spring constant

$Kr = \sum_{i=1}^{2}((kvi*A1i*IBi))$ (kN.m/rad)

where IB : celler composed with steel pipe sheet pile

sum of squared distance from centroid to neutral axis of horizontal section of celler (m²)

	periphery sheet pile IB1 (m²)	separation wall sheet pile IB2 (m²)	Kr (kN.m/rad)	
			usual time	in quakes
bridge axis direction	357.98	0.00	6.6800E+007	1.3360E+008
perpendicular direction	1536.40	0.00	2.8669E+008	5.7339E+008

spring constant at bottom of celler(using value)

		usual time	in quakes
vertical spring Kv (kN/m)		6.3444E+006	1.2689E+007
shear spring Ks (kN/m)		1.9033E+006	3.8067E+006
rotational spring Kr (kN.m/rad)	bridge axis direction	6.6800E+007	1.3360E+008
	perpendicular direction	2.8669E+008	5.7339E+008

1.6 allowable bearing capacity

(1)allowable compressive bearing capacity of steel pipe sheet pile

work method : driven construction method

steel pipe sheet pile main body external diameter :Phi.1200.0 (mm)

$$Ra = \frac{1}{n} * Ru$$

$$Ru = qd*A1 + \frac{1}{n1+n2+n3} * \{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

where Ra: allowable compressive bearing capacity of steel pipe sheet pile(kN/pile)

n : factor of safety usual time n = 3

earthquake time n = 2

Ru: ultimate bearing capacity of steel pipe sheet pile in lower ground (kN)

A1: close sectional area of steel pipe sheet pile body (m^2)

A1 = 1.131 (m^2)

qd: ultimate bearing capacity per unit area supporting steel pipe sheet pile tip (kN/m^2)

$$\frac{\text{equivalent embedment depth to bearing strata}}{\text{pile diameter}} = \frac{1.700}{1.2000} = 1.42$$

$qd / \bar{N} = 85$

$\bar{N}$:design N value in steel pipe sheet pile tip ground $\bar{N}$ = 40.0

qd = 85 * 40.0 = 3400 (kN/m^2)

n1 : celler part periphery steel pipe sheet pile number (number) n1 = 34

n2 : number of steel pipe sheet pile in separation wall part (number) n2 = 0

n3 : intermediate driven single pile number (number) n3 = 0

U1 : enveloping celler part periphery length (m) U1 = 53.145 (m)

U2 : enveloping celler part and separation wall part periphery length
and sum of perimeter of intermediate driven single pile U2 = 45.605 (m)

Li : thickness which celler skin friction of external periphery is considered (m)

fi : maximum skin friction angle of layer which celler skin friction of external periphery is considered (kN/m^2)

Lj : thickness which celler skin friction of internal periphery is considered (m)

fj : maximum skin friction angle of layer which celler skin friction of internal periphery is considered (kN/m^2)
range of internal soil short side length(Lo) from bottom is only considered

Lo = 6.221 (m)

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m^2)		DEi	Li*fi(DEi) (kN/m)	
				usual time	in quakes		usual time	in quakes
1	cohesv	1.0	0.190	0.0	0.0	1.000	0.0	0.0
2	cohesv	1.0	3.064	10.0	10.0	1.000	30.6	30.6
3	cohesv	3.0	3.090	15.0	15.0	0.333	46.3	15.4
4	sandy	3.0	1.060	0.0	0.0	0.333	0.0	0.0
5	sandy	3.0	2.290	0.0	0.0	0.666	0.0	0.0
6	sandy	13.0	8.560	26.0	26.0	1.000	222.6	222.6
7	cohesv	7.0	8.680	70.0	70.0	1.000	607.6	607.6
8	cohesv	18.0	22.570	150.0	150.0	1.000	3385.5	3385.5
9	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			51.210				4463.3	4432.3

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m^2)		DEj	Lj*fj(DEj) (kN/m)	
				usual time	in quakes		usual time	in quakes
8	cohesv	18.0	4.515	150.0	150.0	1.000	677.2	677.2
9	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			6.221				847.8	847.8

DE: reduction coefficient in earthquake time

ultimate bearing capacity

$$Ru = qd*A1 + \frac{1}{n1+n2+n3} * \{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

= 3845 + 8114 = 11959 (kN/number) (usual time)

= 3845 + 8065 = 11911 (kN/number) (earthquake time)

allowable compressive bearing capacity

usual time Ra = (1 / 3) * 11959 = 3986 (kN/number)

earthquake Ra = (1 / 2) * 11911 = 5955 (kN/number)

(2)allowable uplifting force of steel pipe sheet pile

$$Pa = \frac{1}{n} * Pu + W$$

$$Pu = \frac{1}{n1+n2+n3} * \left\{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \right\}$$

where, Pa: allowable uplifting force of steel pipe sheet pile(kN/number)
n : factor of safety   usual time   n = 6
earthquake time   n = 3
Pu: determined from ground, ultimate uplifting force of steel pipe sheet pile (kN/number)
W : effective weight of steel pipe sheet pile(kN)

effective weight of steel pipe sheet pile W(= w1 + w2 + w3 + w4)

		usual time	earthquake time
steel pipe weight	w1 (kN) =	158.4	158.4
joint weight	w2 (kN) =	0.0	0.0
soil weight inside of pipe	w3 (kN) =	372.7	372.7
filling concrete weight	w4 (kN) =	0.0	0.0
	W (kN) =	531.1	531.1

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m²)		DEi	Li*fi(DEi) (kN/m)	
				usual time	in quakes		usual time	in quakes
1	cohesv	1.0	0.190	0.0	0.0	1.000	0.0	0.0
2	cohesv	1.0	3.064	10.0	10.0	1.000	30.6	30.6
3	cohesv	3.0	3.090	15.0	15.0	0.333	46.3	15.4
4	sandy	3.0	1.060	0.0	0.0	0.333	0.0	0.0
5	sandy	3.0	2.290	0.0	0.0	0.666	0.0	0.0
6	sandy	13.0	8.560	26.0	26.0	1.000	222.6	222.6
7	cohesv	7.0	8.680	70.0	70.0	1.000	607.6	607.6
8	cohesv	18.0	22.570	150.0	150.0	1.000	3385.5	3385.5
9	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			51.210				4463.3	4432.3

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m²)		DEj	Lj*fj(DEj) (kN/m)	
				usual time	in quakes		usual time	in quakes
8	cohesv	18.0	4.515	150.0	150.0	1.000	677.2	677.2
9	sandy	50.0	1.706	100.0	100.0	1.000	170.6	170.6
Sum			6.221				847.8	847.8

DE: reduction coefficient in earthquake time

ultimate uplifting force
Pu = 8114 (kN/number) (usual time time)
Pu = 8065 (kN/number) (earthquake time)

allowable uplifting force
usual time   Pa - (1 / 6) * 8114 + 531 - 1883 (kN/number)
earthquake   Pa - (1 / 3) * 8065 + 531 - 3220 (kN/number)

allowable compressive bearing capacity / uplifting force of steel pipe sheet pile(using value)(kN/number)

allowable compressive bearing capacity	usual time	3986
	in quakes	5955
allowable uplifting force bearing capacity	usual time	1883
	in quakes	3220

1.7 design force

in steel pipe sheet pile foundation, for coffering double use method, external force which works at the center of crest is considered.
yet, vertical load is sum of crest of pile cap load, pile cap weight, filling concrete weight and backfilling soil weight
consider

(1) input shape, unit weight and design seismic coefficient

pile cap shape :oval
pile cap dimension : 8.6212 (m) * 21.6514 (m)
pile cap thickness h1 = 4.000 (m)
steel pipe pile body external diameter Phi. = 1200.0 (mm)
number of external wallsteel pipe sheet pile n = 34
filling concrete cast height h2 = 8.000 (m)
leg column cross sectional area Ap = 44.570 (m^2)
shape : oval
dimension : a = 15.500 (m) perpendicular direction
: b = 3.000 (m) bridge axis direction
unit weight : backfilling soil(wet) Gam.t = 17.5 (kN/m^3)
backfilling soil(saturated) Gam.sat = 17.5 (kN/m^3)
pile cap concrete Gam.c1 = 24.5 (kN/m^3)
filling concrete Gam.c2 = 23.0 (kN/m^3)
footing concrete = 23.0 (kN/m^3)
paving sand (wet) = 19.0 (kN/m^3)
(saturated) = 20.0 (kN/m^3)
water Gam.w = 10.00 (kN/m^3)
design seismic coefficient : pile cap kh = 0.30 bridge axis direction
kh = 0.30 perpendicular direction
internal soil kh = 0.00 bridge axis direction
kh = 0.00 perpendicular direction
ground surface in seismic design = 0.190 (m) (depth from crest of)

1)bridge axis direction

No	load name	backfilling soil height (m)	water table height (m)
1	Wind+Temp	-3.450	4.990
2	Ord+Collision(scour)	-3.450	3.180
3	Earthquake(scour)	-3.450	0.290

2)perpendicular direction

No	load name	backfilling soil height (m)	water table height (m)
1	Wind	-3.450	4.990
2	Ord+Collision(scour)	-3.450	3.180
3	Earthquake(scour)	-3.450	0.290

(2) working force at leg column bottom

1)bridge axis direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Wind+Temp	40500.0	400.0	5900.0
2	Ord+Collision(scour)	40500.0	3200.0	23800.0
3	Earthquake(scour)	36000.0	11100.0	123800.0

2)perpendicular direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Wind	40500.0	800.0	20900.0
2	Ord+Collision(scour)	40500.0	6400.0	54300.0
3	Earthquake(scour)	36000.0	10800.0	146600.0

(3) pile cap area

oval

$$A1 = \frac{Pai}{4}*(B-D)^2 + (B-D)*(L-B) - \frac{Pai}{4}*D^2*\frac{n}{2} = 120.728\ (m^2)$$

filling concrete area

$$A2 = \frac{Pai}{4}*D^2*n = 38.453\ (m^2)$$

backfilling soil area

$$A3 = A1 + A2 - Ap = 114.611\ (m^2)$$

1)bridge axis direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	WN-TM	8.440	0.000	7002.2	3999.1	0.0	3761.7	7239.6
2	OD-CL(SC)	6.630	0.000	7002.2	3999.1	0.0	2955.0	8046.3
3	ETQ(SC)	3.740	0.000	7002.2	3999.1	0.0	1666.9	9334.4

2)perpendicular direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	WN	8.440	0.000	7002.2	3999.1	0.0	3761.7	7239.6
2	OD-CL(SC)	6.630	0.000	7002.2	3999.1	0.0	2955.0	8046.3
3	ETQ(SC)	3.740	0.000	7002.2	3999.1	0.0	1666.9	9334.4

hw: water table(m), height upward from crest of pile cap
V1: weight of pile cap
V2: weight of filling concrete
V3: backfilling soil weight
Vp: buoyancy works at column
V1 = A1*{ h11*Gam.c1 + h21*(Gam.c1 - Gam.w) }
V2 = A2*{ h12*Gam.c2 + h22*(Gam.c2 - Gam.w) }
V3 = A3*{ h13*Gam.t + h23*(Gam.sat - Gam.w) }
h1i: thickness upper than water table(m)
h2i: thickness lower than water table(m)
Vp = Ap*hw*Gam.w
ƒ°V= V1 {V2 {V3 |Vp

(4) inertia force
The case that design ground face on earthquake locates lower than pile cap lower face, upper than design ground face on earthquake
inertia force of foundation main body is applied as distributed load
inertia force of foundation main body is shown below as distributed load

pile cap(working height 0.190 m)
1)bridge axis direction
w = A1*Gam.c1*kh = 887.35 (kN/m)
H = w* 0.190 = 168.60 (kN)
2)perpendicular direction
w = A1*Gam.c1*kh = 887.35 (kN/m)
H = w* 0.190 = 168.60 (kN)

filling concrete (working height 0.190 m)
1)bridge axis direction
w = A2*Gam.c2*kh = 265.33 (kN/m)
H = w* 0.190 = 50.41 (kN)
2)perpendicular direction
w = A2*Gam.c2*kh = 265.33 (kN/m)
H = w* 0.190 = 50.41 (kN)

(5) design external force sum up
1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind+Temp	47739.6	400.0	5900.0	1.35	usual time	usual time
2	Ord+Collision(scour)	48546.3	3200.0	23800.0	1.50	usual time	usual time
3	Earthquake(scour)	45334.4	11100.0	123800.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind	47739.6	800.0	20900.0	1.25	usual time	usual time
2	Ord+Collision(scour)	48546.3	6400.0	54300.0	1.50	usual time	usual time
3	Earthquake(scour)	45334.4	10800.0	146600.0	1.50	earthquake time	earthquake time

1.8 design external force(using value)

1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind+Temp	47739.6	400.0	5900.0	1.35	usual time	usual time
2	Ord+Collision(scour)	48546.3	3200.0	23800.0	1.50	usual time	usual time
3	Earthquake(scour)	45334.4	11100.0	123800.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind	47739.6	800.0	20900.0	1.25	usual time	usual time
2	Ord+Collision(scour)	48546.3	6400.0	54300.0	1.50	usual time	usual time
3	Earthquake(scour)	45334.4	10800.0	146600.0	1.50	earthquake time	earthquake time

1.9 calculation result table

1)bridge axis direction

item			unit	WN-TM	OD-CL(SC)	ETQ(SC)
working force		Vo	kN	47739.6	48546.3	45334.4
		Ho	kN	400.0	3200.0	11100.0
		Mo	kN.m	5900.0	23800.0	123800.0
foundation crest	displacement	Del.1	cm	0.087	0.535	2.164
	deflexion angle	Theta.1	mrad	-0.068	-0.387	-1.653
design ground surface	displacement	Del.2	cm	0.086	0.528	2.132
	deflexion angle	Theta.2	mrad	-0.068	-0.385	-1.645
celler part maximum bending moment		Mmax	kN.m	-7883.0	-43574.0	-194770.0
Mmax accrue location		Lm	m	-13.450	-14.450	-14.450
stress	periphery sheet pile(SKY400)	Sigmax	N/mm^2	33.92	45.62	90.81
		Lm	m	-14.160	-14.450	-14.450
	periphery sheet pile(SKY490)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY490)	Sigmax	N/mm^2	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm^2	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm^2	--------	--------	--------
celler partbottom bending moment		MB	kN.m	133.0	783.0	4396.0
vertical reaction	maximum	Rmax	kN/num	1405	1436	1379
	minimum	Rmin	kN/num	1403	1420	1288
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3986	3986	5955
	uplifting force	Pa	kN/num	-1883	-1883	-3220
	stress(SKY400)	Sig.a	N/mm^2	189.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm^2	--------	--------	--------

note)Lm is elevation

2)perpendicular direction

item			unit	WN	OD-CL(SC)	ETQ(SC)
working force		Vo	kN	47739.6	48546.3	45334.4
		Ho	kN	800.0	6400.0	10800.0
		Mo	kN.m	20900.0	54300.0	146600.0
foundation crest	displacement	Del.1	cm	0.179	0.945	1.554
	deflexion angle	Theta.1	mrad	-0.090	-0.419	-0.785
design ground surface	displacement	Del.2	cm	0.177	0.937	1.540
	deflexion angle	Theta.2	mrad	-0.089	-0.418	-0.783
celler part maximum bending moment		Mmax	kN.m	-27123.0	-118037.0	-253801.0
Mmax accrue location		Lm	m	-16.450	-20.450	-18.450
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	37.78	59.50	89.03
		Lm	m	-16.450	-20.450	-18.450
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------	--------
celler partbottom bending moment		MB	kN.m	-1485.0	-11138.0	-8145.0
vertical reaction	maximum	Rmax	kN/num	1414	1502	1388
	minimum	Rmin	kN/num	1394	1354	1279
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3986	3986	5955
	uplifting force	Pa	kN/num	-1883	-1883	-3220
	stress(SKY400)	Sig.a	N/mm²	175.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------	--------

note)Lm is elevation

1.10 detail output

(1)bridge axis direction

1)Wind+Temp

working force	vertical force	Vo	kN	47739.6
	horizontal force	Ho	kN	400.0
	moment	Mo	kN.m	5900.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.086

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	947	2117
2	2104	4705
3	1262	2823
4	1262	2823
5	5471	12233
6	5155	11527
7	13256	29642
8	36823	82338

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-3.450	0.087	-0.068	-400.0	-5900.0	28.60	0.00	
-3.640	0.086	-0.068	-400.0	-5976.0	28.62	0.00	
-4.450	0.081	-0.066	-369.1	-6287.3	28.70	0.00	
-5.450	0.074	-0.064	-333.6	-6638.4	28.79	0.00	
-6.450	0.068	-0.062	-301.1	-6955.6	28.88	0.00	
-6.704	0.066	-0.061	-293.3	-7031.1	28.90	0.00	
-7.450	0.062	-0.059	-244.7	-7231.6	28.95	0.00	
-8.450	0.056	-0.057	-184.8	-7445.8	29.01	0.00	
-9.450	0.050	-0.054	-130.7	-7603.1	29.05	0.00	
-9.794	0.049	-0.053	-113.3	-7645.1	29.06	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-9.950	0.048	-0.053	-108.7	-7662.4	29.07	0.00	
-10.450	0.045	-0.051	-94.5	-7713.1	29.08	0.00	
-10.854	0.043	-0.050	-83.6	-7749.1	29.09	0.00	
-11.450	0.040	-0.049	-68.5	-7794.4	29.10	0.00	
-12.450	0.035	-0.046	-45.4	-7851.1	29.12	0.00	
-13.144	0.032	-0.044	-31.0	-7877.5	29.13	0.00	
-13.450	0.031	-0.043	-5.4	-7883.0	29.13	0.00	*
-14.160	0.028	-0.041	50.1	-7866.8	29.12	0.00	
-14.160	0.028	-0.041	50.1	-7866.8	33.92	0.00	
-14.450	0.027	-0.040	71.2	-7849.2	33.91	0.00	
-15.450	0.023	-0.037	137.0	-7744.3	33.88	0.00	
-16.450	0.019	-0.034	193.1	-7578.4	33.83	0.00	
-17.450	0.016	-0.031	240.3	-7361.0	33.76	0.00	
-18.450	0.013	-0.028	279.2	-7100.6	33.68	0.00	
-19.450	0.011	-0.025	310.8	-6805.0	33.59	0.00	
-20.450	0.008	-0.022	335.7	-6481.3	33.48	0.00	
-21.450	0.006	-0.020	354.8	-6135.5	33.38	0.00	
-21.704	0.006	-0.019	358.7	-6044.9	33.35	0.00	
-22.450	0.004	-0.017	368.0	-5773.7	33.26	0.00	
-23.450	0.003	-0.015	376.7	-5401.0	33.15	0.00	
-24.450	0.001	-0.013	381.6	-5021.5	33.03	0.00	
-25.450	0.000	-0.011	383.4	-4638.8	32.91	0.00	
-26.450	-0.001	-0.009	382.4	-4255.7	32.79	0.00	
-27.450	-0.002	-0.007	379.1	-3874.8	32.67	0.00	
-28.450	-0.002	-0.006	373.9	-3498.2	32.55	0.00	
-29.450	-0.003	-0.005	367.3	-3127.5	32.44	0.00	
-30.384	-0.003	-0.003	360.1	-2787.7	32.33	0.00	
-30.450	-0.003	-0.003	358.7	-2764.0	32.32	0.00	
-31.450	-0.004	-0.002	336.5	-2416.2	32.21	0.00	
-32.450	-0.004	-0.001	312.8	-2091.5	32.11	0.00	
-33.450	-0.004	-0.001	288.3	-1790.9	32.02	0.00	
-34.450	-0.004	0.000	263.3	-1515.1	31.93	0.00	
-35.450	-0.004	0.001	238.3	-1264.3	31.85	0.00	
-36.450	-0.004	0.001	213.8	-1038.3	31.78	0.00	
-37.450	-0.004	0.001	189.9	-836.5	31.72	0.00	
-38.450	-0.003	0.002	167.0	-658.2	31.66	0.00	
-39.450	-0.003	0.002	145.2	-502.2	31.61	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-40.450	-0.003	0.002	124.7	-367.3	31.57	0.00	
-41.450	-0.003	0.002	105.6	-252.3	31.54	0.00	
-42.450	-0.003	0.002	88.0	-155.6	31.51	0.00	
-43.450	-0.002	0.002	72.0	-75.7	31.48	0.00	
-44.450	-0.002	0.002	57.5	-11.1	31.46	0.00	
-45.450	-0.002	0.002	44.6	39.8	31.47	0.00	
-46.450	-0.002	0.002	33.2	78.5	31.48	0.00	
-47.450	-0.001	0.002	23.4	106.7	31.49	0.00	
-48.450	-0.001	0.002	15.2	125.9	31.50	0.00	
-49.450	-0.001	0.002	8.5	137.6	31.50	0.00	
-50.450	-0.001	0.002	3.2	143.4	31.50	0.00	
-51.450	0.000	0.002	-0.6	144.5	31.50	0.00	
-52.450	0.000	0.002	-3.1	142.6	31.50	0.00	
-52.954	0.000	0.002	-3.8	140.8	31.50	0.00	
-53.450	0.000	0.002	-4.8	138.7	31.50	0.00	
-54.450	0.000	0.002	-4.1	134.0	31.50	0.00	
-54.660	0.000	0.002	-3.5	133.2	31.50	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.640	0.086	-0.068	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	33.92	-14.160
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 133.2 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)

periphery	n1 =	34 (number)	IB1 =	357.98 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 =	0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)
intermediate drive	n1 =	0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 3.711
maximum Rmax = 1405 (kN/number)
minimum Rmin = 1403 (kN/number)

2)Ord+Collision(scour)

working force	vertical force	Vo	kN	48546.3
	horizontal force	Ho	kN	3200.0
	moment	Mo	kN.m	23800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.528

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	947	2117
2	2104	4705
3	1262	2823
4	1262	2823
5	5471	12233
6	5155	11527
7	13256	29642
8	36823	82338

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.535	-0.387	-3200.0	-23800.0	33.86	0.00	
-3.640	0.528	-0.385	-3200.0	-24408.0	34.03	0.00	
-4.450	0.497	-0.378	-3009.7	-26922.1	34.70	0.00	
-5.450	0.460	-0.368	-2790.3	-29820.7	35.48	0.00	
-6.450	0.424	-0.357	-2587.9	-32508.4	36.21	0.00	
-6.704	0.415	-0.354	-2539.1	-33159.5	36.38	0.00	
-7.450	0.389	-0.345	-2233.9	-34938.6	36.86	0.00	
-8.450	0.355	-0.333	-1855.5	-36980.5	37.41	0.00	
-9.450	0.322	-0.319	-1511.0	-38661.0	37.86	0.00	
-9.794	0.311	-0.315	-1400.0	-39161.6	38.00	0.00	
-9.950	0.306	-0.312	-1370.6	-39377.7	38.05	0.00	
-10.450	0.291	-0.305	-1279.4	-40039.9	38.23	0.00	
-10.854	0.279	-0.300	-1209.1	-40542.5	38.37	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-11.450	0.261	-0.291	-1110.8	-41233.5	38.55	0.00	
-12.450	0.233	-0.277	-960.1	-42267.5	38.83	0.00	
-13.144	0.214	-0.266	-865.4	-42900.5	39.00	0.00	
-13.450	0.206	-0.262	-695.5	-43139.1	39.06	0.00	
-14.160	0.187	-0.251	-325.9	-43499.7	39.16	0.00	
-14.160	0.187	-0.251	-325.9	-43499.7	45.60	0.00	
-14.450	0.180	-0.246	-184.7	-43573.6	45.62	0.00	*
-15.450	0.157	-0.228	261.0	-43530.2	45.61	0.00	
-16.450	0.135	-0.210	646.4	-43071.7	45.46	0.00	
-17.450	0.115	-0.193	976.1	-42256.0	45.21	0.00	
-18.450	0.096	-0.176	1254.8	-41136.5	44.86	0.00	
-19.450	0.079	-0.159	1486.8	-39762.0	44.43	0.00	
-20.450	0.064	-0.143	1676.8	-38176.8	43.93	0.00	
-21.450	0.051	-0.128	1828.7	-36421.1	43.38	0.00	
-21.704	0.048	-0.124	1861.7	-35952.4	43.24	0.00	
-22.450	0.039	-0.114	1941.8	-34532.6	42.79	0.00	
-23.450	0.028	-0.100	2024.6	-32547.2	42.17	0.00	
-24.450	0.019	-0.087	2082.5	-30491.7	41.53	0.00	
-25.450	0.011	-0.075	2118.7	-28389.4	40.87	0.00	
-26.450	0.004	-0.064	2136.1	-26260.6	40.20	0.00	
-27.450	-0.002	-0.054	2137.5	-24122.6	39.54	0.00	
-28.450	-0.007	-0.044	2125.6	-21990.0	38.87	0.00	
-29.450	-0.011	-0.036	2102.6	-19875.1	38.21	0.00	
-30.384	-0.014	-0.028	2073.1	-17924.5	37.60	0.00	
-30.450	-0.014	-0.028	2067.1	-17787.9	37.55	0.00	
-31.450	-0.017	-0.021	1967.1	-15769.5	36.92	0.00	
-32.450	-0.019	-0.015	1853.6	-13858.2	36.32	0.00	
-33.450	-0.020	-0.010	1730.4	-12065.6	35.76	0.00	
-34.450	-0.021	-0.005	1600.9	-10399.6	35.24	0.00	
-35.450	-0.021	-0.001	1468.0	-8865.0	34.76	0.00	
-36.450	-0.021	0.002	1334.3	-7463.9	34.32	0.00	
-37.450	-0.020	0.005	1201.9	-6196.0	33.93	0.00	
-38.450	-0.020	0.007	1072.6	-5059.1	33.57	0.00	
-39.450	-0.019	0.009	947.8	-4049.4	33.26	0.00	
-40.450	-0.018	0.010	828.8	-3161.5	32.98	0.00	
-41.450	-0.017	0.012	716.6	-2389.4	32.74	0.00	
-42.450	-0.016	0.012	611.7	-1725.9	32.53	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.450	-0.014	0.013	514.9	-1163.3	32.35	0.00	
-44.450	-0.013	0.013	426.3	-693.4	32.21	0.00	
-45.450	-0.012	0.014	346.4	-307.7	32.08	0.00	
-46.450	-0.010	0.014	275.2	2.4	31.99	0.00	
-47.450	-0.009	0.014	212.8	245.6	32.07	0.00	
-48.450	-0.008	0.013	159.1	430.9	32.12	0.00	
-49.450	-0.006	0.013	114.0	566.7	32.17	0.00	
-50.450	-0.005	0.013	77.5	661.8	32.20	0.00	
-51.450	-0.004	0.013	49.3	724.5	32.22	0.00	
-52.450	-0.002	0.012	29.3	763.1	32.23	0.00	
-52.954	-0.002	0.012	22.2	775.9	32.23	0.00	
-53.450	-0.001	0.012	8.3	783.3	32.23	0.00	
-54.450	0.000	0.012	-3.5	783.9	32.23	0.00	
-54.660	0.000	0.012	-3.3	783.2	32.23	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.640	0.528	-0.385	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	45.62	-14.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 783.2 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)

periphery n1 = 34 (number) IB1 = 357.98 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.711

maximum Rmax = 1436 (kN/number)
minimum Rmin = 1420 (kN/number)

3)Earthquake(scour)

working force	vertical force	Vo	kN	45334.4
	horizontal force	Ho	kN	11100.0
	moment	Mo	kN.m	123800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	2.139
	calculation displacement	Del.	cm	2.132

convergence rate (Del.1 - Del.) / Del.1 = 0.30 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1894	2896
2	1401	2143
3	841	1286
4	1682	2571
5	10942	16730
6	10310	15765
7	26512	40539
8	73645	112607

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	2.164	-1.653	-11100.0	-123800.0	58.94	0.00	
-3.640	2.132	-1.645	-11319.0	-125929.8	59.51	0.00	
-4.450	2.000	-1.608	-10269.8	-134668.8	61.86	0.00	
-5.450	1.842	-1.559	-9065.5	-144328.1	64.46	0.00	
-6.450	1.689	-1.507	-7958.9	-152832.3	66.74	0.00	
-6.704	1.651	-1.493	-7693.0	-154820.0	67.28	0.00	
-7.450	1.541	-1.452	-7140.9	-160350.7	68.76	0.00	
-8.450	1.398	-1.395	-6459.3	-167145.2	70.59	0.00	
-9.450	1.262	-1.335	-5842.3	-173290.8	72.24	0.00	
-9.794	1.216	-1.314	-5644.6	-175266.3	72.77	0.00	
-9.950	1.196	-1.304	-5592.2	-176142.8	73.01	0.00	
-10.450	1.132	-1.273	-5430.3	-178898.0	73.75	0.00	
-10.854	1.081	-1.248	-5305.9	-181066.5	74.33	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-11.450	1.007	-1.210	-4959.5	-184124.4	75.16	0.00	
-12.450	0.890	-1.144	-4431.8	-188814.6	76.42	0.00	
-13.144	0.812	-1.098	-4103.2	-191774.5	77.21	0.00	
-13.450	0.779	-1.077	-3221.7	-192894.2	77.51	0.00	
-14.160	0.704	-1.029	-1316.2	-194493.8	77.94	0.00	
-14.160	0.704	-1.029	-1316.2	-194493.8	90.72	0.00	
-14.450	0.674	-1.006	-592.4	-194769.8	90.81	0.00	*
-15.450	0.578	-0.927	1672.7	-194200.5	90.63	0.00	
-16.450	0.489	-0.848	3602.3	-191536.2	89.80	0.00	
-17.450	0.408	-0.770	5224.6	-187098.4	88.41	0.00	
-18.450	0.335	-0.695	6567.8	-181180.0	86.56	0.00	
-19.450	0.269	-0.623	7659.1	-174046.7	84.33	0.00	
-20.450	0.210	-0.553	8524.7	-165937.0	81.79	0.00	
-21.450	0.158	-0.487	9189.8	-157064.0	79.01	0.00	
-21.704	0.146	-0.471	9329.7	-154711.8	78.28	0.00	
-22.450	0.113	-0.425	9658.1	-147624.1	76.06	0.00	
-23.450	0.073	-0.367	9973.2	-137797.2	72.98	0.00	
-24.450	0.039	-0.313	10162.8	-127719.5	69.83	0.00	
-25.450	0.010	-0.263	10245.6	-117507.2	66.64	0.00	
-26.450	-0.014	-0.217	10238.6	-107258.2	63.43	0.00	
-27.450	-0.033	-0.175	10157.5	-97054.6	60.24	0.00	
-28.450	-0.049	-0.138	10016.5	-86963.1	57.08	0.00	
-29.450	-0.061	-0.104	9828.5	-77037.2	53.97	0.00	
-30.384	-0.069	-0.076	9620.4	-67952.5	51.13	0.00	
-30.450	-0.070	-0.075	9580.2	-67318.9	50.93	0.00	
-31.450	-0.076	-0.049	8939.1	-58054.7	48.04	0.00	
-32.450	-0.080	-0.027	8254.7	-49455.0	45.35	0.00	
-33.450	-0.081	-0.009	7546.2	-41553.3	42.87	0.00	
-34.450	-0.082	0.007	6830.0	-34365.1	40.62	0.00	
-35.450	-0.080	0.020	6119.5	-27891.3	38.60	0.00	
-36.450	-0.078	0.030	5426.0	-22120.4	36.79	0.00	
-37.450	-0.074	0.038	4758.5	-17030.6	35.20	0.00	
-38.450	-0.070	0.044	4123.9	-12592.4	33.81	0.00	
-39.450	-0.066	0.048	3527.5	-8770.1	32.62	0.00	
-40.450	-0.061	0.051	2973.2	-5523.4	31.60	0.00	
-41.450	-0.055	0.053	2463.5	-2808.8	30.75	0.00	
-42.450	-0.050	0.053	1999.9	-581.0	30.05	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.450	-0.045	0.053	1583.1	1206.6	30.25	0.00	
-44.450	-0.040	0.052	1212.9	2600.8	30.69	0.00	
-45.450	-0.034	0.051	888.6	3647.8	31.01	0.00	
-46.450	-0.029	0.049	609.2	4393.0	31.25	0.00	
-47.450	-0.024	0.048	373.1	4880.6	31.40	0.00	
-48.450	-0.020	0.045	178.7	5153.1	31.48	0.00	
-49.450	-0.015	0.043	24.3	5251.3	31.52	0.00	
-50.450	-0.011	0.041	-92.1	5214.3	31.50	0.00	
-51.450	-0.007	0.039	-172.3	5079.2	31.46	0.00	
-52.450	-0.003	0.037	-218.2	4881.1	31.40	0.00	
-52.954	-0.001	0.036	-228.9	4768.1	31.36	0.00	
-53.450	0.000	0.035	-236.3	4651.9	31.33	0.00	
-54.450	0.004	0.033	-187.6	4433.0	31.26	0.00	
-54.660	0.004	0.033	-166.9	4395.7	31.25	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.640	2.132	-1.645	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	90.81	-14.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 4395.7 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 15.979 (m^4)
periphery n1 = 34 (number) IB1 = 357.98 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.711
maximum Rmax = 1379 (kN/number)
minimum Rmin = 1288 (kN/number)

(2)perpendicular direction
1)Wind

working force	vertical force	Vo	kN	47739.6
	horizontal force	Ho	kN	800.0
	moment	Mo	kN.m	20900.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.177

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1143	2556
2	2540	5679
3	1524	3407
4	1524	3407
5	6603	14766
6	6222	13914
7	16001	35778
8	44446	99385

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-3.450	0.179	-0.090	-800.0	-20900.0	31.20	0.00	
-3.640	0.177	-0.089	-800.0	-21052.0	31.23	0.00	
-4.450	0.170	-0.088	-769.1	-21687.4	31.35	0.00	
-5.450	0.161	-0.086	-732.6	-22438.1	31.50	0.00	
-6.450	0.153	-0.084	-698.1	-23153.2	31.65	0.00	
-6.704	0.150	-0.084	-689.6	-23329.5	31.68	0.00	
-7.450	0.144	-0.082	-635.8	-23823.7	31.78	0.00	
-8.450	0.136	-0.080	-567.1	-24424.8	31.90	0.00	
-9.450	0.128	-0.078	-502.5	-24959.3	32.01	0.00	
-9.794	0.125	-0.078	-481.1	-25128.4	32.04	0.00	
-9.950	0.124	-0.077	-475.4	-25203.0	32.06	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-10.450	0.120	-0.076	-457.4	-25436.2	32.11	0.00	
-10.854	0.117	-0.075	-443.3	-25618.1	32.14	0.00	
-11.450	0.113	-0.074	-423.1	-25876.3	32.19	0.00	
-12.450	0.106	-0.072	-391.0	-26283.2	32.28	0.00	
-13.144	0.101	-0.070	-370.0	-26547.2	32.33	0.00	
-13.450	0.099	-0.070	-331.2	-26654.5	32.35	0.00	
-14.160	0.094	-0.068	-244.4	-26858.6	32.39	0.00	
-14.160	0.094	-0.068	-244.4	-26858.6	37.72	0.00	
-14.450	0.092	-0.067	-210.1	-26924.4	37.73	0.00	
-15.450	0.085	-0.065	-97.7	-27077.7	37.77	0.00	
-16.450	0.079	-0.062	6.6	-27122.5	37.78	0.00	*
-17.450	0.073	-0.060	102.9	-27067.1	37.77	0.00	
-18.450	0.067	-0.057	191.7	-26919.2	37.73	0.00	
-19.450	0.061	-0.054	273.2	-26686.2	37.68	0.00	
-20.450	0.056	-0.052	347.8	-26375.2	37.60	0.00	
-21.450	0.051	-0.049	415.8	-25992.9	37.52	0.00	
-21.704	0.050	-0.049	432.0	-25885.2	37.49	0.00	
-22.450	0.046	-0.047	474.9	-25546.7	37.41	0.00	
-23.450	0.042	-0.044	527.4	-25045.1	37.29	0.00	
-24.450	0.037	-0.042	574.7	-24493.6	37.17	0.00	
-25.450	0.033	-0.040	616.9	-23897.4	37.03	0.00	
-26.450	0.029	-0.037	654.4	-23261.3	36.88	0.00	
-27.450	0.026	-0.035	687.4	-22590.0	36.72	0.00	
-28.450	0.022	-0.033	716.3	-21887.8	36.56	0.00	
-29.450	0.019	-0.031	741.1	-21158.8	36.39	0.00	
-30.384	0.016	-0.029	761.0	-20457.1	36.23	0.00	
-30.450	0.016	-0.029	764.3	-20406.7	36.21	0.00	
-31.450	0.013	-0.027	809.9	-19618.9	36.03	0.00	
-32.450	0.011	-0.025	847.1	-18789.7	35.84	0.00	
-33.450	0.008	-0.023	876.7	-17927.2	35.64	0.00	
-34.450	0.006	-0.022	899.1	-17038.8	35.43	0.00	
-35.450	0.004	-0.020	914.8	-16131.3	35.22	0.00	
-36.450	0.002	-0.018	924.4	-15211.2	35.00	0.00	
-37.450	0.000	-0.017	928.3	-14284.4	34.79	0.00	
-38.450	-0.001	-0.016	926.9	-13356.4	34.57	0.00	
-39.450	-0.003	-0.014	920.7	-12432.2	34.35	0.00	
-40.450	-0.004	-0.013	910.1	-11516.4	34.14	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-41.450	-0.005	-0.012	895.4	-10613.4	33.93	0.00	
-42.450	-0.007	-0.011	876.9	-9726.9	33.72	0.00	
-43.450	-0.008	-0.010	855.0	-8860.7	33.52	0.00	
-44.450	-0.009	-0.009	829.8	-8018.1	33.33	0.00	
-45.450	-0.010	-0.009	801.8	-7202.0	33.14	0.00	
-46.450	-0.010	-0.008	771.0	-6415.4	32.95	0.00	
-47.450	-0.011	-0.008	737.8	-5660.8	32.78	0.00	
-48.450	-0.012	-0.007	702.2	-4940.6	32.61	0.00	
-49.450	-0.013	-0.007	664.5	-4257.1	32.45	0.00	
-50.450	-0.013	-0.006	624.7	-3612.3	32.30	0.00	
-51.450	-0.014	-0.006	583.1	-3008.3	32.16	0.00	
-52.450	-0.014	-0.006	539.6	-2446.8	32.03	0.00	
-52.954	-0.015	-0.005	517.1	-2180.5	31.97	0.00	
-53.450	-0.015	-0.005	454.2	-1939.6	31.91	0.00	
-54.450	-0.015	-0.005	324.1	-1550.0	31.82	0.00	
-54.660	-0.016	-0.005	296.2	-1484.9	31.80	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.640	0.177	-0.089	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	37.78	-16.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -1484.9 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 68.578 (m^4)

periphery	n1 = 34 (number)	IB1 = 1536.40 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 10.226
maximum Rmax = 1414 (kN/number)
minimum Rmin = 1394 (kN/number)

2)Ord+Collision(scour)

working force	vertical force	Vo	kN	48546.3
	horizontal force	Ho	kN	6400.0
	moment	Mo	kN.m	54300.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.937

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1143	2556
2	2540	5679
3	1524	3407
4	1524	3407
5	6603	14766
6	6222	13914
7	16001	35778
8	44446	99385

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-3.450	0.945	-0.419	-6400.0	-54300.0	38.35	0.00	
-3.640	0.937	-0.418	-6400.0	-55516.0	38.59	0.00	
-4.450	0.904	-0.414	-6235.7	-60633.1	39.61	0.00	
-5.450	0.863	-0.409	-6041.2	-66770.8	40.84	0.00	
-6.450	0.822	-0.403	-5855.6	-72718.4	42.04	0.00	
-6.704	0.812	-0.401	-5809.9	-74199.9	42.33	0.00	
-7.450	0.782	-0.397	-5518.9	-78424.9	43.18	0.00	
-8.450	0.743	-0.390	-5145.6	-83755.5	44.25	0.00	
-9.450	0.704	-0.383	-4791.5	-88722.5	45.24	0.00	
-9.794	0.691	-0.380	-4674.0	-90350.5	45.57	0.00	
-9.950	0.685	-0.379	-4642.5	-91077.2	45.72	0.00	
-10.450	0.666	-0.375	-4543.3	-93373.5	46.18	0.00	
-10.854	0.651	-0.372	-4465.1	-95193.1	46.54	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-11.450	0.629	-0.367	-4353.0	-97820.8	47.07	0.00	
-12.450	0.593	-0.359	-4173.6	-102083.2	47.92	0.00	
-13.144	0.568	-0.353	-4055.3	-104938.3	48.49	0.00	
-13.450	0.557	-0.350	-3836.1	-106145.6	48.73	0.00	
-14.160	0.533	-0.344	-3343.6	-108693.1	49.25	0.00	
-14.160	0.533	-0.344	-3343.6	-108693.1	57.32	0.00	
-14.450	0.523	-0.341	-3148.8	-109634.4	57.54	0.00	
-15.450	0.489	-0.330	-2504.8	-112457.7	58.20	0.00	
-16.450	0.457	-0.319	-1902.9	-114658.1	58.71	0.00	
-17.450	0.425	-0.308	-1341.6	-116277.0	59.09	0.00	
-18.450	0.395	-0.297	-819.4	-117354.3	59.34	0.00	
-19.450	0.366	-0.285	-335.1	-117928.5	59.48	0.00	
-20.450	0.338	-0.274	113.0	-118036.5	59.50	0.00	*
-21.450	0.311	-0.262	526.2	-117714.1	59.43	0.00	
-21.704	0.305	-0.259	625.8	-117567.7	59.39	0.00	
-22.450	0.286	-0.251	889.9	-117001.3	59.26	0.00	
-23.450	0.261	-0.240	1217.7	-115945.0	59.01	0.00	
-24.450	0.238	-0.229	1516.7	-114575.5	58.69	0.00	
-25.450	0.215	-0.218	1788.3	-112920.8	58.31	0.00	
-26.450	0.194	-0.207	2033.8	-111007.6	57.86	0.00	
-27.450	0.174	-0.196	2254.5	-108861.4	57.36	0.00	
-28.450	0.155	-0.186	2451.7	-106506.4	56.81	0.00	
-29.450	0.137	-0.176	2626.6	-103965.4	56.22	0.00	
-30.384	0.121	-0.166	2770.9	-101443.4	55.63	0.00	
-30.450	0.120	-0.166	2795.4	-101259.8	55.59	0.00	
-31.450	0.104	-0.156	3139.8	-98288.1	54.90	0.00	
-32.450	0.089	-0.147	3436.1	-94996.2	54.13	0.00	
-33.450	0.074	-0.138	3687.2	-91430.9	53.30	0.00	
-34.450	0.061	-0.129	3895.8	-87636.0	52.41	0.00	
-35.450	0.049	-0.121	4064.7	-83652.5	51.49	0.00	
-36.450	0.037	-0.113	4196.3	-79519.0	50.52	0.00	
-37.450	0.026	-0.105	4293.1	-75271.6	49.53	0.00	
-38.450	0.016	-0.098	4357.4	-70943.7	48.52	0.00	
-39.450	0.006	-0.092	4391.4	-66566.8	47.50	0.00	
-40.450	-0.003	-0.085	4397.2	-62170.2	46.48	0.00	
-41.450	-0.011	-0.080	4376.6	-57781.2	45.46	0.00	
-42.450	-0.018	-0.074	4331.5	-53425.2	44.44	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.450	-0.026	-0.069	4263.5	-49125.8	43.44	0.00	
-44.450	-0.032	-0.065	4174.1	-44905.3	42.46	0.00	
-45.450	-0.039	-0.061	4064.8	-40784.2	41.49	0.00	
-46.450	-0.044	-0.057	3936.8	-36781.9	40.56	0.00	
-47.450	-0.050	-0.053	3791.3	-32916.4	39.66	0.00	
-48.450	-0.055	-0.050	3629.3	-29204.8	38.80	0.00	
-49.450	-0.060	-0.048	3451.7	-25663.0	37.97	0.00	
-50.450	-0.065	-0.045	3259.4	-22306.2	37.19	0.00	
-51.450	-0.069	-0.043	3053.1	-19148.8	36.45	0.00	
-52.450	-0.073	-0.042	2833.4	-16204.5	35.77	0.00	
-52.954	-0.075	-0.041	2717.8	-14805.4	35.44	0.00	
-53.450	-0.077	-0.040	2392.9	-13537.6	35.14	0.00	
-54.450	-0.081	-0.039	1712.3	-11482.2	34.66	0.00	
-54.660	-0.082	-0.039	1565.1	-11138.0	34.58	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.640	0.937	-0.418	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	59.50	-20.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -11138.0 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 68.578 (m^4)
periphery n1 = 34 (number) IB1 = 1536.40 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 10.226
maximum Rmax = 1502 (kN/number)
minimum Rmin = 1354 (kN/number)

3)Earthquake(scour)

working force	vertical force	Vo	kN	45334.4
	horizontal force	Ho	kN	10800.0
	moment	Mo	kN.m	146600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.547
	calculation displacement	Del.	cm	1.540

convergence rate (Del.1 - Del.) / Del.1 = 0.48 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	2286	4109
2	1691	3041
3	1015	1825
4	2030	3649
5	13207	23743
6	12445	22374
7	32001	57532
8	88892	159811

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-3.450	1.554	-0.785	-10800.0	-146600.0	55.02	0.00	
-3.640	1.540	-0.783	-11019.0	-148672.8	55.44	0.00	
-4.450	1.477	-0.773	-10586.3	-157421.7	57.19	0.00	
-5.450	1.400	-0.759	-10076.8	-167751.0	59.26	0.00	
-6.450	1.325	-0.745	-9594.1	-177584.2	61.23	0.00	
-6.704	1.306	-0.741	-9475.8	-180006.0	61.72	0.00	
-7.450	1.251	-0.730	-9225.8	-186981.0	63.12	0.00	
-8.450	1.179	-0.714	-8907.3	-196046.0	64.93	0.00	
-9.450	1.108	-0.697	-8607.5	-204801.9	66.69	0.00	
-9.794	1.084	-0.691	-8508.6	-207745.8	67.28	0.00	
-9.950	1.074	-0.689	-8482.2	-209071.1	67.54	0.00	
-10.450	1.039	-0.680	-8399.1	-213291.3	68.39	0.00	
-10.854	1.012	-0.673	-8333.9	-216671.3	69.07	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-11.450	0.972	-0.662	-8147.9	-221582.5	70.05	0.00	
-12.450	0.907	-0.643	-7852.3	-229580.8	71.65	0.00	
-13.144	0.863	-0.630	-7659.1	-234962.7	72.73	0.00	
-13.450	0.844	-0.624	-7124.6	-237224.3	73.18	0.00	
-14.160	0.800	-0.610	-5930.3	-241855.0	74.11	0.00	
-14.160	0.800	-0.610	-5930.3	-241855.0	86.24	0.00	
-14.450	0.782	-0.603	-5460.7	-243506.5	86.63	0.00	
-15.450	0.723	-0.579	-3920.0	-248186.7	87.72	0.00	
-16.450	0.667	-0.555	-2497.9	-251386.0	88.47	0.00	
-17.450	0.612	-0.530	-1189.4	-253220.4	88.89	0.00	
-18.450	0.561	-0.506	10.6	-253800.9	89.03	0.00	*
-19.450	0.511	-0.481	1107.1	-253233.6	88.90	0.00	
-20.450	0.464	-0.457	2105.0	-251619.6	88.52	0.00	
-21.450	0.420	-0.433	3009.5	-249054.7	87.92	0.00	
-21.704	0.409	-0.427	3224.9	-248262.8	87.74	0.00	
-22.450	0.378	-0.409	3790.7	-245643.3	87.13	0.00	
-23.450	0.338	-0.385	4480.6	-241501.2	86.16	0.00	
-24.450	0.301	-0.362	5096.2	-236706.8	85.04	0.00	
-25.450	0.266	-0.339	5642.0	-231332.0	83.79	0.00	
-26.450	0.233	-0.317	6122.4	-225444.5	82.42	0.00	
-27.450	0.202	-0.296	6541.5	-219107.7	80.94	0.00	
-28.450	0.174	-0.275	6903.5	-212380.6	79.37	0.00	
-29.450	0.147	-0.255	7212.5	-205318.4	77.73	0.00	
-30.384	0.124	-0.237	7456.6	-198464.7	76.13	0.00	
-30.450	0.123	-0.235	7497.0	-197971.2	76.02	0.00	
-31.450	0.100	-0.216	8048.5	-190189.1	74.20	0.00	
-32.450	0.079	-0.198	8492.6	-181910.0	72.27	0.00	
-33.450	0.060	-0.181	8838.2	-173236.8	70.25	0.00	
-34.450	0.043	-0.165	9093.8	-164263.6	68.16	0.00	
-35.450	0.027	-0.150	9267.6	-155076.4	66.02	0.00	
-36.450	0.013	-0.135	9367.2	-145753.1	63.84	0.00	
-37.450	0.000	-0.121	9399.8	-136364.3	61.66	0.00	
-38.450	-0.011	-0.109	9372.2	-126973.6	59.47	0.00	
-39.450	-0.021	-0.097	9290.7	-117637.9	57.29	0.00	
-40.450	-0.031	-0.086	9161.1	-108408.2	55.14	0.00	
-41.450	-0.039	-0.076	8988.9	-99329.9	53.02	0.00	
-42.450	-0.046	-0.067	8779.1	-90442.9	50.95	0.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.450	-0.052	-0.058	8536.3	-81782.6	48.93	0.00	
-44.450	-0.057	-0.051	8264.4	-73380.0	46.98	0.00	
-45.450	-0.062	-0.044	7967.4	-65262.1	45.08	0.00	
-46.450	-0.066	-0.038	7648.4	-57452.6	43.26	0.00	
-47.450	-0.070	-0.033	7310.5	-49971.6	41.52	0.00	
-48.450	-0.073	-0.028	6956.2	-42837.0	39.86	0.00	
-49.450	-0.076	-0.025	6587.7	-36064.0	38.28	0.00	
-50.450	-0.078	-0.021	6207.0	-29665.7	36.79	0.00	
-51.450	-0.080	-0.019	5815.6	-23653.6	35.39	0.00	
-52.450	-0.082	-0.017	5414.7	-18037.7	34.08	0.00	
-52.954	-0.083	-0.016	5209.5	-15360.3	33.45	0.00	
-53.450	-0.083	-0.015	4642.9	-12916.7	32.88	0.00	
-54.450	-0.085	-0.014	3484.8	-8851.2	31.94	0.00	
-54.660	-0.085	-0.014	3239.1	-8145.1	31.77	0.00	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-3.640	1.540	-0.783	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	89.03	-18.450
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	------	--------
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

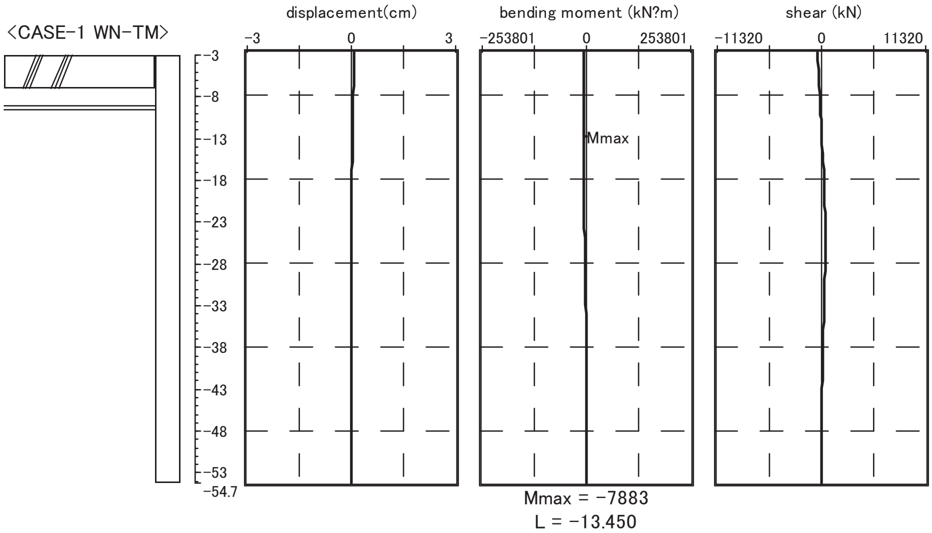
MB = -8145.1 (kN.m)
Sum(ni*Aoi) = 1.518 (m^2)
Sum(IBi*Aoi) = 68.578 (m^4)

periphery	n1 = 34 (number)	IB1 =	1536.40 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

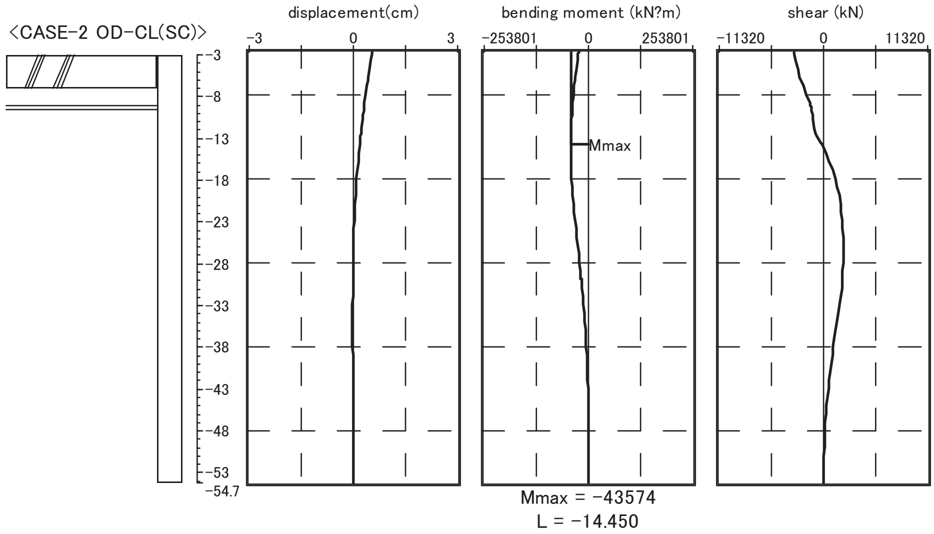
x = 10.226
maximum Rmax = 1388 (kN/number)
minimum Rmin = 1279 (kN/number)

1.11 displacement / member force diagram

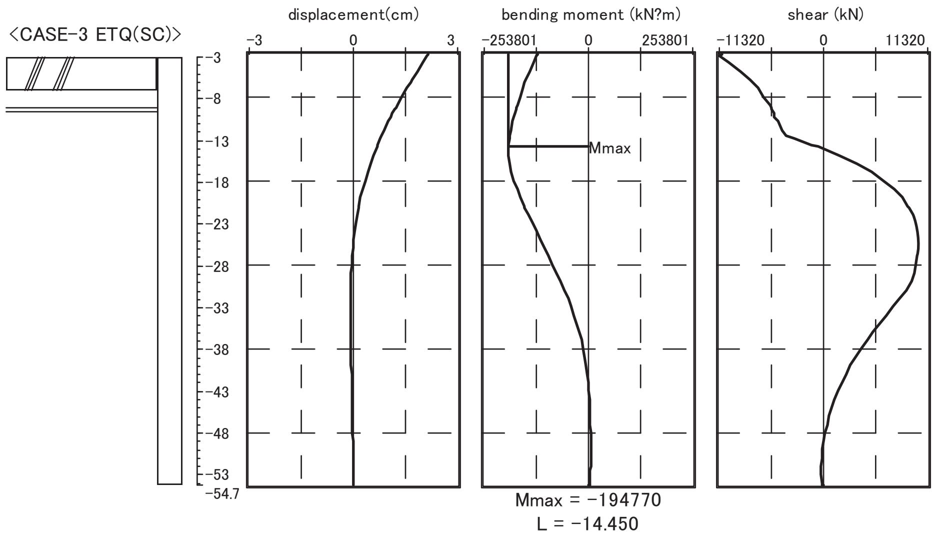
bridge axis direction



<CASE-2 OD-CL(SC)>



<CASE-3 ETQ(SC)>



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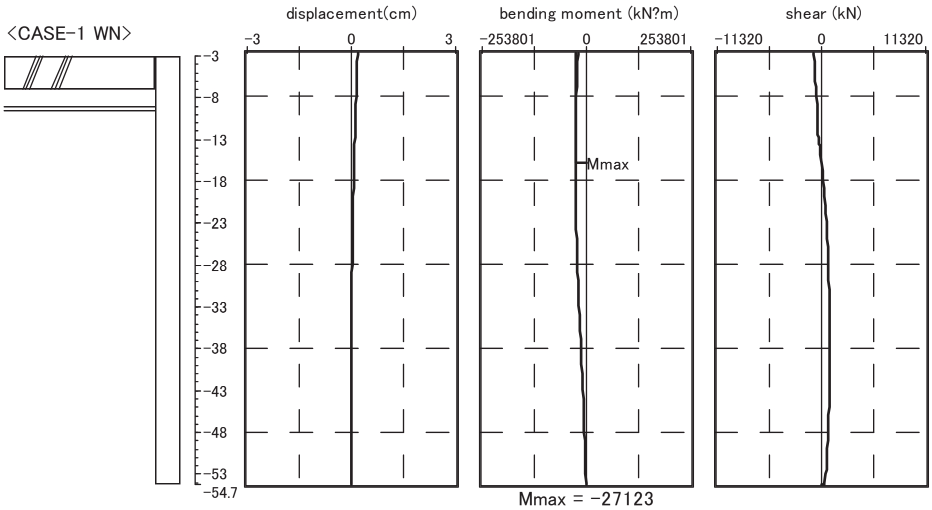
perpendicular direction

<CASE-1 WN>



Mmax = −27123
L = −16.450

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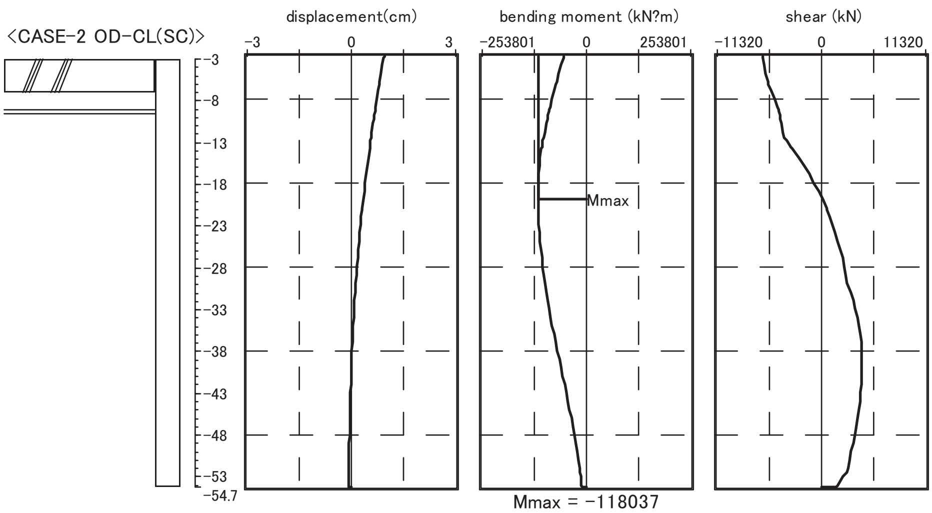
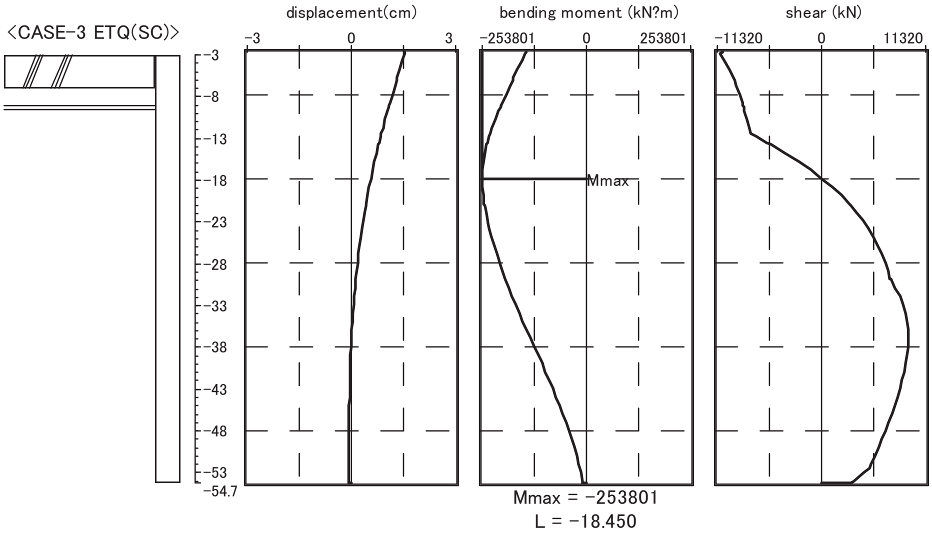
<CASE-2 OD-CL(SC)>

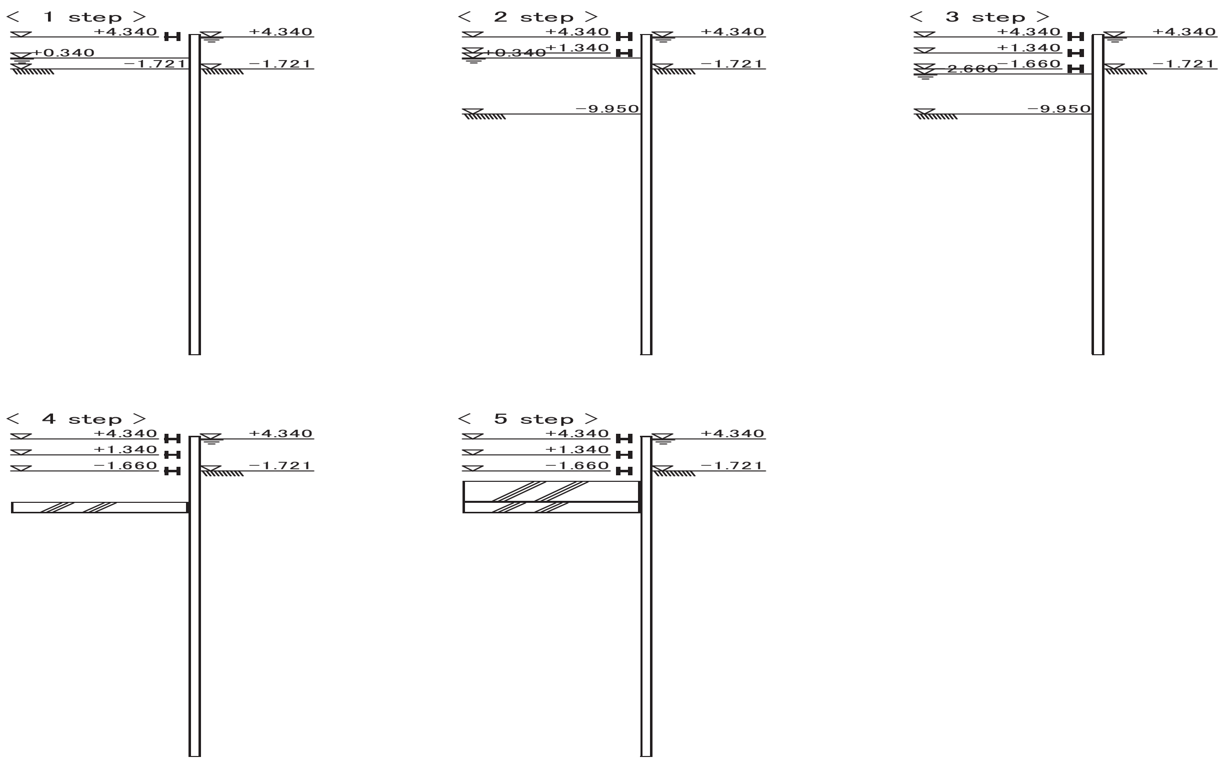


Mmax = −118037
L = −20.450



2 coffering calculation

2.1 construction step diagram



2.2 section properties

steel pipe pile body external diameter Phi.1200.0 (mm)
errosion allowance external side = 0.0 (mm) internal side = 0.0 (mm)

No	L (m)	bridge axis direction		perpendicular direction		material
		I(cm⁴/m)	Z(cm³/m)	I(cm⁴/m)	Z(cm³/m)	
1	7.000	633569.6	10559.5	633569.6	10559.5	SKY400
2	12.000	720452.4	12007.5	720452.4	12007.5	SKY400
3	40.500	633569.6	10559.5	633569.6	10559.5	SKY400
						Sig.= 59.500 (m)

2.3 soil condition

current ground surface elevation -1.721 (m)
riverside water table elevation +4.340 (m)
boundary condition of steel pipe sheet pile tip :free

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m³)		c (kN/m²)	Phi. Deg.	elastic assing (*)
				Gam.	Gam.'			
1	cohesv	4.983	1.0	17.5	7.5	10.0	0.0	0
2	cohesv	3.090	3.0	17.5	7.5	15.0	0.0	0
3	sandy	1.060	3.0	17.5	8.5	0.0	28.0	0
4	sandy	2.290	3.0	17.5	8.5	0.0	28.0	0
5	sandy	8.560	13.0	17.0	8.0	0.0	33.0	0
6	cohesv	8.680	7.0	17.5	7.5	42.0	0.0	0
7	cohesv	22.570	18.0	18.0	8.0	108.0	0.0	0
8	sandy	1.706	50.0	19.0	10.0	0.0	35.0	0

(*)0:if subgrade reaction> upper limit of subgrade reaction plastic area, 1: always elastic area

horizontal modulus of subgrade reaction kH (kN/m³)

No	bridge axis direction		perpendicular direction		step
	KH1	KH2	KH1	KH2	
1	865	865	865	865	0
2	1922	1922	1922	1922	0
3	1153	1153	1153	1153	0
4	1153	1153	1153	1153	0
5	4998	4998	4998	4998	0
6	4710	4710	4710	4710	0
7	12110	12110	12110	12110	0
8	33639	33639	33639	33639	0

2.4 timbering, construction step

(1) timbering

row	installation level(m)	step No		support point condition (tensile)	H shaped steel		
		set	remove		arc part	linear part(wailing)	linear part(strut)
1	+4.340	1	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15
2	+1.340	2	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15
3	-1.660	3	0	invld	2H-350*350*12*19	2H-350*350*12*19	2H-350*350*12*19

(2)H shaped steel
1)linear
**wailing

row	H (cm)	B (cm)	A (cm²)	Aw (cm²)	Iy (cm⁴)	Zy (cm³)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

2) arc

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

(3) strut spacing/brace span

row	perpendicular direction	
	strut spacing L1(m)	brace span L2(m)
1	4.000	1.300
2	4.000	1.300
3	4.000	1.300

(4)construction step

step	excavation area(m)	inside water level(m)
1	-1.721	+0.340
2	-9.950	+0.340
3	-9.950	-2.660
4	-9.950	-9.950
5	-9.950	-9.950

footing concrete cast --- 4 step
pile capcast --- 5 step

2.5 arbitrary load

No	working elevation (m)	load type	working width (m)	load (kN,kN/m)		working step number	
				top end	bottom end	begin	end
1	+4.340	distributed	6.061	0.270	0.068	1	5

note: positive load is applied from back side, negative load is applied from excavation area side

2.6 support point spring

(1) spring constant of timbering

arc part

$$K = \frac{E*A1}{r^2} \quad (kN/m/m)$$

linear part

$$K = \frac{E*A2}{\frac{L1}{2}} * \frac{1}{L2} \quad (kN/m/m)$$

Here, E : Young's modulus of timbering = 2.00 * 10^8(kN/m^2)
A1 : sectional area of wailing(m^2)
A2 : sectional area of strut (m^2)
r : timbering radius in arc part (m)
L1 : strut length (m)
L2 : strut spacing (m)

1)bridge axis direction

linear part

row	A2 (cm^2)	L1 (m)	L2 (m)	K (kN/m/m)
1	118.40	5.921	4.000	1.9996E+005
2	118.40	5.921	4.000	1.9996E+005
3	343.80	5.871	4.000	5.8557E+005

arc part

row	A1 (cm^2)	r (m)	K (kN/m/m)
1	118.40	2.961	2.7016E+005
2	118.40	2.961	2.7016E+005
3	343.80	2.936	7.9789E+005

(2)footing concrete spring constant

$$K = \frac{Alp.*(Ec*Ac)}{\frac{B}{2}} \quad (kN/m/m)$$

where, Alp. : reduction coefficient of spring = 0.050
Ec : Young's modulus of concrete at bottom = 2.35 * 10^7(kN/m^2)
Ac : sectional area per unit width of footing concrete = 2.000 (m^2/m)
B : footing concrete width (m)
bridge axis direction B = 6.221
perpendicular direction B = 19.251

1)bridge axis direction
K = 7.5548E+005 (kN/m/m)

2)perpendicular direction
K = 2.4414E+005 (kN/m/m)

(4) using value

1)support point spring constant (kN/m/m)

	support point condition(tensile)	bridge axis direction	perpendicular direction
timbering 1row	invld	1.9996E+005	2.7016E+005
timbering 2row	invld	1.9996E+005	2.7016E+005
timbering 3row	invld	5.8557E+005	7.9789E+005
footing concrete	invld	7.5548E+005	2.4414E+005

2.7 side pressure

(1) active side pressure

sand soil

$Pa = Ka(Gam.*h - pw1 + q) - 2c * \sqrt{Ka} + pw1$

where, Pa : active side pressure (kN/m^2)
Ka : active earth pressure coefficient $Ka = \tan^2(45Deg.- Phi. / 2)$
q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
Gam. : unit weight of wet soil (kN/m^3)
pw1 : backsides water pressure at depth h (kN/m^2)
h : depth from ground surface (m)
Phi. : internal friction angle of soil (Deg.)
c : cohesion of soil (kN/m^2)

------

h<=H

$Pa = Ka1(Gam.*h + q)$

h>H

$Pa = Ka1(Gam.*H + q) + Ka2*Gam.(h - H)$

where, Ka1,Ka2 : active earth pressure coefficient for cohesive soil

cohesive soil N value	Ka1		Ka2
	presumption equation	minimum	
8 <= N	0.5 - 0.010H	0.3	0.5
4 <= N < 8	0.6 - 0.010H	0.4	0.6
2 <= N < 4	0.7 - 0.025H	0.5	0.7
N < 2	0.8 - 0.025H	0.6	0.8

H : excavation depth

(2)passive side pressure

sand soil

$Pp = Kp(Gam.*h - pw2 + q) + 2c* \sqrt{Kp} + pw2$

$Pp = Kp(Gam.*h + q) + 2c*\sqrt{Kp}$

where, Pp : passive side pressure (kN/m^2)
Kp : passive earth pressure coefficient

$$Kp = \frac{\cos^2 Phi}{\left(1 - \sqrt{\sin(Phi - Del.)*\frac{\sin Phi}{\cos Del.}} \right)^2}$$

pw2 : water pressure on excavation side at depth h (kN/m^2)
Del. : friction angle between steel pipe sheet pile and soil (Deg.) (Del. = -Phi./3)
q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
(after concrete is casted to footing, includes weight of footing concrete and paving sand)

(3)at rest side pressure
use less value of either Po or Po'

1)before excavation
sand soil
Po = Ko(Gam.*h - pw1 + q) + pw1

cohesive soil
Po = ko(Gam.*h + q)

where, Po : side pressure at rest before excavation (kN/m^2)
Ko : at rest side pressure coefficient
Ko = 1 - sinPhi.(sand soil)
cohesive soil

N value of cohesive soil	Ko
8 <= N	0.5
4 <= N < 8	0.6
2 <= N < 4	0.7
N < 2	0.8

q : surcharge load (kN/m^2) (including weight of water upper than ground surface)

2)after excavation
sand soil

$$Po' = Ko(Gam.*h' - pw2 + q) + Ko*\frac{f*h'}{B} + pw2$$

cohesive soil

$$Po' = Ko(Gam.*h' + q) + Ko*\frac{f*h'}{B}$$

where, Po' : side pressure at rest after excavation (kN/m^2)
h' : depth from excavation areah (m)
q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
(after concrete is casted to footing, includes weight of footing concrete and paving sand)
B : range of friction influence (m)
(let B=5.0m, if excavation width is less than 10m, then let excavation width 1/2)
f : friction force between steel pipe sheet pile and ground (kN/m^2)
sand soil : 1 * N(<=50)
cohesive soil : 0.5 * c or 5 * N(<=100)
where, if N<=2 weak layer, then friction force is not considered

steel pipe sheet pile length L = 59.500 (m)
design water tableelevation +4.340 (m)
design ground elevation -1.721 (m)

(4)sum up
1) 1 step
excavation area elevation = -1.721 (m)
landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
3	-1.721 -6.704	4.983	48.49 118.25	40.61 127.81	16.49 86.25	32.00 32.00	24.12 41.56
4	-6.704 -9.794	3.090	103.47 141.32	137.81 191.89	75.47 118.54	28.00 22.78	62.34 73.35
5	-9.794 -10.854	1.060	163.20 176.67	321.68 361.21	137.41 152.77	25.79 23.90	184.27 208.44
6	-10.854 -13.144	2.290	176.67 205.77	361.21 446.61	152.77 185.96	23.90 19.81	208.44 260.65
7	-13.144 -20.207	7.063	200.10 285.31	553.96 866.47	178.72 285.31	21.38 0.00	375.24 581.17
8	-20.207 -21.704	1.497	285.31 303.36	866.47 932.69	285.31 307.89	0.00 0.00	581.17 624.80
9	-21.704 -24.347	2.643	243.62 271.37	450.03 496.29	243.62 271.37	0.00 0.00	206.41 224.91
10	-24.347 -30.384	6.037	271.37 334.76	496.29 601.93	271.37 334.76	0.00 0.00	224.91 267.17
11	-30.384 -52.954	22.570	278.97 482.10	733.93 1140.19	278.97 482.10	0.00 0.00	454.96 658.09
12	-52.954 -54.660	1.706	678.97 700.19	2526.90 2629.37	739.78 763.39	0.00 0.00	1787.12 1865.98

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00
3	-1.721 -6.704	4.983	48.49 118.25	40.61 127.81	16.49 86.25	32.00 32.00	24.12 41.56
4	-6.704 -9.794	3.090	103.47 141.32	137.81 191.89	75.47 116.57	28.00 24.75	62.34 75.32
5	-9.794 -10.854	1.060	163.20 176.67	321.68 361.21	135.92 151.08	27.28 25.59	185.76 210.13
6	-10.854 -13.144	2.290	176.67 205.77	361.21 446.61	151.08 183.82	25.59 21.95	210.13 262.79

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
7	-13.144 -20.207	7.063	200.10 285.31	553.96 866.47	176.88 278.39	23.22 6.91	377.08 588.08
8	-20.207 -21.704	1.497	285.31 303.36	866.47 932.69	278.39 299.90	6.91 3.46	588.08 632.79
9	-21.704 -24.347	2.643	243.62 271.37	450.03 496.29	236.96 271.37	6.66 0.00	213.07 224.91
10	-24.347 -30.384	6.037	271.37 334.76	496.29 601.93	271.37 334.76	0.00 0.00	224.91 267.17
11	-30.384 -52.954	22.570	278.97 482.10	733.93 1140.19	278.97 482.10	0.00 0.00	454.96 658.09
12	-52.954 -54.660	1.706	678.97 700.19	2526.90 2629.37	739.78 763.39	0.00 0.00	1787.12 1865.98

2) 2 step
excavation area elevation = -9.950 (m)
landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00
3	-1.721 -6.704	4.983	36.37 88.69	20.61 70.44	20.61 70.44	15.76 18.25	0.00 0.00
4	-6.704 -9.477	2.773	73.91 98.17	70.44 98.17	70.44 98.17	3.47 0.00	0.00 0.00
5	-9.477 -9.794	0.317	98.17 100.94	98.17 101.34	98.17 101.34	0.00 0.00	0.00 0.00
6	-9.794 -9.950	0.156	163.20 165.18	101.34 102.90	101.34 102.90	61.86 62.28	0.00 0.00
7	-9.950 -10.854	0.904	165.18 176.67	102.90 136.61	102.90 116.00	62.28 60.67	0.00 20.61
8	-10.854 -13.144	2.290	176.67 205.77	136.61 222.01	116.00 149.18	60.67 56.59	20.61 72.83
9	-13.144 -21.704	8.560	200.10 303.36	252.03 630.77	147.15 276.33	52.95 27.03	104.88 354.44
10	-21.704 -26.859	5.155	226.78 280.90	388.32 478.52	205.90 280.90	20.88 0.00	182.41 197.62
11	-26.859 -30.384	3.525	280.90 317.92	478.52 540.22	280.90 332.20	0.00 0.00	197.62 208.01
12	-30.384 -30.630	0.246	262.13 264.34	672.22 676.63	276.83 281.18	0.00 0.00	395.38 395.46
13	-30.630 -31.070	0.441	264.34 268.31	676.63 684.57	281.18 285.14	0.00 0.00	395.46 399.43
14	-31.070 -34.189	3.118	268.31 296.37	684.57 740.70	285.14 313.21	0.00 0.00	399.43 427.49
15	-34.189 -52.954	18.765	296.37 465.26	740.70 1078.47	313.21 482.10	0.00 0.00	427.49 596.38

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
16	-52.954 -54.660	1.706	678.97 700.19	2183.58 2286.05	739.78 763.39	0.00 0.00	1443.80 1522.66

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -1.721	2.061	40.00 60.61	0.00 20.61	0.00 20.61	40.00 40.00	0.00 0.00
3	-1.721 -6.704	4.983	36.37 88.69	20.61 70.44	20.61 70.44	15.76 18.25	0.00 0.00
4	-6.704 -9.477	2.773	73.91 98.17	70.44 98.17	70.44 98.17	3.47 0.00	0.00 0.00
5	-9.477 -9.794	0.317	98.17 100.94	98.17 101.34	98.17 101.34	0.00 0.00	0.00 0.00
6	-9.794 -9.950	0.156	163.20 165.18	101.34 102.90	101.34 102.90	61.86 62.28	0.00 0.00
7	-9.950 -10.854	0.904	165.18 176.67	102.90 136.61	102.90 115.82	62.28 60.85	0.00 20.79
8	-10.854 -13.144	2.290	176.67 205.77	136.61 222.01	115.82 148.57	60.85 57.21	20.79 73.45
9	-13.144 -21.704	8.560	200.10 303.36	252.03 630.77	146.62 269.64	53.48 33.72	105.41 361.12
10	-21.704 -26.859	5.155	226.78 280.90	388.32 478.52	197.09 264.20	29.69 16.70	191.22 214.32
11	-26.859 -30.384	3.525	280.90 317.92	478.52 540.22	264.20 310.11	16.70 7.82	214.32 230.11
12	-30.384 -30.630	0.246	262.13 264.34	672.22 676.63	258.42 261.96	3.71 2.38	413.79 414.68
13	-30.630 -31.070	0.441	264.34 268.31	676.63 684.57	261.96 268.31	2.38 0.00	414.68 416.26
14	-31.070 -34.189	3.118	268.31 296.37	684.57 740.70	268.31 313.21	0.00 0.00	416.26 427.49
15	-34.189 -52.954	18.765	296.37 465.26	740.70 1078.47	313.21 482.10	0.00 0.00	427.49 596.38

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
16	-52.954 -54.660	1.706	678.97 700.19	2183.58 2286.05	739.78 763.39	0.00 0.00	1443.80 1522.66

3) 3 step

excavation area elevation = -9.950 (m)

landside water table elevation = -2.660 (m)

before footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -2.660	0.939	36.37 46.23	0.00 0.00	0.00 0.00	36.37 46.23	0.00 0.00
3	-2.660 -6.704	4.044	46.23 88.69	0.00 40.44	0.00 40.44	46.23 48.25	0.00 0.00
4	-6.704 -9.794	3.090	73.91 100.94	40.44 71.34	40.44 71.34	33.47 29.60	0.00 0.00
5	-9.794 -9.950	0.156	163.20 165.18	71.34 72.90	71.34 72.90	91.86 92.28	0.00 0.00
6	-9.950 -10.854	0.904	165.18 176.67	72.90 106.61	72.90 86.00	92.28 90.67	0.00 20.61
7	-10.854 -13.144	2.290	176.67 205.77	106.61 192.01	86.00 119.18	90.67 86.59	20.61 72.83
8	-13.144 -21.704	8.560	200.10 303.36	222.03 600.77	117.15 246.33	82.95 57.03	104.88 354.44
9	-21.704 -30.384	8.680	226.78 317.92	358.32 510.21	187.90 314.20	38.88 3.72	170.41 196.01
10	-30.384 -30.418	0.034	262.13 262.43	642.22 642.82	261.83 262.43	0.29 0.00	380.38 380.39
11	-30.418 -32.358	1.940	262.43 279.89	642.82 677.74	262.43 296.73	0.00 0.00	380.39 381.01
12	-32.358 -33.848	1.491	279.89 293.31	677.74 704.57	296.73 310.14	0.00 0.00	381.01 394.43
13	-33.848 -36.966	3.118	293.31 321.37	704.57 760.70	310.14 338.21	0.00 0.00	394.43 422.49
14	-36.966 -52.954	15.988	321.37 465.26	760.70 1048.47	338.21 482.10	0.00 0.00	422.49 566.38
15	-52.954 -54.660	1.706	678.97 700.19	2016.69 2119.16	739.78 763.39	0.00 0.00	1276.91 1355.78

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -2.660	0.939	36.37 46.23	0.00 0.00	0.00 0.00	36.37 46.23	0.00 0.00
3	-2.660 -6.704	4.044	46.23 88.69	0.00 40.44	0.00 40.44	46.23 48.25	0.00 0.00
4	-6.704 -9.794	3.090	73.91 100.94	40.44 71.34	40.44 71.34	33.47 29.60	0.00 0.00
5	-9.794 -9.950	0.156	163.20 165.18	71.34 72.90	71.34 72.90	91.86 92.28	0.00 0.00
6	-9.950 -10.854	0.904	165.18 176.67	72.90 106.61	72.90 85.82	92.28 90.85	0.00 20.79
7	-10.854 -13.144	2.290	176.67 205.77	106.61 192.01	85.82 118.57	90.85 87.21	20.79 73.45
8	-13.144 -21.704	8.560	200.10 303.36	222.03 600.77	116.62 239.64	83.48 63.72	105.41 361.12
9	-21.704 -30.384	8.680	226.78 317.92	358.32 510.21	179.09 292.11	47.69 25.82	179.22 218.11
10	-30.384 -30.418	0.034	262.13 262.43	642.22 642.82	243.42 243.91	18.71 18.52	398.79 398.92
11	-30.418 -32.358	1.940	262.43 279.89	642.82 677.74	243.91 271.84	18.52 8.05	398.92 405.90
12	-32.358 -33.848	1.491	279.89 293.31	677.74 704.57	271.84 293.31	8.05 0.00	405.90 411.26
13	-33.848 -36.966	3.118	293.31 321.37	704.57 760.70	293.31 338.21	0.00 0.00	411.26 422.49
14	-36.966 -52.954	15.988	321.37 465.26	760.70 1048.47	338.21 482.10	0.00 0.00	422.49 566.38
15	-52.954 -54.660	1.706	678.97 700.19	2016.69 2119.16	739.78 763.39	0.00 0.00	1276.91 1355.78

4) 4 step

excavation area elevation = -9.950 (m)
landside water table elevation = -9.950 (m)

after footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.55	148.74 147.12	96.37 116.98
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.55 62.73	147.12 143.04	116.98 169.20
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	58.37 187.54	141.73 115.82	242.42 491.98
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	162.76 289.06	64.02 28.86	153.65 179.25
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	240.88 284.15	21.24 0.00	359.43 360.21
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	284.15 318.45	0.00 0.00	360.21 360.83
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	318.45 345.06	0.00 0.00	360.83 387.44
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	345.06 373.12	0.00 0.00	387.44 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.37	148.74 147.30	96.37 117.15
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.37 62.11	147.30 143.66	117.15 169.81
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	57.84 180.86	142.26 122.50	242.95 498.66
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	153.95 266.97	72.83 50.96	162.46 201.35
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	222.47 257.71	39.66 26.44	377.84 386.65
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	257.71 285.65	26.44 15.97	386.65 393.64
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	285.65 328.22	15.97 0.00	393.64 404.28
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	328.22 373.12	0.00 0.00	404.28 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

5) 5 step

excavation area elevation = -9.950 (m)

landside water table elevation = -9.950 (m)

after footing concrete cast, after pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.55	148.74 147.12	96.37 116.98
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.55 62.73	147.12 143.04	116.98 169.20
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	58.37 187.54	141.73 115.82	242.42 491.98
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	162.76 289.06	64.02 28.86	153.65 179.25
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	240.88 284.15	21.24 0.00	359.43 360.21
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	284.15 318.45	0.00 0.00	360.21 360.83
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	318.45 345.06	0.00 0.00	360.83 387.44
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	345.06 373.12	0.00 0.00	387.44 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -1.721	6.061	0.00 60.61	0.00 0.00	0.00 0.00	0.00 60.61	0.00 0.00
2	-1.721 -6.704	4.983	36.37 88.69	0.00 0.00	0.00 0.00	36.37 88.69	0.00 0.00
3	-6.704 -9.794	3.090	73.91 100.94	0.00 0.00	0.00 0.00	73.91 100.94	0.00 0.00
4	-9.794 -9.950	0.156	163.20 165.18	0.00 0.00	0.00 0.00	163.20 165.18	0.00 0.00
5	-9.950 -10.854	0.904	165.18 176.67	112.81 146.52	16.45 29.37	148.74 147.30	96.37 117.15
6	-10.854 -13.144	2.290	176.67 205.77	146.52 231.93	29.37 62.11	147.30 143.66	117.15 169.81
7	-13.144 -21.704	8.560	200.10 303.36	300.79 679.52	57.84 180.86	142.26 122.50	242.95 498.66
8	-21.704 -30.384	8.680	226.78 317.92	316.42 468.32	153.95 266.97	72.83 50.96	162.46 201.35
9	-30.384 -32.831	2.447	262.13 284.15	600.32 644.37	222.47 257.71	39.66 26.44	377.84 386.65
10	-32.831 -34.771	1.940	284.15 301.61	644.37 679.29	257.71 285.65	26.44 15.97	386.65 393.64
11	-34.771 -37.728	2.957	301.61 328.22	679.29 732.50	285.65 328.22	15.97 0.00	393.64 404.28
12	-37.728 -40.846	3.118	328.22 356.29	732.50 788.63	328.22 373.12	0.00 0.00	404.28 415.51
13	-40.846 -52.954	12.108	356.29 465.26	788.63 1006.57	373.12 482.10	0.00 0.00	415.51 524.48
14	-52.954 -54.660	1.706	678.97 700.19	1783.61 1886.08	739.78 763.39	0.00 0.00	1043.83 1122.69

2.8 side pressure detail output

(1)construction step [1]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -1.721	2.061	----	----	----	----
3	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
4	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
5	sandy	-9.794 -10.854	1.060	17.5	0.0	28.00	3.0
6	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
7	sandy	-13.144 -20.207	7.063	17.0	0.0	33.00	13.0
8	sandy	-20.207 -21.704	1.497	17.0	0.0	33.00	13.0
9	cohesv	-21.704 -24.347	2.643	17.5	42.0	0.00	7.0
10	cohesv	-24.347 -30.384	6.037	17.5	42.0	0.00	7.0
11	cohesv	-30.384 -52.954	22.570	18.0	108.0	0.00	18.0
12	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00
2	----	+0.340 -1.721	2.061	0.00 0.00	-------- --------	40.00 60.61	------- -------	------- -------	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	0.000 87.202	-------- --------	0.8000 0.8000	0.8000 0.8000	48.49 118.25	48.49 118.25

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	87.202 141.277	-------- --------	0.7000 0.7000	0.7000 0.7000	103.47 141.32	103.47 141.32
5	sandy	-9.794 -10.854	1.060	201.89 220.44	0.000 0.000	141.34 151.94	0.3610 0.3610	------- -------	21.86 24.73	163.20 176.67
6	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
7	sandy	-13.144 -20.207	7.063	260.51 380.59	0.000 0.000	174.84 245.47	0.2948 0.2948	------- -------	25.26 39.83	200.10 285.31
8	sandy	-20.207 -21.704	1.497	380.59 406.03	0.000 0.000	245.47 260.44	0.2948 0.2948	------- -------	39.83 42.92	285.31 303.36
9	cohesv	-21.704 -24.347	2.643	406.03 452.28	345.423 391.668	-------- --------	0.6000 0.6000	0.6000 0.6000	243.62 271.37	243.62 271.37
10	cohesv	-24.347 -30.384	6.037	452.28 557.93	391.668 497.323	-------- --------	0.6000 0.6000	0.6000 0.6000	271.37 334.76	271.37 334.76
11	cohesv	-30.384 -52.954	22.570	557.93 964.19	497.323 903.582	-------- --------	0.5000 0.5000	0.5000 0.5000	278.97 482.10	278.97 482.10
12	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

$$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \qquad (\text{ sand soil })$$

$$Pa = Pa1 + pw1 \qquad (\text{ sand soil })$$

$$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\} \quad (\text{ cohesive soil })$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	----	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	20.61 107.81	-------- --------	1.0000 1.0000	40.61 127.81	40.61 127.81
4	cohesv	-6.704 -9.794	3.090	107.81 161.89	-------- --------	1.0000 1.0000	137.81 191.89	137.81 191.89
5	sandy	-9.794 -10.854	1.060	161.89 180.44	101.34 111.94	3.6391 3.6391	220.34 249.27	321.68 361.21

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
6	sandy	-10.854 -13.144	2.290	180.44 220.51	111.94 134.84	3.6391 3.6391	249.27 311.77	361.21 446.61
7	sandy	-13.144 -20.207	7.063	220.51 340.59	134.84 205.47	4.8921 4.8921	419.12 661.00	553.96 866.47
8	sandy	-20.207 -21.704	1.497	340.59 366.03	205.47 220.44	4.8921 4.8921	661.00 712.25	866.47 932.69
9	cohesv	-21.704 -24.347	2.643	366.03 412.28	-------- --------	1.0000 1.0000	450.03 496.28	450.03 496.28
10	cohesv	-24.347 -30.384	6.037	412.28 517.93	-------- --------	1.0000 1.0000	496.28 601.93	496.28 601.93
11	cohesv	-30.384 -52.954	22.570	517.93 924.19	-------- --------	1.0000 1.0000	733.93 1140.19	733.93 1140.19
12	sandy	-52.954 -54.660	1.706	924.19 956.61	572.94 590.00	5.5628 5.5628	1953.96 2039.37	2526.90 2629.37

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \qquad (\text{ sand soil })$$

$$Pp = Pp1 + pw2 \qquad (\text{ sand soil })$$

$$Pp = Pp1 - Kp * \left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp} \qquad (\text{cohesive soil })$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	40.00 60.61	0.0000 0.0000	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
5	sandy	-9.794 -10.854	1.060	201.89 220.44	141.34 151.94	0.5305 0.5305	32.12 36.34	173.46 188.28
6	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
7	sandy	-13.144 -20.207	7.063	260.51 380.59	174.84 245.47	0.4554 0.4554	39.01 61.53	213.85 307.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
8	sandy	-20.207 -21.704	1.497	380.59 406.03	245.47 260.44	0.4554 0.4554	61.53 66.30	307.00 326.74
9	cohesv	-21.704 -24.347	2.643	406.03 452.28	-------- --------	0.6000 0.6000	243.62 271.37	243.62 271.37
10	cohesv	-24.347 -30.384	6.037	452.28 557.93	-------- --------	0.6000 0.6000	271.37 334.76	271.37 334.76
11	cohesv	-30.384 -52.954	22.570	557.93 964.19	-------- --------	0.5000 0.5000	278.97 482.10	278.97 482.10
12	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	20.61 107.81	-------- --------	0.00	0.00 0.00	0.8000 0.8000	16.49 86.25	16.49 86.25
4	cohesv	-6.704 -9.794	3.090	107.81 161.89	-------- --------	7.50	0.00 23.17	0.7000 0.7000	75.47 118.54	75.47 118.54
5	sandy	-9.794 -10.854	1.060	161.89 180.44	101.34 111.94	3.00	23.17 26.35	0.5305 0.5305	36.07 40.83	137.41 152.77
6	sandy	-10.854 -13.144	2.290	180.44 220.51	111.94 134.84	3.00	26.35 33.22	0.5305 0.5305	40.83 51.12	152.77 185.96
7	sandy	-13.144 -20.207	7.063	220.51 340.59	134.84 205.47	13.00	33.22 125.05	0.4554 0.4554	43.88 79.83	178.72 285.31
8	sandy	-20.207 -21.704	1.497	340.59 366.03	205.47 220.44	13.00	125.05 144.51	0.4554 0.4554	79.83 87.45	285.31 307.89

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
9	cohesv	-21.704 -24.347	2.643	366.03 412.28	-------- --------	21.00	144.51 200.00	0.6000 0.6000	247.49 285.94	247.49 285.94
10	cohesv	-24.347 -30.384	6.037	412.28 517.93	-------- --------	21.00	200.00 326.79	0.6000 0.6000	285.94 373.79	285.94 373.79
11	cohesv	-30.384 -52.954	22.570	517.93 924.19	-------- --------	54.00	326.79 1545.56	0.5000 0.5000	311.49 710.53	311.49 710.53
12	sandy	-52.954 -54.660	1.706	924.19 956.61	572.94 590.00	50.00	1545.56 1630.86	0.4264 0.4264	361.66 379.90	934.60 969.90

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	20.61 107.81	-------- --------	0.00	0.00 0.00	0.8000 0.8000	16.49 86.25	16.49 86.25
4	cohesv	-6.704 -9.794	3.090	107.81 161.89	-------- --------	7.50	0.00 23.17	0.7000 0.7000	75.47 116.57	75.47 116.57
5	sandy	-9.794 -10.854	1.060	161.89 180.44	101.34 111.94	3.00	23.17 26.35	0.5305 0.5305	34.58 39.14	135.92 151.08
6	sandy	-10.854 -13.144	2.290	180.44 220.51	111.94 134.84	3.00	26.35 33.22	0.5305 0.5305	39.14 48.98	151.08 183.82
7	sandy	-13.144 -20.207	7.063	220.51 340.59	134.84 205.47	13.00	33.22 125.05	0.4554 0.4554	42.04 72.91	176.88 278.39
8	sandy	-20.207 -21.704	1.497	340.59 366.03	205.47 220.44	13.00	125.05 144.51	0.4554 0.4554	72.91 79.46	278.39 299.90

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
9	cohesv	-21.704 -24.347	2.643	366.03 412.28	-------- --------	21.00	144.51 200.00	0.6000 0.6000	236.96 271.37	236.96 271.37
10	cohesv	-24.347 -30.384	6.037	412.28 517.93	-------- --------	21.00	200.00 326.79	0.6000 0.6000	271.37 349.97	271.37 349.97
11	cohesv	-30.384 -52.954	22.570	517.93 924.19	-------- --------	54.00	326.79 1545.56	0.5000 0.5000	291.64 616.65	291.64 616.65
12	sandy	-52.954 -54.660	1.706	924.19 956.61	572.94 590.00	50.00	1545.56 1630.86	0.4264 0.4264	281.60 295.42	854.54 885.42

friction force B7027influence range B = 5.000 (m)

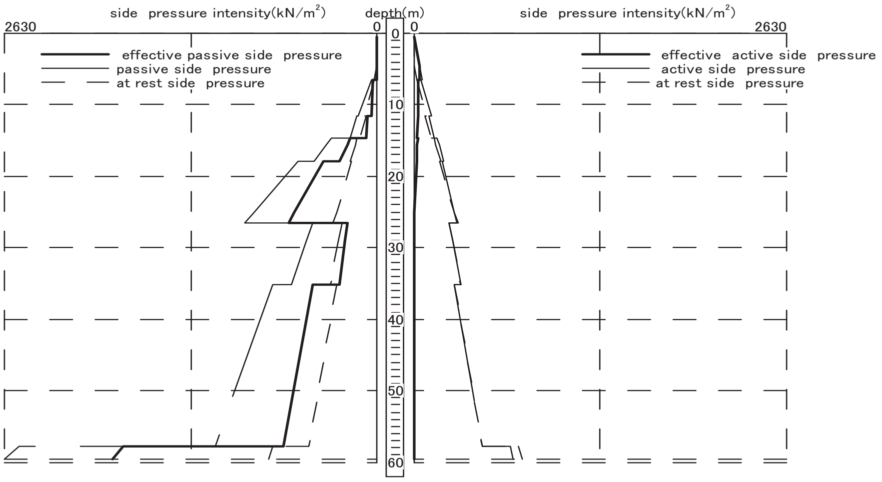
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

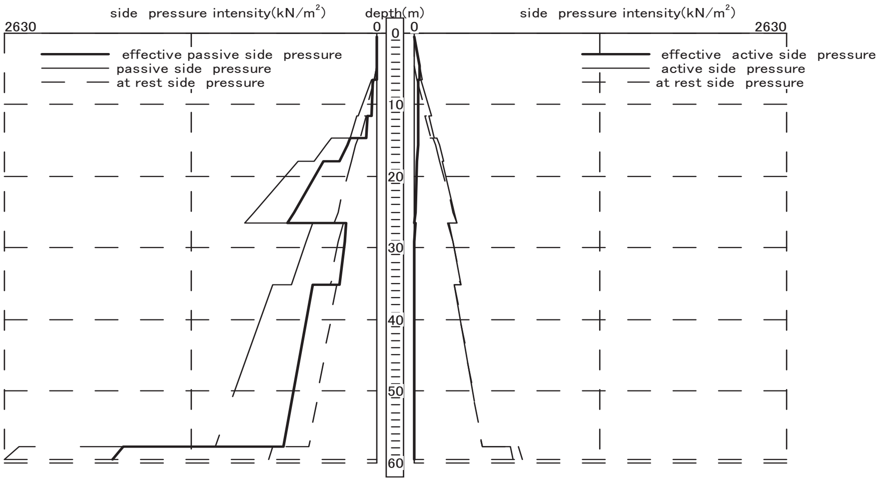
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(2)construction step [2]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -1.721	2.061	----	----	----	----
3	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
4	cohesv	-6.704 -9.477	2.773	17.5	15.0	0.00	3.0
5	cohesv	-9.477 -9.794	0.317	17.5	15.0	0.00	3.0
6	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
7	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
8	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
9	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
10	cohesv	-21.704 -26.859	5.155	17.5	42.0	0.00	7.0
11	cohesv	-26.859 -30.384	3.525	17.5	42.0	0.00	7.0
12	cohesv	-30.384 -30.630	0.246	18.0	108.0	0.00	18.0
13	cohesv	-30.630 -31.070	0.441	18.0	108.0	0.00	18.0
14	cohesv	-31.070 -34.189	3.118	18.0	108.0	0.00	18.0
15	cohesv	-34.189 -52.954	18.765	18.0	108.0	0.00	18.0
16	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00
2	----	+0.340 -1.721	2.061	0.00 0.00	-------- --------	40.00 60.61	------- -------	------- -------	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 88.69	36.37 88.69
4	cohesv	-6.704 -9.477	2.773	147.81 196.34	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 98.17	73.91 98.17
5	cohesv	-9.477 -9.794	0.317	196.34 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	98.17 100.94	98.17 100.94
6	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
7	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
8	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
9	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
10	cohesv	-21.704 -26.859	5.155	406.03 496.24	201.415 291.620	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 280.90	226.78 280.90
11	cohesv	-26.859 -30.384	3.525	496.24 557.93	291.620 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	280.90 317.92	280.90 317.92
12	cohesv	-30.384 -30.630	0.246	557.93 562.35	353.315 357.735	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 264.34	262.13 264.34
13	cohesv	-30.630 -31.070	0.441	562.35 570.29	357.735 365.670	-------- --------	0.4177 0.4177	0.5000 0.5000	264.34 268.31	264.34 268.31
14	cohesv	-31.070 -34.189	3.118	570.29 626.41	365.670 421.797	-------- --------	0.4177 0.4177	0.5000 0.5000	268.31 296.37	268.31 296.37
15	cohesv	-34.189 -52.954	18.765	626.41 964.19	421.797 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	296.37 465.26	296.37 465.26
16	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1*\left\{ Sum.(Gam.*H) + q \right\} + Ka2*\left\{ Sum.\left(Gam.(h - H)\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	----	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	20.61 70.44
4	cohesv	-6.704 -9.477	2.773	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	70.44 98.17
5	cohesv	-9.477 -9.794	0.317	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	98.17 101.34
6	sandy	-9.794 -9.950	0.156	0.00 0.00	101.34 102.90	0.0000 0.0000	0.00 0.00	101.34 102.90
7	sandy	-9.950 -10.854	0.904	102.90 118.72	102.90 111.94	3.6391 3.6391	0.00 24.67	102.90 136.61
8	sandy	-10.854 -13.144	2.290	118.72 158.80	111.94 134.84	3.6391 3.6391	24.67 87.17	136.61 222.01
9	sandy	-13.144 -21.704	8.560	158.80 304.32	134.84 220.44	4.8921 4.8921	117.19 410.32	252.03 630.77
10	cohesv	-21.704 -26.859	5.155	304.32 394.52	-------- --------	1.0000 1.0000	388.32 478.52	388.32 478.52
11	cohesv	-26.859 -30.384	3.525	394.52 456.21	-------- --------	1.0000 1.0000	478.52 540.22	478.52 540.22
12	cohesv	-30.384 -30.630	0.246	456.21 460.63	-------- --------	1.0000 1.0000	672.22 676.63	672.22 676.63
13	cohesv	-30.630 -31.070	0.441	460.63 468.57	-------- --------	1.0000 1.0000	676.63 684.57	676.63 684.57
14	cohesv	-31.070 -34.189	3.118	468.57 524.70	-------- --------	1.0000 1.0000	684.57 740.70	684.57 740.70
15	cohesv	-34.189 -52.954	18.765	524.70 862.47	-------- --------	1.0000 1.0000	740.70 1078.47	740.70 1078.47
16	sandy	-52.954 -54.660	1.706	862.47 894.89	572.94 590.00	5.5628 5.5628	1610.64 1696.05	2183.58 2286.05

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{Kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	40.00 60.61	0.0000 0.0000	0.00 0.00	40.00 60.61
3	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
4	cohesv	-6.704 -9.477	2.773	147.81 196.34	-------- --------	0.7000 0.7000	103.47 137.44	103.47 137.44
5	cohesv	-9.477 -9.794	0.317	196.34 201.89	-------- --------	0.7000 0.7000	137.44 141.32	137.44 141.32
6	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
7	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
8	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
9	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
10	cohesv	-21.704 -26.859	5.155	406.03 496.24	-------- --------	0.6000 0.6000	243.62 297.74	243.62 297.74
11	cohesv	-26.859 -30.384	3.525	496.24 557.93	-------- --------	0.6000 0.6000	297.74 334.76	297.74 334.76
12	cohesv	-30.384 -30.630	0.246	557.93 562.35	-------- --------	0.5000 0.5000	278.97 281.18	278.97 281.18
13	cohesv	-30.630 -31.070	0.441	562.35 570.29	-------- --------	0.5000 0.5000	281.18 285.14	281.18 285.14
14	cohesv	-31.070 -34.189	3.118	570.29 626.41	-------- --------	0.5000 0.5000	285.14 313.21	285.14 313.21
15	cohesv	-34.189 -52.954	18.765	626.41 964.19	-------- --------	0.5000 0.5000	313.21 482.10	313.21 482.10
16	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)
bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	20.61 70.44
4	cohesv	-6.704 -9.477	2.773	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	70.44 98.17
5	cohesv	-9.477 -9.794	0.317	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	98.17 101.34
6	sandy	-9.794 -9.950	0.156	0.00 0.00	101.34 102.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	101.34 102.90
7	sandy	-9.950 -10.854	0.904	102.90 118.72	102.90 111.94	3.00	0.00 2.71	0.5305 0.5305	0.00 4.06	102.90 116.00
8	sandy	-10.854 -13.144	2.290	118.72 158.80	111.94 134.84	3.00	2.71 9.58	0.5305 0.5305	4.06 14.34	116.00 149.18
9	sandy	-13.144 -21.704	8.560	158.80 304.32	134.84 220.44	13.00	9.58 120.86	0.4554 0.4554	12.31 55.89	147.15 276.33
10	cohesv	-21.704 -26.859	5.155	304.32 394.52	-------- --------	21.00	120.86 229.11	0.6000 0.6000	205.90 280.90	205.90 280.90
11	cohesv	-26.859 -30.384	3.525	394.52 456.21	-------- --------	21.00	229.11 303.14	0.6000 0.6000	280.90 332.20	280.90 332.20
12	cohesv	-30.384 -30.630	0.246	456.21 460.63	-------- --------	54.00	303.14 316.40	0.5000 0.5000	276.83 281.18	276.83 281.18
13	cohesv	-30.630 -31.070	0.441	460.63 468.57	-------- --------	54.00	316.40 340.21	0.5000 0.5000	281.18 288.97	281.18 288.97
14	cohesv	-31.070 -34.189	3.118	468.57 524.70	-------- --------	54.00	340.21 508.59	0.5000 0.5000	288.97 344.10	288.97 344.10
15	cohesv	-34.189 -52.954	18.765	524.70 862.47	-------- --------	54.00	508.59 1521.92	0.5000 0.5000	344.10 675.87	344.10 675.87

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
16	sandy	-52.954 -54.660	1.706	862.47 894.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	332.10 350.34	905.04 940.34

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -1.721	2.061	0.00 0.00	0.00 20.61	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 20.61
3	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	20.61 70.44
4	cohesv	-6.704 -9.477	2.773	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	70.44 98.17
5	cohesv	-9.477 -9.794	0.317	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	98.17 101.34
6	sandy	-9.794 -9.950	0.156	0.00 0.00	101.34 102.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	101.34 102.90
7	sandy	-9.950 -10.854	0.904	102.90 118.72	102.90 111.94	3.00	0.00 2.71	0.5305 0.5305	0.00 3.88	102.90 115.82
8	sandy	-10.854 -13.144	2.290	118.72 158.80	111.94 134.84	3.00	2.71 9.58	0.5305 0.5305	3.88 13.73	115.82 148.57
9	sandy	-13.144 -21.704	8.560	158.80 304.32	134.84 220.44	13.00	9.58 120.86	0.4554 0.4554	11.78 49.20	146.62 269.64
10	cohesv	-21.704 -26.859	5.155	304.32 394.52	-------- --------	21.00	120.86 229.11	0.6000 0.6000	197.09 264.20	197.09 264.20
11	cohesv	-26.859 -30.384	3.525	394.52 456.21	-------- --------	21.00	229.11 303.14	0.6000 0.6000	264.20 310.11	264.20 310.11

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
12	cohesv	-30.384 -30.630	0.246	456.21 460.63	-------- --------	54.00	303.14 316.40	0.5000 0.5000	258.42 261.96	258.42 261.96
13	cohesv	-30.630 -31.070	0.441	460.63 468.57	-------- --------	54.00	316.40 340.21	0.5000 0.5000	261.96 268.31	261.96 268.31
14	cohesv	-31.070 -34.189	3.118	468.57 524.70	-------- --------	54.00	340.21 508.59	0.5000 0.5000	268.31 313.21	268.31 313.21
15	cohesv	-34.189 -52.954	18.765	524.70 862.47	-------- --------	54.00	508.59 1521.92	0.5000 0.5000	313.21 583.43	313.21 583.43
16	sandy	-52.954 -54.660	1.706	862.47 894.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	253.26 267.08	826.20 857.08

friction force B7027influence range B = 5.000 (m)

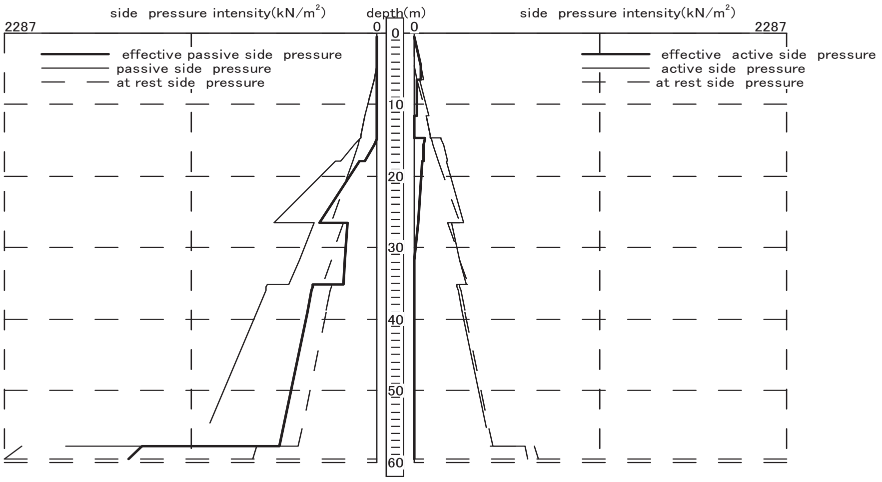
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

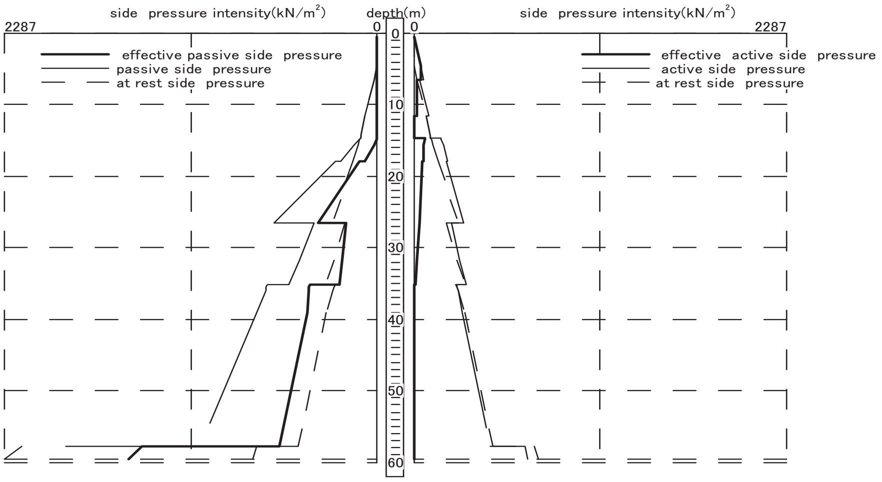
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(3)construction step [3]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -1.721	6.061	----	----	----	----
2	cohesv	-1.721 -2.660	0.939	17.5	10.0	0.00	1.0
3	cohesv	-2.660 -6.704	4.044	17.5	10.0	0.00	1.0
4	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
5	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
6	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
7	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
8	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
9	cohesv	-21.704 -30.384	8.680	17.5	42.0	0.00	7.0
10	cohesv	-30.384 -30.418	0.034	18.0	108.0	0.00	18.0
11	cohesv	-30.418 -32.358	1.940	18.0	108.0	0.00	18.0
12	cohesv	-32.358 -33.848	1.491	18.0	108.0	0.00	18.0
13	cohesv	-33.848 -36.966	3.118	18.0	108.0	0.00	18.0
14	cohesv	-36.966 -52.954	15.988	18.0	108.0	0.00	18.0
15	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	-------- --------	0.00 60.61	------- -------	------- -------	0.00 0.00	0.00 60.61
2	cohesv	-1.721 -2.660	0.939	60.61 77.04	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 46.23	36.37 46.23
3	cohesv	-2.660 -6.704	4.044	77.04 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	46.23 88.69	46.23 88.69
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 100.94	73.91 100.94
5	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
6	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
7	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
8	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
9	cohesv	-21.704 -30.384	8.680	406.03 557.93	201.415 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 317.92	226.78 317.92
10	cohesv	-30.384 -30.418	0.034	557.93 558.54	353.315 353.923	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 262.43	262.13 262.43
11	cohesv	-30.418 -32.358	1.940	558.54 593.46	353.923 388.841	-------- --------	0.4177 0.4177	0.5000 0.5000	262.43 279.89	262.43 279.89
12	cohesv	-32.358 -33.848	1.491	593.46 620.29	388.841 415.670	-------- --------	0.4177 0.4177	0.5000 0.5000	279.89 293.31	279.89 293.31
13	cohesv	-33.848 -36.966	3.118	620.29 676.41	415.670 471.797	-------- --------	0.4177 0.4177	0.5000 0.5000	293.31 321.37	293.31 321.37
14	cohesv	-36.966 -52.954	15.988	676.41 964.19	471.797 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	321.37 465.26	321.37 465.26
15	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1*\left\{ Sum.(Gam.*H) + q \right\} + Ka2*\left\{ Sum.\left(Gam.(h - H)\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -2.660	0.939	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-2.660 -6.704	4.044	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 40.44
4	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	40.44 71.34
5	sandy	-9.794 -9.950	0.156	0.00 0.00	71.34 72.90	0.0000 0.0000	0.00 0.00	71.34 72.90
6	sandy	-9.950 -10.854	0.904	72.90 88.72	72.90 81.94	3.6391 3.6391	0.00 24.67	72.90 106.61
7	sandy	-10.854 -13.144	2.290	88.72 128.80	81.94 104.84	3.6391 3.6391	24.67 87.17	106.61 192.01
8	sandy	-13.144 -21.704	8.560	128.80 274.32	104.84 190.44	4.8921 4.8921	117.19 410.32	222.03 600.77
9	cohesv	-21.704 -30.384	8.680	274.32 426.21	-------- --------	1.0000 1.0000	358.32 510.21	358.32 510.21
10	cohesv	-30.384 -30.418	0.034	426.21 426.82	-------- --------	1.0000 1.0000	642.22 642.82	642.22 642.82
11	cohesv	-30.418 -32.358	1.940	426.82 461.74	-------- --------	1.0000 1.0000	642.82 677.74	642.82 677.74
12	cohesv	-32.358 -33.848	1.491	461.74 488.57	-------- --------	1.0000 1.0000	677.74 704.57	677.74 704.57
13	cohesv	-33.848 -36.966	3.118	488.57 544.70	-------- --------	1.0000 1.0000	704.57 760.70	704.57 760.70
14	cohesv	-36.966 -52.954	15.988	544.70 832.47	-------- --------	1.0000 1.0000	760.70 1048.47	760.70 1048.47
15	sandy	-52.954 -54.660	1.706	832.47 864.89	572.94 590.00	5.5628 5.5628	1443.75 1529.16	2016.69 2119.16

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 60.61	0.0000 0.0000	0.00 0.00	0.00 60.61
2	cohesv	-1.721 -2.660	0.939	60.61 77.04	-------- --------	0.8000 0.8000	48.49 61.63	48.49 61.63
3	cohesv	-2.660 -6.704	4.044	77.04 147.81	-------- --------	0.8000 0.8000	61.63 118.25	61.63 118.25
4	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
5	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
6	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
7	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
8	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
9	cohesv	-21.704 -30.384	8.680	406.03 557.93	-------- --------	0.6000 0.6000	243.62 334.76	243.62 334.76
10	cohesv	-30.384 -30.418	0.034	557.93 558.54	-------- --------	0.5000 0.5000	278.97 279.27	278.97 279.27
11	cohesv	-30.418 -32.358	1.940	558.54 593.46	-------- --------	0.5000 0.5000	279.27 296.73	279.27 296.73
12	cohesv	-32.358 -33.848	1.491	593.46 620.29	-------- --------	0.5000 0.5000	296.73 310.14	296.73 310.14
13	cohesv	-33.848 -36.966	3.118	620.29 676.41	-------- --------	0.5000 0.5000	310.14 338.21	310.14 338.21
14	cohesv	-36.966 -52.954	15.988	676.41 964.19	-------- --------	0.5000 0.5000	338.21 482.10	338.21 482.10
15	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (sand soil)

$Po = Po1 + pw1$ (sand soil)

$Po = Po1 = Ko * \left\{ Sum.(Gam.*h) + q \right\}$ (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -2.660	0.939	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-2.660 -6.704	4.044	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 40.44
4	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	40.44 71.34
5	sandy	-9.794 -9.950	0.156	0.00 0.00	71.34 72.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	71.34 72.90
6	sandy	-9.950 -10.854	0.904	72.90 88.72	72.90 81.94	3.00	0.00 2.71	0.5305 0.5305	0.00 4.06	72.90 86.00
7	sandy	-10.854 -13.144	2.290	88.72 128.80	81.94 104.84	3.00	2.71 9.58	0.5305 0.5305	4.06 14.34	86.00 119.18
8	sandy	-13.144 -21.704	8.560	128.80 274.32	104.84 190.44	13.00	9.58 120.86	0.4554 0.4554	12.31 55.89	117.15 246.33
9	cohesv	-21.704 -30.384	8.680	274.32 426.21	-------- --------	21.00	120.86 303.14	0.6000 0.6000	187.90 314.20	187.90 314.20
10	cohesv	-30.384 -30.418	0.034	426.21 426.82	-------- --------	54.00	303.14 304.97	0.5000 0.5000	261.83 262.43	261.83 262.43
11	cohesv	-30.418 -32.358	1.940	426.82 461.74	-------- --------	54.00	304.97 409.72	0.5000 0.5000	262.43 296.73	262.43 296.73
12	cohesv	-32.358 -33.848	1.491	461.74 488.57	-------- --------	54.00	409.72 490.21	0.5000 0.5000	296.73 323.08	296.73 323.08
13	cohesv	-33.848 -36.966	3.118	488.57 544.70	-------- --------	54.00	490.21 658.59	0.5000 0.5000	323.08 378.21	323.08 378.21
14	cohesv	-36.966 -52.954	15.988	544.70 832.47	-------- --------	54.00	658.59 1521.92	0.5000 0.5000	378.21 660.87	378.21 660.87

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
15	sandy	-52.954 -54.660	1.706	832.47 864.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	319.31 337.55	892.25 927.55

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -2.660	0.939	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-2.660 -6.704	4.044	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 40.44
4	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	40.44 71.34
5	sandy	-9.794 -9.950	0.156	0.00 0.00	71.34 72.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	71.34 72.90
6	sandy	-9.950 -10.854	0.904	72.90 88.72	72.90 81.94	3.00	0.00 2.71	0.5305 0.5305	0.00 3.88	72.90 85.82
7	sandy	-10.854 -13.144	2.290	88.72 128.80	81.94 104.84	3.00	2.71 9.58	0.5305 0.5305	3.88 13.73	85.82 118.57
8	sandy	-13.144 -21.704	8.560	128.80 274.32	104.84 190.44	13.00	9.58 120.86	0.4554 0.4554	11.78 49.20	116.62 239.64
9	cohesv	-21.704 -30.384	8.680	274.32 426.21	-------- --------	21.00	120.86 303.14	0.6000 0.6000	179.09 292.11	179.09 292.11
10	cohesv	-30.384 -30.418	0.034	426.21 426.82	-------- --------	54.00	303.14 304.97	0.5000 0.5000	243.42 243.91	243.42 243.91
11	cohesv	-30.418 -32.358	1.940	426.82 461.74	-------- --------	54.00	304.97 409.72	0.5000 0.5000	243.91 271.84	243.91 271.84

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
12	cohesv	-32.358 -33.848	1.491	461.74 488.57	-------- --------	54.00	409.72 490.21	0.5000 0.5000	271.84 293.31	271.84 293.31
13	cohesv	-33.848 -36.966	3.118	488.57 544.70	-------- --------	54.00	490.21 658.59	0.5000 0.5000	293.31 338.21	293.31 338.21
14	cohesv	-36.966 -52.954	15.988	544.70 832.47	-------- --------	54.00	658.59 1521.92	0.5000 0.5000	338.21 568.43	338.21 568.43
15	sandy	-52.954 -54.660	1.706	832.47 864.89	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	240.47 254.29	813.41 844.29

friction force B7027influence range B = 5.000 (m)

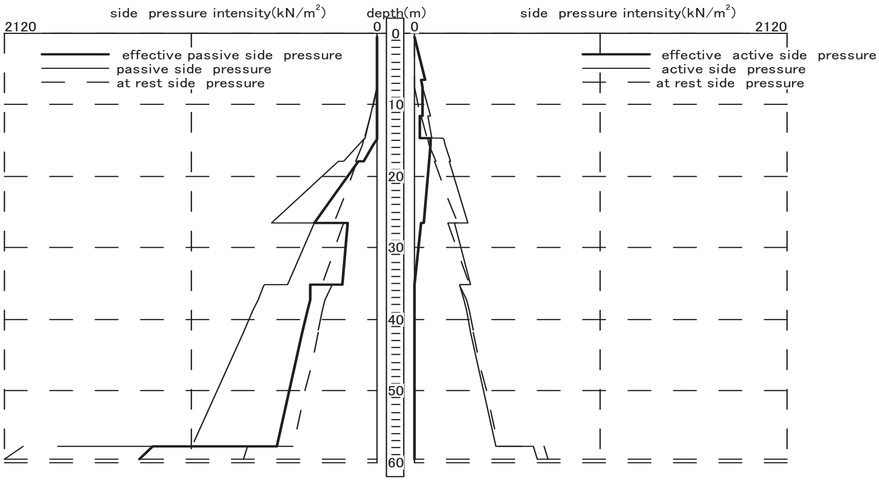
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

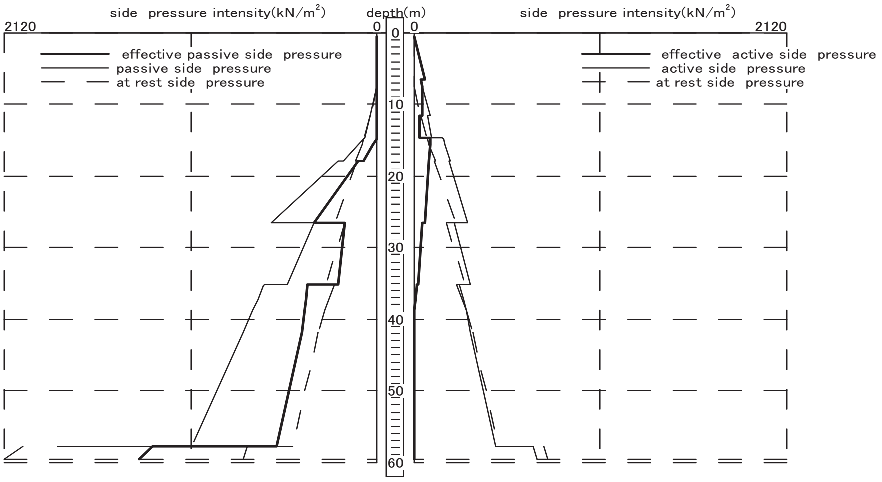
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(4)construction step [4]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -1.721	6.061	----	----	----	----
2	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
3	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
4	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
5	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
6	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
7	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
8	cohesv	-21.704 -30.384	8.680	17.5	42.0	0.00	7.0
9	cohesv	-30.384 -32.831	2.447	18.0	108.0	0.00	18.0
10	cohesv	-32.831 -34.771	1.940	18.0	108.0	0.00	18.0
11	cohesv	-34.771 -37.728	2.957	18.0	108.0	0.00	18.0
12	cohesv	-37.728 -40.846	3.118	18.0	108.0	0.00	18.0
13	cohesv	-40.846 -52.954	12.108	18.0	108.0	0.00	18.0
14	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	-------- --------	0.00 60.61	------- -------	------- -------	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 88.69	36.37 88.69
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 100.94	73.91 100.94
4	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
5	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
6	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
7	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	201.415 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 317.92	226.78 317.92
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	353.315 397.368	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 284.15	262.13 284.15
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	397.368 432.285	-------- --------	0.4177 0.4177	0.5000 0.5000	284.15 301.61	284.15 301.61
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	432.285 485.504	-------- --------	0.4177 0.4177	0.5000 0.5000	301.61 328.22	301.61 328.22
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	485.504 541.630	-------- --------	0.4177 0.4177	0.5000 0.5000	328.22 356.29	328.22 356.29
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	541.630 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	356.29 465.26	356.29 465.26
14	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

$$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \qquad \text{(sand soil)}$$

$$Pa = Pa1 + pw1 \qquad \text{(sand soil)}$$

$$Pa = Pa1 = Ka1*\left\{ Sum.(Gam.*H) + q \right\} + Ka2*\left\{ Sum.\left(Gam.(h - H)\right) \right\} \qquad \text{(cohesive soil)}$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.6391 3.6391	112.81 137.48	112.81 146.52
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.6391 3.6391	137.48 199.99	146.52 231.93
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	4.8921 4.8921	268.85 561.98	300.79 679.52
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	1.0000 1.0000	316.42 468.32	316.42 468.32
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	1.0000 1.0000	600.32 644.37	600.32 644.37
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	1.0000 1.0000	644.37 679.29	644.37 679.29
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	1.0000 1.0000	679.29 732.50	679.29 732.50
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	1.0000 1.0000	732.50 788.63	732.50 788.63
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	1.0000 1.0000	788.63 1006.57	788.63 1006.57
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	5.5628 5.5628	1210.67 1296.08	1783.61 1886.08

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \qquad \text{(sand soil)}$$

$$Pp = Pp1 + pw2 \qquad \text{(sand soil)}$$

$$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp} \qquad \text{(cohesive soil)}$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 60.61	0.0000 0.0000	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
4	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
5	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
6	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
7	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	-------- --------	0.6000 0.6000	243.62 334.76	243.62 334.76
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	-------- --------	0.5000 0.5000	278.97 300.99	278.97 300.99
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	-------- --------	0.5000 0.5000	300.99 318.45	300.99 318.45
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	-------- --------	0.5000 0.5000	318.45 345.06	318.45 345.06
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	-------- --------	0.5000 0.5000	345.06 373.12	345.06 373.12
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	-------- --------	0.5000 0.5000	373.12 482.10	373.12 482.10
14	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.51	16.45 29.55
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.51 30.79	29.55 62.73
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	26.43 70.00	58.37 187.54
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	162.76 289.06	162.76 289.06
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	240.88 284.15	240.88 284.15
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	284.15 318.45	284.15 318.45
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	318.45 370.72	318.45 370.72
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	370.72 425.85	370.72 425.85
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	425.85 639.92	425.85 639.92
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	301.44 319.68	874.38 909.68

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.33	16.45 29.37
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.33 30.17	29.37 62.11
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	25.90 63.32	57.84 180.86
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	153.95 266.97	153.95 266.97
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	222.47 257.71	222.47 257.71
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	257.71 285.65	257.71 285.65
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	285.65 328.22	285.65 328.22
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	328.22 373.12	328.22 373.12
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	373.12 547.48	373.12 547.48
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	222.60 236.42	795.54 826.42

friction force B7027influence range B = 5.000 (m)

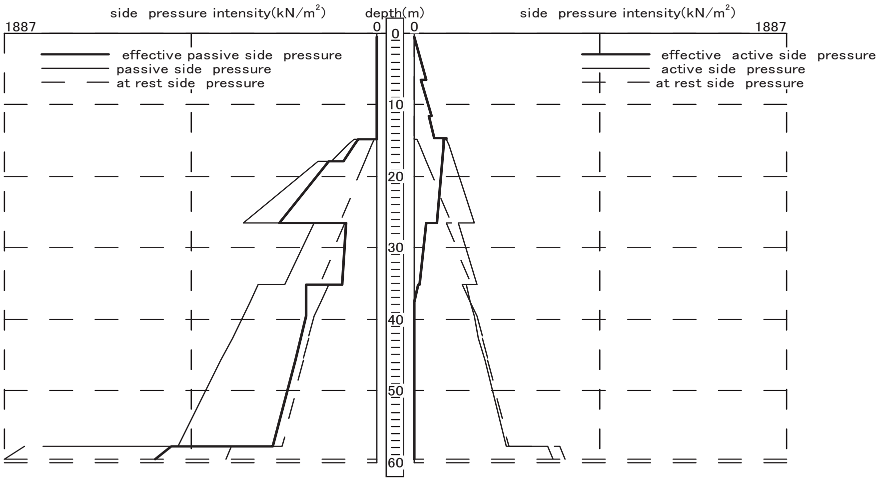
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

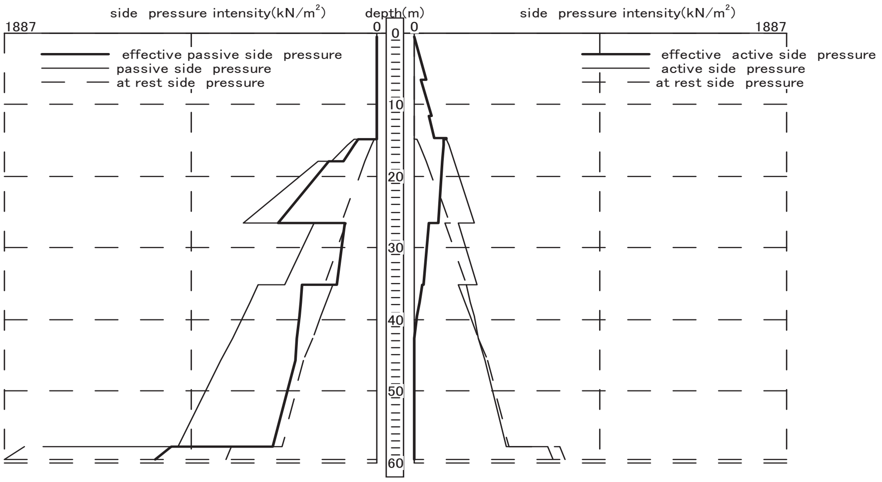
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(5)construction step [5]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -1.721	6.061	----	----	----	----
2	cohesv	-1.721 -6.704	4.983	17.5	10.0	0.00	1.0
3	cohesv	-6.704 -9.794	3.090	17.5	15.0	0.00	3.0
4	sandy	-9.794 -9.950	0.156	17.5	0.0	28.00	3.0
5	sandy	-9.950 -10.854	0.904	17.5	0.0	28.00	3.0
6	sandy	-10.854 -13.144	2.290	17.5	0.0	28.00	3.0
7	sandy	-13.144 -21.704	8.560	17.0	0.0	33.00	13.0
8	cohesv	-21.704 -30.384	8.680	17.5	42.0	0.00	7.0
9	cohesv	-30.384 -32.831	2.447	18.0	108.0	0.00	18.0
10	cohesv	-32.831 -34.771	1.940	18.0	108.0	0.00	18.0
11	cohesv	-34.771 -37.728	2.957	18.0	108.0	0.00	18.0
12	cohesv	-37.728 -40.846	3.118	18.0	108.0	0.00	18.0
13	cohesv	-40.846 -52.954	12.108	18.0	108.0	0.00	18.0
14	sandy	-52.954 -54.660	1.706	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	-------- --------	0.00 60.61	------- -------	------- -------	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	-------- --------	0.6000 0.6000	0.8000 0.8000	36.37 88.69	36.37 88.69
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	-------- --------	0.5000 0.5000	0.7000 0.7000	73.91 100.94	73.91 100.94
4	sandy	-9.794 -9.950	0.156	201.89 204.62	-------- --------	141.34 142.90	0.3610 0.3610	------- -------	21.86 22.28	163.20 165.18
5	sandy	-9.950 -10.854	0.904	204.62 220.44	0.000 0.000	142.90 151.94	0.3610 0.3610	------- -------	22.28 24.73	165.18 176.67
6	sandy	-10.854 -13.144	2.290	220.44 260.51	0.000 0.000	151.94 174.84	0.3610 0.3610	------- -------	24.73 30.93	176.67 205.77
7	sandy	-13.144 -21.704	8.560	260.51 406.03	0.000 0.000	174.84 260.44	0.2948 0.2948	------- -------	25.26 42.92	200.10 303.36
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	201.415 353.315	-------- --------	0.5177 0.5177	0.6000 0.6000	226.78 317.92	226.78 317.92
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	353.315 397.368	-------- --------	0.4177 0.4177	0.5000 0.5000	262.13 284.15	262.13 284.15
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	397.368 432.285	-------- --------	0.4177 0.4177	0.5000 0.5000	284.15 301.61	284.15 301.61
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	432.285 485.504	-------- --------	0.4177 0.4177	0.5000 0.5000	301.61 328.22	301.61 328.22
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	485.504 541.630	-------- --------	0.4177 0.4177	0.5000 0.5000	328.22 356.29	328.22 356.29
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	541.630 759.575	-------- --------	0.4177 0.4177	0.5000 0.5000	356.29 465.26	356.29 465.26
14	sandy	-52.954 -54.660	1.706	964.19 996.61	0.000 0.000	572.94 590.00	0.2710 0.2710	------- -------	106.03 110.19	678.97 700.19

Pa1 = Ka1*$\{$ Sum.$\big($(Gam.*h)$\big)$ + q - pw1 $\}$ - 2 * c * $\sqrt{\text{Ka1}}$ (sand soil)

Pa = Pa1 + pw1 (sand soil)

Pa = Pa1 = Ka1*$\{$ Sum.(Gam.*H) + q $\}$ + Ka2*$\{$ Sum.$\big($Gam.(h - H)$\big)$ $\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.6391 3.6391	112.81 137.48	112.81 146.52
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.6391 3.6391	137.48 199.99	146.52 231.93
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	4.8921 4.8921	268.85 561.98	300.79 679.52
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	1.0000 1.0000	316.42 468.32	316.42 468.32
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	1.0000 1.0000	600.32 644.37	600.32 644.37
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	1.0000 1.0000	644.37 679.29	644.37 679.29
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	1.0000 1.0000	679.29 732.50	679.29 732.50
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	1.0000 1.0000	732.50 788.63	732.50 788.63
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	1.0000 1.0000	788.63 1006.57	788.63 1006.57
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	5.5628 5.5628	1210.67 1296.08	1783.61 1886.08

Pp1 = Kp * $\{$ Sum.$\big($(Gam.*h)$\big)$ + q - pw2 $\}$ + 2*c*$\sqrt{\text{Kp}}$ (sand soil)

Pp = Pp1 + pw2 (sand soil)

Pp = Pp1 - Kp*$\{$ Sum.$\big($(Gam.*h)$\big)$ + q $\}$ + 2*c*$\sqrt{\text{kp}}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 60.61	0.0000 0.0000	0.00 0.00	0.00 60.61

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
2	cohesv	-1.721 -6.704	4.983	60.61 147.81	-------- --------	0.8000 0.8000	48.49 118.25	48.49 118.25
3	cohesv	-6.704 -9.794	3.090	147.81 201.89	-------- --------	0.7000 0.7000	103.47 141.32	103.47 141.32
4	sandy	-9.794 -9.950	0.156	201.89 204.62	141.34 142.90	0.5305 0.5305	32.12 32.74	173.46 175.64
5	sandy	-9.950 -10.854	0.904	204.62 220.44	142.90 151.94	0.5305 0.5305	32.74 36.34	175.64 188.28
6	sandy	-10.854 -13.144	2.290	220.44 260.51	151.94 174.84	0.5305 0.5305	36.34 45.45	188.28 220.29
7	sandy	-13.144 -21.704	8.560	260.51 406.03	174.84 260.44	0.4554 0.4554	39.01 66.30	213.85 326.74
8	cohesv	-21.704 -30.384	8.680	406.03 557.93	-------- --------	0.6000 0.6000	243.62 334.76	243.62 334.76
9	cohesv	-30.384 -32.831	2.447	557.93 601.99	-------- --------	0.5000 0.5000	278.97 300.99	278.97 300.99
10	cohesv	-32.831 -34.771	1.940	601.99 636.90	-------- --------	0.5000 0.5000	300.99 318.45	300.99 318.45
11	cohesv	-34.771 -37.728	2.957	636.90 690.12	-------- --------	0.5000 0.5000	318.45 345.06	318.45 345.06
12	cohesv	-37.728 -40.846	3.118	690.12 746.25	-------- --------	0.5000 0.5000	345.06 373.12	345.06 373.12
13	cohesv	-40.846 -52.954	12.108	746.25 964.19	-------- --------	0.5000 0.5000	373.12 482.10	373.12 482.10
14	sandy	-52.954 -54.660	1.706	964.19 996.61	572.94 590.00	0.4264 0.4264	166.84 173.39	739.78 763.39

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.51	16.45 29.55
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.51 30.79	29.55 62.73
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	26.43 70.00	58.37 187.54
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	162.76 289.06	162.76 289.06
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	240.88 284.15	240.88 284.15
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	284.15 318.45	284.15 318.45
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	318.45 370.72	318.45 370.72
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	370.72 425.85	370.72 425.85
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	425.85 639.92	425.85 639.92
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	301.44 319.68	874.38 909.68

friction force B7027influence range B = 3.111 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -1.721	6.061	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-1.721 -6.704	4.983	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	cohesv	-6.704 -9.794	3.090	0.00 0.00	-------- --------	7.50	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-9.794 -9.950	0.156	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-9.950 -10.854	0.904	31.00 46.82	0.00 9.04	3.00	0.00 2.71	0.5305 0.5305	16.45 20.33	16.45 29.37
6	sandy	-10.854 -13.144	2.290	46.82 86.90	9.04 31.94	3.00	2.71 9.58	0.5305 0.5305	20.33 30.17	29.37 62.11
7	sandy	-13.144 -21.704	8.560	86.90 232.42	31.94 117.54	13.00	9.58 120.86	0.4554 0.4554	25.90 63.32	57.84 180.86
8	cohesv	-21.704 -30.384	8.680	232.42 384.32	-------- --------	21.00	120.86 303.14	0.6000 0.6000	153.95 266.97	153.95 266.97
9	cohesv	-30.384 -32.831	2.447	384.32 428.37	-------- --------	54.00	303.14 435.30	0.5000 0.5000	222.47 257.71	222.47 257.71
10	cohesv	-32.831 -34.771	1.940	428.37 463.29	-------- --------	54.00	435.30 540.05	0.5000 0.5000	257.71 285.65	257.71 285.65
11	cohesv	-34.771 -37.728	2.957	463.29 516.50	-------- --------	54.00	540.05 699.71	0.5000 0.5000	285.65 328.22	285.65 328.22
12	cohesv	-37.728 -40.846	3.118	516.50 572.63	-------- --------	54.00	699.71 868.09	0.5000 0.5000	328.22 373.12	328.22 373.12
13	cohesv	-40.846 -52.954	12.108	572.63 790.57	-------- --------	54.00	868.09 1521.92	0.5000 0.5000	373.12 547.48	373.12 547.48
14	sandy	-52.954 -54.660	1.706	790.57 822.99	572.94 590.00	50.00	1521.92 1607.22	0.4264 0.4264	222.60 236.42	795.54 826.42

friction force B7027influence range B = 5.000 (m)

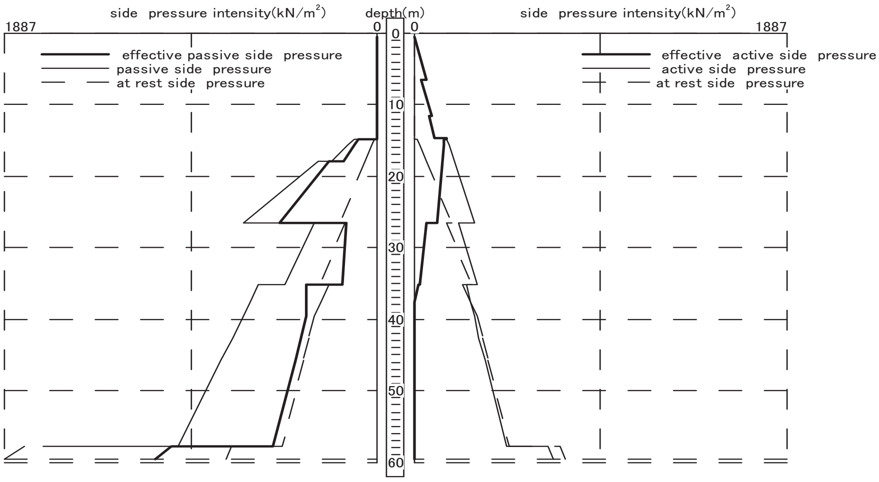
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

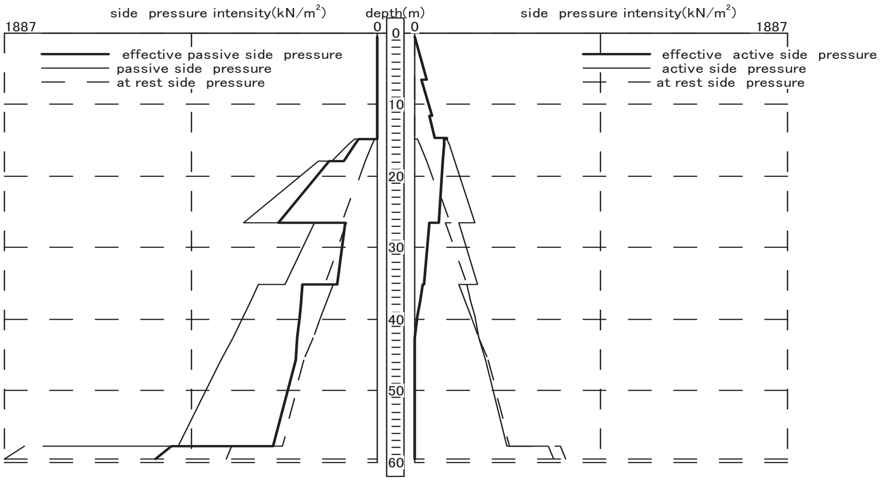
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



2.9 calculation result table

1)bridge axis direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	1.866	2.665	3.599	3.809
	accrue location	Lm	m	-5.160	-7.160	-9.160	-10.854
displace coffer displace part	max bending moment	Mmax	kN.m	637.0	623.0	418.0	382.0
		Sig.	N/mm²	60.37	51.89	34.80	31.81
		Lm	m	-1.721	-3.450	-3.450	-3.450
	SKY400	M	kN.m	637.0	570.0	418.0	382.0
		Sig.max	N/mm²	60.37	53.96	34.80	31.81
		Lm	m	-1.721	-2.160	-3.450	-3.450
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	614.0	651.0	965.0	804.0
		Sig.	N/mm²	51.13	54.21	80.35	66.97
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY400	M	kN.m	614.0	651.0	965.0	804.0
		Sig.max	N/mm²	51.13	54.21	80.35	66.97
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	164.6	75.2	25.6	30.2
		2nd row	kN/m	------	147.0	52.0	56.8
		3rd row	kN/m	------	------	405.6	353.1
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	0.0	487.1

note)Lm shows elevation

item			unit	the5step
displace ment	max displacement	Del.max	cm	3.811
	accrue location	Lm	m	-10.854
displace coffer displace part	max bending moment	Mmax	kN.m	389.0
		Sig.	N/mm²	32.42
		Lm	m	-3.450
	SKY400	M	kN.m	389.0
		Sig.max	N/mm²	32.42
		Lm	m	-3.450
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
displace celler displace part	max bending moment	Mmax	kN.m	806.0
		Sig.	N/mm²	67.16
		Lm	m	-11.160
	SKY400	M	kN.m	806.0
		Sig.max	N/mm²	67.16
		Lm	m	-11.160
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
(SKY400)		Sig.a	N/mm²	210.00
(SKY490)		Sig.a	N/mm²	------

support point reaction force	timbering reaction	1st row	kN/m	30.4
		2nd row	kN/m	57.8
		3rd row	kN/m	353.6
		4th row	kN/m	------
		5th row	kN/m	------
		6th row	kN/m	------
		7th row	kN/m	------
		8th row	kN/m	------
		9th row	kN/m	------
		10th row	kN/m	------
	footing concrete reaction		kN/m	491.9

note)Lm shows elevation

2)perpendicular direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	1.905	2.658	3.578	3.918
	accrue location	Lm	m	-5.160	-7.450	-9.160	-11.160
displace coffer displace part	max bending moment	Mmax	kN.m	637.0	611.0	388.0	322.0
		Sig.	N/mm^2	60.32	50.85	32.28	26.82
		Lm	m	-1.721	-3.450	-3.450	-3.450
	SKY400	M	kN.m	637.0	558.0	388.0	322.0
		Sig.max	N/mm^2	60.32	52.82	32.28	26.82
		Lm	m	-1.721	-2.160	-3.450	-3.450
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm^2	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	614.0	638.0	942.0	833.0
		Sig.	N/mm^2	51.10	53.10	78.41	69.36
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY400	M	kN.m	614.0	638.0	942.0	833.0
		Sig.max	N/mm^2	51.10	53.10	78.41	69.36
		Lm	m	-3.450	-5.160	-9.160	-11.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm^2	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm^2	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm^2	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	164.5	71.7	31.9	30.7
		2nd row	kN/m	------	150.0	28.7	19.2
		3rd row	kN/m	------	------	423.9	418.1
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	0.0	440.1

note)Lm shows elevation

item			unit	the5step
displace ment	max displacement	Del.max	cm	3.920
	accrue location	Lm	m	-11.160
displace coffer displace part	max bending moment	Mmax	kN.m	330.0
		Sig.	N/mm²	27.50
		Lm	m	-3.450
	SKY400	M	kN.m	330.0
		Sig.max	N/mm²	27.50
		Lm	m	-3.450
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
displace celler displace part	max bending moment	Mmax	kN.m	836.0
		Sig.	N/mm²	69.59
		Lm	m	-11.160
	SKY400	M	kN.m	836.0
		Sig.max	N/mm²	69.59
		Lm	m	-11.160
	SKY490	M	kN.m	--------
		Sig.max	N/mm²	------
		Lm	m	------
(SKY400)		Sig.a	N/mm²	210.00
(SKY490)		Sig.a	N/mm²	------

support point reaction force	timbering reaction	1st row	kN/m	30.8
		2nd row	kN/m	20.3
		3rd row	kN/m	419.2
		4th row	kN/m	------
		5th row	kN/m	------
		6th row	kN/m	------
		7th row	kN/m	------
		8th row	kN/m	------
		9th row	kN/m	------
		10th row	kN/m	------
	footing concrete reaction		kN/m	442.2

note)Lm shows elevation

2.10 detail output

(1)bridge axis direction 1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.083	3.308	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.082	3.308	0.0	0.0	0.00	0.0	0.0	
164.6										
	+4.340	0.3	0.082	3.308	0.0	164.6	0.00	0.0	0.0	
	+3.840	5.3	0.247	3.292	82.1	163.2	7.77	0.0	0.0	
	+2.840	15.2	0.571	3.163	241.0	153.0	22.82	0.0	0.0	
	+1.840	25.2	0.876	2.915	384.7	132.8	36.43	0.0	0.0	
	+1.340	30.2	1.018	2.751	447.8	118.9	42.40	0.0	0.0	
	+0.840	35.2	1.151	2.563	503.2	102.6	47.66	0.0	0.0	
	+0.340	40.1	1.274	2.355	550.0	83.8	52.08	0.0	0.0	
	-0.160	40.1	1.386	2.130	586.8	63.7	55.57	0.0	0.0	
	-1.160	40.1	1.575	1.647	630.5	23.6	59.71	0.0	0.0	
	-1.660	40.1	1.651	1.397	637.3	3.6	60.35	0.0	0.0	
	-1.721	32.0	1.660	1.366	637.5	1.1	60.37	14.4	24.1	
	-2.160	32.0	1.715	1.145	636.3	-6.5	60.26	14.8	25.7	
	-2.160	32.0	1.715	1.145	636.3	-6.5	52.99	14.8	25.7	
	-3.160	32.0	1.807	0.708	621.3	-23.2	51.75	15.6	29.2	
	-3.450	32.0	1.826	0.584	613.9	-28.0	51.13	15.8	30.2	
	-4.160	32.0	1.857	0.287	590.0	-39.4	49.14	16.1	32.7	
	-5.160	32.0	1.866	-0.107	542.7	-55.2	45.20	16.1	36.2	
	-6.160	32.0	1.837	-0.463	479.5	-71.2	39.94	15.9	39.7	
	-6.704	28.0	1.807	-0.636	438.4	-80.0	36.51	34.7	62.3	
	-7.160	27.2	1.775	-0.769	402.6	-76.9	33.53	34.1	64.0	
	-7.450	26.7	1.751	-0.848	380.6	-74.9	31.70	33.7	65.0	
	-8.160	25.5	1.685	-1.023	329.2	-70.0	27.41	32.4	67.5	
	-8.450	25.1	1.654	-1.087	309.2	-68.0	25.75	31.8	68.6	
	-9.160	23.9	1.572	-1.228	262.5	-63.4	21.86	30.2	71.1	
	-9.794	25.8	1.490	-1.335	223.6	-59.5	18.62	17.2	184.3	
	-10.160	25.1	1.441	-1.389	201.2	-62.6	16.76	16.6	192.6	
	-10.854	23.9	1.341	-1.475	155.7	-68.5	12.97	15.5	208.4	
	-11.160	23.4	1.295	-1.506	134.4	-71.1	11.19	14.9	215.4	
	-11.450	22.8	1.251	-1.531	113.4	-73.5	9.44	14.4	222.0	
	-12.160	21.6	1.141	-1.573	59.1	-79.5	4.92	13.2	238.2	
	-13.144	21.4	0.985	-1.586	-23.2	-87.8	1.94	49.2	375.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-13.160	21.3	0.983	-1.586	-24.6	-87.4	2.05	49.1	375.7	
	-14.160	18.3	0.826	-1.541	-98.9	-62.0	8.24	41.3	404.9	
	-14.160	18.3	0.826	-1.541	-98.9	-62.0	9.37	41.3	404.9	
	-15.160	15.3	0.676	-1.442	-150.2	-41.3	14.22	33.8	434.0	
	-16.160	12.3	0.539	-1.309	-182.9	-24.8	17.32	26.9	463.2	
	-17.160	9.2	0.415	-1.157	-200.9	-11.7	19.02	20.7	492.3	
	-18.160	6.2	0.307	-0.995	-207.3	-1.4	19.63	15.4	521.5	
	-19.160	3.2	0.216	-0.832	-204.4	6.9	19.36	10.8	550.6	
	-20.160	0.1	0.141	-0.675	-193.9	14.1	18.36	7.0	579.8	
	-20.207	0.0	0.138	-0.667	-193.2	14.4	18.30	6.9	581.2	
	-21.160	0.0	0.081	-0.528	-176.8	19.6	16.75	4.0	608.9	
	-21.704	0.0	0.054	-0.454	-165.7	21.4	15.69	2.5	206.4	
	-22.160	0.0	0.035	-0.397	-155.7	22.3	14.74	1.6	209.6	
	-23.160	0.0	0.001	-0.283	-132.8	23.1	12.58	0.0	216.6	
	-24.160	0.0	-0.022	-0.187	-109.9	22.6	10.41	0.0	223.6	
	-24.347	0.0	-0.026	-0.171	-105.7	22.4	10.01	0.0	224.9	
	-25.160	0.0	-0.037	-0.109	-88.0	21.1	8.33	0.0	230.6	
	-26.160	0.0	-0.045	-0.048	-67.8	19.2	6.42	0.0	237.6	
	-27.160	0.0	-0.047	-0.001	-49.7	17.0	4.71	0.0	244.6	
	-28.160	0.0	-0.046	0.031	-33.8	14.8	3.20	0.0	251.6	
	-29.160	0.0	-0.041	0.052	-20.0	12.8	1.90	0.0	258.6	
	-30.160	0.0	-0.035	0.063	-8.2	10.9	0.78	0.0	265.6	
	-30.384	0.0	-0.034	0.065	-5.8	10.6	0.55	0.0	455.0	
	-31.160	0.0	-0.029	0.066	1.2	7.6	0.12	0.0	461.9	
	-32.160	0.0	-0.022	0.062	7.3	4.5	0.69	0.0	470.9	
	-33.160	0.0	-0.016	0.055	10.5	2.2	1.00	0.0	479.9	
	-34.160	0.0	-0.011	0.046	11.8	0.5	1.12	0.0	488.9	
	-35.160	0.0	-0.007	0.037	11.7	-0.6	1.11	0.0	497.9	
	-36.160	0.0	-0.004	0.028	10.8	-1.3	1.02	0.0	506.9	
	-37.160	0.0	-0.002	0.020	9.3	-1.6	0.88	0.0	515.9	
	-38.160	0.0	0.000	0.013	7.6	-1.7	0.72	0.0	524.9	
	-39.160	0.0	0.001	0.008	5.9	-1.6	0.56	0.1	533.9	
	-40.160	0.0	0.002	0.004	4.4	-1.4	0.42	0.2	542.9	
	-41.160	0.0	0.002	0.001	3.1	-1.2	0.29	0.2	551.9	
	-42.160	0.0	0.002	-0.001	2.0	-1.0	0.19	0.2	560.9	
	-43.160	0.0	0.002	-0.002	1.1	-0.7	0.10	0.2	569.9	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-44.160	0.0	0.002	-0.003	0.5	-0.5	0.04	0.2	578.9	
	-45.160	0.0	0.001	-0.003	0.0	-0.4	0.00	0.2	587.9	
	-46.160	0.0	0.001	-0.003	-0.2	-0.2	0.02	0.1	596.9	
	-47.160	0.0	0.001	-0.002	-0.4	-0.1	0.04	0.1	605.9	
	-48.160	0.0	0.001	-0.002	-0.5	0.0	0.04	0.1	614.9	
	-49.160	0.0	0.000	-0.002	-0.4	0.0	0.04	0.0	623.9	
	-50.160	0.0	0.000	-0.001	-0.4	0.1	0.03	0.0	632.9	
	-51.160	0.0	0.000	-0.001	-0.3	0.1	0.03	0.0	641.9	
	-52.160	0.0	0.000	-0.001	-0.2	0.1	0.02	0.0	650.9	
	-52.954	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1787.1	
	-53.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1796.6	
	-54.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1842.9	
	-54.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1866.0	

(2)bridge axis direction   2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.142	3.596	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.038	3.596	0.0	0.0	0.00	0.0	0.0	
75.2										
	+4.340	0.3	0.038	3.596	0.0	75.2	0.00	0.0	0.0	
	+3.840	5.3	0.217	3.589	37.3	73.8	3.54	0.0	0.0	
	+2.840	15.2	0.574	3.531	106.8	63.5	10.12	0.0	0.0	
	+1.840	25.2	0.922	3.424	161.1	43.3	15.26	0.0	0.0	
	+1.340	30.2	1.091	3.357	179.4	29.5	16.99	0.0	0.0	
147.0										
	+1.340	30.2	1.091	3.357	179.4	176.6	16.99	0.0	0.0	
	+0.840	35.2	1.257	3.269	263.7	160.2	24.98	0.0	0.0	
	+0.340	40.1	1.418	3.150	339.2	141.4	32.13	0.0	0.0	
	-0.160	40.1	1.572	3.003	404.9	121.3	38.35	0.0	0.0	
	-1.160	40.1	1.855	2.640	506.2	81.2	47.94	0.0	0.0	
	-1.660	40.1	1.981	2.433	541.8	61.2	51.31	0.0	0.0	
	-1.721	15.8	1.996	2.407	545.5	58.8	51.66	0.0	0.0	
	-2.160	16.0	2.098	2.214	569.7	51.8	53.96	0.0	0.0	
	-2.160	16.0	2.098	2.214	569.7	51.8	47.45	0.0	0.0	
	-3.160	16.5	2.299	1.802	613.5	35.6	51.09	0.0	0.0	
	-3.450	16.6	2.349	1.678	623.1	30.8	51.89	0.0	0.0	
	-4.160	17.0	2.457	1.366	640.7	18.8	53.36	0.0	0.0	
	-5.160	17.5	2.572	0.917	651.0	1.6	54.21	0.0	0.0	
	-6.160	18.0	2.641	0.467	643.7	-16.1	53.61	0.0	0.0	
	-6.704	3.5	2.660	0.226	632.3	-26.0	52.66	0.0	0.0	
	-7.160	2.9	2.665	0.028	620.1	-27.4	51.64	0.0	0.0	
	-7.450	2.5	2.664	-0.096	612.1	-28.2	50.97	0.0	0.0	
	-8.160	1.6	2.647	-0.393	591.5	-29.7	49.26	0.0	0.0	
	-8.450	1.3	2.634	-0.511	582.8	-30.1	48.53	0.0	0.0	
	-9.160	0.4	2.587	-0.793	561.2	-30.7	46.73	0.0	0.0	
	-9.477	0.0	2.560	-0.915	551.4	-30.8	45.92	0.0	0.0	
	-9.794	61.9	2.529	-1.036	541.6	-30.8	45.11	0.0	0.0	
	-9.950	62.3	2.513	-1.094	536.1	-40.5	44.65	0.0	0.0	
	-9.950	62.3	2.513	-1.094	536.1	-40.5	44.65	0.0	0.0	*
	-10.160	61.9	2.489	-1.171	526.3	-53.0	43.83	4.8	4.8	*
	-10.854	60.7	2.399	-1.414	477.1	-86.7	39.73	20.6	20.6	*

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-11.142	60.2	2.357	-1.507	450.6	-97.2	37.52	27.2	27.2	*
	-11.142	60.2	2.357	-1.507	450.6	-97.2	37.52	27.2	27.2	
	-11.160	60.1	2.354	-1.512	448.8	-97.8	37.38	27.1	27.6	
	-11.450	59.6	2.309	-1.600	419.0	-107.4	34.90	26.6	34.2	
	-12.160	58.3	2.189	-1.786	334.5	-130.8	27.86	25.2	50.4	
	-13.144	52.9	2.003	-1.967	189.7	-163.6	15.79	100.1	104.9	
	-13.160	52.9	2.000	-1.969	187.0	-162.8	15.58	100.0	105.3	
	-14.160	49.9	1.798	-2.048	46.6	-119.3	3.88	89.9	134.5	
	-14.160	49.9	1.798	-2.048	46.6	-119.3	4.41	89.9	134.5	
	-15.160	46.8	1.593	-2.042	-53.9	-82.9	5.10	79.6	163.7	
	-16.160	43.8	1.392	-1.971	-121.5	-53.6	11.51	69.6	192.8	
	-17.160	40.8	1.201	-1.857	-163.4	-31.2	15.47	60.0	222.0	
	-18.160	37.8	1.022	-1.718	-186.0	-15.0	17.61	51.1	251.1	
	-19.160	34.7	0.857	-1.567	-195.2	-4.3	18.48	42.8	280.3	
	-20.160	31.7	0.708	-1.412	-196.2	1.5	18.58	35.4	309.4	
	-21.160	28.7	0.575	-1.259	-193.5	3.3	18.33	28.7	338.6	
	-21.704	20.9	0.509	-1.176	-191.8	2.9	18.16	24.0	182.4	
	-22.160	19.0	0.456	-1.107	-190.2	4.1	18.01	21.5	183.8	
	-23.160	15.0	0.353	-0.959	-185.0	6.1	17.52	16.6	186.7	
	-24.160	10.9	0.265	-0.816	-178.1	7.7	16.87	12.5	189.7	
	-25.160	6.9	0.190	-0.678	-169.6	9.4	16.06	8.9	192.6	
	-26.160	2.8	0.129	-0.548	-159.0	12.0	15.06	6.1	195.6	
	-26.859	0.0	0.093	-0.463	-149.8	14.6	14.18	4.4	197.6	
	-27.160	0.0	0.080	-0.428	-145.1	15.9	13.75	3.8	198.5	
	-28.160	0.0	0.043	-0.320	-127.7	18.7	12.09	2.0	201.5	
	-29.160	0.0	0.015	-0.227	-108.2	20.0	10.25	0.7	204.4	
	-30.160	0.0	-0.003	-0.150	-88.0	20.3	8.33	0.0	207.4	
	-30.384	0.0	-0.007	-0.134	-83.4	20.2	7.90	0.0	395.4	
	-30.630	0.0	-0.010	-0.119	-78.5	20.0	7.43	0.0	395.5	
	-31.070	0.0	-0.014	-0.093	-69.8	19.4	6.61	0.0	399.4	
	-31.160	0.0	-0.015	-0.088	-68.1	19.2	6.45	0.0	400.2	
	-32.160	0.0	-0.021	-0.042	-50.0	16.9	4.73	0.0	409.2	
	-33.160	0.0	-0.024	-0.009	-34.4	14.1	3.26	0.0	418.2	
	-34.160	0.0	-0.024	0.013	-21.7	11.3	2.06	0.0	427.2	
	-34.189	0.0	-0.024	0.014	-21.4	11.2	2.03	0.0	427.5	
	-35.160	0.0	-0.022	0.026	-11.8	8.5	1.12	0.0	436.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-36.160	0.0	-0.019	0.033	-4.6	6.1	0.43	0.0	445.2	
	-37.160	0.0	-0.015	0.034	0.4	4.0	0.04	0.0	454.2	
	-38.160	0.0	-0.012	0.033	3.6	2.4	0.34	0.0	463.2	
	-39.160	0.0	-0.009	0.029	5.4	1.2	0.51	0.0	472.2	
	-40.160	0.0	-0.006	0.024	6.1	0.3	0.58	0.0	481.2	
	-41.160	0.0	-0.004	0.019	6.1	-0.3	0.58	0.0	490.2	
	-42.160	0.0	-0.002	0.015	5.6	-0.6	0.53	0.0	499.2	
	-43.160	0.0	-0.001	0.011	4.9	-0.8	0.46	0.0	508.2	
	-44.160	0.0	0.000	0.007	4.0	-0.9	0.38	0.0	517.2	
	-45.160	0.0	0.001	0.004	3.1	-0.8	0.30	0.1	526.2	
	-46.160	0.0	0.001	0.002	2.4	-0.7	0.22	0.1	535.2	
	-47.160	0.0	0.001	0.001	1.7	-0.6	0.16	0.1	544.2	
	-48.160	0.0	0.001	-0.001	1.1	-0.5	0.11	0.1	553.2	
	-49.160	0.0	0.001	-0.001	0.7	-0.4	0.07	0.1	562.2	
	-50.160	0.0	0.001	-0.002	0.4	-0.3	0.04	0.1	571.2	
	-51.160	0.0	0.001	-0.002	0.2	-0.2	0.02	0.1	580.2	
	-52.160	0.0	0.000	-0.002	0.1	-0.1	0.01	0.1	589.2	
	-52.954	0.0	0.000	-0.002	0.0	-0.1	0.00	0.1	1443.8	
	-53.160	0.0	0.000	-0.002	0.0	0.0	0.00	0.1	1453.3	
	-54.160	0.0	0.000	-0.002	0.0	0.0	0.00	0.0	1499.5	
	-54.660	0.0	0.000	-0.002	0.0	0.0	0.00	0.0	1522.7	

*showing plastic

(3)bridge axis direction 3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.160	3.462	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.013	3.462	0.0	0.0	0.00	0.0	0.0	
25.6										
	+4.340	0.3	0.013	3.462	0.0	25.6	0.00	0.0	0.0	
	+3.840	5.3	0.186	3.459	12.6	24.2	1.19	0.0	0.0	
	+2.840	15.2	0.531	3.441	32.5	14.0	3.08	0.0	0.0	
	+1.840	25.2	0.874	3.412	37.2	-6.2	3.53	0.0	0.0	
	+1.340	30.2	1.044	3.398	30.8	-20.0	2.92	0.0	0.0	
52.0										
	+1.340	30.2	1.044	3.398	30.8	32.0	2.92	0.0	0.0	
	+0.840	35.2	1.213	3.383	42.8	15.6	4.05	0.0	0.0	
	-0.160	45.1	1.550	3.348	39.2	-24.5	3.71	0.0	0.0	
	-1.160	55.1	1.884	3.333	-9.5	-74.6	0.90	0.0	0.0	
	-1.660	60.1	2.051	3.346	-53.9	-103.4	5.11	0.0	0.0	
405.6										
	-1.660	60.1	2.051	3.346	-53.9	302.2	5.11	0.0	0.0	
	-1.721	36.4	2.071	3.348	-35.6	298.5	3.37	0.0	0.0	
	-2.160	41.0	2.218	3.338	91.8	281.5	8.69	0.0	0.0	
	-2.160	41.0	2.218	3.338	91.8	281.5	7.64	0.0	0.0	
	-2.660	46.2	2.384	3.282	227.2	259.7	18.92	0.0	0.0	
	-3.160	46.5	2.545	3.181	351.3	236.5	29.25	0.0	0.0	
	-3.450	46.6	2.637	3.104	417.9	223.0	34.80	0.0	0.0	
	-4.160	47.0	2.849	2.861	564.5	189.8	47.01	0.0	0.0	
	-5.160	47.5	3.113	2.409	730.7	142.6	60.85	0.0	0.0	
	-6.160	48.0	3.327	1.858	849.5	94.9	70.75	0.0	0.0	
	-6.704	33.5	3.419	1.528	894.0	68.7	74.45	0.0	0.0	
	-7.160	32.9	3.483	1.241	921.8	53.6	76.77	0.0	0.0	
	-7.450	32.5	3.516	1.054	936.0	44.1	77.95	0.0	0.0	
	-8.160	31.6	3.574	0.586	959.2	21.3	79.88	0.0	0.0	
	-8.450	31.3	3.588	0.392	964.0	12.2	80.28	0.0	0.0	
	-9.160	30.4	3.599	-0.083	964.8	-9.7	80.35	0.0	0.0	
	-9.794	91.9	3.581	-0.506	952.6	-28.8	79.34	0.0	0.0	
	-9.950	92.3	3.572	-0.609	947.0	-43.1	78.87	0.0	0.0	
	-9.950	92.3	3.572	-0.609	947.0	-43.1	78.87	0.0	0.0	*
	-10.160	91.9	3.558	-0.746	936.0	-62.0	77.95	4.8	4.8	*

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	90.7	3.491	-1.183	873.4	-116.5	72.73	20.6	20.6	*
	-11.160	90.1	3.452	-1.365	834.6	-136.8	69.50	27.6	27.6	*
	-11.450	89.6	3.410	-1.528	792.4	-153.9	65.99	34.2	34.2	*
	-11.656	89.2	3.377	-1.639	759.5	-164.8	63.25	38.9	38.9	*
	-11.656	89.2	3.377	-1.639	759.5	-164.8	63.25	38.9	38.9	
	-12.160	88.3	3.288	-1.890	670.1	-190.1	55.81	37.9	50.4	
	-13.144	86.6	3.082	-2.278	458.5	-240.0	38.18	35.5	72.8	
	-13.144	82.9	3.082	-2.278	458.5	-240.0	38.18	104.9	104.9	*
	-13.160	82.9	3.078	-2.283	454.6	-239.7	37.86	105.3	105.3	*
	-14.160	79.9	2.837	-2.519	231.5	-201.1	19.28	134.5	134.5	*
	-14.160	79.9	2.837	-2.519	231.5	-201.1	21.93	134.5	134.5	*
	-14.331	79.4	2.793	-2.548	198.1	-191.4	18.76	139.5	139.5	*
	-14.331	79.4	2.793	-2.548	198.1	-191.4	18.76	139.6	139.5	
	-15.160	76.8	2.578	-2.630	59.1	-144.8	5.60	128.9	163.7	
	-16.160	73.8	2.315	-2.626	-61.3	-97.8	5.81	115.7	192.8	
	-17.160	70.8	2.056	-2.544	-139.9	-61.0	13.25	102.7	222.0	
	-18.160	67.8	1.807	-2.413	-186.5	-33.8	17.66	90.3	251.1	
	-19.160	64.7	1.574	-2.255	-210.5	-15.6	19.93	78.7	280.3	
	-20.160	61.7	1.357	-2.085	-220.4	-5.6	20.87	67.8	309.4	
	-21.160	58.7	1.157	-1.909	-224.2	-3.1	21.23	57.8	338.6	
	-21.704	38.9	1.056	-1.813	-226.2	-4.5	21.42	49.7	170.4	
	-22.160	37.0	0.975	-1.731	-227.2	0.0	21.51	45.9	171.8	
	-23.160	33.0	0.811	-1.553	-223.4	7.0	21.15	38.2	174.7	
	-24.160	28.9	0.664	-1.380	-214.3	10.7	20.29	31.3	177.7	
	-25.160	24.9	0.535	-1.215	-202.8	12.0	19.20	25.2	180.6	
	-26.160	20.8	0.421	-1.060	-190.9	11.5	18.08	19.8	183.6	
	-27.160	16.8	0.322	-0.914	-180.0	10.2	17.05	15.2	186.5	
	-28.160	12.7	0.238	-0.775	-170.7	8.6	16.16	11.2	189.5	
	-29.160	8.7	0.167	-0.644	-162.8	7.3	15.41	7.9	192.4	
	-30.160	4.6	0.109	-0.518	-155.6	7.1	14.74	5.1	195.4	
	-30.384	0.3	0.098	-0.491	-154.0	7.3	14.58	11.8	380.4	
	-30.418	0.0	0.096	-0.487	-153.7	7.7	14.56	11.6	380.4	
	-31.160	0.0	0.063	-0.399	-145.2	14.8	13.75	7.7	380.6	
	-32.160	0.0	0.029	-0.291	-127.3	20.3	12.06	3.5	380.9	
	-32.358	0.0	0.023	-0.271	-123.3	20.9	11.67	2.8	381.0	
	-33.160	0.0	0.004	-0.199	-105.9	22.2	10.03	0.5	388.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-33.848	0.0	-0.007	-0.145	-90.6	22.0	8.58	0.0	394.4	
	-34.160	0.0	-0.012	-0.124	-83.8	21.7	7.93	0.0	397.2	
	-35.160	0.0	-0.021	-0.066	-63.0	19.7	5.97	0.0	406.2	
	-36.160	0.0	-0.025	-0.024	-44.7	16.8	4.24	0.0	415.2	
	-36.966	0.0	-0.026	0.000	-32.2	14.3	3.05	0.0	422.5	
	-37.160	0.0	-0.026	0.005	-29.5	13.7	2.79	0.0	424.2	
	-38.160	0.0	-0.025	0.023	-17.4	10.6	1.64	0.0	433.2	
	-39.160	0.0	-0.022	0.033	-8.2	7.8	0.78	0.0	442.2	
	-40.160	0.0	-0.018	0.037	-1.7	5.4	0.16	0.0	451.2	
	-41.160	0.0	-0.014	0.037	2.6	3.4	0.25	0.0	460.2	
	-42.160	0.0	-0.011	0.033	5.2	1.8	0.49	0.0	469.2	
	-43.160	0.0	-0.008	0.029	6.5	0.7	0.61	0.0	478.2	
	-44.160	0.0	-0.005	0.023	6.8	-0.1	0.64	0.0	487.2	
	-45.160	0.0	-0.003	0.018	6.4	-0.6	0.61	0.0	496.2	
	-46.160	0.0	-0.002	0.013	5.7	-0.8	0.54	0.0	505.2	
	-47.160	0.0	0.000	0.009	4.8	-1.0	0.45	0.0	514.2	
	-48.160	0.0	0.000	0.006	3.8	-1.0	0.36	0.0	523.2	
	-49.160	0.0	0.001	0.003	2.9	-0.9	0.27	0.1	532.2	
	-50.160	0.0	0.001	0.001	2.1	-0.8	0.20	0.1	541.2	
	-51.160	0.0	0.001	0.000	1.3	-0.7	0.13	0.1	550.2	
	-52.160	0.0	0.001	-0.001	0.7	-0.5	0.07	0.1	559.2	
	-52.954	0.0	0.001	-0.001	0.4	-0.4	0.03	0.3	1276.9	
	-53.160	0.0	0.001	-0.001	0.3	-0.4	0.03	0.3	1286.4	
	-54.160	0.0	0.001	-0.001	0.0	-0.1	0.00	0.2	1332.7	
	-54.660	0.0	0.001	-0.001	0.0	0.0	0.00	0.2	1355.8	

*showing plastic

(4)bridge axis direction 4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.158	3.468	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.015	3.468	0.0	0.0	0.00	0.0	0.0	
30.2										
	+4.340	0.3	0.015	3.468	0.0	30.2	0.00	0.0	0.0	
	+3.840	5.3	0.188	3.465	14.9	28.8	1.41	0.0	0.0	
	+2.840	15.2	0.534	3.442	39.4	18.6	3.73	0.0	0.0	
	+1.840	25.2	0.876	3.406	48.7	-1.6	4.61	0.0	0.0	
	+1.340	30.2	1.046	3.388	44.6	-15.5	4.22	0.0	0.0	
56.8										
	+1.340	30.2	1.046	3.388	44.6	41.4	4.22	0.0	0.0	
	+0.840	35.2	1.215	3.367	61.3	25.0	5.80	0.0	0.0	
	-0.160	45.1	1.549	3.313	67.1	-15.1	6.35	0.0	0.0	
	-1.160	55.1	1.878	3.273	27.8	-65.2	2.63	0.0	0.0	
	-1.660	60.1	2.042	3.269	-11.9	-94.0	1.13	0.0	0.0	
353.1										
	-1.660	60.1	2.042	3.269	-11.9	259.1	1.13	0.0	0.0	
	-1.721	36.4	2.062	3.269	3.8	255.4	0.36	0.0	0.0	
	-2.160	41.0	2.205	3.249	112.3	238.4	10.63	0.0	0.0	
	-2.160	41.0	2.205	3.249	112.3	238.4	9.35	0.0	0.0	
	-3.160	51.5	2.523	3.093	328.5	192.2	27.35	0.0	0.0	
	-3.450	54.5	2.612	3.022	382.0	176.8	31.81	0.0	0.0	
	-4.160	62.0	2.819	2.805	493.2	135.5	41.07	0.0	0.0	
	-5.160	72.5	3.081	2.423	595.9	68.3	49.63	0.0	0.0	
	-6.160	83.0	3.302	1.995	626.2	-9.5	52.15	0.0	0.0	
	-6.704	73.9	3.404	1.761	608.5	-56.2	50.68	0.0	0.0	
	-7.160	77.9	3.480	1.573	575.1	-90.8	47.89	0.0	0.0	
	-7.450	80.4	3.524	1.460	545.4	-113.7	45.42	0.0	0.0	
	-8.160	86.6	3.619	1.215	505.3	-173.0	42.08	0.0	0.0	
	-8.450	89.2	3.653	1.131	511.8	-198.5	42.62	0.0	0.0	
487.1										
	-8.450	89.2	3.653	1.131	511.8	288.6	42.62	0.0	0.0	
	-9.160	95.4	3.725	0.892	582.2	223.1	48.48	0.0	0.0	
	-9.794	163.2	3.773	0.612	693.8	160.8	57.78	0.0	0.0	
	-9.950	148.7	3.782	0.535	716.9	135.2	59.70	43.6	96.4	
	-10.160	148.4	3.792	0.429	743.0	113.2	61.88	43.7	101.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	147.1	3.809	0.056	796.4	41.1	66.33	43.9	117.0	
	-11.160	146.6	3.808	-0.114	804.2	9.6	66.97	43.9	124.0	
	-11.450	146.1	3.803	-0.276	802.7	-20.1	66.85	43.8	130.6	
	-12.160	144.8	3.769	-0.664	762.7	-92.4	63.52	43.5	146.8	
	-13.144	141.7	3.680	-1.142	622.9	-191.7	51.87	183.9	242.4	
	-13.160	141.7	3.678	-1.149	619.8	-191.0	51.62	183.8	242.9	
	-14.160	138.7	3.543	-1.518	449.3	-150.6	37.42	177.1	272.0	
	-14.160	138.7	3.543	-1.518	449.3	-150.6	42.55	177.1	272.0	
	-15.160	135.6	3.376	-1.818	317.2	-114.7	30.04	168.7	301.2	
	-16.160	132.6	3.183	-2.027	218.0	-84.8	20.64	159.1	330.3	
	-17.160	129.6	2.973	-2.169	145.2	-62.0	13.75	148.6	359.5	
	-18.160	126.5	2.751	-2.261	91.4	-47.0	8.65	137.5	388.7	
	-19.160	123.5	2.522	-2.316	48.4	-40.3	4.59	126.0	417.8	
	-20.160	120.5	2.289	-2.338	8.0	-42.1	0.76	114.4	447.0	
	-21.160	117.5	2.055	-2.327	-38.6	-52.5	3.65	102.7	476.1	
	-21.704	64.0	1.929	-2.304	-69.5	-61.8	6.59	90.9	153.7	
	-22.160	62.2	1.825	-2.274	-95.0	-50.3	9.00	85.9	155.0	
	-23.160	58.1	1.601	-2.182	-134.5	-29.8	12.74	75.4	157.9	
	-24.160	54.1	1.389	-2.066	-156.6	-15.5	14.83	65.4	160.9	
	-25.160	50.0	1.189	-1.938	-167.3	-6.9	15.85	56.0	163.8	
	-26.160	46.0	1.001	-1.804	-172.0	-3.3	16.29	47.2	166.8	
	-27.160	41.9	0.828	-1.667	-175.5	-4.2	16.62	39.0	169.7	
	-28.160	37.9	0.668	-1.526	-181.8	-9.0	17.22	31.5	172.7	
	-29.160	33.8	0.523	-1.378	-194.4	-16.8	18.41	24.6	175.6	
	-30.160	29.8	0.393	-1.217	-216.2	-27.1	20.48	18.5	178.6	
	-30.384	21.2	0.366	-1.178	-222.6	-29.7	21.08	44.3	359.4	
	-31.160	14.5	0.280	-1.036	-239.0	-13.2	22.64	33.9	359.7	
	-32.160	5.8	0.186	-0.845	-243.1	4.6	23.02	22.5	360.0	
	-32.831	0.0	0.134	-0.717	-236.3	15.6	22.38	16.2	360.2	
	-33.160	0.0	0.111	-0.657	-230.3	20.5	21.81	13.5	360.3	
	-34.160	0.0	0.054	-0.485	-204.3	30.3	19.35	6.6	360.6	
	-34.771	0.0	0.028	-0.391	-184.8	33.3	17.50	3.3	360.8	
	-35.160	0.0	0.013	-0.336	-171.6	34.3	16.25	1.6	364.3	
	-36.160	0.0	-0.014	-0.214	-137.1	34.1	12.99	0.0	373.3	
	-37.160	0.0	-0.030	-0.119	-104.2	31.4	9.87	0.0	382.3	
	-37.728	0.0	-0.036	-0.076	-87.1	29.1	8.24	0.0	387.4	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-38.160	0.0	-0.039	-0.049	-74.9	27.1	7.09	0.0	391.3	
	-39.160	0.0	-0.041	0.000	-50.2	22.3	4.75	0.0	400.3	
	-40.160	0.0	-0.039	0.032	-30.3	17.4	2.87	0.0	409.3	
	-40.846	0.0	-0.036	0.045	-19.5	14.3	1.85	0.0	415.5	
	-41.160	0.0	-0.035	0.049	-15.2	12.9	1.44	0.0	418.3	
	-42.160	0.0	-0.029	0.057	-4.3	9.0	0.41	0.0	427.3	
	-43.160	0.0	-0.024	0.057	3.0	5.8	0.29	0.0	436.3	
	-44.160	0.0	-0.018	0.053	7.5	3.3	0.71	0.0	445.3	
	-45.160	0.0	-0.013	0.046	9.8	1.4	0.92	0.0	454.3	
	-46.160	0.0	-0.009	0.038	10.4	0.0	0.99	0.0	463.3	
	-47.160	0.0	-0.006	0.030	9.9	-0.9	0.94	0.0	472.3	
	-48.160	0.0	-0.003	0.022	8.8	-1.4	0.83	0.0	481.3	
	-49.160	0.0	-0.001	0.016	7.2	-1.7	0.68	0.0	490.3	
	-50.160	0.0	0.000	0.011	5.5	-1.7	0.52	0.0	499.3	
	-51.160	0.0	0.001	0.007	3.8	-1.6	0.36	0.1	508.3	
	-52.160	0.0	0.002	0.005	2.3	-1.5	0.21	0.2	517.3	
	-52.954	0.0	0.002	0.004	1.2	-1.3	0.11	0.7	1043.8	
	-53.160	0.0	0.002	0.004	0.9	-1.2	0.09	0.7	1053.4	
	-54.160	0.0	0.002	0.003	0.1	-0.4	0.01	0.8	1099.6	
	-54.660	0.0	0.003	0.003	0.0	0.0	0.00	0.9	1122.7	

bending moment at support of footing concrete is reduced value

(5)bridge axis direction　5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.158	3.469	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.015	3.469	0.0	0.0	0.00	0.0	0.0	
30.4										
	+4.340	0.3	0.015	3.469	0.0	30.4	0.00	0.0	0.0	
	+3.840	5.3	0.189	3.466	15.0	29.0	1.42	0.0	0.0	
	+2.840	15.2	0.534	3.444	39.7	18.8	3.76	0.0	0.0	
	+1.840	25.2	0.877	3.407	49.2	-1.4	4.66	0.0	0.0	
	+1.340	30.2	1.047	3.389	45.2	-15.2	4.28	0.0	0.0	
57.8										
	+1.340	30.2	1.047	3.389	45.2	42.6	4.28	0.0	0.0	
	+0.840	35.2	1.216	3.367	62.5	26.2	5.92	0.0	0.0	
	-0.160	45.1	1.550	3.312	69.5	-13.9	6.58	0.0	0.0	
	-1.160	55.1	1.879	3.269	31.4	-64.0	2.97	0.0	0.0	
	-1.660	60.1	2.042	3.264	-7.7	-92.8	0.73	0.0	0.0	
353.6										
	-1.660	60.1	2.042	3.264	-7.7	260.8	0.73	0.0	0.0	
	-1.721	36.4	2.062	3.264	8.1	257.2	0.76	0.0	0.0	
	-2.160	41.0	2.205	3.242	117.3	240.2	11.11	0.0	0.0	
	-2.160	41.0	2.205	3.242	117.3	240.2	9.77	0.0	0.0	
	-3.160	51.5	2.522	3.082	335.3	194.0	27.92	0.0	0.0	
	-3.450	261249.0	2.611	3.009	389.3	178.6	32.42	0.0	0.0	
	-4.160	281973.4	2.817	2.791	490.8	95.9	40.88	0.0	0.0	
	-5.160	308183.3	3.078	2.422	574.4	56.9	47.83	0.0	0.0	
	-6.160	330299.4	3.300	2.012	618.4	45.2	51.50	0.0	0.0	
	-6.704	340501.4	3.403	1.777	616.7	-43.1	51.36	0.0	0.0	
	-7.160	348101.9	3.480	1.587	585.1	-90.5	48.73	0.0	0.0	
	-7.450	80.4	3.524	1.472	554.5	-119.1	46.18	0.0	0.0	
	-8.160	86.6	3.619	1.223	511.2	-178.4	42.57	0.0	0.0	
	-8.450	89.2	3.653	1.138	516.7	-203.9	43.03	0.0	0.0	
491.9										
	-8.450	89.2	3.653	1.138	516.7	288.0	43.03	0.0	0.0	
	-9.160	95.4	3.726	0.897	585.6	222.5	48.77	0.0	0.0	
	-9.794	163.2	3.775	0.616	696.8	160.3	58.03	0.0	0.0	
	-9.950	148.7	3.784	0.539	719.8	134.7	59.95	43.6	96.4	
	-10.160	148.4	3.794	0.432	745.8	112.6	62.11	43.7	101.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	147.1	3.811	0.058	798.9	40.5	66.53	43.9	117.0	
	-11.160	146.6	3.810	-0.112	806.4	9.1	67.16	43.9	124.0	
	-11.450	146.1	3.804	-0.275	804.8	-20.6	67.02	43.9	130.6	
	-12.160	144.8	3.771	-0.663	764.4	-92.9	63.66	43.5	146.8	
	-13.144	141.7	3.681	-1.143	624.1	-192.2	51.98	184.0	242.4	
	-13.160	141.7	3.680	-1.150	621.0	-191.5	51.72	183.9	242.9	
	-14.160	138.7	3.545	-1.519	450.1	-151.0	37.49	177.2	272.0	
	-14.160	138.7	3.545	-1.519	450.1	-151.0	42.63	177.2	272.0	
	-15.160	135.6	3.377	-1.820	317.6	-115.0	30.08	168.8	301.2	
	-16.160	132.6	3.184	-2.029	218.2	-85.0	20.66	159.1	330.3	
	-17.160	129.6	2.974	-2.171	145.2	-62.2	13.75	148.6	359.5	
	-18.160	126.5	2.752	-2.263	91.2	-47.1	8.64	137.5	388.7	
	-19.160	123.5	2.522	-2.318	48.2	-40.3	4.56	126.1	417.8	
	-20.160	120.5	2.289	-2.340	7.7	-42.1	0.73	114.4	447.0	
	-21.160	117.5	2.055	-2.328	-38.9	-52.5	3.68	102.7	476.1	
	-21.704	64.0	1.929	-2.305	-69.9	-61.8	6.61	90.9	153.7	
	-22.160	62.2	1.825	-2.275	-95.3	-50.2	9.03	86.0	155.0	
	-23.160	58.1	1.602	-2.183	-134.8	-29.7	12.76	75.4	157.9	
	-24.160	54.1	1.389	-2.067	-156.9	-15.4	14.86	65.4	160.9	
	-25.160	50.0	1.189	-1.939	-167.6	-6.8	15.87	56.0	163.8	
	-26.160	46.0	1.001	-1.804	-172.2	-3.3	16.31	47.2	166.8	
	-27.160	41.9	0.828	-1.667	-175.6	-4.2	16.63	39.0	169.7	
	-28.160	37.9	0.668	-1.526	-181.9	-8.9	17.23	31.5	172.7	
	-29.160	33.8	0.523	-1.378	-194.5	-16.8	18.42	24.6	175.6	
	-30.160	29.8	0.393	-1.217	-216.3	-27.1	20.48	18.5	178.6	
	-30.384	21.2	0.366	-1.178	-222.6	-29.6	21.08	44.3	359.4	
	-31.160	14.5	0.280	-1.036	-239.1	-13.2	22.64	33.9	359.7	
	-32.160	5.8	0.186	-0.845	-243.1	4.7	23.03	22.5	360.0	
	-32.831	0.0	0.134	-0.717	-236.3	15.6	22.38	16.2	360.2	
	-33.160	0.0	0.111	-0.657	-230.3	20.5	21.81	13.5	360.3	
	-34.160	0.0	0.054	-0.485	-204.3	30.3	19.35	6.6	360.6	
	-34.771	0.0	0.028	-0.391	-184.8	33.3	17.50	3.3	360.8	
	-35.160	0.0	0.013	-0.336	-171.6	34.3	16.25	1.6	364.3	
	-36.160	0.0	-0.014	-0.214	-137.1	34.1	12.99	0.0	373.3	
	-37.160	0.0	-0.030	-0.119	-104.2	31.4	9.87	0.0	382.3	
	-37.728	0.0	-0.036	-0.076	-87.0	29.1	8.24	0.0	387.4	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-38.160	0.0	-0.039	-0.049	-74.9	27.1	7.09	0.0	391.3	
	-39.160	0.0	-0.041	0.000	-50.2	22.3	4.75	0.0	400.3	
	-40.160	0.0	-0.039	0.032	-30.3	17.4	2.87	0.0	409.3	
	-40.846	0.0	-0.036	0.045	-19.5	14.3	1.84	0.0	415.5	
	-41.160	0.0	-0.035	0.049	-15.2	12.9	1.44	0.0	418.3	
	-42.160	0.0	-0.029	0.057	-4.3	9.0	0.41	0.0	427.3	
	-43.160	0.0	-0.024	0.057	3.0	5.8	0.29	0.0	436.3	
	-44.160	0.0	-0.018	0.053	7.5	3.3	0.71	0.0	445.3	
	-45.160	0.0	-0.013	0.046	9.8	1.4	0.92	0.0	454.3	
	-46.160	0.0	-0.009	0.038	10.4	0.0	0.99	0.0	463.3	
	-47.160	0.0	-0.006	0.030	9.9	-0.9	0.94	0.0	472.3	
	-48.160	0.0	-0.003	0.022	8.8	-1.4	0.83	0.0	481.3	
	-49.160	0.0	-0.001	0.016	7.2	-1.7	0.68	0.0	490.3	
	-50.160	0.0	0.000	0.011	5.5	-1.7	0.52	0.0	499.3	
	-51.160	0.0	0.001	0.007	3.8	-1.6	0.36	0.1	508.3	
	-52.160	0.0	0.002	0.005	2.3	-1.5	0.21	0.2	517.3	
	-52.954	0.0	0.002	0.004	1.2	-1.3	0.11	0.7	1043.8	
	-53.160	0.0	0.002	0.004	0.9	-1.2	0.09	0.7	1053.4	
	-54.160	0.0	0.002	0.003	0.1	-0.4	0.01	0.8	1099.6	
	-54.660	0.0	0.003	0.003	0.0	0.0	0.00	0.9	1122.7	

bending moment at support of footing concrete is reduced value

(6)perpendicular direction   1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.108	3.372	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.061	3.372	0.0	0.0	0.00	0.0	0.0	
164.5										
	+4.340	0.3	0.061	3.372	0.0	164.5	0.00	0.0	0.0	
	+3.840	5.3	0.229	3.355	82.0	163.1	7.77	0.0	0.0	
	+2.840	15.2	0.559	3.227	240.9	152.9	22.81	0.0	0.0	
	+1.840	25.2	0.871	2.979	384.5	132.7	36.41	0.0	0.0	
	+1.340	30.2	1.016	2.815	447.5	118.9	42.38	0.0	0.0	
	+0.840	35.2	1.152	2.627	503.0	102.5	47.63	0.0	0.0	
	+0.340	40.1	1.278	2.419	549.6	83.7	52.05	0.0	0.0	
	-0.160	40.1	1.393	2.194	586.5	63.7	55.54	0.0	0.0	
	-1.160	40.1	1.589	1.712	630.1	23.5	59.67	0.0	0.0	
	-1.660	40.1	1.668	1.462	636.8	3.5	60.31	0.0	0.0	
	-1.721	32.0	1.677	1.431	637.0	1.1	60.32	14.5	24.1	
	-2.160	32.0	1.735	1.210	635.8	-6.5	60.21	15.0	25.7	
	-2.160	32.0	1.735	1.210	635.8	-6.5	52.95	15.0	25.7	
	-3.160	32.0	1.834	0.773	620.9	-23.0	51.71	15.9	29.2	
	-3.450	32.0	1.855	0.649	613.6	-27.7	51.10	16.0	30.2	
	-4.160	32.0	1.890	0.352	589.9	-38.9	49.13	16.4	32.7	
	-5.160	32.0	1.905	-0.042	543.3	-54.4	45.24	16.5	36.2	
	-6.160	32.0	1.883	-0.398	481.0	-70.0	40.06	16.3	39.7	
	-6.704	28.0	1.857	-0.572	440.6	-78.6	36.69	35.7	62.3	
	-7.160	27.5	1.827	-0.706	405.5	-75.2	33.77	35.1	64.3	
	-7.450	27.2	1.806	-0.786	384.1	-73.0	31.98	34.7	65.5	
	-8.160	26.5	1.744	-0.963	334.1	-67.8	27.83	33.5	68.5	
	-8.450	26.2	1.715	-1.028	314.7	-65.8	26.21	33.0	69.7	
	-9.160	25.4	1.637	-1.172	269.7	-61.2	22.46	31.5	72.7	
	-9.794	27.3	1.559	-1.282	232.1	-57.6	19.33	18.0	185.8	
	-10.160	26.7	1.511	-1.338	210.3	-61.0	17.52	17.4	194.2	
	-10.854	25.6	1.415	-1.429	165.8	-67.5	13.80	16.3	210.1	
	-11.160	25.1	1.370	-1.462	144.7	-70.3	12.05	15.8	217.2	
	-11.450	24.6	1.327	-1.489	123.9	-73.0	10.32	15.3	223.8	
	-12.160	23.5	1.220	-1.537	69.7	-79.7	5.81	14.1	240.2	
	-13.144	23.2	1.067	-1.557	-13.3	-89.1	1.11	53.3	377.1	
	-13.160	23.2	1.065	-1.556	-14.7	-88.6	1.22	53.2	377.6	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-14.160	20.9	0.911	-1.519	-89.2	-61.3	7.43	45.5	407.4	
	-14.160	20.9	0.911	-1.519	-89.2	-61.3	8.44	45.5	407.4	
	-15.160	18.6	0.763	-1.427	-139.0	-39.2	13.16	38.1	437.3	
	-16.160	16.3	0.626	-1.305	-169.2	-21.9	16.02	31.3	467.2	
	-17.160	13.9	0.503	-1.164	-184.3	-8.9	17.45	25.1	497.0	
	-18.160	11.6	0.394	-1.017	-188.1	0.6	17.82	19.7	526.9	
	-19.160	9.3	0.299	-0.869	-183.9	7.4	17.42	15.0	556.8	
	-20.160	7.0	0.219	-0.728	-174.0	12.1	16.48	11.0	586.7	
	-20.207	6.9	0.216	-0.721	-173.5	12.3	16.43	10.8	588.1	
	-21.160	4.7	0.153	-0.596	-160.1	15.5	15.17	7.7	616.5	
	-21.704	6.7	0.123	-0.529	-151.3	17.0	14.33	5.8	213.1	
	-22.160	5.5	0.100	-0.476	-143.6	16.6	13.60	4.7	215.1	
	-23.160	3.0	0.058	-0.369	-127.3	16.1	12.06	2.7	219.6	
	-24.160	0.5	0.026	-0.275	-111.2	16.2	10.53	1.2	224.1	
	-24.347	0.0	0.021	-0.259	-108.2	16.4	10.24	1.0	224.9	
	-25.160	0.0	0.002	-0.194	-94.6	16.8	8.96	0.1	230.6	
	-26.160	0.0	-0.014	-0.126	-77.9	16.5	7.38	0.0	237.6	
	-27.160	0.0	-0.023	-0.071	-61.8	15.6	5.85	0.0	244.6	
	-28.160	0.0	-0.028	-0.028	-46.7	14.4	4.42	0.0	251.6	
	-29.160	0.0	-0.029	0.003	-33.0	13.1	3.12	0.0	258.6	
	-30.160	0.0	-0.028	0.025	-20.6	11.7	1.95	0.0	265.6	
	-30.384	0.0	-0.027	0.028	-18.0	11.4	1.70	0.0	455.0	
	-31.160	0.0	-0.025	0.036	-10.1	9.0	0.96	0.0	461.9	
	-32.160	0.0	-0.021	0.041	-2.5	6.2	0.24	0.0	470.9	
	-33.160	0.0	-0.017	0.041	2.5	4.0	0.24	0.0	479.9	
	-34.160	0.0	-0.013	0.038	5.6	2.2	0.53	0.0	488.9	
	-35.160	0.0	-0.009	0.033	7.1	0.9	0.67	0.0	497.9	
	-36.160	0.0	-0.006	0.027	7.5	0.0	0.71	0.0	506.9	
	-37.160	0.0	-0.004	0.021	7.2	-0.6	0.68	0.0	515.9	
	-38.160	0.0	-0.002	0.016	6.4	-0.9	0.61	0.0	524.9	
	-39.160	0.0	-0.001	0.011	5.4	-1.1	0.51	0.0	533.9	
	-40.160	0.0	0.000	0.007	4.4	-1.1	0.41	0.0	542.9	
	-41.160	0.0	0.001	0.004	3.3	-1.0	0.32	0.1	551.9	
	-42.160	0.0	0.001	0.002	2.4	-0.9	0.23	0.1	560.9	
	-43.160	0.0	0.001	0.000	1.6	-0.7	0.15	0.2	569.9	
	-44.160	0.0	0.001	-0.001	1.0	-0.5	0.10	0.2	578.9	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-45.160	0.0	0.001	-0.001	0.5	-0.4	0.05	0.1	587.9	
	-46.160	0.0	0.001	-0.002	0.2	-0.3	0.02	0.1	596.9	
	-47.160	0.0	0.001	-0.002	0.0	-0.2	0.00	0.1	605.9	
	-48.160	0.0	0.001	-0.002	-0.2	-0.1	0.02	0.1	614.9	
	-49.160	0.0	0.000	-0.002	-0.2	0.0	0.02	0.1	623.9	
	-50.160	0.0	0.000	-0.001	-0.2	0.0	0.02	0.0	632.9	
	-51.160	0.0	0.000	-0.001	-0.2	0.0	0.02	0.0	641.9	
	-52.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	650.9	
	-52.954	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1787.1	
	-53.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1796.6	
	-54.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1842.9	
	-54.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1866.0	

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(7)perpendicular direction   2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.152	3.561	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.027	3.561	0.0	0.0	0.00	0.0	0.0	
71.7										
	+4.340	0.3	0.027	3.561	0.0	71.7	0.00	0.0	0.0	
	+3.840	5.3	0.204	3.554	35.6	70.3	3.37	0.0	0.0	
	+2.840	15.2	0.558	3.499	101.7	60.1	9.63	0.0	0.0	
	+1.840	25.2	0.903	3.398	152.5	39.9	14.44	0.0	0.0	
	+1.340	30.2	1.071	3.334	169.1	26.1	16.01	0.0	0.0	
150.0										
	+1.340	30.2	1.071	3.334	169.1	176.1	16.01	0.0	0.0	
	+0.840	35.2	1.236	3.251	253.2	159.8	23.97	0.0	0.0	
	+0.340	40.1	1.396	3.135	328.4	140.9	31.10	0.0	0.0	
	-0.160	40.1	1.549	2.993	393.9	120.9	37.30	0.0	0.0	
	-1.160	40.1	1.831	2.639	494.7	80.8	46.85	0.0	0.0	
	-1.660	40.1	1.958	2.437	530.1	60.7	50.20	0.0	0.0	
	-1.721	15.8	1.973	2.411	533.7	58.3	50.55	0.0	0.0	
	-2.160	16.0	2.075	2.222	557.8	51.3	52.82	0.0	0.0	
	-2.160	16.0	2.075	2.222	557.8	51.3	46.45	0.0	0.0	
	-3.160	16.5	2.277	1.819	601.1	35.1	50.06	0.0	0.0	
	-3.450	16.6	2.328	1.697	610.5	30.3	50.85	0.0	0.0	
	-4.160	17.0	2.438	1.392	627.8	18.4	52.29	0.0	0.0	
	-5.160	17.5	2.555	0.951	637.6	1.2	53.10	0.0	0.0	
	-6.160	18.0	2.628	0.511	630.0	-16.6	52.46	0.0	0.0	
	-6.704	3.5	2.649	0.275	618.3	-26.4	51.49	0.0	0.0	
	-7.160	2.9	2.657	0.081	605.9	-27.9	50.46	0.0	0.0	
	-7.450	2.5	2.658	-0.040	597.7	-28.7	49.78	0.0	0.0	
	-8.160	1.6	2.645	-0.329	576.8	-30.1	48.03	0.0	0.0	
	-8.450	1.3	2.634	-0.445	568.0	-30.6	47.30	0.0	0.0	
	-9.160	0.4	2.592	-0.719	546.0	-31.2	45.47	0.0	0.0	
	-9.477	0.0	2.568	-0.838	536.1	-31.2	44.65	0.0	0.0	
	-9.794	61.9	2.539	-0.955	526.2	-31.2	43.82	0.0	0.0	
	-9.950	62.3	2.524	-1.012	520.6	-40.9	43.36	0.0	0.0	
	-9.950	62.3	2.524	-1.012	520.6	-40.9	43.36	0.0	0.0	*
	-10.160	61.9	2.502	-1.087	510.7	-53.5	42.53	4.8	4.8	*
	-10.854	60.8	2.418	-1.322	461.2	-87.2	38.41	20.8	20.8	*

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-11.143	60.4	2.378	-1.412	434.4	-97.7	36.18	27.4	27.4	*
	-11.143	60.4	2.378	-1.412	434.4	-97.7	36.18	27.4	27.4	
	-11.160	60.4	2.376	-1.417	432.8	-98.3	36.04	27.4	27.8	
	-11.450	59.9	2.334	-1.501	402.9	-107.8	33.55	26.9	34.5	
	-12.160	58.8	2.221	-1.679	318.0	-131.3	26.48	25.6	50.8	
	-13.144	53.5	2.046	-1.849	172.6	-164.1	14.38	102.3	105.4	
	-13.160	53.4	2.043	-1.851	170.0	-163.4	14.16	102.1	105.9	
	-14.160	51.1	1.854	-1.917	29.8	-118.2	2.48	92.7	135.8	
	-14.160	51.1	1.854	-1.917	29.8	-118.2	2.82	92.7	135.8	
	-15.160	48.8	1.663	-1.899	-68.9	-80.3	6.52	83.1	165.6	
	-16.160	46.5	1.476	-1.818	-133.2	-49.6	12.62	73.8	195.5	
	-17.160	44.2	1.300	-1.696	-170.3	-25.6	16.13	65.0	225.4	
	-18.160	41.9	1.138	-1.554	-186.6	-7.8	17.67	56.9	255.3	
	-19.160	39.6	0.990	-1.406	-187.8	4.5	17.78	49.5	285.1	
	-20.160	37.3	0.856	-1.260	-179.1	12.2	16.96	42.8	315.0	
	-21.160	35.0	0.737	-1.125	-164.8	15.8	15.60	36.8	344.9	
	-21.704	29.7	0.678	-1.056	-156.0	16.4	14.77	31.9	191.2	
	-22.160	28.5	0.631	-1.001	-148.3	17.1	14.04	29.7	193.3	
	-23.160	26.0	0.537	-0.891	-130.9	17.3	12.40	25.3	197.7	
	-24.160	23.5	0.453	-0.794	-114.2	15.8	10.82	21.3	202.2	
	-25.160	21.0	0.377	-0.710	-99.7	13.1	9.44	17.8	206.7	
	-26.160	18.5	0.310	-0.636	-88.3	9.5	8.37	14.6	211.2	
	-26.859	16.7	0.267	-0.589	-82.7	6.7	7.83	12.6	214.3	
	-27.160	15.9	0.250	-0.569	-80.8	5.5	7.65	11.8	215.7	
	-28.160	13.4	0.196	-0.507	-77.4	1.3	7.33	9.2	220.1	
	-29.160	10.9	0.149	-0.446	-78.2	-2.8	7.40	7.0	224.6	
	-30.160	8.4	0.107	-0.383	-82.8	-6.4	7.84	5.0	229.1	
	-30.384	3.7	0.099	-0.368	-84.3	-7.2	7.99	11.9	413.8	
	-30.630	2.4	0.090	-0.352	-85.9	-5.1	8.13	10.9	414.7	
	-31.070	0.0	0.075	-0.321	-87.3	-1.2	8.26	9.1	416.3	
	-31.160	0.0	0.072	-0.315	-87.3	-0.4	8.27	8.7	416.6	
	-32.160	0.0	0.044	-0.247	-84.0	6.5	7.96	5.3	420.2	
	-33.160	0.0	0.022	-0.184	-75.3	10.5	7.13	2.7	423.8	
	-34.160	0.0	0.007	-0.129	-63.8	12.2	6.04	0.8	427.4	
	-34.189	0.0	0.007	-0.128	-63.4	12.2	6.01	0.8	427.5	
	-35.160	0.0	-0.004	-0.084	-51.4	12.4	4.87	0.0	436.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-36.160	0.0	-0.010	-0.048	-39.4	11.5	3.73	0.0	445.2	
	-37.160	0.0	-0.014	-0.021	-28.6	10.0	2.71	0.0	454.2	
	-38.160	0.0	-0.015	-0.002	-19.4	8.3	1.84	0.0	463.2	
	-39.160	0.0	-0.014	0.010	-12.0	6.5	1.14	0.0	472.2	
	-40.160	0.0	-0.013	0.017	-6.3	4.9	0.59	0.0	481.2	
	-41.160	0.0	-0.011	0.020	-2.1	3.5	0.20	0.0	490.2	
	-42.160	0.0	-0.009	0.021	0.7	2.3	0.07	0.0	499.2	
	-43.160	0.0	-0.007	0.019	2.5	1.3	0.24	0.0	508.2	
	-44.160	0.0	-0.005	0.017	3.4	0.6	0.33	0.0	517.2	
	-45.160	0.0	-0.003	0.014	3.8	0.1	0.36	0.0	526.2	
	-46.160	0.0	-0.002	0.011	3.7	-0.2	0.35	0.0	535.2	
	-47.160	0.0	-0.001	0.008	3.3	-0.5	0.31	0.0	544.2	
	-48.160	0.0	0.000	0.006	2.8	-0.6	0.27	0.0	553.2	
	-49.160	0.0	0.000	0.004	2.2	-0.6	0.21	0.0	562.2	
	-50.160	0.0	0.000	0.002	1.7	-0.6	0.16	0.0	571.2	
	-51.160	0.0	0.001	0.001	1.1	-0.5	0.11	0.1	580.2	
	-52.160	0.0	0.001	0.001	0.7	-0.4	0.06	0.1	589.2	
	-52.954	0.0	0.001	0.000	0.3	-0.4	0.03	0.2	1443.8	
	-53.160	0.0	0.001	0.000	0.3	-0.3	0.02	0.2	1453.3	
	-54.160	0.0	0.001	0.000	0.0	-0.1	0.00	0.2	1499.5	
	-54.660	0.0	0.001	0.000	0.0	0.0	0.00	0.2	1522.7	

*showing plastic

(8)perpendicular direction   3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.159	3.414	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.012	3.414	0.0	0.0	0.00	0.0	0.0	
31.9										
	+4.340	0.3	0.012	3.414	0.0	31.9	0.00	0.0	0.0	
	+3.840	5.3	0.182	3.410	15.7	30.5	1.49	0.0	0.0	
	+2.840	15.2	0.522	3.387	41.9	20.3	3.97	0.0	0.0	
	+1.840	25.2	0.859	3.348	52.9	0.0	5.01	0.0	0.0	
	+1.340	30.2	1.026	3.328	49.5	-13.8	4.69	0.0	0.0	
28.7										
	+1.340	30.2	1.026	3.328	49.5	14.9	4.69	0.0	0.0	
	+0.840	35.2	1.192	3.307	53.0	-1.5	5.02	0.0	0.0	
	-0.160	45.1	1.521	3.271	32.3	-41.6	3.06	0.0	0.0	
	-1.160	55.1	1.847	3.268	-33.5	-91.7	3.17	0.0	0.0	
	-1.660	60.1	2.011	3.291	-86.5	-120.5	8.19	0.0	0.0	
423.9										
	-1.660	60.1	2.011	3.291	-86.5	303.4	8.19	0.0	0.0	
	-1.721	36.4	2.031	3.295	-68.1	299.7	6.44	0.0	0.0	
	-2.160	41.0	2.176	3.296	59.9	282.7	5.67	0.0	0.0	
	-2.160	41.0	2.176	3.296	59.9	282.7	4.99	0.0	0.0	
	-2.660	46.2	2.340	3.252	195.9	260.9	16.31	0.0	0.0	
	-3.160	46.5	2.501	3.162	320.6	237.8	26.70	0.0	0.0	
	-3.450	46.6	2.591	3.090	387.6	224.3	32.28	0.0	0.0	
	-4.160	47.0	2.803	2.862	535.0	191.0	44.56	0.0	0.0	
	-5.160	47.5	3.069	2.430	702.5	143.8	58.50	0.0	0.0	
	-6.160	48.0	3.286	1.898	822.5	96.1	68.50	0.0	0.0	
	-6.704	33.5	3.380	1.579	867.6	69.9	72.26	0.0	0.0	
	-7.160	32.9	3.446	1.299	896.1	54.8	74.63	0.0	0.0	
	-7.450	32.5	3.481	1.117	910.6	45.3	75.83	0.0	0.0	
	-8.160	31.6	3.544	0.662	934.6	22.5	77.84	0.0	0.0	
	-8.450	31.3	3.561	0.474	939.8	13.4	78.27	0.0	0.0	
	-9.160	30.4	3.578	0.009	941.5	-8.5	78.41	0.0	0.0	
	-9.794	91.9	3.565	-0.403	930.1	-27.5	77.46	0.0	0.0	
	-9.950	92.3	3.558	-0.503	924.6	-41.9	77.01	0.0	0.0	
	-9.950	92.3	3.558	-0.503	924.6	-41.9	77.01	0.0	0.0	*
	-10.160	91.9	3.546	-0.637	913.8	-60.7	76.11	4.8	4.8	*

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	90.8	3.487	-1.064	852.1	-115.3	70.96	20.8	20.8	*
	-11.160	90.4	3.452	-1.241	813.7	-135.6	67.76	27.8	27.8	*
	-11.450	89.9	3.414	-1.401	771.8	-152.7	64.28	34.5	34.5	*
	-11.646	89.6	3.385	-1.504	740.8	-163.1	61.70	39.0	39.0	*
	-11.646	89.6	3.385	-1.504	740.8	-163.1	61.70	39.0	39.0	
	-12.160	88.8	3.301	-1.752	650.4	-189.1	54.16	38.1	50.8	
	-13.144	87.2	3.109	-2.127	439.7	-239.2	36.62	35.9	73.4	
	-13.144	83.5	3.109	-2.127	439.7	-239.2	36.62	105.4	105.4	*
	-13.160	83.4	3.106	-2.132	435.9	-238.9	36.30	105.9	105.9	*
	-14.160	81.1	2.880	-2.355	213.6	-200.3	17.79	135.8	135.8	*
	-14.160	81.1	2.880	-2.355	213.6	-200.3	20.23	135.8	135.8	*
	-14.353	80.7	2.835	-2.385	176.0	-189.2	16.67	141.5	141.5	*
	-14.353	80.7	2.835	-2.385	176.0	-189.2	16.67	141.7	141.5	
	-15.160	78.8	2.639	-2.452	42.3	-143.2	4.01	131.9	165.6	
	-16.160	76.5	2.394	-2.436	-75.9	-95.1	7.19	119.6	195.5	
	-17.160	74.2	2.154	-2.344	-151.1	-56.8	14.31	107.7	225.4	
	-18.160	71.9	1.926	-2.206	-192.7	-28.0	18.25	96.3	255.3	
	-19.160	69.6	1.714	-2.046	-210.0	-7.8	19.88	85.6	285.1	
	-20.160	67.3	1.517	-1.879	-211.1	4.4	19.99	75.8	315.0	
	-21.160	65.0	1.338	-1.715	-203.5	9.5	19.28	66.9	344.9	
	-21.704	47.7	1.247	-1.629	-198.2	9.6	18.77	58.7	179.2	
	-22.160	46.5	1.174	-1.559	-192.8	14.2	18.26	55.3	181.3	
	-23.160	44.0	1.026	-1.413	-175.0	20.6	16.58	48.3	185.7	
	-24.160	41.5	0.891	-1.283	-152.9	22.9	14.48	42.0	190.2	
	-25.160	39.0	0.768	-1.172	-130.4	21.7	12.34	36.2	194.7	
	-26.160	36.5	0.656	-1.077	-110.5	17.5	10.47	30.9	199.2	
	-27.160	33.9	0.552	-0.996	-96.2	10.7	9.11	26.0	203.7	
	-28.160	31.4	0.457	-0.923	-89.8	1.8	8.51	21.5	208.1	
	-29.160	28.9	0.368	-0.851	-93.3	-9.0	8.84	17.3	212.6	
	-30.160	26.4	0.286	-0.773	-108.4	-21.3	10.26	13.5	217.1	
	-30.384	18.7	0.269	-0.753	-113.4	-24.2	10.74	32.6	398.8	
	-30.418	18.5	0.267	-0.750	-114.3	-23.7	10.82	32.3	398.9	
	-31.160	14.5	0.214	-0.679	-128.3	-14.4	12.15	25.9	401.6	
	-32.160	9.1	0.151	-0.573	-137.5	-4.2	13.02	18.3	405.2	
	-32.358	8.0	0.140	-0.552	-138.1	-2.5	13.08	17.0	405.9	
	-33.160	3.7	0.099	-0.464	-137.3	4.4	13.00	12.0	408.8	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-33.848	0.0	0.070	-0.391	-132.3	10.1	12.53	8.5	411.3	
	-34.160	0.0	0.058	-0.359	-128.8	12.5	12.20	7.1	412.4	
	-35.160	0.0	0.027	-0.263	-113.4	17.6	10.74	3.3	416.0	
	-36.160	0.0	0.005	-0.180	-94.6	19.5	8.96	0.6	419.6	
	-36.966	0.0	-0.007	-0.125	-78.9	19.4	7.47	0.0	422.5	
	-37.160	0.0	-0.009	-0.114	-75.1	19.2	7.11	0.0	424.2	
	-38.160	0.0	-0.018	-0.062	-56.7	17.5	5.37	0.0	433.2	
	-39.160	0.0	-0.022	-0.023	-40.4	15.0	3.83	0.0	442.2	
	-40.160	0.0	-0.023	0.003	-26.8	12.2	2.54	0.0	451.2	
	-41.160	0.0	-0.022	0.020	-15.9	9.5	1.51	0.0	460.2	
	-42.160	0.0	-0.019	0.029	-7.7	7.0	0.73	0.0	469.2	
	-43.160	0.0	-0.016	0.032	-1.8	4.8	0.17	0.0	478.2	
	-44.160	0.0	-0.013	0.032	2.1	3.0	0.20	0.0	487.2	
	-45.160	0.0	-0.010	0.029	4.4	1.7	0.42	0.0	496.2	
	-46.160	0.0	-0.007	0.025	5.5	0.6	0.52	0.0	505.2	
	-47.160	0.0	-0.005	0.021	5.7	-0.1	0.54	0.0	514.2	
	-48.160	0.0	-0.003	0.016	5.4	-0.6	0.51	0.0	523.2	
	-49.160	0.0	-0.002	0.012	4.6	-0.9	0.43	0.0	532.2	
	-50.160	0.0	-0.001	0.009	3.6	-1.0	0.34	0.0	541.2	
	-51.160	0.0	0.000	0.007	2.6	-1.0	0.24	0.0	550.2	
	-52.160	0.0	0.001	0.005	1.6	-1.0	0.15	0.1	559.2	
	-52.954	0.0	0.001	0.004	0.8	-0.9	0.08	0.4	1276.9	
	-53.160	0.0	0.001	0.004	0.6	-0.8	0.06	0.4	1286.4	
	-54.160	0.0	0.002	0.004	0.1	-0.3	0.01	0.6	1332.7	
	-54.660	0.0	0.002	0.004	0.0	0.0	0.00	0.6	1355.8	

*showing plastic

(9)perpendicular direction 4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.159	3.402	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.011	3.402	0.0	0.0	0.00	0.0	0.0	
30.7										
	+4.340	0.3	0.011	3.402	0.0	30.7	0.00	0.0	0.0	
	+3.840	5.3	0.181	3.399	15.1	29.3	1.43	0.0	0.0	
	+2.840	15.2	0.520	3.376	40.1	19.1	3.80	0.0	0.0	
	+1.840	25.2	0.856	3.340	50.0	-1.1	4.73	0.0	0.0	
	+1.340	30.2	1.023	3.320	46.0	-15.0	4.36	0.0	0.0	
19.2										
	+1.340	30.2	1.023	3.320	46.0	4.3	4.36	0.0	0.0	
	+0.840	35.2	1.188	3.302	44.2	-12.1	4.18	0.0	0.0	
	-0.160	45.1	1.517	3.277	12.9	-52.2	1.22	0.0	0.0	
	-1.160	55.1	1.845	3.294	-63.6	-102.3	6.02	0.0	0.0	
	-1.660	60.1	2.011	3.330	-121.8	-131.1	11.54	0.0	0.0	
418.1										
	-1.660	60.1	2.011	3.330	-121.8	287.0	11.54	0.0	0.0	
	-1.721	36.4	2.031	3.335	-104.4	283.3	9.89	0.0	0.0	
	-2.160	41.0	2.178	3.350	16.3	266.4	1.54	0.0	0.0	
	-2.160	41.0	2.178	3.350	16.3	266.4	1.36	0.0	0.0	
	-3.160	51.5	2.509	3.252	260.4	220.1	21.69	0.0	0.0	
	-3.450	54.5	2.603	3.193	322.0	204.8	26.82	0.0	0.0	
	-4.160	62.0	2.823	3.001	453.1	163.4	37.73	0.0	0.0	
	-5.160	72.5	3.106	2.637	583.7	96.2	48.61	0.0	0.0	
	-6.160	83.0	3.348	2.208	641.9	18.5	53.46	0.0	0.0	
	-6.704	73.9	3.462	1.965	639.4	-28.2	53.25	0.0	0.0	
	-7.160	77.9	3.547	1.765	618.7	-62.9	51.52	0.0	0.0	
	-7.450	80.4	3.596	1.643	597.1	-85.8	49.73	0.0	0.0	
	-8.160	86.6	3.703	1.367	570.9	-145.1	47.54	0.0	0.0	
	-8.450	89.2	3.741	1.268	579.7	-170.6	48.28	0.0	0.0	
440.1										
	-8.450	89.2	3.741	1.268	579.7	269.4	48.28	0.0	0.0	
	-9.160	95.4	3.822	0.993	647.2	203.9	53.90	0.0	0.0	
	-9.794	163.2	3.875	0.687	747.7	141.7	62.27	0.0	0.0	
	-9.950	148.7	3.885	0.605	767.8	116.1	63.94	44.8	96.4	
	-10.160	148.4	3.897	0.491	789.9	94.3	65.78	44.9	101.2	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-10.854	147.3	3.917	0.099	830.5	23.0	69.17	45.2	117.2	
	-11.160	146.8	3.918	-0.078	832.8	-8.2	69.36	45.2	124.2	
	-11.450	146.4	3.913	-0.245	826.1	-37.6	68.80	45.1	130.9	
	-12.160	145.2	3.882	-0.641	774.0	-109.2	64.46	44.8	147.2	
	-13.144	142.3	3.794	-1.122	618.0	-207.7	51.47	189.6	242.9	
	-13.160	142.2	3.792	-1.129	614.7	-207.0	51.19	189.5	243.4	
	-14.160	139.9	3.660	-1.489	430.8	-161.7	35.87	182.9	273.3	
	-14.160	139.9	3.660	-1.489	430.8	-161.7	40.79	182.9	273.3	
	-15.160	137.6	3.496	-1.771	289.7	-121.5	27.43	174.7	303.2	
	-16.160	135.3	3.309	-1.956	185.7	-87.8	17.58	165.4	333.0	
	-17.160	133.0	3.107	-2.072	111.6	-61.5	10.57	155.3	362.9	
	-18.160	130.7	2.896	-2.138	59.9	-43.3	5.67	144.8	392.8	
	-19.160	128.4	2.681	-2.170	22.2	-33.5	2.10	134.0	422.7	
	-20.160	126.1	2.463	-2.175	-9.9	-32.1	0.93	123.1	452.5	
	-21.160	123.8	2.247	-2.154	-44.9	-39.4	4.25	112.3	482.4	
	-21.704	72.8	2.130	-2.130	-68.2	-46.9	6.46	100.3	162.5	
	-22.160	71.7	2.034	-2.101	-86.9	-35.1	8.23	95.8	164.5	
	-23.160	69.2	1.827	-2.022	-111.1	-14.6	10.52	86.1	169.0	
	-24.160	66.6	1.630	-1.930	-118.5	-1.2	11.22	76.7	173.5	
	-25.160	64.1	1.441	-1.838	-115.6	5.7	10.95	67.9	177.9	
	-26.160	61.6	1.262	-1.749	-109.0	6.5	10.33	59.4	182.4	
	-27.160	59.1	1.091	-1.665	-104.6	1.5	9.90	51.4	186.9	
	-28.160	56.6	0.929	-1.582	-107.7	-8.7	10.20	43.7	191.4	
	-29.160	54.0	0.775	-1.492	-123.7	-24.0	11.72	36.5	195.9	
	-30.160	51.5	0.631	-1.382	-157.2	-43.7	14.88	29.7	200.3	
	-30.384	39.7	0.601	-1.353	-167.5	-48.6	15.86	72.7	377.8	
	-31.160	35.5	0.500	-1.241	-196.1	-26.2	18.57	60.5	380.6	
	-32.160	30.1	0.384	-1.079	-211.3	-5.6	20.01	46.5	384.2	
	-32.831	26.4	0.315	-0.967	-211.7	3.8	20.05	38.2	386.7	
	-33.160	24.7	0.284	-0.912	-209.8	7.3	19.87	34.4	387.8	
	-34.160	19.3	0.201	-0.750	-198.5	14.6	18.80	24.4	391.4	
	-34.771	16.0	0.158	-0.657	-188.7	17.1	17.87	19.2	393.6	
	-35.160	13.9	0.134	-0.600	-181.9	18.1	17.22	16.2	395.0	
	-36.160	8.5	0.081	-0.464	-162.8	19.8	15.42	9.8	398.6	
	-37.160	3.1	0.040	-0.343	-142.3	21.3	13.48	4.9	402.2	
	-37.728	0.0	0.023	-0.282	-129.9	22.5	12.30	2.7	404.3	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-38.160	0.0	0.011	-0.240	-119.9	23.4	11.36	1.4	405.8	
	-39.160	0.0	-0.008	-0.155	-96.2	23.5	9.12	0.0	409.4	
	-40.160	0.0	-0.020	-0.088	-73.5	21.8	6.96	0.0	413.0	
	-40.846	0.0	-0.025	-0.052	-59.2	19.9	5.60	0.0	415.5	
	-41.160	0.0	-0.026	-0.038	-53.1	18.9	5.03	0.0	418.3	
	-42.160	0.0	-0.028	-0.003	-35.8	15.6	3.39	0.0	427.3	
	-43.160	0.0	-0.027	0.020	-22.0	12.2	2.08	0.0	436.3	
	-44.160	0.0	-0.025	0.032	-11.4	9.0	1.08	0.0	445.3	
	-45.160	0.0	-0.021	0.038	-3.8	6.3	0.36	0.0	454.3	
	-46.160	0.0	-0.017	0.039	1.3	3.9	0.12	0.0	463.3	
	-47.160	0.0	-0.013	0.037	4.3	2.1	0.41	0.0	472.3	
	-48.160	0.0	-0.010	0.033	5.7	0.7	0.54	0.0	481.3	
	-49.160	0.0	-0.007	0.028	5.8	-0.3	0.55	0.0	490.3	
	-50.160	0.0	-0.004	0.024	5.2	-1.0	0.49	0.0	499.3	
	-51.160	0.0	-0.002	0.020	4.0	-1.3	0.38	0.0	508.3	
	-52.160	0.0	0.000	0.017	2.6	-1.5	0.25	0.0	517.3	
	-52.954	0.0	0.001	0.016	1.4	-1.4	0.14	0.4	1043.8	
	-53.160	0.0	0.001	0.016	1.1	-1.3	0.11	0.5	1053.4	
	-54.160	0.0	0.003	0.015	0.1	-0.6	0.01	1.0	1099.6	
	-54.660	0.0	0.004	0.015	0.0	0.0	0.00	1.3	1122.7	

bending moment at support of footing concrete is reduced value

(10)perpendicular direction 5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.159	3.403	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.011	3.403	0.0	0.0	0.00	0.0	0.0	
30.8										
	+4.340	0.3	0.011	3.403	0.0	30.8	0.00	0.0	0.0	
	+3.840	5.3	0.182	3.400	15.2	29.4	1.44	0.0	0.0	
	+2.840	15.2	0.521	3.378	40.3	19.2	3.82	0.0	0.0	
	+1.840	25.2	0.857	3.341	50.2	-1.0	4.76	0.0	0.0	
	+1.340	30.2	1.023	3.321	46.4	-14.8	4.39	0.0	0.0	
20.3										
	+1.340	30.2	1.023	3.321	46.4	5.5	4.39	0.0	0.0	
	+0.840	35.2	1.189	3.303	45.1	-10.9	4.28	0.0	0.0	
	-0.160	45.1	1.518	3.277	15.0	-51.0	1.43	0.0	0.0	
	-1.160	55.1	1.845	3.291	-60.2	-101.1	5.70	0.0	0.0	
	-1.660	60.1	2.011	3.326	-117.8	-129.9	11.16	0.0	0.0	
419.2										
	-1.660	60.1	2.011	3.326	-117.8	289.3	11.16	0.0	0.0	
	-1.721	36.4	2.031	3.331	-100.3	285.6	9.50	0.0	0.0	
	-2.160	41.0	2.178	3.344	21.5	268.7	2.03	0.0	0.0	
	-2.160	41.0	2.178	3.344	21.5	268.7	1.79	0.0	0.0	
	-3.160	51.5	2.508	3.241	267.9	222.4	22.31	0.0	0.0	
	-3.450	260338.8	2.602	3.181	330.2	207.1	27.50	0.0	0.0	
	-4.160	282373.4	2.821	2.987	451.9	124.4	37.63	0.0	0.0	
	-5.160	310650.8	3.103	2.635	562.2	81.3	46.82	0.0	0.0	
	-6.160	334919.1	3.346	2.224	632.3	71.9	52.66	0.0	0.0	
	-6.704	346258.3	3.460	1.982	645.4	-15.7	53.75	0.0	0.0	
	-7.160	354764.7	3.546	1.780	626.6	-61.5	52.18	0.0	0.0	
	-7.450	80.4	3.596	1.656	604.6	-88.6	50.35	0.0	0.0	
	-8.160	86.6	3.703	1.377	576.6	-147.9	48.02	0.0	0.0	
	-8.450	89.2	3.742	1.277	584.9	-173.4	48.71	0.0	0.0	
442.2										
	-8.450	89.2	3.742	1.277	584.9	268.8	48.71	0.0	0.0	
	-9.160	95.4	3.823	1.000	651.4	203.2	54.25	0.0	0.0	
	-9.794	163.2	3.877	0.692	751.4	141.0	62.58	0.0	0.0	
	-9.950	148.7	3.887	0.609	771.4	115.4	64.24	44.8	96.4	
	-10.160	148.4	3.899	0.495	793.4	93.6	66.07	45.0	101.2	

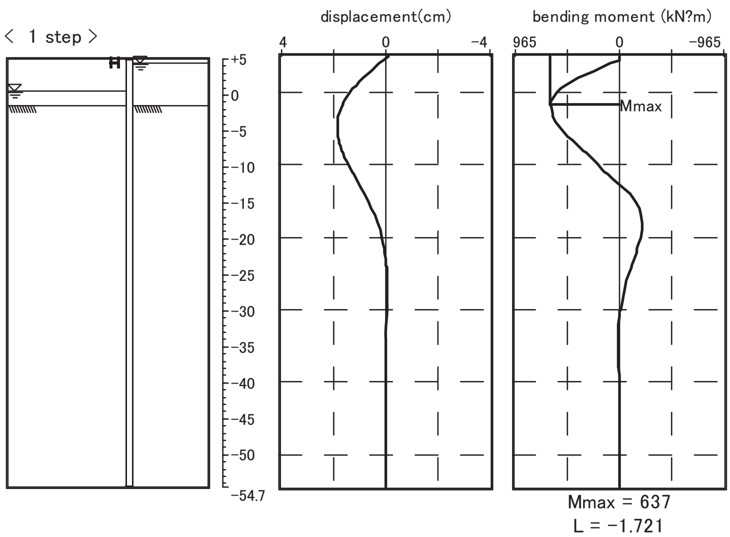
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-10.854	147.3	3.920	0.102	833.5	22.3	69.42	45.2	117.2	
	-11.160	146.8	3.920	-0.076	835.6	-8.9	69.59	45.2	124.2	
	-11.450	146.4	3.915	-0.243	828.7	-38.3	69.02	45.2	130.9	
	-12.160	145.2	3.884	-0.641	776.1	-109.8	64.64	44.8	147.2	
	-13.144	142.3	3.796	-1.123	619.6	-208.3	51.60	189.7	242.9	
	-13.160	142.2	3.794	-1.130	616.2	-207.6	51.32	189.6	243.4	
	-14.160	139.9	3.662	-1.491	431.7	-162.1	35.96	183.0	273.3	
	-14.160	139.9	3.662	-1.491	431.7	-162.1	40.89	183.0	273.3	
	-15.160	137.6	3.498	-1.773	290.2	-121.9	27.49	174.8	303.2	
	-16.160	135.3	3.311	-1.959	185.9	-88.1	17.60	165.5	333.0	
	-17.160	133.0	3.109	-2.074	111.6	-61.7	10.57	155.4	362.9	
	-18.160	130.7	2.898	-2.141	59.7	-43.5	5.65	144.8	392.8	
	-19.160	128.4	2.682	-2.172	21.9	-33.5	2.07	134.0	422.7	
	-20.160	126.1	2.464	-2.177	-10.2	-32.2	0.97	123.2	452.5	
	-21.160	123.8	2.247	-2.155	-45.3	-39.4	4.29	112.3	482.4	
	-21.704	72.8	2.131	-2.131	-68.6	-46.8	6.50	100.3	162.5	
	-22.160	71.7	2.034	-2.103	-87.3	-35.1	8.26	95.8	164.5	
	-23.160	69.2	1.828	-2.023	-111.5	-14.6	10.56	86.1	169.0	
	-24.160	66.6	1.630	-1.931	-118.8	-1.1	11.25	76.8	173.5	
	-25.160	64.1	1.441	-1.838	-115.9	5.8	10.98	67.9	177.9	
	-26.160	61.6	1.262	-1.749	-109.3	6.5	10.35	59.4	182.4	
	-27.160	59.1	1.091	-1.665	-104.8	1.6	9.92	51.4	186.9	
	-28.160	56.6	0.929	-1.582	-107.9	-8.7	10.22	43.7	191.4	
	-29.160	54.0	0.775	-1.492	-123.8	-23.9	11.73	36.5	195.9	
	-30.160	51.5	0.631	-1.382	-157.2	-43.6	14.89	29.7	200.3	
	-30.384	39.7	0.601	-1.353	-167.6	-48.6	15.87	72.7	377.8	
	-31.160	35.5	0.500	-1.241	-196.2	-26.1	18.58	60.5	380.6	
	-32.160	30.1	0.384	-1.079	-211.3	-5.6	20.01	46.5	384.2	
	-32.831	26.4	0.315	-0.967	-211.7	3.8	20.05	38.1	386.7	
	-33.160	24.7	0.284	-0.912	-209.8	7.3	19.87	34.4	387.8	
	-34.160	19.3	0.201	-0.750	-198.5	14.6	18.80	24.4	391.4	
	-34.771	16.0	0.158	-0.657	-188.7	17.1	17.87	19.1	393.6	
	-35.160	13.9	0.134	-0.600	-181.9	18.2	17.22	16.2	395.0	
	-36.160	8.5	0.081	-0.464	-162.8	19.8	15.42	9.8	398.6	
	-37.160	3.1	0.040	-0.343	-142.3	21.3	13.48	4.9	402.2	
	-37.728	0.0	0.023	-0.282	-129.9	22.5	12.30	2.7	404.3	

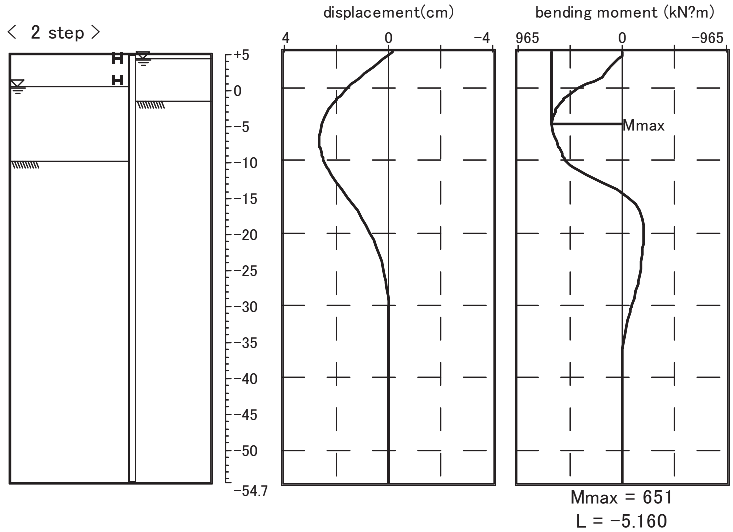
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-38.160	0.0	0.011	-0.240	-119.9	23.4	11.36	1.4	405.8	
	-39.160	0.0	-0.008	-0.154	-96.2	23.5	9.11	0.0	409.4	
	-40.160	0.0	-0.020	-0.088	-73.5	21.8	6.96	0.0	413.0	
	-40.846	0.0	-0.025	-0.052	-59.2	19.9	5.60	0.0	415.5	
	-41.160	0.0	-0.026	-0.038	-53.1	18.9	5.03	0.0	418.3	
	-42.160	0.0	-0.028	-0.003	-35.8	15.6	3.39	0.0	427.3	
	-43.160	0.0	-0.027	0.020	-21.9	12.2	2.08	0.0	436.3	
	-44.160	0.0	-0.025	0.032	-11.4	9.0	1.08	0.0	445.3	
	-45.160	0.0	-0.021	0.038	-3.8	6.3	0.36	0.0	454.3	
	-46.160	0.0	-0.017	0.039	1.3	3.9	0.12	0.0	463.3	
	-47.160	0.0	-0.013	0.037	4.3	2.1	0.41	0.0	472.3	
	-48.160	0.0	-0.010	0.033	5.7	0.7	0.54	0.0	481.3	
	-49.160	0.0	-0.007	0.028	5.8	-0.3	0.55	0.0	490.3	
	-50.160	0.0	-0.004	0.024	5.2	-1.0	0.49	0.0	499.3	
	-51.160	0.0	-0.002	0.020	4.0	-1.3	0.38	0.0	508.3	
	-52.160	0.0	0.000	0.017	2.6	-1.5	0.25	0.0	517.3	
	-52.954	0.0	0.001	0.016	1.4	-1.4	0.14	0.4	1043.8	
	-53.160	0.0	0.001	0.016	1.1	-1.3	0.11	0.5	1053.4	
	-54.160	0.0	0.003	0.015	0.1	-0.6	0.01	1.0	1099.6	
	-54.660	0.0	0.004	0.015	0.0	0.0	0.00	1.3	1122.7	

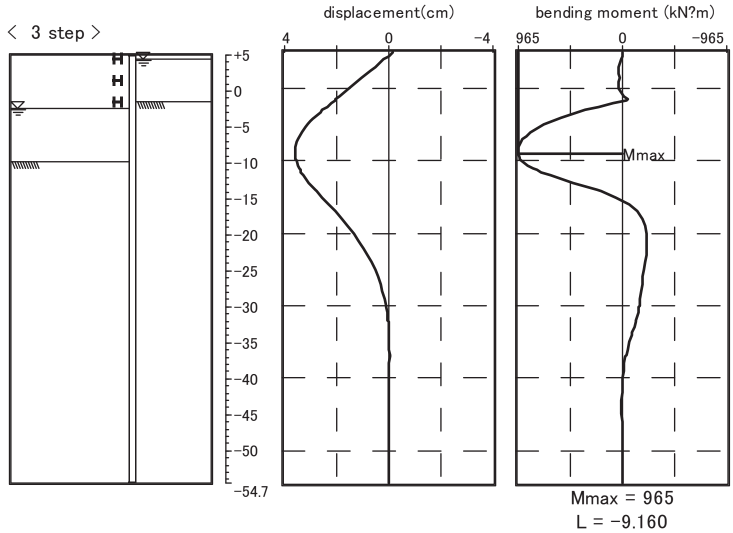
bending moment at support of footing concrete is reduced value

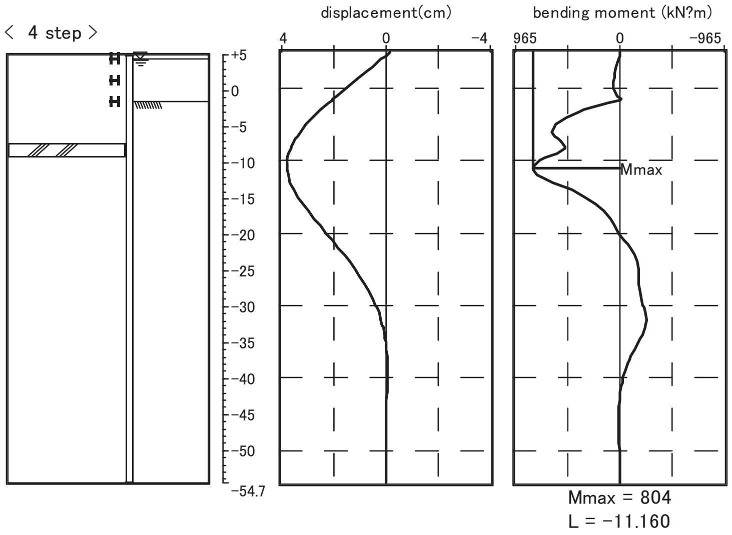
2.11 displacement / member force diagram

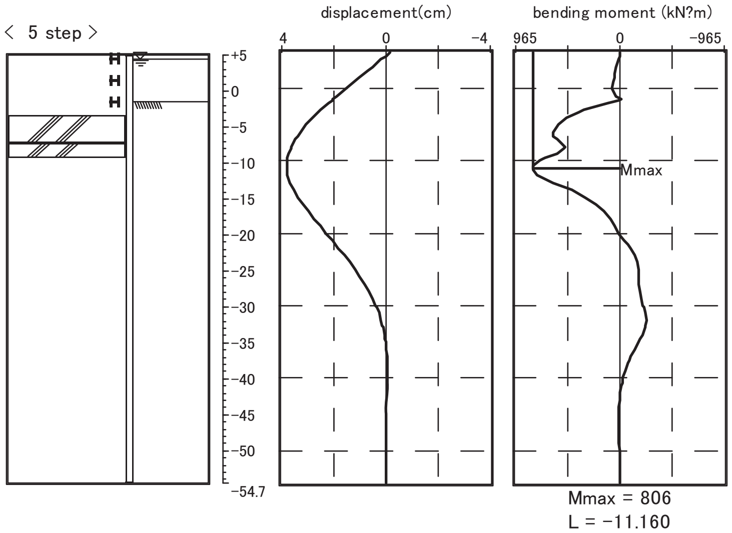
bridge axis direction



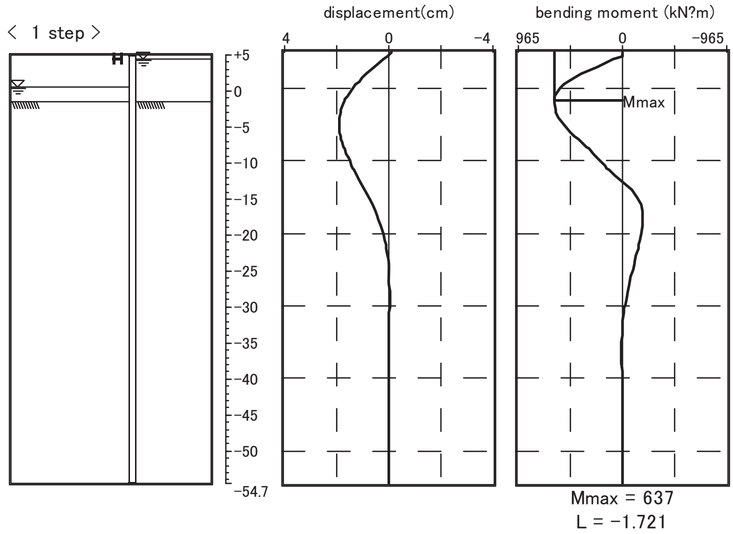

< 2 step >
displacement(cm)
bending moment (kN?m)
4
0
−4
965
0
−965
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−54.7
Mmax
Mmax = 651
L = −5.160

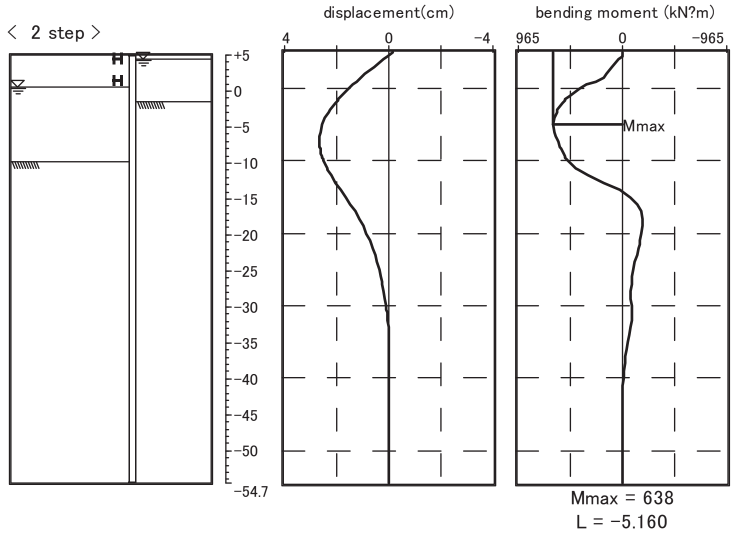

< 3 step >
displacement(cm)
bending moment (kN?m)
4
0
−4
965
0
−965
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−54.7
Mmax
Mmax = 965
L = −9.160

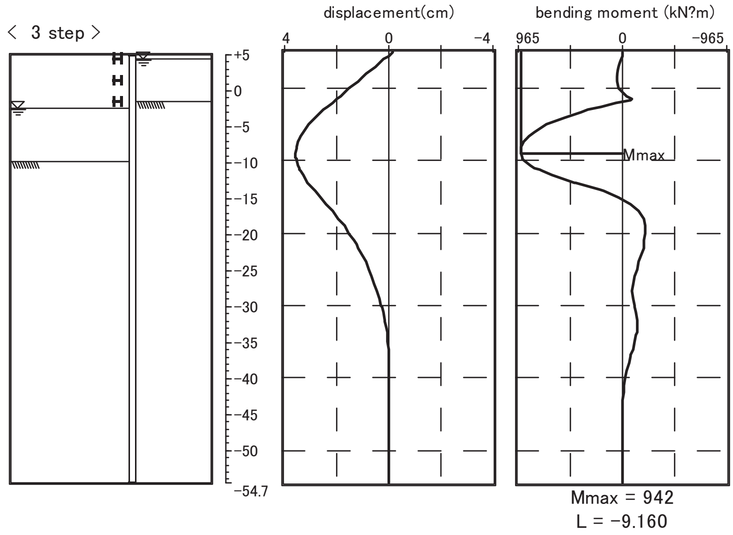

< 4 step >
displacement(cm)
bending moment (kN?m)
4
0
-4
965
0
-965
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-54.7
Mmax
Mmax = 804
L = -11.160

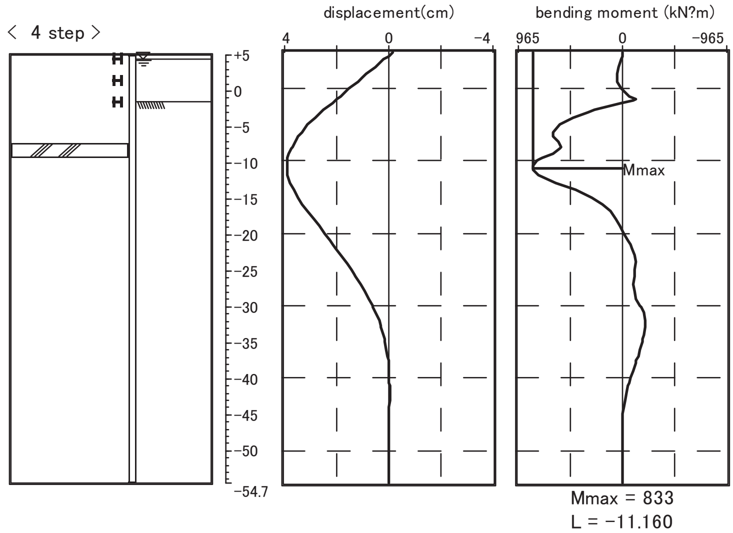

< 5 step >
displacement(cm)
bending moment (kN?m)
4
0
-4
965
0
-965
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-54.7
Mmax
Mmax = 806
L = -11.160

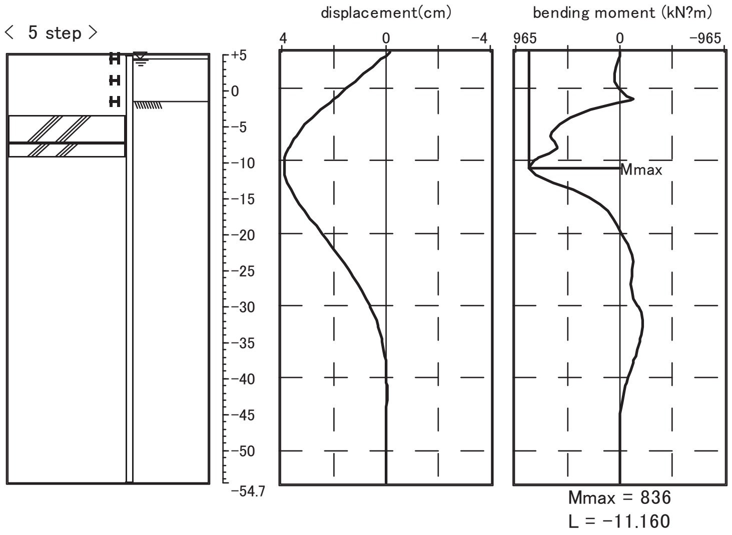
perpendicular direction






< 3 step >
displacement(cm)
bending moment (kN?m)
4
0
−4
965
0
−965
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−54.7
Mmax
Mmax = 942
L = −9.160


< 4 step >
displacement(cm)
bending moment (kN?m)
4
0
−4
965
0
−965
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−54.7
Mmax
Mmax = 833
L = −11.160



2.12 check timbering

(1) section performance

1)bridge axis direction (linear)

**wailing

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

2)perpendicular direction (arc)

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
2	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
3	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89

(2) maximum timbering reaction Rmax (kN/m)

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
1	H-300*300*10*15	164.61	H-300*300*10*15	164.53
2	H-300*300*10*15	147.05	H-300*300*10*15	150.04
3	2H-350*350*12*19	202.79	2H-350*350*12*19	211.94

note)double timbering is 1/2 value

(3)arc part

1)check of ring buckling

about buckling of arc wailing, following equation to calculate allowable timbering reaction in considertaion of ring buckling safety is checked

$$Ra = \frac{2*E*Iy}{r^3} >= R1max$$

where, Ra : allowable timbering reaction (N/mm)

E : Young's modulus of wailing = 2.00 * 10^5(N/mm^2)

Iy : moment of inertia of wailing(mm^4)

r : radius of circular timbering (mm)

R1max : maximum timbering reaction (N/mm) ------ perpendicular direction(arc part)

row	section	r (cm)	Iy (cm^4)	Ra (kN/m)	R1max (kN/m)	judge
1	H-300*300*10*15	296.06	20200	3113.70	164.53	OK
2	H-300*300*10*15	296.06	20200	3113.70	150.04	OK
3	2H-350*350*12*19	293.56	39800	6292.99	211.94	OK

2)wailing stress check

arc wailing may be calculated as an axial compression member under uniformly distributed pressure

Acutually, irregular shape of timbering and precision to cast steel pipe sheet pile (actual observation, radius in oval part about 1 to 2%), because imbalanced pressure induced moment is observed,

for safety, following procedure is taken to consider influence of ovalization in principle

stress working at wailing is given by the following equation.

$$Sig.s = \frac{N}{A} + \frac{M1 + M2}{Z} <= Sig.sa$$

where, Sig.s : stress of wailing(N/mm^2)

Sig.sa : allowable stress of wailing (N/mm^2)

A : sectional area of wailing (mm^2)

Z : section coefficient of wailing (mm^3)

N : axial force (N) = R1max * r

R1max : maximum timbering reaction (N/mm)

r : radius of wailing (mm)

M1 : bending moment in consideration of ovalization (N.mm) = R1max * r^2* Del.

Del. : ovalization rate, 2% wailing radius is supposed to be standard.

M2 : support point bending moment in linear part (N.mm) = (R2max.L1^2) / 12

R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)

L1 : effective span in linear part of wailing (mm)

row	section	A (cm^2)	Z (cm^3)	R1max (kN/m)	R2max (kN/m)	r (cm)
1	H-300*300*10*15	118.40	1350	164.53	164.61	296.06
2	H-300*300*10*15	118.40	1350	150.04	147.05	296.06
3	2H-350*350*12*19	171.90	2280	211.94	202.79	293.56

row	L1 (m)	N (kN)	M1 (kN.m)	M2 (kN.m)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	judge
1	2.700	487.1	28.8	100.0	136.58	210.00	OK
2	2.700	444.2	26.3	89.3	123.17	210.00	OK
3	2.700	622.2	36.5	123.2	106.25	210.00	OK

(4)linear part

1)check of wailing

wailing in linear part is a member which receives both axial compressive force and bending moment together are supposed to be checked using the following equation
besides, as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy * \left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0 \quad --- \quad check1$$

$$Sig.c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} <= Sig.cal \quad --- \quad check2$$

where, Sig.c : compressive stress by axial force acting on check section (N/mm^2)
Sig.bcy : bending compressive stress by bending moment about strong axis (N/mm^2)
Sig.caz : about weak axis allowable axial direction compressive stress (N/mm^2)

$$\frac{L5}{rz} <= 18 : Sig.caz = 210.0$$

$$18 < \frac{L5}{rz} <= 92 : Sig.caz = 1.5*\left\{ 140.0 - 0.82\left(\frac{L5}{rz} - 18\right) \right\}$$

$$92 < \frac{L5}{rz} \quad : Sig.caz = \frac{1.5*1,200,000}{6700 + \left(\frac{L5}{rz}\right)^2}$$

L5 : about weak axis effective buckling length (mm)
rz : about weak axis section second radius (mm)
Sig.bagy : without considering local tbuckling, allowable bending compressive stress about strong axis (N/mm^2)

$$\frac{L2}{b} <= 4.5 \quad : Sig.bagy = 210.0$$

$$4.5 < \frac{L2}{b} <= 30 \quad : Sig.bagy = 1.5*\left\{ 140.0 - 2.4\left(\frac{L2}{b} - 4.5 \right) \right\}$$

L2 : distance between fixed flange (mm)
b : compressive flange width (mm)
Sig.cal : allowable stress for local buckling of protrusion under compressive force (N/mm^2)
(= 210.0 (N/mm^2))

Sig.eay : Euler buckling stress about strong axis(N/mm^2) = $\frac{1,200,000}{\left(\frac{L4}{ry}\right)^2}$

L4 : effective buckling length about strong axis (mm)
ry : section second radius about strong axis (mm)

a)stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0$$

N = R1max*r + Del.N

$$M = \frac{R2max*L1^2}{8}$$

$$sc = \frac{N}{A}, \quad sbcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \quad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, R1max : maximum timbering reaction (N/mm) perpendicular direction(arc part)
R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)
N : axial force (N)
L : maximum strut spacing (mm)
L' : brace setting length (mm)
L1 : effective buckling length (mm) = L - L'
L2 : distance between fixed flange (mm)
L4 : effective buckling length about strong axis (mm)
L5 : effective buckling length about weak axis (mm)

row	section	A (cm^2)	Z (cm^3)	r (cm)	L (m)	L' (m)	L1 (m)	L2 (m)	L4 (m)	L5 (m)
1	H-300*300*10*15	118.40	1350	296.06	4.000	1.300	2.700	2.700	2.700	2.700
2	H-300*300*10*15	118.40	1350	296.06	4.000	1.300	2.700	2.700	2.700	2.700
3	2H-350*350*12*19	171.90	2280	293.56	4.000	1.300	2.700	2.700	2.700	2.700

row	L5/rz	Sig.caz (N/mm²)	L2/b	Sig.bagy (N/mm²)	L4/ry (m)	Sig.eay (N/mm²)
1	35.76	188.15	9.00	193.80	20.61	2824.86
2	35.76	188.15	9.00	193.80	20.61	2824.86
3	30.37	194.78	7.71	198.43	17.76	3803.13

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	164.53	164.61	637.10	150.00	53.81	111.11
2	150.04	147.05	594.21	134.00	50.19	99.26
3	211.94	202.79	772.17	184.79	44.92	81.05

row	Alp.	Beta	Alp.+Beta	judgement
1	0.286	0.584	0.870	OK
2	0.267	0.521	0.788	OK
3	0.231	0.413	0.644	OK

b)stability check2

$$\text{Sig..c} + \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}} \le \text{Sig.cal}$$

$$\text{Gam.} = \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	53.81	111.11	2824.86	113.27	167.08	210.00	OK
2	50.19	99.26	2824.86	101.05	151.24	210.00	OK
3	44.92	81.05	3803.13	82.02	126.94	210.00	OK

c) check of shear stress

$$\text{Smax} = \frac{\text{R2max*L1}}{2}$$

$$\text{Tau.s} = \frac{\text{Smax}}{\text{Aw}} \le \text{Tau.sa}$$

where, Smax : maximum shear force (N)
Aw : web sectional area (mm^2)
Tau.s : accrue shear stress (N/mm^2)
Tau.sa : allowable shear stress (N/mm^2)

row	R2max (kN/m)	L1 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	164.61	2.700	222.22	27.00	82.30	120.00	OK
2	147.05	2.700	198.52	27.00	73.52	120.00	OK
3	202.79	2.700	273.76	37.44	73.12	120.00	OK

2) check of strut

strut is a member which receives both axial compression force and bending moment with wailing likewise check. vertical load working at strut is sume of strut dead weight+surcharge load (w = 5.0 kN/m) as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

a) stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0$$

$$N = R2max*L1 + Del.N$$

$$M = \frac{w*L3^2}{8}$$

$$Sig.c = \frac{N}{A}, \quad Sig.bcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \quad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, L1 : axial force sharing width of strut (mm)
L2 : distance between fixed flange (mm)
L3 : strut bending span (mm)
L4 : effective buckling length about strong axis (mm)
L5 : effective buckling length about weak axis (mm)

row	section	A (cm2)	Z (cm3)	L1 (m)	L2 (m)	L3 (m)	L4 (m)	L5 (m)
1	H-300*300*10*15	118.40	1350	4.000	3.021	5.621	5.621	3.021
2	H-300*300*10*15	118.40	1350	4.000	3.021	5.621	5.621	3.021
3	2H-350*350*12*19	171.90	2280	4.000	2.921	5.521	5.521	2.921

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	40.01	182.92	10.07	189.95	42.91	651.77
2	40.01	182.92	10.07	189.95	42.91	651.77
3	32.86	191.73	8.35	196.16	36.32	909.56

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	164.53	164.61	808.43	19.75	68.28	14.63
2	150.04	147.05	738.19	19.75	62.35	14.63
3	211.94	202.79	961.15	19.05	55.91	8.36

row	Alp.	Beta	Alp.+Beta	judgement
1	0.373	0.086	0.459	OK
2	0.341	0.085	0.426	OK
3	0.292	0.045	0.337	OK

b)stability check2

$$Sig..c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} <= Sig.cal$$

$$Gam. = \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	68.28	14.63	651.77	16.34	84.62	210.00	OK
2	62.35	14.63	651.77	16.17	78.52	210.00	OK
3	55.91	8.36	909.56	8.90	64.82	210.00	OK

c) check of shear stress

$$Smax = \frac{5.0*L3}{2}$$

$$Tau.s = \frac{Smax}{Aw} <= Tau.sa$$

row	L3 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	5.621	14.05	27.00	5.20	120.00	OK
2	5.621	14.05	27.00	5.20	120.00	OK

row	L3 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
3	5.521	13.80	37.44	3.69	120.00	OK

3)check of brace beam

brace beam is a member which receives only axial compression force from wailing and use the following equation are supposed to be checked

$$Sig.c = \frac{N}{A} <= Sig.caz$$

$$N = \frac{(L1 + L2)*R2max}{2*cosTheta}$$

where, L : brace length (mm)

L1 : brace setting length (mm)

L2 : strut spacing - 2 * brace span (mm)

Theta : brace setting angle (Deg.)

row	section	A (cm2)	Theta (Deg.)	L (m)	L1 (m)	L2 (m)
1	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400
2	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400
3	2H-350*350*12*19	171.90	45.0	1.838	1.300	1.400

row	L/rz	R2max (kN/m)	N (kN)	Sig.c (N/mm2)	Sig.caz (N/mm2)	judgement
1	24.35	164.61	314.26	26.54	202.19	OK
2	24.35	147.05	280.74	23.71	202.19	OK
3	20.68	202.79	387.16	22.52	206.70	OK

2.13 check of embedment length

current ground surface elevation -1.721 (m)
riverside water table elevation +4.340 (m)
steel pipe sheet pile length 59.500 (m)

(1)final excavation time (4 step)
observing strut elevation = -1.660 (m)
coffered landside excavation area elevation = -9.950 (m)
coffered landside water table elevation = -9.950 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	-1.660 -1.721	0.061	------- -------	0.00 0.00	60.00 60.61
2	-1.721 -4.388	2.667	------- -------	0.00 0.00	60.61 87.28
3	-4.388 -6.704	2.316	------- -------	0.00 17.37	87.28 110.44
4	-6.704 -9.794	3.090	------- -------	7.37 30.55	110.44 141.34
5	-9.794 -9.950	0.156	------- -------	21.86 22.34	141.34 142.90
6	-9.950 -10.854	0.904	0.00 21.28	22.34 25.11	142.90 128.19
7	-10.854 -13.144	2.290	21.28 75.20	25.11 32.14	128.19 90.92
8	-13.144 -18.731	5.587	92.09 243.71	26.24 39.42	90.92 0.00

active earth pressure /water pressure Pa = 1821.0 (kN/m)
ya = 8.259 (m)
Ma = 15039 (kN.m/m)
passive earth pressure Pp = 1058.2 (kN/m)
yp = 14.212 (m)
Mp = 15039 (kN.m/m)
balanced depth Z = 8.781 (m) (elevation = -18.731 (m))
embedment length D = 10.537 (m) (elevation = -20.487 (m))

required sheet pile length L = 25.327 (m)

(2)before installation of the lower strut (2 step)
observing strut elevation = +1.340 (m)
coffered landside excavation area elevation = -9.950 (m)
coffered landside water table elevation = +0.340 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	+1.340 +0.340	1.000	------- -------	0.00 0.00	30.00 40.00
2	+0.340 -1.721	2.061	------- -------	0.00 0.00	40.00 8.51
3	-1.721 -4.388	2.667	------- -------	0.00 0.00	8.51 6.77
4	-4.388 -6.704	2.316	------- -------	0.00 17.37	6.77 5.25
5	-6.704 -9.794	3.090	------- -------	7.37 30.55	5.25 3.24
6	-9.794 -9.950	0.156	------- -------	21.86 22.34	3.24 3.14
7	-9.950 -10.854	0.904	0.00 21.28	22.34 25.11	3.14 2.55
8	-10.854 -13.144	2.290	21.28 75.20	25.11 32.14	2.55 1.05
9	-13.144 -14.755	1.611	92.09 135.81	26.24 30.04	1.05 0.00

active earth pressure /water pressure Pa = 551.4 (kN/m)
ya = 8.031 (m)
Ma = 4428 (kN.m/m)
passive earth pressure Pp = 303.7 (kN/m)
yp = 14.581 (m)
Mp = 4428 (kN.m/m)
balanced depth Z = 4.805 (m) (elevation = -14.755 (m))
embedment length D = 5.766 (m) (elevation = -15.716 (m))
required sheet pile length L = 20.556 (m)

3 composite stress calculation

3.1 maximum stress table

(1)bridge axis direction

1) material :SKY400

Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Wind+Temp	-11.160	29.10	66.97	96.07	189.00
2	Ord+Collision(scour)	-11.160	38.46	66.97	105.44	210.00
3	Earthquake(scour)	-11.450	75.16	66.85	142.00	210.00

(2)perpendicular direction

1) material :SKY400

Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Wind	-11.160	32.17	69.36	101.52	175.00
2	Ord+Collision(scour)	-11.160	46.81	69.36	116.17	210.00
3	Earthquake(scour)	-11.160	69.57	69.36	138.93	210.00

occurence location shows elevation

Sig.1 : stress after completion by design external force

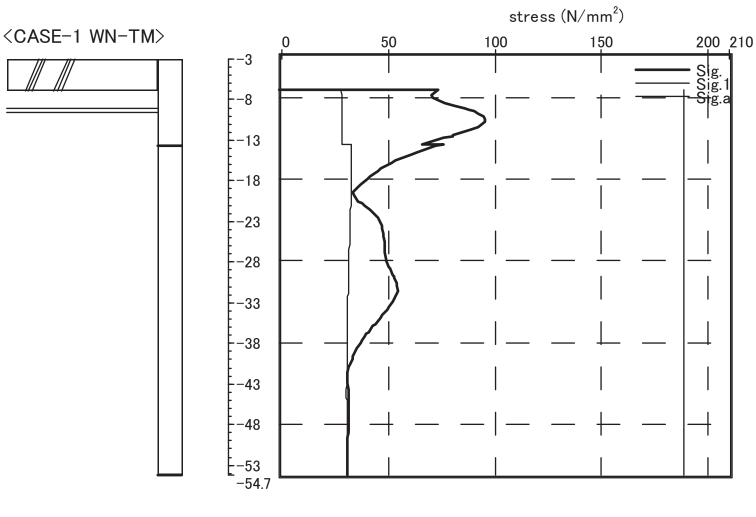
Sig.2 : resultant stress(4 step)

Sig.max: composite stress

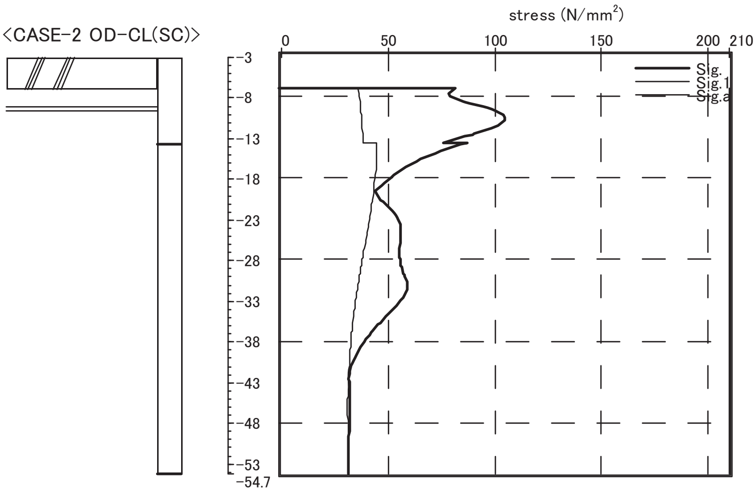
Sig.a : allowabe stress of steel pipe sheet pile

3.2 stress distribution diagram

(1)bridge axis direction



<CASE-2 OD-CL(SC)>



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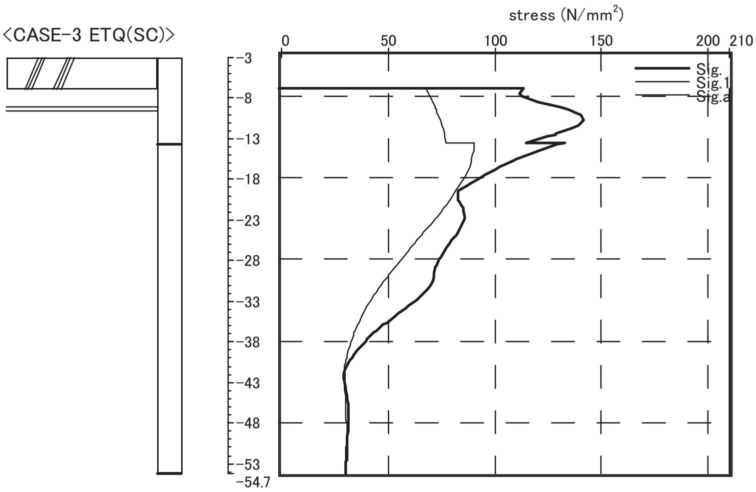
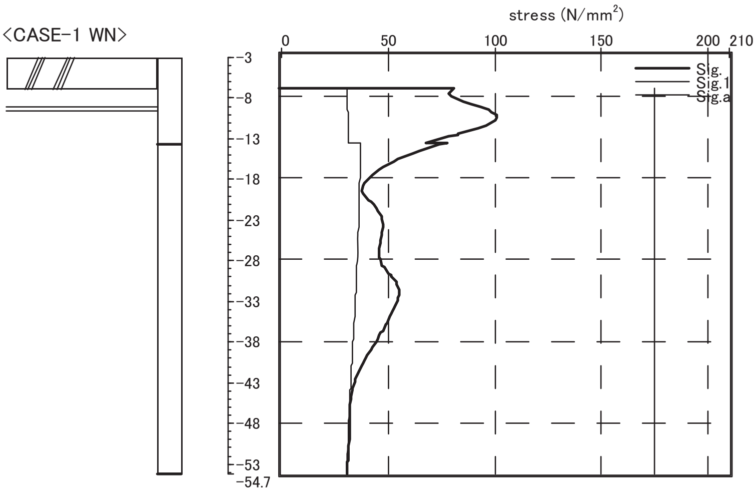
<CASE-3 ETQ(SC)>

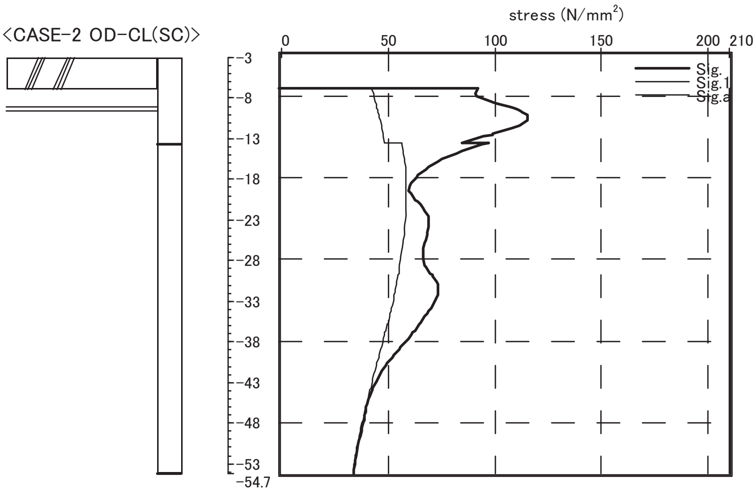


(2)perpendicular direction

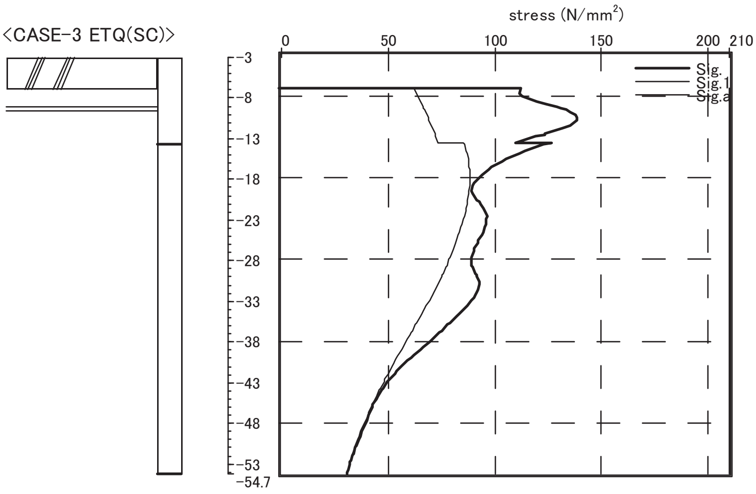
<CASE-1 WN>



<CASE-2 OD-CL(SC)>



<CASE-3 ETQ(SC)>



3.3 detail output

(1)bridge axis direction

1)Wind+Temp

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	28.95	45.42	74.38	
-8.160	28.99	42.08	71.07	
-8.450	29.01	42.62	71.63	
-9.160	29.04	48.48	77.52	
-9.450	29.05	52.74	81.79	
-9.794	29.06	57.78	86.84	
-9.950	29.07	59.70	88.77	
-10.160	29.07	61.88	90.95	
-10.450	29.08	63.74	92.82	
-10.854	29.09	66.33	95.42	
-11.160	29.10	66.97	96.07	**
-11.450	29.10	66.85	95.95	
-12.160	29.12	63.52	92.63	
-12.450	29.12	60.09	89.21	
-13.144	29.13	51.87	81.00	
-13.160	29.13	51.62	80.75	
-13.450	29.13	47.50	76.63	
-14.160	29.12	37.42	66.55	
-14.160	33.92	42.55	76.47	
-14.450	33.91	38.92	72.84	
-15.160	33.89	30.04	63.93	
-15.450	33.88	27.31	61.19	
-16.160	33.84	20.64	54.49	
-16.450	33.83	18.64	52.47	
-17.160	33.78	13.75	47.53	
-17.450	33.76	12.27	46.03	
-18.160	33.70	8.65	42.35	
-18.450	33.68	7.47	41.15	
-19.160	33.61	4.59	38.20	
-19.450	33.59	3.48	37.06	
-20.160	33.51	0.76	34.27	
-20.450	33.48	1.60	35.08	
-21.160	33.41	3.65	37.06	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-21.450	33.38	5.22	38.59	
-21.704	33.35	6.59	39.93	
-22.160	33.30	9.00	42.30	
-22.450	33.26	10.08	43.35	
-23.160	33.18	12.74	45.92	
-23.450	33.15	13.34	46.49	
-24.160	33.06	14.83	47.89	
-24.450	33.03	15.12	48.15	
-25.160	32.94	15.85	48.79	
-25.450	32.91	15.97	48.88	
-26.160	32.82	16.29	49.11	
-26.450	32.79	16.39	49.17	
-27.160	32.70	16.62	49.32	
-27.450	32.67	16.79	49.46	
-28.160	32.59	17.22	49.80	
-28.450	32.55	17.56	50.11	
-29.160	32.47	18.41	50.88	
-29.450	32.44	19.01	51.45	
-30.160	32.35	20.48	52.83	
-30.384	32.33	21.08	53.41	
-30.450	32.32	21.21	53.53	
-31.160	32.24	22.64	54.88	
-31.450	32.21	22.75	54.96	
-32.160	32.14	23.02	55.16	
-32.450	32.11	22.74	54.86	
-32.831	32.08	22.38	54.45	
-33.160	32.04	21.81	53.86	
-33.450	32.02	21.10	53.12	
-34.160	31.96	19.35	51.31	
-34.450	31.93	18.47	50.40	
-34.771	31.91	17.50	49.41	
-35.160	31.88	16.25	48.13	
-35.450	31.85	15.31	47.16	
-36.160	31.80	12.99	44.79	
-36.450	31.78	12.08	43.87	
-37.160	31.74	9.87	41.61	
-37.450	31.72	9.04	40.76	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-37.728	31.70	8.24	39.95	
-38.160	31.68	7.09	38.77	
-38.450	31.66	6.41	38.08	
-39.160	31.63	4.75	36.38	
-39.450	31.61	4.21	35.82	
-40.160	31.58	2.87	34.46	
-40.450	31.57	2.44	34.01	
-40.846	31.56	1.85	33.40	
-41.160	31.55	1.44	32.99	
-41.450	31.54	1.14	32.68	
-42.160	31.51	0.41	31.92	
-42.450	31.51	0.37	31.88	
-43.160	31.49	0.29	31.78	
-43.450	31.48	0.41	31.89	
-44.160	31.47	0.71	32.18	
-44.450	31.46	0.77	32.23	
-45.160	31.47	0.92	32.39	
-45.450	31.47	0.94	32.41	
-46.160	31.48	0.99	32.46	
-46.450	31.48	0.97	32.45	
-47.160	31.49	0.94	32.43	
-47.450	31.49	0.91	32.40	
-48.160	31.49	0.83	32.33	
-48.450	31.50	0.79	32.28	
-49.160	31.50	0.68	32.18	
-49.450	31.50	0.64	32.14	
-50.160	31.50	0.52	32.02	
-50.450	31.50	0.48	31.98	
-51.160	31.50	0.36	31.87	
-51.450	31.50	0.32	31.82	
-52.160	31.50	0.21	31.72	
-52.450	31.50	0.18	31.68	
-52.954	31.50	0.11	31.61	
-53.160	31.50	0.09	31.59	
-53.450	31.50	0.06	31.56	
-54.160	31.50	0.01	31.51	
-54.450	31.50	0.00	31.50	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	31.50	0.00	31.50	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

2)Ord+Collision(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	36.86	45.42	82.28	
-8.160	37.25	42.08	79.33	
-8.450	37.41	42.62	80.03	
-9.160	37.73	48.48	86.21	
-9.450	37.86	52.74	90.60	
-9.794	38.00	57.78	95.78	
-9.950	38.05	59.70	97.76	
-10.160	38.13	61.88	100.00	
-10.450	38.23	63.74	101.97	
-10.854	38.37	66.33	104.70	
-11.160	38.46	66.97	105.44	**
-11.450	38.55	66.85	105.40	
-12.160	38.75	63.52	102.27	
-12.450	38.83	60.09	98.92	
-13.144	39.00	51.87	90.87	
-13.160	39.00	51.62	90.62	
-13.450	39.06	47.50	86.57	
-14.160	39.16	37.42	76.58	
-14.160	45.60	42.55	88.15	
-14.450	45.62	38.92	84.54	
-15.160	45.61	30.04	75.65	
-15.450	45.61	27.31	72.92	
-16.160	45.51	20.64	66.15	
-16.450	45.46	18.64	64.11	
-17.160	45.28	13.75	59.03	
-17.450	45.21	12.27	57.48	
-18.160	44.96	8.65	53.61	
-18.450	44.86	7.47	52.33	
-19.160	44.55	4.59	49.14	
-19.450	44.43	3.48	47.90	
-20.160	44.08	0.76	44.83	
-20.450	43.93	1.60	45.53	
-21.160	43.54	3.65	47.20	
-21.450	43.38	5.22	48.60	
-21.704	43.24	6.59	49.82	
-22.160	42.97	9.00	51.96	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	42.79	10.08	52.88	
-23.160	42.35	12.74	55.09	
-23.450	42.17	13.34	55.52	
-24.160	41.71	14.83	56.55	
-24.450	41.53	15.12	56.65	
-25.160	41.06	15.85	56.91	
-25.450	40.87	15.97	56.85	
-26.160	40.40	16.29	56.69	
-26.450	40.20	16.39	56.59	
-27.160	39.73	16.62	56.35	
-27.450	39.54	16.79	56.33	
-28.160	39.06	17.22	56.28	
-28.450	38.87	17.56	56.43	
-29.160	38.40	18.41	56.81	
-29.450	38.21	19.01	57.22	
-30.160	37.74	20.48	58.22	
-30.384	37.60	21.08	58.67	
-30.450	37.55	21.21	58.76	
-31.160	37.11	22.64	59.74	
-31.450	36.92	22.75	59.67	
-32.160	36.50	23.02	59.52	
-32.450	36.32	22.74	59.07	
-32.831	36.11	22.38	58.49	
-33.160	35.93	21.81	57.74	
-33.450	35.76	21.10	56.86	
-34.160	35.39	19.35	54.75	
-34.450	35.24	18.47	53.72	
-34.771	35.09	17.50	52.59	
-35.160	34.90	16.25	51.15	
-35.450	34.76	15.31	50.07	
-36.160	34.45	12.99	47.44	
-36.450	34.32	12.08	46.41	
-37.160	34.04	9.87	43.91	
-37.450	33.93	9.04	42.97	
-37.728	33.83	8.24	42.07	
-38.160	33.67	7.09	40.77	
-38.450	33.57	6.41	39.99	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	33.35	4.75	38.10	
-39.450	33.26	4.21	37.46	
-40.160	33.06	2.87	35.93	
-40.450	32.98	2.44	35.42	
-40.846	32.88	1.85	34.73	
-41.160	32.81	1.44	34.25	
-41.450	32.74	1.14	33.88	
-42.160	32.59	0.41	33.00	
-42.450	32.53	0.37	32.90	
-43.160	32.40	0.29	32.69	
-43.450	32.35	0.41	32.76	
-44.160	32.25	0.71	32.96	
-44.450	32.21	0.77	32.98	
-45.160	32.12	0.92	33.04	
-45.450	32.08	0.94	33.03	
-46.160	32.02	0.99	33.00	
-46.450	31.99	0.97	32.96	
-47.160	32.04	0.94	32.98	
-47.450	32.07	0.91	32.97	
-48.160	32.11	0.83	32.94	
-48.450	32.12	0.79	32.91	
-49.160	32.15	0.68	32.84	
-49.450	32.17	0.64	32.80	
-50.160	32.19	0.52	32.71	
-50.450	32.20	0.48	32.67	
-51.160	32.21	0.36	32.57	
-51.450	32.22	0.32	32.54	
-52.160	32.22	0.21	32.44	
-52.450	32.23	0.18	32.40	
-52.954	32.23	0.11	32.34	
-53.160	32.23	0.09	32.32	
-53.450	32.23	0.06	32.30	
-54.160	32.23	0.01	32.24	
-54.450	32.23	0.00	32.24	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	32.23	0.00	32.23	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

3)Earthquake(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	68.76	45.42	114.19	
-8.160	70.06	42.08	112.14	
-8.450	70.59	42.62	113.21	
-9.160	71.76	48.48	120.25	
-9.450	72.24	52.74	124.98	
-9.794	72.77	57.78	130.56	
-9.950	73.01	59.70	132.71	
-10.160	73.32	61.88	135.20	
-10.450	73.75	63.74	137.49	
-10.854	74.33	66.33	140.66	
-11.160	74.76	66.97	141.73	
-11.450	75.16	66.85	142.00	**
-12.160	76.05	63.52	139.57	
-12.450	76.42	60.09	136.50	
-13.144	77.21	51.87	129.09	
-13.160	77.23	51.62	128.85	
-13.450	77.51	47.50	125.02	
-14.160	77.94	37.42	115.37	
-14.160	90.72	42.55	133.28	
-14.450	90.81	38.92	129.73	
-15.160	90.68	30.04	120.72	
-15.450	90.63	27.31	117.94	
-16.160	90.04	20.64	110.68	
-16.450	89.80	18.64	108.44	
-17.160	88.81	13.75	102.56	
-17.450	88.41	12.27	100.68	
-18.160	87.09	8.65	95.75	
-18.450	86.56	7.47	94.03	
-19.160	84.97	4.59	89.56	
-19.450	84.33	3.48	87.80	
-20.160	82.52	0.76	83.28	
-20.450	81.79	1.60	83.38	
-21.160	79.82	3.65	83.47	
-21.450	79.01	5.22	84.23	
-21.704	78.28	6.59	84.86	
-22.160	76.92	9.00	85.92	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	76.06	10.08	86.14	
-23.160	73.88	12.74	86.61	
-23.450	72.98	13.34	86.33	
-24.160	70.75	14.83	85.58	
-24.450	69.83	15.12	84.96	
-25.160	67.56	15.85	83.41	
-25.450	66.64	15.97	82.61	
-26.160	64.36	16.29	80.65	
-26.450	63.43	16.39	79.82	
-27.160	61.16	16.62	77.78	
-27.450	60.24	16.79	77.03	
-28.160	58.00	17.22	75.21	
-28.450	57.08	17.56	74.64	
-29.160	54.88	18.41	73.29	
-29.450	53.97	19.01	72.99	
-30.160	51.81	20.48	72.29	
-30.384	51.13	21.08	72.21	
-30.450	50.93	21.21	72.14	
-31.160	48.88	22.64	71.51	
-31.450	48.04	22.75	70.78	
-32.160	46.13	23.02	69.15	
-32.450	45.35	22.74	68.09	
-32.831	44.40	22.38	66.78	
-33.160	43.59	21.81	65.40	
-33.450	42.87	21.10	63.97	
-34.160	41.28	19.35	60.63	
-34.450	40.62	18.47	59.10	
-34.771	39.97	17.50	57.47	
-35.160	39.19	16.25	55.44	
-35.450	38.60	15.31	53.90	
-36.160	37.32	12.99	50.30	
-36.450	36.79	12.08	48.88	
-37.160	35.66	9.87	45.53	
-37.450	35.20	9.04	44.24	
-37.728	34.81	8.24	43.06	
-38.160	34.21	7.09	41.31	
-38.450	33.81	6.41	40.23	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	32.96	4.75	37.71	
-39.450	32.62	4.21	36.82	
-40.160	31.89	2.87	34.77	
-40.450	31.60	2.44	34.04	
-40.846	31.26	1.85	33.11	
-41.160	31.00	1.44	32.44	
-41.450	30.75	1.14	31.89	
-42.160	30.26	0.41	30.66	
-42.450	30.05	0.37	30.43	
-43.160	30.19	0.29	30.48	
-43.450	30.25	0.41	30.66	
-44.160	30.56	0.71	31.27	
-44.450	30.69	0.77	31.46	
-45.160	30.92	0.92	31.84	
-45.450	31.01	0.94	31.96	
-46.160	31.18	0.99	32.16	
-46.450	31.25	0.97	32.22	
-47.160	31.35	0.94	32.30	
-47.450	31.40	0.91	32.31	
-48.160	31.46	0.83	32.29	
-48.450	31.48	0.79	32.27	
-49.160	31.51	0.68	32.19	
-49.450	31.52	0.64	32.15	
-50.160	31.51	0.52	32.03	
-50.450	31.50	0.48	31.98	
-51.160	31.47	0.36	31.84	
-51.450	31.46	0.32	31.78	
-52.160	31.42	0.21	31.63	
-52.450	31.40	0.18	31.58	
-52.954	31.36	0.11	31.47	
-53.160	31.35	0.09	31.43	
-53.450	31.33	0.06	31.39	
-54.160	31.28	0.01	31.29	
-54.450	31.26	0.00	31.26	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	31.25	0.00	31.25	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

(2)perpendicular direction
1)Wind

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	31.78	49.73	81.51	
-8.160	31.87	47.54	79.41	
-8.450	31.90	48.28	80.18	
-9.160	31.98	53.90	85.88	
-9.450	32.01	57.73	89.74	
-9.794	32.04	62.27	94.31	
-9.950	32.06	63.94	96.00	
-10.160	32.08	65.78	97.86	
-10.450	32.11	67.20	99.30	
-10.854	32.14	69.17	101.31	
-11.160	32.17	69.36	101.52	**
-11.450	32.19	68.80	101.00	
-12.160	32.25	64.46	96.71	
-12.450	32.28	60.63	92.91	
-13.144	32.33	51.47	83.80	
-13.160	32.33	51.19	83.52	
-13.450	32.35	46.75	79.10	
-14.160	32.39	35.87	68.27	
-14.160	37.72	40.79	78.51	
-14.450	37.73	36.92	74.65	
-15.160	37.76	27.43	65.19	
-15.450	37.77	24.58	62.35	
-16.160	37.78	17.58	55.36	
-16.450	37.78	15.55	53.33	
-17.160	37.77	10.57	48.34	
-17.450	37.77	9.15	46.92	
-18.160	37.74	5.67	43.41	
-18.450	37.73	4.64	42.37	
-19.160	37.69	2.10	39.80	
-19.450	37.68	1.77	39.44	
-20.160	37.63	0.93	38.56	
-20.450	37.60	1.90	39.50	
-21.160	37.54	4.25	41.79	
-21.450	37.52	5.43	42.95	
-21.704	37.49	6.46	43.95	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.160	37.44	8.23	45.67	
-22.450	37.41	8.89	46.30	
-23.160	37.33	10.52	47.85	
-23.450	37.29	10.73	48.02	
-24.160	37.20	11.22	48.42	
-24.450	37.17	11.14	48.31	
-25.160	37.07	10.95	48.02	
-25.450	37.03	10.77	47.80	
-26.160	36.92	10.33	47.25	
-26.450	36.88	10.20	47.08	
-27.160	36.77	9.90	46.67	
-27.450	36.72	9.99	46.71	
-28.160	36.61	10.20	46.81	
-28.450	36.56	10.64	47.20	
-29.160	36.44	11.72	48.15	
-29.450	36.39	12.63	49.02	
-30.160	36.26	14.88	51.15	
-30.384	36.23	15.86	52.09	
-30.450	36.21	16.09	52.31	
-31.160	36.08	18.57	54.66	
-31.450	36.03	18.99	55.02	
-32.160	35.89	20.01	55.90	
-32.450	35.84	20.02	55.86	
-32.831	35.76	20.05	55.81	
-33.160	35.69	19.87	55.57	
-33.450	35.64	19.56	55.20	
-34.160	35.49	18.80	54.29	
-34.450	35.43	18.36	53.79	
-34.771	35.36	17.87	53.23	
-35.160	35.28	17.22	52.50	
-35.450	35.22	16.70	51.92	
-36.160	35.06	15.42	50.48	
-36.450	35.00	14.86	49.86	
-37.160	34.85	13.48	48.33	
-37.450	34.79	12.88	47.66	
-37.728	34.73	12.30	47.03	
-38.160	34.63	11.36	45.99	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-38.450	34.57	10.71	45.28	
-39.160	34.42	9.12	43.53	
-39.450	34.35	8.49	42.84	
-40.160	34.20	6.96	41.16	
-40.450	34.14	6.39	40.53	
-40.846	34.06	5.60	39.66	
-41.160	33.99	5.03	39.02	
-41.450	33.93	4.55	38.48	
-42.160	33.78	3.39	37.18	
-42.450	33.72	3.01	36.74	
-43.160	33.58	2.08	35.66	
-43.450	33.52	1.79	35.31	
-44.160	33.38	1.08	34.46	
-44.450	33.33	0.87	34.19	
-45.160	33.19	0.36	33.55	
-45.450	33.14	0.29	33.42	
-46.160	33.01	0.12	33.13	
-46.450	32.95	0.21	33.16	
-47.160	32.83	0.41	33.23	
-47.450	32.78	0.44	33.22	
-48.160	32.66	0.54	33.19	
-48.450	32.61	0.54	33.15	
-49.160	32.50	0.55	33.05	
-49.450	32.45	0.54	32.98	
-50.160	32.34	0.49	32.83	
-50.450	32.30	0.46	32.76	
-51.160	32.20	0.38	32.58	
-51.450	32.16	0.34	32.50	
-52.160	32.07	0.25	32.31	
-52.450	32.03	0.21	32.23	
-52.954	31.97	0.14	32.10	
-53.160	31.94	0.11	32.05	
-53.450	31.91	0.08	31.99	
-54.160	31.84	0.01	31.86	
-54.450	31.82	0.01	31.82	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	31.80	0.00	31.80	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

2)Ord+Collision(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	43.18	49.73	92.91	
-8.160	43.94	47.54	91.48	
-8.450	44.25	48.28	92.52	
-9.160	44.95	53.90	98.86	
-9.450	45.24	57.73	102.97	
-9.794	45.57	62.27	107.84	
-9.950	45.72	63.94	109.66	
-10.160	45.91	65.78	111.69	
-10.450	46.18	67.20	113.37	
-10.854	46.54	69.17	115.71	
-11.160	46.81	69.36	116.17	**
-11.450	47.07	68.80	115.87	
-12.160	47.67	64.46	112.13	
-12.450	47.92	60.63	108.55	
-13.144	48.49	51.47	99.96	
-13.160	48.51	51.19	99.70	
-13.450	48.73	46.75	95.49	
-14.160	49.25	35.87	85.12	
-14.160	57.32	40.79	98.12	
-14.450	57.54	36.92	94.46	
-15.160	58.01	27.43	85.44	
-15.450	58.20	24.58	82.78	
-16.160	58.56	17.58	76.15	
-16.450	58.71	15.55	74.26	
-17.160	58.98	10.57	69.55	
-17.450	59.09	9.15	68.24	
-18.160	59.27	5.67	64.94	
-18.450	59.34	4.64	63.98	
-19.160	59.44	2.10	61.54	
-19.450	59.48	1.77	61.24	
-20.160	59.49	0.93	60.43	
-20.450	59.50	1.90	61.40	
-21.160	59.45	4.25	63.70	
-21.450	59.43	5.43	64.86	
-21.704	59.39	6.46	65.85	
-22.160	59.31	8.23	67.54	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-22.450	59.26	8.89	68.15	
-23.160	59.08	10.52	69.61	
-23.450	59.01	10.73	69.74	
-24.160	58.79	11.22	70.01	
-24.450	58.69	11.14	69.84	
-25.160	58.42	10.95	69.37	
-25.450	58.31	10.77	69.08	
-26.160	57.99	10.33	68.32	
-26.450	57.86	10.20	68.07	
-27.160	57.51	9.90	67.41	
-27.450	57.36	9.99	67.35	
-28.160	56.97	10.20	67.18	
-28.450	56.81	10.64	67.46	
-29.160	56.39	11.72	68.11	
-29.450	56.22	12.63	68.86	
-30.160	55.77	14.88	70.66	
-30.384	55.63	15.86	71.50	
-30.450	55.59	16.09	71.68	
-31.160	55.10	18.57	73.67	
-31.450	54.90	18.99	73.89	
-32.160	54.35	20.01	74.36	
-32.450	54.13	20.02	74.15	
-32.831	53.81	20.05	73.86	
-33.160	53.54	19.87	73.41	
-33.450	53.30	19.56	72.86	
-34.160	52.67	18.80	71.47	
-34.450	52.41	18.36	70.77	
-34.771	52.12	17.87	69.99	
-35.160	51.76	17.22	68.98	
-35.450	51.49	16.70	68.19	
-36.160	50.80	15.42	66.22	
-36.450	50.52	14.86	65.38	
-37.160	49.82	13.48	63.30	
-37.450	49.53	12.88	62.41	
-37.728	49.25	12.30	61.55	
-38.160	48.82	11.36	60.17	
-38.450	48.52	10.71	59.23	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-39.160	47.80	9.12	56.91	
-39.450	47.50	8.49	55.99	
-40.160	46.78	6.96	53.73	
-40.450	46.48	6.39	52.86	
-40.846	46.07	5.60	51.68	
-41.160	45.75	5.03	50.78	
-41.450	45.46	4.55	50.01	
-42.160	44.74	3.39	48.13	
-42.450	44.44	3.01	47.45	
-43.160	43.73	2.08	45.81	
-43.450	43.44	1.79	45.23	
-44.160	42.74	1.08	43.82	
-44.450	42.46	0.87	43.32	
-45.160	41.77	0.36	42.13	
-45.450	41.49	0.29	41.78	
-46.160	40.83	0.12	40.96	
-46.450	40.56	0.21	40.77	
-47.160	39.92	0.41	40.33	
-47.450	39.66	0.44	40.11	
-48.160	39.05	0.54	39.58	
-48.450	38.80	0.54	39.34	
-49.160	38.21	0.55	38.76	
-49.450	37.97	0.54	38.51	
-50.160	37.41	0.49	37.91	
-50.450	37.19	0.46	37.65	
-51.160	36.67	0.38	37.05	
-51.450	36.45	0.34	36.79	
-52.160	35.96	0.25	36.21	
-52.450	35.77	0.21	35.97	
-52.954	35.44	0.14	35.58	
-53.160	35.32	0.11	35.43	
-53.450	35.14	0.08	35.23	
-54.160	34.80	0.01	34.82	
-54.450	34.66	0.01	34.67	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-54.660	34.58	0.00	34.58	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

3)Earthquake(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-7.450	63.12	49.73	112.85	
-8.160	64.41	47.54	111.95	
-8.450	64.93	48.28	113.21	
-9.160	66.18	53.90	120.08	
-9.450	66.69	57.73	124.42	
-9.794	67.28	62.27	129.55	
-9.950	67.54	63.94	131.49	
-10.160	67.90	65.78	133.68	
-10.450	68.39	67.20	135.58	
-10.854	69.07	69.17	138.23	
-11.160	69.57	69.36	138.93	**
-11.450	70.05	68.80	138.85	
-12.160	71.19	64.46	135.65	
-12.450	71.65	60.63	132.28	
-13.144	72.73	51.47	124.20	
-13.160	72.75	51.19	123.95	
-13.450	73.18	46.75	119.94	
-14.160	74.11	35.87	109.99	
-14.160	86.24	40.79	127.04	
-14.450	86.63	36.92	123.55	
-15.160	87.40	27.43	114.84	
-15.450	87.72	24.58	112.30	
-16.160	88.25	17.58	105.83	
-16.450	88.47	15.55	104.02	
-17.160	88.77	10.57	99.34	
-17.450	88.89	9.15	98.05	
-18.160	88.99	5.67	94.66	
-18.450	89.03	4.64	93.67	
-19.160	88.93	2.10	91.04	
-19.450	88.90	1.77	90.66	
-20.160	88.63	0.93	89.56	
-20.450	88.52	1.90	90.42	
-21.160	88.10	4.25	92.35	
-21.450	87.92	5.43	93.35	
-21.704	87.74	6.46	94.20	
-22.160	87.36	8.23	95.59	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-22.450	87.13	8.89	96.02	
-23.160	86.44	10.52	96.97	
-23.450	86.16	10.73	96.89	
-24.160	85.37	11.22	96.59	
-24.450	85.04	11.14	96.19	
-25.160	84.15	10.95	95.11	
-25.450	83.79	10.77	94.56	
-26.160	82.82	10.33	93.14	
-26.450	82.42	10.20	92.62	
-27.160	81.37	9.90	91.27	
-27.450	80.94	9.99	90.93	
-28.160	79.83	10.20	90.03	
-28.450	79.37	10.64	90.02	
-29.160	78.21	11.72	89.92	
-29.450	77.73	12.63	90.36	
-30.160	76.51	14.88	91.40	
-30.384	76.13	15.86	91.99	
-30.450	76.02	16.09	92.11	
-31.160	74.73	18.57	93.30	
-31.450	74.20	18.99	93.19	
-32.160	72.83	20.01	92.84	
-32.450	72.27	20.02	92.30	
-32.831	71.50	20.05	91.55	
-33.160	70.84	19.87	90.71	
-33.450	70.25	19.56	89.81	
-34.160	68.77	18.80	87.56	
-34.450	68.16	18.36	86.52	
-34.771	67.47	17.87	85.35	
-35.160	66.64	17.22	83.86	
-35.450	66.02	16.70	82.72	
-36.160	64.47	15.42	79.89	
-36.450	63.84	14.86	78.70	
-37.160	62.29	13.48	75.77	
-37.450	61.66	12.88	74.53	
-37.728	61.05	12.30	73.35	
-38.160	60.10	11.36	71.46	
-38.450	59.47	10.71	70.18	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-39.160	57.92	9.12	67.04	
-39.450	57.29	8.49	65.78	
-40.160	55.76	6.96	62.72	
-40.450	55.14	6.39	61.53	
-40.846	54.30	5.60	59.91	
-41.160	53.64	5.03	58.66	
-41.450	53.02	4.55	57.58	
-42.160	51.55	3.39	54.95	
-42.450	50.95	3.01	53.96	
-43.160	49.52	2.08	51.60	
-43.450	48.93	1.79	50.72	
-44.160	47.54	1.08	48.62	
-44.450	46.98	0.87	47.84	
-45.160	45.63	0.36	45.99	
-45.450	45.08	0.29	45.37	
-46.160	43.79	0.12	43.92	
-46.450	43.26	0.21	43.47	
-47.160	42.03	0.41	42.43	
-47.450	41.52	0.44	41.96	
-48.160	40.34	0.54	40.88	
-48.450	39.86	0.54	40.40	
-49.160	38.74	0.55	39.29	
-49.450	38.28	0.54	38.81	
-50.160	37.22	0.49	37.71	
-50.450	36.79	0.46	37.25	
-51.160	35.79	0.38	36.17	
-51.450	35.39	0.34	35.73	
-52.160	34.46	0.25	34.70	
-52.450	34.08	0.21	34.28	
-52.954	33.45	0.14	33.59	
-53.160	33.22	0.11	33.32	
-53.450	32.88	0.08	32.96	
-54.160	32.21	0.01	32.22	
-54.450	31.94	0.01	31.94	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-54.660	31.77	0.00	31.77	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4 member calculation

4.1 calculation of pile cap

4.1.1 design condition

(1) calculation method : cantilever
(2) concrete design standard strength : Sig.ck = 24 (N/mm^2)
(3) rebar in use : SD345(underwater member)
(4) shape dimension
pile cap thickness h = 4.000 (m)
1)bridge axis direction
span length L = 1.611 (m)
shear stress check location Ls = 1.611 (m) (distance from external edge of leg column)
center spacing of steel pipe sheet piles a = 1.4478 (m)
2)perpendicular direction
span length L = 2.176 (m)
shear stress check location Ls = 2.000 (m) (distance from external edge of leg column)
center spacing of steel pipe sheet piles a = 1.4478 (m)
(5) dead weight of pile cap and surcharge load
1)bridge axis direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m^2)
1	WN-TM	-3.450	4.990	58.00
2	OD-CL(SC)	-3.450	3.180	58.00
3	ETQ(SC)	-3.450	0.290	58.00

2)perpendicular direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m^2)
1	WN	-3.450	4.990	58.00
2	OD-CL(SC)	-3.450	3.180	58.00
3	ETQ(SC)	-3.450	0.290	58.00

note: backfilling soil height , water table height is shown in elevation(crest of pile cap elevation = -3.450m)

4.1.2 reaction

(1)bridge axis direction

No	load name	max vertical reaction (kN/number)	min vertical reaction (kN/number)	increment coeff.
1	Wind+Temp	1348	1193	1.35
2	Ord+Collision(scour)	1674	915	1.50
3	Earthquake(scour)	2952	-552	1.50

(2)perpendicular direction

No	load name	max vertical reaction (kN/number)	min vertical reaction (kN/number)	increment coeff.
1	Wind	1431	1110	1.25
2	Ord+Collision(scour)	1826	763	1.50
3	Earthquake(scour)	2469	-69	1.50

4.1.3 calculation of member force

(1)section of leg column bottom external edge

calculate cantilever with leg column bottom external edge as fixed end

$$MA = \frac{R}{Do'} * \left(L + \frac{Do}{2} \right) - \frac{w*L^2}{2} \quad (kN.m/m)$$

where, R : vertical reaction induced in steel pipe sheet pile (kN/number)

Do' : center spacing of steel pipe sheet piles (m)

L : distance from external edge of leg column bottom to steel pipe sheet pile side (m)

Do : periphery steel pipe pile body diameter (m)

w : dead weight of pile cap and surcharge load (kN/m^2)

(2)steel pipe sheet pile front section

$$QB = \frac{R}{Do'} \quad (kN/m)$$

(3)shear stress check section

$$S = \frac{R}{Do'} - w*(L - Ls) \quad (kN/m)$$

where, Ls:distance from external edge of leg column bottom to check location (m)

(4)member force sum up table

1)bridge axis direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	S (kN/m)
1	Wind+Temp	1983	1747	931	931
2	Ord+Collision(scour)	2481	1322	1156	1156
3	Earthquake(scour)	4433	-918	2039	2039

2)perpendicular direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	S (kN/m)
1	Wind	2606	1991	988	978
2	Ord+Collision(scour)	3364	1326	1261	1251
3	Earthquake(scour)	4597	-270	1705	1695

4.1.4 stress calculation

(1)bridge axis direction

b = 100.0 (cm)   h = 400.0 (cm)

rebar in use

lower tensile (As = 77.306 (cm^2))

1 row cover 150 (mm) D32 @ 203

2 row cover 300 (mm) D32 @ 208

upper tensile (As = 27.576 (cm^2))

1 row cover 150 (mm) D32 @ 288

			unit	WN-TM	OD-CL(SC)	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	1983.0	2481.0	4433.0
	required rebar amount	Asr	cm^2	26.016	23.378	42.403
	neutral axis	x	cm	82.7	82.7	82.7
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.37 75.11	1.71 93.96	3.06 167.86
	tensile resultant force required rebar amount	T As	kN cm^2	881.5 40.809	1102.7 36.758	1970.2 65.672
top side ten sile	bending moment	MA'	kN.m	1747.0	1322.0	-918.0
	required rebar amount	Asr	cm^2	0.000	0.000	8.159
	neutral axis	x	cm	7.8	7.8	52.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	0.95 90.59
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	408.1 13.604
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	10.80 216.00	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	931.0 0.25 1.19	1156.0 0.31 1.34	2039.0 0.54 1.34
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	931.0 0.25 1.19	1156.0 0.31 1.34	2039.0 0.54 1.34
shear force to share by concrete		SC a	kN	4489.0	5060.0	5060.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.171	0.171	0.171
	allowable tensile stress	Sig.sa	N/mm^2	160.00	200.00	200.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height   Ce = 0.661 : effective height   d = 377.59 (cm)

2) correction coefficient about tensile rebar percentage   Cpt = 0.905 : tensile rebar percentage   pt = 0.205 (%)

3) for shear span ratio increment coefficient   Cdc = 6.400 : shear span   a = 1.611 (m)

(2)perpendicular direction
b = 100.0 (cm)   h = 400.0 (cm)
rebar in use
lower tensile (As = 81.534 (cm²))
1 row   cover 118 (mm)   D32 @ 189
2 row   cover 268 (mm)   D32 @ 201
upper tensile (As = 33.989 (cm²))
1 row   cover 120 (mm)   D29 @ 189

			unit	WN	OD-CL(SC)	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	2606.0	3364.0	4597.0
	required rebar amount	Asr	cm²	36.896	31.614	43.577
	neutral axis	x	cm	85.1	85.1	85.1
	stress	Sig.c Sig.s	N/mm² N/mm²	1.74 92.84	2.24 119.81	3.06 163.72
	tensile resultant force required rebar amount	T As	kN cm²	1158.4 57.922	1495.0 49.835	2043.0 68.100
top side ten sile	bending moment	MA'	kN.m	1991.0	1326.0	-270.0
	required rebar amount	Asr	cm²	0.000	0.000	2.349
	neutral axis	x	cm	7.1	7.1	58.0
	stress	Sig.c Sig.s	N/mm² N/mm²	0.00 0.00	0.00 0.00	0.25 21.52
	tensile resultant force required rebar amount	T As	kN cm²	0.0 0.000	0.0 0.000	119.8 3.994
allowable stress		Sig.ca Sig.sa	N/mm² N/mm²	10.00 200.00	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm² N/mm²	988.0 0.26 1.05	1261.0 0.33 1.28	1705.0 0.45 1.28
average shear force		S Tau.m Tau.a1'	kN N/mm² N/mm²	978.0 0.26 1.05	1251.0 0.33 1.28	1695.0 0.44 1.28
shear force to share by concrete		SC a	kN	4000.0	4869.0	4869.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.228	0.228	0.228
	allowable tensile stress	Sig.sa	N/mm²	160.00	200.00	200.00
	amount of rebar in use	Aw	cm²	3.871	3.871	3.871
	required rebar amount	Awreq	cm²	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc
1) correction coefficient about effective height   Ce = 0.660 : effective height   d = 380.93 (cm)
2) correction coefficient about tensile rebar percentage   Cpt = 0.914 : tensile rebar percentage   pt = 0.214 (%)
3) for shear span ratio increment coefficient   Cdc = 6.058 : shear span   a = 2.176 (m)

(3) required thickness of pile cap

$$h >= 1.94 * \sqrt[3]{\frac{kp*Lambda^4}{E}} = 1.056\ (m)$$

where, h : required thickness of pile cap(m)

kp : equivalent modulus of subgrade reaction (kN/m^3)

$$kp = \frac{Kv1*n1 + Kv2*n2 + Kv3*n3}{A}$$

Kv : axial direction spring constant of steel pipe sheet pile or intermediate driven single pile (kN/m)

$$Kv = a * \frac{Ap*Ep}{L}$$

Ap : pure cross sectional area of steel pipe sheet pile or intermediate driven single pile (m^2)

Ep : Young's modulus of steel pipe sheet pile or 1 center pick single pile (kN/m^2)

L : pile length (m)

a : correction coefficient

a = 0.014*(L/D) + 0.72

Kv1(periphery steel pipe sheet pile) = 2.7987E+005

Kv2(separation wall steel pipe sheet pile) = 0.0000E+000

Kv3(intermediate driven single pile) = 0.0000E+000

n1 : number of periphery steel pipe sheet pile = 34

n2 : number of separation wall steel pipe sheet pile = 0

n3 : number of intermediate driven single pile = 0

A : area of pile cap (m^2) = 140.0

E : Young's modulus of pile cap (kN/m^2) = $2.50 * 10^7$

Lambda : protrusion length of pile cap (m) = 2.78

(4) minimum rebar amount check

		Mu(kN.m)	Mc(kN.m)	1.7M(kN.m)	As(mm^2/m)	judge
bridge axis direction	lower tensile	9891	5103	7536	7731	OK
	upper tensile	3640	5103	1561	2758	OK
perpendicular direction	lower tensile	10516	5103	7814	8153	OK
	upper tensile	4515	5103	458	3399	OK

Note: 1)Mu>=Mc, 2)1.7M<=Mc, 3)As>=500(mm^2/m)

if either 1) or 2) and 3) are satisfied, it is OK

Note: 1.7M is the value against maximum moment in all cases.

4.2 calculation of pile cap / sheet pile joint part

4.2.1 design condition

(1) steel material in use :SS400,SM400

(2) rebar in use :SD345(underwater member)

(3) concrete design standard strength :Sig.ck = 24 (N/mm^2)

(4) material of steel pipe sheet pile :SKY400

(5) diameter of steel material main body :D = 1200.0 (mm)

(6) section coefficient of steel pipe pile body :Z = 15184.5 (cm^3)

(7) joint method :rebar stud welding method

4.2.2 reaction

(1)bridge axis direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Wind+Temp	1348	12	1.35
2	Ord+Collision(scour)	1674	94	1.50
3	Earthquake(scour)	2952	333	1.50

(2)perpendicular direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Wind	1431	24	1.25
2	Ord+Collision(scour)	1826	188	1.50
3	Earthquake(scour)	2469	324	1.50

4.2.3 rebar stud welding method

(1) design bending moment

$Me = Rp*e$

$MFix = Sig.sa * Zo$

where, Me : moment by eccentricity of reaction(kN.m)
MFix : constraining moment (kN.m)
Rp : vertical reaction per single steel pipe sheet pile(kN)
e : eccentricity (m) = 0.6000
Sig.sa: allowable stress of steel pipe sheet pile (kN/m^2) = 140.00 (N/mm^2)
Zo : section coefficient of steel pipe pile body (m^3) = 15184.5 (cm^3)

select bigger of either Me or MFix

(2) moment rebar design

1) tensile stress by moment

$$T1 = \frac{M}{h}$$

$$Sig.s1 = \frac{T1}{nb*Ab}$$

where, T1 : tensile force working at moment rebar row (N)
M : design moment (N.mm)
h : center spacing of moment rebar row (mm) = 2950.00
Sig.s1: moment rebar tensile stress (N/mm^2)
nb : number of moment rebar (number/ row) = 16
Ab : cross sectional area of single moment rebar (mm^2) = 387.1 (D22)

2)tensile stress by horizontal force

$$T2 = \frac{Ho}{n1}$$

$$Sig.s2 = \frac{T2}{2*nb*Ab}$$

where, T2 : horizontal tensile force working at moment rebar row (N)
Ho : horizontal force working at bottom of pile cap(N)
n1 : number of periphery steel pipe sheet pile
Sig.s2: moment rebar tensile stress (N/mm^2)

3)composite

$Sig.s = Sig.s1 + Sig.s2 <= Sig.sa$

where, Sig.sa: moment rebar allowable tensile stress (N/mm^2)

4)required number of rebar

$$nba >= \frac{2*T1 + T2}{2*Sig.sa*Ab}$$

where, nba: required number of moment rebar (rebar/ row)

(3) shear rebar design

1) shear stress

$$Tau_s = \frac{Rp}{ns*As} <= Tau.sa$$

where, Tau.s : shear rebar shear stress (N/mm^2)
Rp : vertical reaction per single steel pipe sheet pile (N)
ns : number of shear rebar = 56
As : cross sectional area of single shear rebar (mm^2) = 387.1 (D22)
Tau.sa: shear rebar allowable shear stress (N/mm^2)

2)required number of rebar

$$nsa >= \frac{Rp}{Tau.sa*As}$$

where, nsa: required number of shear rebar (number)

bridge axis direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	WN-TM	1348.0	809	2870	2870	972.8	12.0
2	OD-CL(SC)	1674.0	1004	3189	3189	1080.9	94.0
3	ETQ(SC)	2952.0	1771	3189	3189	1080.9	333.0

No	Sig.s1 (N/mm^2)	Sig.s2 (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	nb nba (rebar/row)	Tau.s (N/mm^2)	Tau.sa (N/mm^2)	ns nsa (rebar)
1	157.07	0.97	158.04	216.00	16 >= 12	62.18	129.60	56 >= 27
2	174.52	7.59	182.11	300.00	16 >= 10	77.22	180.00	56 >= 25
3	174.52	26.88	201.41	300.00	16 >= 11	136.18	180.00	56 >= 43

perpendicular direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	WN	1431.0	859	2657	2657	900.8	24.0
2	OD-CL(SC)	1826.0	1096	3189	3189	1080.9	188.0
3	ETQ(SC)	2469.0	1481	3189	3189	1080.9	324.0

No	Sig.s1 (N/mm^2)	Sig.s2 (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	nb nba (rebar/row)	Tau.s (N/mm^2)	Tau.sa (N/mm^2)	ns nsa (rebar)
1	145.44	1.94	147.37	200.00	16 >= 12	66.01	120.00	56 >= 31
2	174.52	15.18	189.70	300.00	16 >= 11	84.23	180.00	56 >= 27
3	174.52	26.16	200.68	300.00	16 >= 11	113.90	180.00	56 >= 36

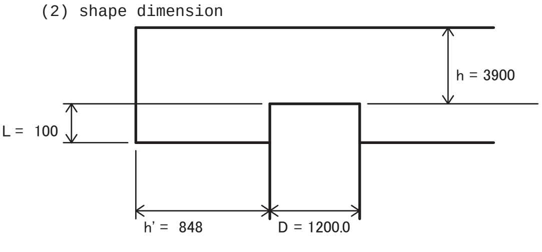
4.3 calculation of pile head joint part

4.3.1 design condition

(1) design condition

1) joint method : method B
2) concrete design standard strength :Sig.ck = 24 (N/mm^2)
3) rebar in use :SD345(underwater member)

(2) shape dimension



(3) pile head working force

1)bridge axis direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Wind+Temp	1.35	0	0	0	0
2	Ord+Collision(scour)	1.50	0	0	0	0
3	Earthquake(scour)	1.50	0	0	0	0

2)perpendicular direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Wind	1.25	0	0	0	0
2	Ord+Collision(scour)	1.50	0	0	0	0
3	Earthquake(scour)	1.50	0	0	0	0

4.3.2 pile head joint part stress calculation

(1) pile cap concrete vertical bearing stress

$$Sig.cv = \frac{PNmax}{Pai*D^2/4} <= Sig.ca$$

where, PNmax : axial direction maximum compressive force (N)
D : pile external diameter (mm) = 120.00 (cm)
Sig.ca : concrete allowable bearing stress (N/mm²)

(2) punching shear stress at pile cap concrete

$$Tau_v = \frac{PNmax}{Pai*(D + h)*h} <= Tau_a$$

where, h : effective thickness of pile cap to resist vertical punching shear force (mm) = 390.0 (cm)
Tau.a: concrete allowable punching shear stress (N/mm²)

1)bridge axis direction

No	load name	PNmax (kN)	Sig.cv (N/mm²)	Sig.ca (N/mm²)	Tau.v (N/mm²)	Tau.a (N/mm²)
1	Wind+Temp	0	0.00	9.72	0.000	0.900
2	Ord+Collision(scour)	0	0.00	10.80	0.000	0.900
3	Earthquake(scour)	0	0.00	10.80	0.000	0.900

2)perpendicular direction

No	load name	PNmax (kN)	Sig.cv (N/mm²)	Sig.ca (N/mm²)	Tau.v (N/mm²)	Tau.a (N/mm²)
1	Wind	0	0.00	9.00	0.000	0.900
2	Ord+Collision(scour)	0	0.00	10.80	0.000	0.900
3	Earthquake(scour)	0	0.00	10.80	0.000	0.900

(3) horizontal bearing stress at pile cap concrete

$$Sig.ch = \frac{PHmax}{D*I} <= Sig.ca$$

where, PHmax : axial orthogonal direction force (N)
I : pile embedment length (mm) = 10.0 (cm)
Sig.ca : concrete allowable bearing stress (N/mm²)

1)bridge axis direction

No	load name	PHmax (kN)	Sig.ch (N/mm²)	Sig.ca (N/mm²)
1	Wind+Temp	0	0.000	9.720
2	Ord+Collision(scour)	0	0.000	10.800
3	Earthquake(scour)	0	0.000	10.800

2)perpendicular direction

No	load name	PHmax (kN)	Sig.ch (N/mm²)	Sig.ca (N/mm²)
1	Wind	0	0.000	9.000
2	Ord+Collision(scour)	0	0.000	10.800
3	Earthquake(scour)	0	0.000	10.800

4.3.3 pile head reinforcing rebar calculation

(1)calculation of imaginary rebar concrete section

sec	dia(cm)	cover(cm)	rebar	amount of used rebar(cm^2)
1row	160.00	26.0	D22 - 12 (@283)	46.452

1)bridge axis direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
1	WN-TM	0.0	0.0	0.000	30.88	0.00	10.80	0.00	216.00
		0.0	0.0	0.000	30.88	0.00	10.80	0.00	216.00
2	OD-CL(SC)	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
3	ETQ(SC)	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

2)perpendicular direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
1	WN	0.0	0.0	0.000	30.88	0.00	10.00	0.00	200.00
		0.0	0.0	0.000	30.88	0.00	10.00	0.00	200.00
2	OD-CL(SC)	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
3	ETQ(SC)	0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00
		0.0	0.0	0.000	30.88	0.00	12.00	0.00	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

(2) pile head reinforcing rebar anchor length

$$Lo = \frac{Sig.sa}{4*Tau.oa} Phi = 687 \text{ (mm)}$$

Lo : rebaranchor length (mm)
Sig.sa : rebar allowable tensile stress = 200.00 (N/mm^2)
Tau.oa : allowable rebar bond stress = 1.600 (N/mm^2)
Phi. : pile head reinforcing rebar diameter = 22 (mm)

embedment length L >= Lo + 10 * Phi. = 908 (mm)

assure L from center of rebar in bottom of pile cap

(3) welding length of pile head supplemental rebar welding part by shear stress

$$Tau_s = \frac{Sig.sa*Ast}{1.4*Lambda*Ls} \le Tau.sa$$

$$Ls = \frac{Sig.s*Ast}{1.4*Lambda*Tau_{sa}}$$

where, Tau.sa: allowable shear stress of fillet welding = 72.00 (N/mm^2)
Sig.sa: rebar allowable tensile stress(to estimate anchor length) = 200.00 (N/mm^2)
Ast : sectional area of sigle pile head supplemental rebar = 3.871 (cm^2)
Lambda : fleg length of fillet welding (cm)
Ls : fillet welding length

welding leg length Lambda (cm)	0.6	0.7	0.8	0.9
welding length Ls (cm)	12.8	11.0	9.6	8.5

5 foundation spring calculation

subgrade reaction constant value used in calculation of natural period
It is calculated by the analysis model used in horizontal capacity method. But the upper limit of the subgrade reaction is not considered.

(1)Layer data

	type sand	thick(m) Layer	Nvalue	usual time	in quakes	calculation natural period	
				Alp.*Eo (kN/m^2)	Alp.*Eo (kN/m^2)	dyna.het.coef ED(kN/m)	dyna.pois.rate NyuD
1	clay	3.254	1.0	3600	7200	34286	0.50
2	clay	3.090	3.0	8000	16000	71312	0.50
3	sandy	1.060	3.0	4800	9600	45643	0.50
4	sandy	2.290	3.0	4800	9600	45643	0.50
5	sandy	8.560	13.0	20800	41600	117855	0.50
6	clay	8.680	7.0	19600	39200	125458	0.50
7	clay	22.570	18.0	50400	100800	242205	0.50
8	sandy	1.706	50.0	140000	280000	323331	0.50

(2)modulus of subgrade reaction

1) foundation bottom spring

	vertical direction kv(kN/m^3)	horizontal direction shear ks(kN/m^3)
periphery sheet pile	381049	114315
separation wall sheet pile	----------	----------
intermediate driven pile	----------	----------

2) foundation front , side spring

usual time/ earthquake time $kHo = Alp.*Eo/0.3$
estimate natural period $kHo = ED/0.3$
foundation front horizontal direction $kh = Alp.k*kHo*(Be/0.3)^{(-3/4)}(kN/m^3)$
foundation front vertical direction $kSVB = 0.3*Alp.k*kHo*(Be/0.3)^{(-3/4)}(kN/m^3)$
foundation side horizontal direction $kSHD = 0.6*Alp.k*kHo*(De/0.3)^{(-3/4)}(kN/m^3)$
foundation side vertical direction $kSVD = 0.3*Alp.k*kHo*(De/0.3)^{(-3/4)}(kN/m^3)$

where Alp.k : modulus of subgrade reaction correction coefficient (= 1.50)
Alp. : modulus of elasticity in ground (kN/m^2)
Eo : dynamic modulus of elasticity in ground (kN/m^2)
ED : dynamic modulus of elasticity in ground (kN/m^2)
Nu.D: dynamic Poisson's ratio
Be : equivalent loading width in orthogonal direction to external force, foundation width (m)
De : equivalent loading width in external force direction, foundation width (m)
both Be,De are values which 0.2*D is deducted in case of circular and oval shape (D:circular diameter (m))

usual time

1.bridge axis direction(Be = 19.92714, De = 6.89694)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	774	232	1029	514
2	-6.704 - -7.450	1719	516	2286	1143
3	-7.450 - -9.794	1719	516	2286	1143
4	-9.794 - -10.854	1031	309	1372	686
5	-10.854 - -13.144	1031	309	1372	686
6	-13.144 - -21.704	4470	1341	5943	2972
7	-21.704 - -30.384	4212	1264	5600	2800
8	-30.384 - -48.439	10831	3249	14401	7201
9	-48.439 - -52.954	10831	6498	14401	14401
10	-52.954 - -54.660	30085	18051	40003	40003

2.perpendicular direction(Be = 6.89694, De = 19.92714)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	1714	514	464	232
2	-6.704 - -7.450	3810	1143	1031	516
3	-7.450 - -9.794	3810	1143	1031	516
4	-9.794 - -10.854	2286	686	619	309
5	-10.854 - -13.144	2286	686	619	309
6	-13.144 - -21.704	9906	2972	2682	1341
7	-21.704 - -30.384	9334	2800	2527	1264
8	-30.384 - -48.439	24002	7201	6498	3249
9	-48.439 - -52.954	24002	14401	6498	6498
10	-52.954 - -54.660	66672	40003	18051	18051

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -48.439(m) evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

earthquake time

1.bridge axis direction(Be = 19.92714, De = 6.89694)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	1547	464	2057	1029
2	-6.704 - -7.450	1145	343	1522	761
3	-7.450 - -9.794	1145	343	1522	761
4	-9.794 - -10.854	687	206	913	457
5	-10.854 - -13.144	1374	412	1827	913
6	-13.144 - -21.704	8940	2682	11887	5943
7	-21.704 - -30.384	8424	2527	11201	5600
8	-30.384 - -48.439	21661	6498	28803	14401
9	-48.439 - -52.954	21661	12997	28803	28803
10	-52.954 - -54.660	60171	36102	80007	80007

2.perpendicular direction(Be = 6.89694, De = 19.92714)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	3429	1029	928	464
2	-6.704 - -7.450	2537	761	687	343
3	-7.450 - -9.794	2537	761	687	343
4	-9.794 - -10.854	1522	457	412	206
5	-10.854 - -13.144	3045	913	824	412
6	-13.144 - -21.704	19811	5943	5364	2682
7	-21.704 - -30.384	18668	5600	5054	2527
8	-30.384 - -48.439	48004	14401	12997	6498
9	-48.439 - -52.954	48004	28803	12997	12997
10	-52.954 - -54.660	133345	80007	36102	36102

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -48.439(m) evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

to estimate natural period

1.bridge axis direction(Be = 19.92714, De = 6.89694)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	7368	2210	9797	4898
2	-6.704 - -7.450	15325	4597	20377	10188
3	-7.450 - -9.794	15325	4597	20377	10188
4	-9.794 - -10.854	9808	2943	13042	6521
5	-10.854 - -13.144	9808	2943	13042	6521
6	-13.144 - -21.704	25327	7598	33676	16838
7	-21.704 - -30.384	26960	8088	35848	17924
8	-30.384 - -48.439	52049	15615	69207	34604
9	-48.439 - -52.954	52049	31229	69207	69207
10	-52.954 - -54.660	69482	41689	92388	92388

2.perpendicular direction(Be = 6.89694, De = 19.92714)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-3.640 - -6.704	16328	4898	4421	2210
2	-6.704 - -7.450	33961	10188	9195	4597
3	-7.450 - -9.794	33961	10188	9195	4597
4	-9.794 - -10.854	21737	6521	5885	2943
5	-10.854 - -13.144	21737	6521	5885	2943
6	-13.144 - -21.704	56126	16838	15196	7598
7	-21.704 - -30.384	59747	17924	16176	8088
8	-30.384 - -48.439	115346	34604	31229	15615
9	-48.439 - -52.954	115346	69207	31229	31229
10	-52.954 - -54.660	153981	92388	41689	41689

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -48.439(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

(3)joint pipe external diameter ,shear resistance of joint

joint pipe external diameter

periphery :linear part = 0.1652 (m)
periphery :curve part = 0.1652 (m)
separation wall:Y direction = 0.1652 (m)
separation wall:X direction = 0.1652 (m)

shear resistance of joint

shear rigidity Gj = 1200000 (kN/m^2)
shear capacity qju = 200 (kN/m)

(4) ground spring constant to estimate natural period

general equation

$$\begin{bmatrix} H \\ M \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del. \\ Theta \end{bmatrix}$$

hence

$$\begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}$$

$$\begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} = \begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}^{-1}$$

where Ho : unit horizontal force to apply at crest of foundation (kN)
Mo : unit moment to apply at crest of foundation (kN.m)
Del.oH : horizontal displacement at crest of foundation by Ho(m)
$Theta_{oH}$: rotational angle at crest of foundation by Ho (rad)
Del.oM : horizontal displacement at crest of foundation by Mo(m)
$Theta_{oM}$: rotational angle at crest of foundation by Mo (rad)
Ass : ground spring constant (kN/m)
Asr : ground spring constant (kN/rad)
Ars : ground spring constant (kN.m/m)
Arr : ground spring constant (kN.m/rad)

usual time

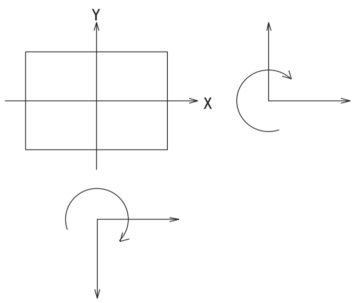
item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.6085E-001	8.6398E-002
ThetaoH	mrad	7.3638E-003	2.6922E-003
Del.oM	mm	7.3638E-002	2.6922E-002
ThetaoM	mrad	6.8044E-003	1.9235E-003
Ass	kN/m	1.2321E+006	2.0527E+006
Asr	kN/rad	-1.3334E+007	-2.8730E+007
Ars	kN.m/m	-1.3334E+007	-2.8730E+007
Arr	kN.m/rad	2.9127E+008	9.2201E+008

earthquake time

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.3127E-001	6.6386E-002
ThetaoH	mrad	6.4262E-003	2.1862E-003
Del.oM	mm	6.4262E-002	2.1862E-002
ThetaoM	mrad	6.3418E-003	1.7206E-003
Ass	kN/m	1.5117E+006	2.5902E+006
Asr	kN/rad	-1.5318E+007	-3.2911E+007
Ars	kN.m/m	-1.5318E+007	-3.2911E+007
Arr	kN.m/rad	3.1290E+008	9.9936E+008

to estimate natural period

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	3.7293E-002	2.1016E-002
ThetaoH	mrad	2.6494E-003	9.2951E-004
Del.oM	mm	2.6494E-002	9.2951E-003
ThetaoM	mrad	3.7700E-003	1.0243E-003
Ass	kN/m	5.3548E+006	7.9487E+006
Asr	kN/rad	-3.7631E+007	-7.2133E+007
Ars	kN.m/m	-3.7631E+007	-7.2133E+007
Arr	kN.m/rad	5.2971E+008	1.6309E+009



Y direction: bridge axis direction
X direction:perpendicular direction

3.4 DETAIL CALCULATION SHEET OF SPSP OF P7 (LOAD CASE-1)

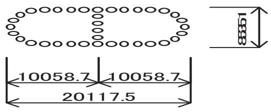
Load Case-1 is the case which considers:

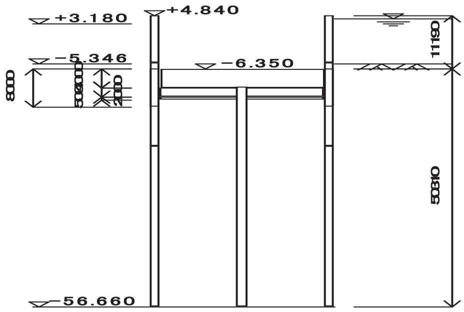
- without local scouring, thus design elevation is set on the elevation of top of footing EL-6.35m.
- High tide and Low tide in spring tide
- Load combinations of Ordinary Condition, Ordinary Condition＋Effect of Temperature Change, Extreme wind situation＋Effect of Temperature Change, Vessel Collision, Earthquake Condition

Contents

1 concrete body calculation

1.1 foundation shape dimension diagram





1.2 steel pipe sheet pile composing points

1)periphery sheet pile

external diameter = 1200.0(mm)
pile length = 61.500(m)
number = 32(number)

steel pipe thickness (mm)	length (m)	material
14.0	10.000	SKY400
16.0	17.500	SKY400
14.0	34.000	SKY400

2)separation wall sheet pile

external diameter = 1200.0(mm)
pile length = 46.410(m)
number = 4(number)

steel pipe thickness (mm)	length (m)	material
14.0	46.410	SKY400

1.3 ground condition

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m^3)		c (kN/m^2)	Phi. (angle)	modulus of elasticity Alp.*Eo(kN/m^2)		reduction coefficient		
				Gam.	Gam.'			usual	earthquake	DE	DE' Type1	DE' Type2
1	chsv	2.070	1.0	17.5	7.5	10.0	0.00	3600	7200	0.333	0.333	0.333
2	sand	4.000	3.0	17.5	8.5	0.0	28.00	4800	9600	0.333	0.333	0.333
3	sand	7.000	13.0	17.0	8.0	0.0	33.00	20800	41600	1.000	1.000	1.000
4	chsv	4.000	9.0	17.5	7.5	54.0	0.00	25200	50400	1.000	1.000	1.000
5	chsv	17.000	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
6	chsv	15.000	18.0	18.0	8.0	108.0	0.00	50400	100800	1.000	1.000	1.000
7	sand	5.400	50.0	19.0	10.0	0.0	35.00	140000	280000	1.000	1.000	1.000

1.4 section properties

(1)section properties of steel pipe pile body

errosion margin external side = 2.0 (mm) internal side = 0.0 (mm)

1)periphery sheet pile Do = 1200(mm) number = 32

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
16.0	16.310	519.9	908031	15184	SKY400
14.0	34.000	446.4	782242	13081	SKY400

2)separation wall sheet pile Do = 1200(mm) number = 4

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
14.0	46.310	446.4	782242	13081	SKY400

(2)sum of squared distance from centroid of steel pipe sheet to neutral axis of horizontal section of celler IB(m^2)

	bridge axis direction	perpendicular direction
periphery sheet pile	322.82	1255.78
separation wall sheet pile	10.76	0.00

(3)sum of moment of inertia in celler part I(m^4)

bridge axis direction $I = SumIoi + Mu * Sum(Aoi * Yi^2)$

perpendicular direction $I = SumIoi + Mu * Sum(Aoi * Xi^2)$

Mu : composite efficiency - 0.75

No	L(m)	bridge axis direction	perpendicular direction
1	16.310	13.268884	49.285200
2	34.000	11.448796	42.321287

foundation length = 50.310 (m)

(4)coordinates of cetroid of steel pipe sheet pile

1) periphery sheet pile

No	Y(m)	X(m)	number
1	3.6675	0.0000	2
2	3.6675	1.4478	4

No	Y(m)	X(m)	number
3	3.6675	2.8956	4
4	3.6675	4.3434	4
5	3.6675	5.7912	4
6	0.0000	9.4587	2
7	1.4035	9.1796	4
8	2.5933	8.3845	4
9	3.3884	7.1947	4

2) separation wall sheet pile

No	Y(m)	X(m)	number
1	2.2005	0.0000	2
2	0.7335	0.0000	2

1.5 ground constant

(1) ground modulus of elasticity

layer No	usual time		earthquake time		
	layer thickness (m)	Alp.*Eo(kN/m²)	layer thickness (m)	Alp.*Eo(kN/m²)	DE
protrusion length	0.000	------	0.000	------	----
1	1.066	3600	1.066	7200	0.333
2	4.000	4800	4.000	9600	0.333
3	7.000	20800	7.000	41600	1.000
4	4.000	25200	4.000	50400	1.000
5	17.000	19600	17.000	39200	1.000
6	15.000	50400	15.000	100800	1.000
7	2.244	140000	2.244	280000	1.000

(2)vertical modulus of subgrade reaction

$$kv = \frac{1}{0.3} * Alp. * Eo * \left(\frac{Bv}{0.3}\right)^{-3/4}$$

where kv : vertical modulus of subgrade reaction (kN/m^3)
Alp.*Eo: ground modulus of elasticity (kN/m^2)
usual time = 140000
earthquake time = 280000
Bv : foundation equivalent loading width of foundation (m) -- external diameter of steel pipe sheet pile main body

	Bv (mm)	kv(kN/m³)	
		usual	earthquake
periphery sheet pile	1200.0	164992	329983
separation wall sheet pile	1200.0	164992	329983

(3)horizontal modulus of subgrade reaction

$$kH = \frac{1}{0.3} * Alp. * Eo * \left(\frac{BH}{0.3}\right)^{-3/4}$$

where kH : horizontal modulus of subgrade reaction (kN/m^3)
BH : equivalent loading width of foundation in orthogonal to load working direction (m)
$BH = \sqrt{D/Beta} \le \sqrt{De*Le}$
D : loading width of foundation in orthogonal to load working direction (m)
De : effective loading width of foundation in orthogonal to load working direction (m)
1/Beta : ground depth to relate with horizontal resistance, less than foundation length (m)
Beta : characteristic value of foundation(m^{-1})

$$Beta = \sqrt[4]{\frac{kH*D}{4*E*I}}$$

E : Young's modulus of foundation = 2.00 * 10^8(kN/m^2)
I : moment of inertia of foundation (m^4)
Le : effective embedment depth of foundation(m)

$$kH1 = (1 + Alp.H)*kH*\left(\frac{y}{yo}\right)^{-1/2}$$

where kH1 : in case of considering strain-dependance, standard modulus of subgrade reaction in horizontal direction (kN/m^3) (assuming y = yo, standard value)
Alp.H : shear subgrade reaction on celler part side in horizontal direction and resistance of internal soil increment coefficient including sharing etc (= 1.00)
y : horizontal displacemen of foundation on design ground surfacet (m)
yo : standard displacement (m)

	bridge axis direction		perpendicular direction	
	usual time	earthquake time	usual time	earthquake time
I (cm⁴)	1.3269E+009		4.9285E+009	
D (cm)	2011.75		853.51	
Beta(cm⁻¹)	0.000463	0.000463	0.000288	0.000288
1/Beta(cm)	2159.3	2159.3	3476.0	3476.0
average Alp.*Eo (N/cm²)	1749.5	1749.5	1979.3	1979.3
BH, $\sqrt{De*Le}$ (cm)	2084.2 < 3181.4	2084.2 < 3181.4	1722.4 < 2072.2	1722.4 < 2072.2

layer No	layer thickness (m)		Alp.*Eo(kN/m²)		bridge axis direction kH1(kN/m³)		perpendicular direction kH1(kN/m³)	
	usual	earthquake	usual	earthquake	usual	in earthquake	usual	in earthquake
protrusion length	0.000	0.000	------	------	------	------	------	------
1	1.066	1.066	3600	7200	997	664	1151	766
2	4.000	4.000	4800	9600	1330	886	1534	1022
3	7.000	7.000	20800	41600	5762	11525	6648	13296
4	4.000	4.000	25200	50400	6981	13963	8055	16109
5	17.000	17.000	19600	39200	5430	10860	6265	12529
6	15.000	15.000	50400	100800	13963	27926	16109	32218
7	2.244	2.244	140000	280000	38786	77571	44748	89495

horizontal modulus of subgrade reaction(using value)(kN/m³)

layer No	layer thickness (m)		bridge axis direction		perpendicular direction	
	usual time	in quakes	usual time	in quakes	usual time	in quakes
protrusion length	0.000	0.000	------	------	------	------
1	1.066	1.066	997	664	1151	766
2	4.000	4.000	1330	886	1534	1022
3	7.000	7.000	5762	11525	6648	13296
4	4.000	4.000	6981	13963	8055	16109
5	17.000	17.000	5430	10860	6265	12529
6	15.000	15.000	13963	27926	16109	32218
7	2.244	2.244	38786	77571	44748	89495

(4)horizontal direction shear modulus of subgrade reaction at bottom of celler

ks = 0.3 * kv

where ks :horizontal direction shear modulus of subgrade reaction at bottom of celler (kN/m³)

	usual time	in quakes
periphery sheet pile	49497	98995
separation wall sheet pile	49497	98995

(5)spring constant at bottom of celler

1)vertical spring constant

$$Kv = \sum_{i=1}^{3}\left((ni*kvi*A1i)\right) \ (kN/m)$$

where A1i : close sectional area of steel pipe sheet pile and intermediate driven single pile (m²)

periphery sheet pile		separation wall sheet pile		intermediate driven pile		Kv (kN/m)	
A11(m²)	n1(number)	A12(m²)	n2(number)	A13(m²)	n3(number)	usual time	earthquake time
1.1310	32	1.1310	4	0.0000	0	6.7176E+006	1.3435E+007

2) shear spring constant

$$Ks = \sum_{i=1}^{2}\left((ni*ksi*A1i)\right) \ (kN/m)$$

usual time	in quakes
2.0153E+006	4.0306E+006

3)rotational spring constant

$$Kr = \sum_{i=1}^{2}\left((kvi*A1i*IBi)\right) \ (kN.m/rad)$$

where IB : celler composed with steel pipe sheet pile

sum of squared distance from centroid to neutral axis of horizontal section of celler (m²)

	periphery sheet pile IB1 (m²)	separation wall sheet pile IB2 (m²)	Kr (kN.m/rad)	
			usual time	in quakes
bridge axis direction	322.82	10.76	6.2246E+007	1.2449E+008
perpendicular direction	1255.78	0.00	2.3433E+008	4.6866E+008

spring constant at bottom of celler(using value)

		usual time	in quakes
vertical spring Kv (kN/m)		6.7176E+006	1.3435E+007
shear spring Ks (kN/m)		2.0153E+006	4.0306E+006
rotational spring Kr (kN.m/rad)	bridge axis direction	6.2246E+007	1.2449E+008
	perpendicular direction	2.3433E+008	4.6866E+008

1.6 allowable bearing capacity

(1)allowable compressive bearing capacity of steel pipe sheet pile

work method : driven construction method

steel pipe sheet pile main body external diameter :Phi.1200.0 (mm)

$$Ra = \frac{1}{n} * Ru$$

$$Ru = qd*A1 + \frac{1}{n1+n2+n3}*\{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

where Ra: allowable compressive bearing capacity of steel pipe sheet pile(kN/pile)

n : factor of safety usual time n = 3

earthquake time n = 2

Ru: ultimate bearing capacity of steel pipe sheet pile in lower ground (kN)

A1: close sectional area of steel pipe sheet pile body (m^2)

A1 = 1.131 (m^2)

qd: ultimate bearing capacity per unit area supporting steel pipe sheet pile tip (kN/m^2)

$$\frac{\text{equivalent embedment depth to bearing strata}}{\text{pile diameter}} = \frac{1.240}{1.2000} = 1.03$$

$qd / \bar{N} = 62$

$\bar{N}$:design N value in steel pipe sheet pile tip ground $\bar{N}$ = 40.0

qd = 62 * 40.0 = 2480 (kN/m^2)

n1 : celler part periphery steel pipe sheet pile number (number) n1 = 32

n2 : number of steel pipe sheet pile in separation wall part (number) n2 = 4

n3 : intermediate driven single pile number (number) n3 = 0

U1 : enveloping celler part periphery length (m) U1 = 49.978 (m)

U2 : enveloping celler part and separation wall part periphery length and sum of perimeter of intermediate driven single pile U2 = 52.309 (m)

Li : thickness which celler skin friction of external periphery is considered (m)

fi : maximum skin friction angle of layer which celler skin friction of external periphery is considered (kN/m^2)

Lj : thickness which celler skin friction of internal periphery is considered (m)

fj : maximum skin friction angle of layer which celler skin friction of internal periphery is considered (kN/m^2)

range of internal soil short side length(Lo) from bottom is only considered

Lo = 6.135 (m)

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m^2) usual time	fi (kN/m^2) in quakes	DEi	Li*fi(DEi) (kN/m) usual time	Li*fi(DEi) (kN/m) in quakes
1	cohesv	1.0	1.066	10.0	10.0	0.333	10.7	3.5
2	sandy	3.0	4.000	0.0	0.0	0.333	0.0	0.0
3	sandy	13.0	7.000	26.0	26.0	1.000	182.0	182.0
4	cohesv	9.0	4.000	90.0	90.0	1.000	360.0	360.0
5	cohesv	7.0	17.000	70.0	70.0	1.000	1190.0	1190.0
6	cohesv	18.0	15.000	150.0	150.0	1.000	2250.0	2250.0
7	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			50.310				4217.1	4209.9

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m^2) usual time	fj (kN/m^2) in quakes	DEj	Lj*fj(DEj) (kN/m) usual time	Lj*fj(DEj) (kN/m) in quakes
6	cohesv	18.0	3.891	150.0	150.0	1.000	583.6	583.6
7	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			6.135				808.0	808.0

DE: reduction coefficient in earthquake time

ultimate bearing capacity

$$Ru = qd*A1 + \frac{1}{n1+n2+n3}*\{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

= 2805 + 7029 = 9833 (kN/number) (usual time)

= 2805 + 7019 = 9824 (kN/number) (earthquake time)

allowable compressive bearing capacity

usual time Ra = (1 / 3) * 9833 = 3278 (kN/number)

earthquake Ra = (1 / 2) * 9824 = 4912 (kN/number)

(2)allowable uplifting force of steel pipe sheet pile

$$Pa = \frac{1}{n}*Pu + W$$

$$Pu = \frac{1}{n1+n2+n3}*\left\{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \right\}$$

where, Pa: allowable uplifting force of steel pipe sheet pile(kN/number)
n : factor of safety usual time n = 6
earthquake time n = 3
Pu: determined from ground, ultimate uplifting force of steel pipe sheet pile (kN/number)
W : effective weight of steel pipe sheet pile(kN)

effective weight of steel pipe sheet pile W(= w1 + w2 + w3 + w4)

		usual time	earthquake time
steel pipe weight	w1 (kN) =	158.5	158.5
joint weight	w2 (kN) =	0.0	0.0
soil weight inside of pipe	w3 (kN) =	358.2	358.2
filling concrete weight	w4 (kN) =	0.0	0.0
	W (kN) =	516.7	516.7

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m²)		DEi	Li*fi(DEi) (kN/m)	
				usual time	in quakes		usual time	in quakes
1	cohesv	1.0	1.066	10.0	10.0	0.333	10.7	3.5
2	sandy	3.0	4.000	0.0	0.0	0.333	0.0	0.0
3	sandy	13.0	7.000	26.0	26.0	1.000	182.0	182.0
4	cohesv	9.0	4.000	90.0	90.0	1.000	360.0	360.0
5	cohesv	7.0	17.000	70.0	70.0	1.000	1190.0	1190.0
6	cohesv	18.0	15.000	150.0	150.0	1.000	2250.0	2250.0
7	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			50.310				4217.1	4209.9

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m²)		DEj	Lj*fj(DEj) (kN/m)	
				usual time	in quakes		usual time	in quakes
6	cohesv	18.0	3.891	150.0	150.0	1.000	583.6	583.6
7	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			6.135				808.0	808.0

DE: reduction coefficient in earthquake time

ultimate uplifting force
Pu = 7029 (kN/number) (usual time time)
Pu = 7019 (kN/number) (earthquake time)

allowable uplifting force
usual time Pa - (1 / 6) * 7029 + 517 - 1688 (kN/number)
earthquake Pa - (1 / 3) * 7019 + 517 - 2856 (kN/number)

allowable compressive bearing capacity / uplifting force of steel pipe sheet pile(using value)(kN/number)

allowable compressive bearing capacity	usual time	3278
	in quakes	4912
allowable uplifting force bearing capacity	usual time	1688
	in quakes	2856

1.7 design force

in steel pipe sheet pile foundation, for coffering double use method, external force which works at the center of crest is considered.
yet, vertical load is sum of crest of pile cap load, pile cap weight, filling concrete weight and backfilling soil weight
consider

(1) input shape, unit weight and design seismic coefficient

```
pile cap shape     :oval
pile cap dimension :  8.5351 (m)  *  20.1175 (m)
pile cap thickness                           h1    =   4.000 (m)
steel pipe pile body external diameter       Phi.  = 1200.0 (mm)
number of external wallsteel pipe sheet pile n     =  32
filling  concrete cast height                h2    =   8.000 (m)
leg column cross sectional area              Ap    =  37.070 (m²)
                                shape      :   oval
                                dimension  : a    =  13.000 (m)      perpendicular direction
                                           : b    =   3.000 (m)      bridge axis direction
unit weight : backfilling soil(wet)         Gam.t  = 17.5  (kN/m³)
              backfilling soil(saturated)  Gam.sat = 17.5  (kN/m³)
              pile cap concrete             Gam.c1 = 24.5  (kN/m³)
             filling concrete               Gam.c2 = 23.0  (kN/m³)
             footing concrete                      = 23.0   (kN/m³)
             paving sand (wet)                     = 19.0   (kN/m³)
                         (saturated)               = 20.0   (kN/m³)
                          water             Gam.w  = 10.00 (kN/m³)
design seismic coefficient  :  pile cap       kh   =  0.30    bridge axis direction
                                 kh   =  0.30    perpendicular direction
             internal soil                    kh   =  0.00    bridge axis direction
                                 kh   =  0.00    perpendicular direction
ground surface in seismic design                   =  0.000 (m) ( depth from crest of  )
```

1)bridge axis direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-5.346	3.180
2	Oridinary(low tide)	-5.346	-2.390
3	Ord+Temp(high tide)	-5.346	3.180

No	load name	backfilling soil height (m)	water table height (m)
4	Ord+Temp(low tide)	-5.346	-2.390
5	Wind+Temp	-5.346	4.990
6	Ord+Collision	-5.346	3.180
7	Earthquake	-5.346	0.290

2)perpendicular direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-5.346	3.180
2	Oridinary(low tide)	-5.346	-2.390
3	Wind	-5.346	4.990
4	Ord+Collision	-5.346	3.180
5	Earthquake	-5.346	0.290

(2) working force at leg column bottom

1)bridge axis direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Oridinary(high tide)	46500.0	0.0	0.0
2	Oridinary(low tide)	46500.0	0.0	0.0
3	Ord+Temp(high tide)	46500.0	200.0	4000.0
4	Ord+Temp(low tide)	46500.0	200.0	4000.0
5	Wind+Temp	46500.0	300.0	5600.0
6	Ord+Collision	46500.0	3800.0	39300.0
7	Earthquake	41300.0	11400.0	153500.0

2)perpendicular direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Oridinary(high tide)	46500.0	0.0	3100.0
2	Oridinary(low tide)	46500.0	0.0	3100.0
3	Wind	46500.0	1000.0	24800.0
4	Ord+Collision	46500.0	7500.0	80600.0
5	Earthquake	41300.0	13000.0	219600.0

(3) pile cap area

oval

$$A1 = \frac{Pai}{4}*(B-D)^2 + (B-D)*(L-B) - \frac{Pai}{4}*D^2* \frac{n}{2} = 109.119\ (m^2)$$

filling concrete area

$$A2 = \frac{Pai}{4}*D^2* n = 36.191\ (m^2)$$

backfilling soil area

$$A3 = A1 + A2 - Ap = 108.240\ (m^2)$$

1)bridge axis direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	OD(HT)	9.530	1.004	6328.9	3763.9	815.0	3532.8	7375.1
2	OD(LT)	3.960	1.004	6328.9	3763.9	815.0	1468.0	9439.9
3	OD-TM(HT)	9.530	1.004	6328.9	3763.9	815.0	3532.8	7375.1
4	OD-TM(LT)	3.960	1.004	6328.9	3763.9	815.0	1468.0	9439.9
5	WN-TM	11.340	1.004	6328.9	3763.9	815.0	4203.7	6704.1
6	OD-CL	9.530	1.004	6328.9	3763.9	815.0	3532.8	7375.1
7	ETQ	6.640	1.004	6328.9	3763.9	815.0	2461.4	8446.4

2)perpendicular direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	OD(HT)	9.530	1.004	6328.9	3763.9	815.0	3532.8	7375.1
2	OD(LT)	3.960	1.004	6328.9	3763.9	815.0	1468.0	9439.9
3	WN	11.340	1.004	6328.9	3763.9	815.0	4203.7	6704.1
4	OD-CL	9.530	1.004	6328.9	3763.9	815.0	3532.8	7375.1
5	ETQ	6.640	1.004	6328.9	3763.9	815.0	2461.4	8446.4

hw: water table(m), height upward from crest of pile cap
V1: weight of pile cap
V2: weight of filling concrete
V3: backfilling soil weight
Vp: buoyancy works at column
V1 = A1*{ h11*Gam.c1 + h21*(Gam.c1 - Gam.w) }
V2 = A2*{ h12*Gam.c2 + h22*(Gam.c2 - Gam.w) }
V3 = A3*{ h13*Gam.t + h23*(Gam.sat - Gam.w) }
h1i: thickness upper than water table(m)
h2i: thickness lower than water table(m)
Vp = Ap*hw*Gam.w
ƒ°V= V1 {V2 {V3 |Vp

(4) design external force sum up

1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	53875.1	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	55939.9	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	53875.1	200.0	4000.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	55939.9	200.0	4000.0	1.15	usual time	usual time
5	Wind+Temp	53204.1	300.0	5600.0	1.35	usual time	usual time
6	Ord+Collision	53875.1	3800.0	39300.0	1.50	usual time	usual time
7	Earthquake	49746.4	11400.0	153500.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	53875.1	0.0	3100.0	1.00	usual time	usual time
2	Oridinary(low tide)	55939.9	0.0	3100.0	1.00	usual time	usual time
3	Wind	53204.1	1000.0	24800.0	1.25	usual time	usual time
4	Ord+Collision	53875.1	7500.0	80600.0	1.50	usual time	usual time
5	Earthquake	49746.4	13000.0	219600.0	1.50	earthquake time	earthquake time

1.8 design external force(using value)

1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	53875.1	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	55939.9	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	53875.1	200.0	4000.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	55939.9	200.0	4000.0	1.15	usual time	usual time
5	Wind+Temp	53204.1	300.0	5600.0	1.35	usual time	usual time
6	Ord+Collision	53875.1	3800.0	39300.0	1.50	usual time	usual time
7	Earthquake	49746.4	11400.0	153500.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Oridinary(high tide)	53875.1	0.0	3100.0	1.00	usual time	usual time
2	Oridinary(low tide)	55939.9	0.0	3100.0	1.00	usual time	usual time
3	Wind	53204.1	1000.0	24800.0	1.25	usual time	usual time
4	Ord+Collision	53875.1	7500.0	80600.0	1.50	usual time	usual time
5	Earthquake	49746.4	13000.0	219600.0	1.50	earthquake time	earthquake time

1.9 calculation result table

1)bridge axis direction

item			unit	OD(HT)	OD(LT)	OD-TM(HT)
working force		Vo	kN	53875.1	55939.9	53875.1
		Ho	kN	0.0	0.0	200.0
		Mo	kN.m	0.0	0.0	4000.0
foundation crest	displacement	Del.1	cm	0.000	0.000	0.042
	deflexion angle	Theta.1	mrad	0.000	0.000	-0.038
design ground surface	displacement	Del.2	cm	0.000	0.000	0.042
	deflexion angle	Theta.2	mrad	0.000	0.000	-0.038
celler part maximum bending moment		Mmax	kN.m	0.0	0.0	-4870.0
Mmax accrue location		Lm	m	-6.350	-6.350	-13.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	33.53	34.81	34.66
		Lm	m	-22.660	-22.660	-22.660
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	33.53	34.81	34.33
		Lm	m	-22.660	-22.660	-22.660
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------	--------
celler partbottom bending moment		MB	kN.m	0.0	0.0	93.0
vertical reaction	maximum	Rmax	kN/num	1497	1554	1498
	minimum	Rmin	kN/num	1497	1554	1496
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3278	3278	3278
	uplifting force	Pa	kN/num	-1688	-1688	-1688
	stress(SKY400)	Sig.a	N/mm²	140.00	140.00	161.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------	--------

note)Lm is elevation

item			unit	OD-TM(LT)	WN-TM	OD-CL
working force		Vo	kN	55939.9	53204.1	53875.1
		Ho	kN	200.0	300.0	3800.0
		Mo	kN.m	4000.0	5600.0	39300.0
foundation crest	displacement	Del.1	cm	0.042	0.060	0.573
	deflexion angle	Theta.1	mrad	-0.038	-0.055	-0.487
design ground surface	displacement	Del.2	cm	0.042	0.060	0.573
	deflexion angle	Theta.2	mrad	-0.038	-0.055	-0.487
celler part maximum bending moment		Mmax	kN.m	-4870.0	-6933.0	-59036.0
Mmax accrue location		Lm	m	-13.350	-13.350	-14.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	35.94	34.74	48.44
		Lm	m	-22.660	-22.660	-22.660
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	35.61	34.26	44.05
		Lm	m	-22.660	-22.660	-22.660
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------	--------
celler partbottom bending moment		MB	kN.m	93.0	134.0	1204.0
vertical reaction	maximum	Rmax	kN/num	1555	1479	1510
	minimum	Rmin	kN/num	1553	1476	1483
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3278	3278	3278
	uplifting force	Pa	kN/num	-1688	-1688	-1688
	stress(SKY400)	Sig.a	N/mm²	161.00	189.00	210.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------	--------

note)Lm is elevation

item			unit	ETQ
working force		Vo	kN	49746.4
		Ho	kN	11400.0
		Mo	kN.m	153500.0
foundation crest	displacement	Del.1	cm	1.782
	deflexion angle	Theta.1	mrad	-1.653
design ground surface	displacement	Del.2	cm	1.782
	deflexion angle	Theta.2	mrad	-1.653
celler part maximum bending moment		Mmax	kN.m	-218648.0
Mmax accrue location		Lm	m	-14.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	87.85
		Lm	m	-14.350
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------
		Lm	m	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	70.01
		Lm	m	-14.350
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------
		Lm	m	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------
celler partbottom bending moment		MB	kN.m	4692.0
vertical reaction	maximum	Rmax	kN/num	1433
	minimum	Rmin	kN/num	1330
allowable value	displacement	Del.a	cm	5.000
	compressive bearing capacity	Ra	kN/num	4912
	uplifting force	Pa	kN/num	-2856
	stress(SKY400)	Sig.a	N/mm²	210.00
	stress(SKY490)	Sig.a	N/mm²	--------

note)Lm is elevation

2)perpendicular direction

item			unit	OD(HT)	OD(LT)	WN
working force		Vo	kN	53875.1	55939.9	53204.1
		Ho	kN	0.0	0.0	1000.0
		Mo	kN.m	3100.0	3100.0	24800.0
foundation crest	displacement	Del.1	cm	0.012	0.012	0.190
	deflexion angle	Theta.1	mrad	-0.009	-0.009	-0.107
design ground surface	displacement	Del.2	cm	0.012	0.012	0.190
	deflexion angle	Theta.2	mrad	-0.009	-0.009	-0.107
celler part maximum bending moment		Mmax	kN.m	-3100.0	-3100.0	-31166.0
Mmax accrue location		Lm	m	-6.350	-6.350	-16.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	34.13	35.41	40.31
		Lm	m	-22.660	-22.660	-22.660
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	33.73	35.02	35.59
		Lm	m	-22.660	-22.660	-22.660
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------	--------
celler partbottom bending moment		MB	kN.m	58.0	58.0	-526.0
vertical reaction	maximum	Rmax	kN/num	1497	1554	1482
	minimum	Rmin	kN/num	1496	1553	1474
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3278	3278	3278
	uplifting force	Pa	kN/num	-1688	-1688	-1688
	stress(SKY400)	Sig.a	N/mm²	140.00	140.00	175.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------	--------

note)Lm is elevation

item			unit	OD-CL	ETQ
working force		Vo	kN	53875.1	49746.4
		Ho	kN	7500.0	13000.0
		Mo	kN.m	80600.0	219600.0
foundation crest	displacement	Del.1	cm	1.028	1.739
	deflexion angle	Theta.1	mrad	-0.516	-1.021
design ground surface	displacement	Del.2	cm	1.028	1.739
	deflexion angle	Theta.2	mrad	-0.516	-1.021
celler part maximum bending moment		Mmax	kN.m	-139045.0	-317009.0
Mmax accrue location		Lm	m	-19.350	-17.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	67.12	104.91
		Lm	m	-22.660	-22.660
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------
		Lm	m	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	45.08	56.40
		Lm	m	-22.660	-22.660
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------
		Lm	m	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------
celler partbottom bending moment		MB	kN.m	-6178.0	4308.0
vertical reaction	maximum	Rmax	kN/num	1543	1414
	minimum	Rmin	kN/num	1450	1349
allowable value	displacement	Del.a	cm	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3278	4912
	uplifting force	Pa	kN/num	-1688	-2856
	stress(SKY400)	Sig.a	N/mm²	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------

note)Lm is elevation

1.10 detail output

(1)bridge axis direction

1)Oridinary(high tide)

working force	vertical force	Vo	kN	53875.1
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	0.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.000

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	997	2230
2	1330	2974
3	5762	12885
4	6981	15611
5	5430	12142
6	13963	31222
7	38786	86727

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-6.350	0.000	0.000	0.0	0.0	29.25	29.25	*
-7.350	0.000	0.000	0.0	0.0	29.25	29.25	
-7.416	0.000	0.000	0.0	0.0	29.25	29.25	
-8.350	0.000	0.000	0.0	0.0	29.25	29.25	
-9.350	0.000	0.000	0.0	0.0	29.25	29.25	
-10.350	0.000	0.000	0.0	0.0	29.25	29.25	
-11.350	0.000	0.000	0.0	0.0	29.25	29.25	
-11.416	0.000	0.000	0.0	0.0	29.25	29.25	
-12.350	0.000	0.000	0.0	0.0	29.25	29.25	
-12.850	0.000	0.000	0.0	0.0	29.25	29.25	
-13.350	0.000	0.000	0.0	0.0	29.25	29.25	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-14.350	0.000	0.000	0.0	0.0	29.25	29.25	
-15.350	0.000	0.000	0.0	0.0	29.25	29.25	
-16.350	0.000	0.000	0.0	0.0	29.25	29.25	
-17.350	0.000	0.000	0.0	0.0	29.25	29.25	
-18.350	0.000	0.000	0.0	0.0	29.25	29.25	
-18.416	0.000	0.000	0.0	0.0	29.25	29.25	
-19.350	0.000	0.000	0.0	0.0	29.25	29.25	
-20.350	0.000	0.000	0.0	0.0	29.25	29.25	
-21.350	0.000	0.000	0.0	0.0	29.25	29.25	
-22.350	0.000	0.000	0.0	0.0	29.25	29.25	
-22.416	0.000	0.000	0.0	0.0	29.25	29.25	
-22.660	0.000	0.000	0.0	0.0	29.25	29.25	
-22.660	0.000	0.000	0.0	0.0	33.53	33.53	
-23.350	0.000	0.000	0.0	0.0	33.53	33.53	
-24.350	0.000	0.000	0.0	0.0	33.53	33.53	
-25.350	0.000	0.000	0.0	0.0	33.53	33.53	
-26.350	0.000	0.000	0.0	0.0	33.53	33.53	
-27.350	0.000	0.000	0.0	0.0	33.53	33.53	
-28.350	0.000	0.000	0.0	0.0	33.53	33.53	
-29.350	0.000	0.000	0.0	0.0	33.53	33.53	
-30.350	0.000	0.000	0.0	0.0	33.53	33.53	
-31.350	0.000	0.000	0.0	0.0	33.53	33.53	
-32.350	0.000	0.000	0.0	0.0	33.53	33.53	
-33.350	0.000	0.000	0.0	0.0	33.53	33.53	
-34.350	0.000	0.000	0.0	0.0	33.53	33.53	
-35.350	0.000	0.000	0.0	0.0	33.53	33.53	
-36.350	0.000	0.000	0.0	0.0	33.53	33.53	
-37.350	0.000	0.000	0.0	0.0	33.53	33.53	
-38.350	0.000	0.000	0.0	0.0	33.53	33.53	
-39.350	0.000	0.000	0.0	0.0	33.53	33.53	
-39.416	0.000	0.000	0.0	0.0	33.53	33.53	
-40.350	0.000	0.000	0.0	0.0	33.53	33.53	
-41.350	0.000	0.000	0.0	0.0	33.53	33.53	
-42.350	0.000	0.000	0.0	0.0	33.53	33.53	
-43.350	0.000	0.000	0.0	0.0	33.53	33.53	
-44.350	0.000	0.000	0.0	0.0	33.53	33.53	
-45.350	0.000	0.000	0.0	0.0	33.53	33.53	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-46.350	0.000	0.000	0.0	0.0	33.53	33.53	
-47.350	0.000	0.000	0.0	0.0	33.53	33.53	
-48.350	0.000	0.000	0.0	0.0	33.53	33.53	
-49.350	0.000	0.000	0.0	0.0	33.53	33.53	
-50.350	0.000	0.000	0.0	0.0	33.53	33.53	
-51.350	0.000	0.000	0.0	0.0	33.53	33.53	
-52.350	0.000	0.000	0.0	0.0	33.53	33.53	
-53.350	0.000	0.000	0.0	0.0	33.53	33.53	
-54.350	0.000	0.000	0.0	0.0	33.53	33.53	
-54.416	0.000	0.000	0.0	0.0	33.53	33.53	
-55.350	0.000	0.000	0.0	0.0	33.53	33.53	
-56.350	0.000	0.000	0.0	0.0	33.53	33.53	
-56.660	0.000	0.000	0.0	0.0	33.53	33.53	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	33.53	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	33.53	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 0.0 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)

periphery	n1 = 32 (number)	IB1 = 322.82 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 4 (number)	IB1 = 10.76 (m^2)	Ao1 = 0.0446 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 3.668
maximum Rmax = 1497 (kN/number)
minimum Rmin = 1497 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	55939.9
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	0.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.000

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	997	2230
2	1330	2974
3	5762	12885
4	6981	15611
5	5430	12142
6	13963	31222
7	38786	86727

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-6.350	0.000	0.000	0.0	0.0	30.37	30.37	*
-7.350	0.000	0.000	0.0	0.0	30.37	30.37	
-7.416	0.000	0.000	0.0	0.0	30.37	30.37	
-8.350	0.000	0.000	0.0	0.0	30.37	30.37	
-9.350	0.000	0.000	0.0	0.0	30.37	30.37	
-10.350	0.000	0.000	0.0	0.0	30.37	30.37	
-11.350	0.000	0.000	0.0	0.0	30.37	30.37	
-11.416	0.000	0.000	0.0	0.0	30.37	30.37	
-12.350	0.000	0.000	0.0	0.0	30.37	30.37	
-12.850	0.000	0.000	0.0	0.0	30.37	30.37	
-13.350	0.000	0.000	0.0	0.0	30.37	30.37	
-14.350	0.000	0.000	0.0	0.0	30.37	30.37	
-15.350	0.000	0.000	0.0	0.0	30.37	30.37	
-16.350	0.000	0.000	0.0	0.0	30.37	30.37	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.000	0.000	0.0	0.0	30.37	30.37	
-18.350	0.000	0.000	0.0	0.0	30.37	30.37	
-18.416	0.000	0.000	0.0	0.0	30.37	30.37	
-19.350	0.000	0.000	0.0	0.0	30.37	30.37	
-20.350	0.000	0.000	0.0	0.0	30.37	30.37	
-21.350	0.000	0.000	0.0	0.0	30.37	30.37	
-22.350	0.000	0.000	0.0	0.0	30.37	30.37	
-22.416	0.000	0.000	0.0	0.0	30.37	30.37	
-22.660	0.000	0.000	0.0	0.0	30.37	30.37	
-22.660	0.000	0.000	0.0	0.0	34.81	34.81	
-23.350	0.000	0.000	0.0	0.0	34.81	34.81	
-24.350	0.000	0.000	0.0	0.0	34.81	34.81	
-25.350	0.000	0.000	0.0	0.0	34.81	34.81	
-26.350	0.000	0.000	0.0	0.0	34.81	34.81	
-27.350	0.000	0.000	0.0	0.0	34.81	34.81	
-28.350	0.000	0.000	0.0	0.0	34.81	34.81	
-29.350	0.000	0.000	0.0	0.0	34.81	34.81	
-30.350	0.000	0.000	0.0	0.0	34.81	34.81	
-31.350	0.000	0.000	0.0	0.0	34.81	34.81	
-32.350	0.000	0.000	0.0	0.0	34.81	34.81	
-33.350	0.000	0.000	0.0	0.0	34.81	34.81	
-34.350	0.000	0.000	0.0	0.0	34.81	34.81	
-35.350	0.000	0.000	0.0	0.0	34.81	34.81	
-36.350	0.000	0.000	0.0	0.0	34.81	34.81	
-37.350	0.000	0.000	0.0	0.0	34.81	34.81	
-38.350	0.000	0.000	0.0	0.0	34.81	34.81	
-39.350	0.000	0.000	0.0	0.0	34.81	34.81	
-39.416	0.000	0.000	0.0	0.0	34.81	34.81	
-40.350	0.000	0.000	0.0	0.0	34.81	34.81	
-41.350	0.000	0.000	0.0	0.0	34.81	34.81	
-42.350	0.000	0.000	0.0	0.0	34.81	34.81	
-43.350	0.000	0.000	0.0	0.0	34.81	34.81	
-44.350	0.000	0.000	0.0	0.0	34.81	34.81	
-45.350	0.000	0.000	0.0	0.0	34.81	34.81	
-46.350	0.000	0.000	0.0	0.0	34.81	34.81	
-47.350	0.000	0.000	0.0	0.0	34.81	34.81	
-48.350	0.000	0.000	0.0	0.0	34.81	34.81	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	0.000	0.000	0.0	0.0	34.81	34.81	
-50.350	0.000	0.000	0.0	0.0	34.81	34.81	
-51.350	0.000	0.000	0.0	0.0	34.81	34.81	
-52.350	0.000	0.000	0.0	0.0	34.81	34.81	
-53.350	0.000	0.000	0.0	0.0	34.81	34.81	
-54.350	0.000	0.000	0.0	0.0	34.81	34.81	
-54.416	0.000	0.000	0.0	0.0	34.81	34.81	
-55.350	0.000	0.000	0.0	0.0	34.81	34.81	
-56.350	0.000	0.000	0.0	0.0	34.81	34.81	
-56.660	0.000	0.000	0.0	0.0	34.81	34.81	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.81	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	34.81	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 0.0 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)
periphery n1 = 32 (number) IB1 = 322.82 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 4 (number) IB1 = 10.76 (m^2) Ao1 = 0.0446 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.668
maximum Rmax = 1554 (kN/number)
minimum Rmin = 1554 (kN/number)

3)Ord+Temp(high tide)

working force	vertical force	Vo	kN	53875.1
	horizontal force	Ho	kN	200.0
	moment	Mo	kN.m	4000.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.042

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	997	2230
2	1330	2974
3	5762	12885
4	6981	15611
5	5430	12142
6	13963	31222
7	38786	86727

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.042	-0.038	-200.0	-4000.0	30.36	30.03	
-7.350	0.038	-0.037	-182.2	-4190.9	30.41	30.07	
-7.416	0.038	-0.037	-181.1	-4202.9	30.42	30.07	
-8.350	0.034	-0.035	-161.0	-4362.5	30.46	30.10	
-9.350	0.031	-0.034	-141.6	-4513.7	30.50	30.13	
-10.350	0.028	-0.032	-124.1	-4646.3	30.54	30.16	
-11.350	0.024	-0.030	-108.6	-4762.6	30.57	30.18	
-11.416	0.024	-0.030	-107.7	-4769.7	30.57	30.18	
-12.350	0.021	-0.028	-52.4	-4844.0	30.59	30.20	
-12.850	0.020	-0.027	-25.5	-4863.4	30.60	30.20	
-13.350	0.019	-0.027	-0.3	-4869.7	30.60	30.20	*
-14.350	0.016	-0.025	44.9	-4846.9	30.59	30.20	
-15.350	0.014	-0.023	83.7	-4782.2	30.58	30.19	
-16.350	0.012	-0.021	116.5	-4681.6	30.55	30.17	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.010	-0.019	144.0	-4550.9	30.51	30.14	
-18.350	0.008	-0.018	166.4	-4395.3	30.47	30.11	
-18.416	0.008	-0.018	167.7	-4384.3	30.47	30.11	
-19.350	0.006	-0.016	187.7	-4218.0	30.42	30.08	
-20.350	0.005	-0.014	204.3	-4021.6	30.37	30.04	
-21.350	0.003	-0.013	216.3	-3811.0	30.31	30.00	
-22.350	0.002	-0.012	224.2	-3590.4	30.25	29.95	
-22.416	0.002	-0.012	224.6	-3575.6	30.24	29.95	
-22.660	0.002	-0.011	225.6	-3520.7	30.23	29.94	
-22.660	0.002	-0.011	225.6	-3520.7	34.66	34.33	
-23.350	0.001	-0.010	227.7	-3364.2	34.61	34.29	
-24.350	0.000	-0.009	228.5	-3135.9	34.54	34.24	
-25.350	-0.001	-0.007	227.3	-2907.9	34.46	34.19	
-26.350	-0.002	-0.006	224.2	-2682.0	34.39	34.14	
-27.350	-0.002	-0.005	219.6	-2460.0	34.32	34.09	
-28.350	-0.003	-0.004	213.7	-2243.3	34.25	34.04	
-29.350	-0.003	-0.003	206.9	-2032.9	34.18	33.99	
-30.350	-0.003	-0.002	199.4	-1829.7	34.12	33.94	
-31.350	-0.003	-0.002	191.2	-1634.3	34.05	33.90	
-32.350	-0.004	-0.001	182.7	-1447.3	33.99	33.86	
-33.350	-0.004	0.000	174.0	-1269.0	33.94	33.82	
-34.350	-0.004	0.000	165.2	-1099.3	33.88	33.78	
-35.350	-0.004	0.001	156.6	-938.4	33.83	33.74	
-36.350	-0.003	0.001	148.0	-786.2	33.78	33.71	
-37.350	-0.003	0.001	139.8	-642.3	33.73	33.67	
-38.350	-0.003	0.002	131.9	-506.5	33.69	33.64	
-39.350	-0.003	0.002	124.4	-378.4	33.65	33.61	
-39.416	-0.003	0.002	123.9	-370.3	33.65	33.61	
-40.350	-0.003	0.002	107.0	-262.5	33.61	33.59	
-41.350	-0.003	0.002	90.1	-164.1	33.58	33.56	
-42.350	-0.002	0.002	74.5	-81.9	33.55	33.55	
-43.350	-0.002	0.002	60.3	-14.7	33.53	33.53	
-44.350	-0.002	0.002	47.4	39.0	33.54	33.54	
-45.350	-0.002	0.002	35.9	80.5	33.55	33.55	
-46.350	-0.002	0.002	25.7	111.2	33.56	33.55	
-47.350	-0.001	0.002	16.8	132.3	33.57	33.56	
-48.350	-0.001	0.002	9.2	145.2	33.57	33.56	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.001	0.002	2.8	151.0	33.58	33.56	
-50.350	-0.001	0.002	-2.4	151.2	33.58	33.56	
-51.350	-0.001	0.002	-6.4	146.7	33.57	33.56	
-52.350	0.000	0.002	-9.3	138.8	33.57	33.56	
-53.350	0.000	0.002	-11.1	128.5	33.57	33.56	
-54.350	0.000	0.002	-11.9	116.9	33.57	33.55	
-54.416	0.000	0.002	-11.9	116.1	33.56	33.55	
-55.350	0.000	0.002	-11.2	105.1	33.56	33.55	
-56.350	0.000	0.002	-7.9	95.4	33.56	33.55	
-56.660	0.000	0.001	-6.3	93.2	33.56	33.55	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.042	-0.038	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.66	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	34.33	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 93.2 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)
periphery n1 = 32 (number) IB1 = 322.82 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 4 (number) IB1 = 10.76 (m^2) Ao1 = 0.0446 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.668
maximum Rmax = 1498 (kN/number)
minimum Rmin = 1496 (kN/number)

4)Ord+Temp(low tide)

working force	vertical force	Vo	kN	55939.9
	horizontal force	Ho	kN	200.0
	moment	Mo	kN.m	4000.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.042

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	997	2230
2	1330	2974
3	5762	12885
4	6981	15611
5	5430	12142
6	13963	31222
7	38786	86727

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.042	-0.038	-200.0	-4000.0	31.48	31.15	
-7.350	0.038	-0.037	-182.2	-4190.9	31.53	31.19	
-7.416	0.038	-0.037	-181.1	-4202.9	31.54	31.19	
-8.350	0.034	-0.035	-161.0	-4362.5	31.58	31.23	
-9.350	0.031	-0.034	-141.6	-4513.7	31.62	31.25	
-10.350	0.028	-0.032	-124.1	-4646.3	31.66	31.28	
-11.350	0.024	-0.030	-108.6	-4762.6	31.69	31.30	
-11.416	0.024	-0.030	-107.7	-4769.7	31.69	31.31	
-12.350	0.021	-0.028	-52.4	-4844.0	31.71	31.32	
-12.850	0.020	-0.027	-25.5	-4863.4	31.72	31.32	
-13.350	0.019	-0.027	-0.3	-4869.7	31.72	31.32	*
-14.350	0.016	-0.025	44.9	-4846.9	31.72	31.32	
-15.350	0.014	-0.023	83.7	-4782.2	31.70	31.31	
-16.350	0.012	-0.021	116.5	-4681.6	31.67	31.29	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.010	-0.019	144.0	-4550.9	31.63	31.26	
-18.350	0.008	-0.018	166.4	-4395.3	31.59	31.23	
-18.416	0.008	-0.018	167.7	-4384.3	31.59	31.23	
-19.350	0.006	-0.016	187.7	-4218.0	31.54	31.20	
-20.350	0.005	-0.014	204.3	-4021.6	31.49	31.16	
-21.350	0.003	-0.013	216.3	-3811.0	31.43	31.12	
-22.350	0.002	-0.012	224.2	-3590.4	31.37	31.07	
-22.416	0.002	-0.012	224.6	-3575.6	31.36	31.07	
-22.660	0.002	-0.011	225.6	-3520.7	31.35	31.06	
-22.660	0.002	-0.011	225.6	-3520.7	35.94	35.61	
-23.350	0.001	-0.010	227.7	-3364.2	35.89	35.58	
-24.350	0.000	-0.009	228.5	-3135.9	35.82	35.52	
-25.350	-0.001	-0.007	227.3	-2907.9	35.75	35.47	
-26.350	-0.002	-0.006	224.2	-2682.0	35.67	35.42	
-27.350	-0.002	-0.005	219.6	-2460.0	35.60	35.37	
-28.350	-0.003	-0.004	213.7	-2243.3	35.53	35.32	
-29.350	-0.003	-0.003	206.9	-2032.9	35.47	35.27	
-30.350	-0.003	-0.002	199.4	-1829.7	35.40	35.23	
-31.350	-0.003	-0.002	191.2	-1634.3	35.34	35.18	
-32.350	-0.004	-0.001	182.7	-1447.3	35.28	35.14	
-33.350	-0.004	0.000	174.0	-1269.0	35.22	35.10	
-34.350	-0.004	0.000	165.2	-1099.3	35.17	35.06	
-35.350	-0.004	0.001	156.6	-938.4	35.11	35.03	
-36.350	-0.003	0.001	148.0	-786.2	35.07	34.99	
-37.350	-0.003	0.001	139.8	-642.3	35.02	34.96	
-38.350	-0.003	0.002	131.9	-506.5	34.98	34.93	
-39.350	-0.003	0.002	124.4	-378.4	34.93	34.90	
-39.416	-0.003	0.002	123.9	-370.3	34.93	34.90	
-40.350	-0.003	0.002	107.0	-262.5	34.90	34.87	
-41.350	-0.003	0.002	90.1	-164.1	34.87	34.85	
-42.350	-0.002	0.002	74.5	-81.9	34.84	34.83	
-43.350	-0.002	0.002	60.3	-14.7	34.82	34.82	
-44.350	-0.002	0.002	47.4	39.0	34.83	34.82	
-45.350	-0.002	0.002	35.9	80.5	34.84	34.83	
-46.350	-0.002	0.002	25.7	111.2	34.85	34.84	
-47.350	-0.001	0.002	16.8	132.3	34.86	34.84	
-48.350	-0.001	0.002	9.2	145.2	34.86	34.85	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.001	0.002	2.8	151.0	34.86	34.85	
-50.350	-0.001	0.002	-2.4	151.2	34.86	34.85	
-51.350	-0.001	0.002	-6.4	146.7	34.86	34.85	
-52.350	0.000	0.002	-9.3	138.8	34.86	34.84	
-53.350	0.000	0.002	-11.1	128.5	34.85	34.84	
-54.350	0.000	0.002	-11.9	116.9	34.85	34.84	
-54.416	0.000	0.002	-11.9	116.1	34.85	34.84	
-55.350	0.000	0.002	-11.2	105.1	34.85	34.84	
-56.350	0.000	0.002	-7.9	95.4	34.84	34.83	
-56.660	0.000	0.001	-6.3	93.2	34.84	34.83	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.042	-0.038	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	35.94	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	35.61	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 93.2 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)

periphery	n1 = 32 (number)	IB1 =	322.82 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 4 (number)	IB1 =	10.76 (m^2)	Ao1 = 0.0446 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 3.668
maximum Rmax = 1555 (kN/number)
minimum Rmin = 1553 (kN/number)

5)Wind+Temp

working force	vertical force	Vo	kN	53204.1
	horizontal force	Ho	kN	300.0
	moment	Mo	kN.m	5600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.060

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	997	2230
2	1330	2974
3	5762	12885
4	6981	15611
5	5430	12142
6	13963	31222
7	38786	86727

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.060	-0.055	-300.0	-5600.0	30.44	29.98	
-7.350	0.055	-0.053	-274.3	-5886.9	30.52	30.04	
-7.416	0.054	-0.053	-272.7	-5905.0	30.53	30.04	
-8.350	0.049	-0.051	-243.7	-6145.9	30.59	30.09	
-9.350	0.045	-0.048	-215.6	-6375.3	30.66	30.14	
-10.350	0.040	-0.046	-190.4	-6578.0	30.71	30.18	
-11.350	0.035	-0.043	-167.9	-6757.0	30.76	30.21	
-11.416	0.035	-0.043	-166.5	-6768.0	30.77	30.21	
-12.350	0.031	-0.041	-86.4	-6885.3	30.80	30.24	
-12.850	0.029	-0.039	-47.3	-6918.6	30.81	30.24	
-13.350	0.027	-0.038	-10.7	-6933.0	30.81	30.25	*
-14.350	0.024	-0.036	55.0	-6910.1	30.80	30.24	
-15.350	0.020	-0.033	111.5	-6826.1	30.78	30.22	
-16.350	0.017	-0.030	159.5	-6690.0	30.74	30.20	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.014	-0.028	199.6	-6509.8	30.69	30.16	
-18.350	0.011	-0.025	232.5	-6293.2	30.63	30.12	
-18.416	0.011	-0.025	234.4	-6277.8	30.63	30.12	
-19.350	0.009	-0.023	263.9	-6044.5	30.56	30.07	
-20.350	0.007	-0.021	288.5	-5767.8	30.49	30.02	
-21.350	0.005	-0.019	306.4	-5469.8	30.40	29.96	
-22.350	0.003	-0.017	318.5	-5156.9	30.32	29.90	
-22.416	0.003	-0.017	319.1	-5135.8	30.31	29.89	
-22.660	0.002	-0.016	320.7	-5057.8	30.29	29.88	
-22.660	0.002	-0.016	320.7	-5057.8	34.74	34.26	
-23.350	0.001	-0.015	323.9	-4835.3	34.66	34.21	
-24.350	0.000	-0.013	325.6	-4510.2	34.56	34.13	
-25.350	-0.001	-0.011	324.2	-4185.0	34.46	34.06	
-26.350	-0.002	-0.009	320.2	-3862.6	34.35	33.99	
-27.350	-0.003	-0.007	313.9	-3545.4	34.25	33.91	
-28.350	-0.004	-0.006	305.9	-3235.4	34.15	33.84	
-29.350	-0.004	-0.005	296.3	-2934.2	34.05	33.78	
-30.350	-0.005	-0.003	285.7	-2643.1	33.96	33.71	
-31.350	-0.005	-0.002	274.3	-2363.0	33.87	33.65	
-32.350	-0.005	-0.001	262.2	-2094.7	33.78	33.59	
-33.350	-0.005	0.000	249.9	-1838.6	33.70	33.53	
-34.350	-0.005	0.000	237.5	-1594.9	33.62	33.47	
-35.350	-0.005	0.001	225.1	-1363.7	33.55	33.42	
-36.350	-0.005	0.002	213.0	-1144.6	33.48	33.37	
-37.350	-0.005	0.002	201.2	-937.6	33.41	33.32	
-38.350	-0.005	0.002	189.9	-742.0	33.35	33.28	
-39.350	-0.004	0.003	179.2	-557.5	33.29	33.24	
-39.416	-0.004	0.003	178.5	-545.7	33.29	33.23	
-40.350	-0.004	0.003	154.4	-390.4	33.24	33.20	
-41.350	-0.004	0.003	130.2	-248.2	33.19	33.17	
-42.350	-0.003	0.003	107.9	-129.3	33.15	33.14	
-43.350	-0.003	0.003	87.5	-31.8	33.12	33.12	
-44.350	-0.003	0.003	69.0	46.3	33.12	33.12	
-45.350	-0.002	0.003	52.5	106.9	33.14	33.13	
-46.350	-0.002	0.003	37.8	151.9	33.16	33.14	
-47.350	-0.002	0.003	25.0	183.1	33.17	33.15	
-48.350	-0.002	0.003	14.1	202.5	33.18	33.16	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.001	0.003	4.9	211.9	33.18	33.16	
-50.350	-0.001	0.003	-2.6	212.9	33.18	33.16	
-51.350	-0.001	0.003	-8.4	207.3	33.18	33.16	
-52.350	-0.001	0.002	-12.6	196.7	33.17	33.15	
-53.350	0.000	0.002	-15.3	182.7	33.17	33.15	
-54.350	0.000	0.002	-16.4	166.7	33.16	33.15	
-54.416	0.000	0.002	-16.5	165.6	33.16	33.15	
-55.350	0.000	0.002	-15.7	150.3	33.16	33.14	
-56.350	0.000	0.002	-11.1	136.7	33.15	33.14	
-56.660	0.000	0.002	-8.9	133.6	33.15	33.14	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.060	-0.055	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.74	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	34.26	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 133.6 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)

periphery	n1 = 32 (number)	IB1 =	322.82 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 4 (number)	IB1 =	10.76 (m^2)	Ao1 = 0.0446 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 3.668
maximum Rmax = 1479 (kN/number)
minimum Rmin = 1476 (kN/number)

6)Ord+Collision

working force	vertical force	Vo	kN	53875.1
	horizontal force	Ho	kN	3800.0
	moment	Mo	kN.m	39300.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.573

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	997	2230
2	1330	2974
3	5762	12885
4	6981	15611
5	5430	12142
6	13963	31222
7	38786	86727

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.573	-0.487	-3800.0	-39300.0	40.18	36.98	
-7.350	0.525	-0.471	-3553.9	-42975.1	41.20	37.70	
-7.416	0.522	-0.470	-3538.4	-43209.2	41.27	37.75	
-8.350	0.478	-0.455	-3259.0	-46381.7	42.15	38.37	
-9.350	0.434	-0.437	-2986.2	-49502.1	43.02	38.98	
-10.350	0.391	-0.417	-2739.6	-52362.9	43.82	39.55	
-11.350	0.350	-0.397	-2517.8	-54989.6	44.55	40.06	
-11.416	0.348	-0.396	-2504.1	-55155.3	44.59	40.09	
-12.350	0.312	-0.376	-1705.9	-57114.5	45.14	40.48	
-12.850	0.293	-0.365	-1313.9	-57868.5	45.35	40.63	
-13.350	0.275	-0.354	-945.5	-58432.3	45.51	40.74	
-14.350	0.241	-0.332	-276.8	-59036.1	45.67	40.86	*
-15.350	0.209	-0.310	305.7	-59014.7	45.67	40.85	
-16.350	0.179	-0.288	808.0	-58451.4	45.51	40.74	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.151	-0.266	1235.7	-57423.6	45.23	40.54	
-18.350	0.126	-0.244	1594.5	-56003.0	44.83	40.26	
-18.416	0.124	-0.243	1615.9	-55897.1	44.80	40.24	
-19.350	0.102	-0.224	1947.9	-54227.8	44.34	39.91	
-20.350	0.081	-0.204	2235.5	-52130.5	43.75	39.50	
-21.350	0.062	-0.184	2459.3	-49778.0	43.10	39.04	
-22.350	0.044	-0.166	2625.1	-47231.3	42.39	38.54	
-22.416	0.043	-0.165	2634.1	-47057.7	42.34	38.50	
-22.660	0.039	-0.161	2658.6	-46412.0	42.16	38.37	
-22.660	0.039	-0.161	2658.6	-46412.0	48.44	44.05	
-23.350	0.029	-0.147	2715.5	-44556.9	47.85	43.63	
-24.350	0.015	-0.128	2768.0	-41812.4	46.97	43.01	
-25.350	0.003	-0.110	2789.2	-39031.4	46.07	42.38	
-26.350	-0.007	-0.094	2783.4	-36243.0	45.18	41.75	
-27.350	-0.016	-0.079	2754.6	-33472.2	44.29	41.12	
-28.350	-0.023	-0.065	2706.6	-30740.2	43.41	40.50	
-29.350	-0.029	-0.052	2642.8	-28064.3	42.55	39.89	
-30.350	-0.034	-0.040	2566.2	-25458.9	41.71	39.30	
-31.350	-0.037	-0.030	2479.8	-22935.2	40.90	38.73	
-32.350	-0.039	-0.020	2386.2	-20501.7	40.12	38.18	
-33.350	-0.041	-0.012	2287.6	-18164.4	39.37	37.65	
-34.350	-0.042	-0.004	2186.1	-15927.4	38.65	37.14	
-35.350	-0.042	0.002	2083.6	-13792.5	37.96	36.66	
-36.350	-0.041	0.008	1981.6	-11760.0	37.31	36.19	
-37.350	-0.040	0.013	1881.5	-9828.6	36.69	35.76	
-38.350	-0.039	0.016	1784.5	-7995.9	36.10	35.34	
-39.350	-0.037	0.020	1691.4	-6258.3	35.54	34.95	
-39.416	-0.037	0.020	1685.4	-6146.9	35.50	34.92	
-40.350	-0.035	0.022	1473.7	-4672.5	35.03	34.59	
-41.350	-0.033	0.024	1260.3	-3306.7	34.59	34.28	
-42.350	-0.030	0.025	1061.7	-2147.0	34.22	34.01	
-43.350	-0.028	0.026	878.6	-1178.1	33.91	33.79	
-44.350	-0.025	0.026	711.6	-384.3	33.65	33.61	
-45.350	-0.023	0.026	560.8	250.5	33.61	33.58	
-46.350	-0.020	0.026	426.3	742.7	33.77	33.70	
-47.350	-0.018	0.025	307.8	1108.5	33.88	33.78	
-48.350	-0.015	0.025	205.3	1363.7	33.97	33.84	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.013	0.024	118.2	1524.2	34.02	33.87	
-50.350	-0.010	0.023	46.3	1605.2	34.04	33.89	
-51.350	-0.008	0.023	-11.0	1621.6	34.05	33.90	
-52.350	-0.006	0.022	-54.0	1587.9	34.04	33.89	
-53.350	-0.004	0.021	-83.2	1518.2	34.02	33.87	
-54.350	-0.001	0.021	-99.0	1426.0	33.99	33.85	
-54.416	-0.001	0.021	-99.6	1419.5	33.98	33.85	
-55.350	0.001	0.020	-105.8	1321.1	33.95	33.83	
-56.350	0.003	0.020	-78.7	1226.0	33.92	33.81	
-56.660	0.003	0.019	-63.3	1203.9	33.91	33.80	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.573	-0.487	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	48.44	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	44.05	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 1203.9 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)

periphery	n1 =	32 (number)	IB1 =	322.82 (m^2)	Ao1 =	0.0446 (m^2/number)
separation wall	n1 =	4 (number)	IB1 =	10.76 (m^2)	Ao1 =	0.0446 (m^2/number)
intermediate drive	n1 =	0 (number)	IB1 =	0.00 (m^2)	Ao1 =	0.0000 (m^2/number)

x = 3.668
maximum Rmax = 1510 (kN/number)
minimum Rmin = 1483 (kN/number)

7)Earthquake

working force	vertical force	Vo	kN	49746.4
	horizontal force	Ho	kN	11400.0
	moment	Mo	kN.m	153500.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.787
	calculation displacement	Del.	cm	1.782

convergence rate (Del.1 - Del.) / Del.1 = 0.28 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	664	1111
2	886	1482
3	11525	19280
4	13963	23358
5	10860	18168
6	27926	46717
7	77571	129769

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	1.782	-1.653	-11400.0	-153500.0	69.72	57.20	
-7.350	1.619	-1.593	-11020.0	-164707.0	72.84	59.40	
-7.416	1.609	-1.589	-10996.2	-165433.5	73.04	59.54	
-8.350	1.463	-1.529	-10568.8	-175501.2	75.84	61.52	
-9.350	1.313	-1.461	-10155.2	-185859.5	78.72	63.56	
-10.350	1.171	-1.389	-9785.1	-195826.0	81.50	65.52	
-11.350	1.036	-1.314	-9456.5	-205443.5	84.17	67.41	
-11.416	1.027	-1.308	-9436.2	-206066.9	84.35	67.54	
-12.350	0.908	-1.235	-5932.7	-213210.7	86.34	68.94	
-12.850	0.848	-1.194	-4230.4	-215746.6	87.04	69.44	
-13.350	0.789	-1.153	-2643.9	-217460.4	87.52	69.78	
-14.350	0.678	-1.071	197.5	-218647.7	87.85	70.01	*
-15.350	0.575	-0.989	2623.4	-217203.9	87.45	69.73	
-16.350	0.480	-0.908	4665.8	-213528.6	86.42	69.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.393	-0.828	6356.1	-207989.6	84.88	67.91	
-18.350	0.314	-0.751	7725.1	-200923.5	82.92	66.52	
-18.416	0.309	-0.746	7804.8	-200411.0	82.77	66.42	
-19.350	0.243	-0.677	9013.7	-192534.1	80.58	64.87	
-20.350	0.179	-0.606	10000.9	-183001.7	77.93	63.00	
-21.350	0.121	-0.539	10703.1	-172627.3	75.04	60.96	
-22.350	0.071	-0.476	11151.8	-161680.0	72.00	58.81	
-22.416	0.068	-0.472	11173.3	-160943.3	71.79	58.66	
-22.660	0.056	-0.457	11228.4	-158210.0	71.03	58.12	
-22.660	0.056	-0.457	11228.4	-158210.0	81.81	66.84	
-23.350	0.026	-0.411	11331.7	-150422.5	79.30	65.08	
-24.350	-0.012	-0.348	11356.4	-139066.9	75.65	62.50	
-25.350	-0.043	-0.289	11253.9	-127752.1	72.02	59.93	
-26.350	-0.070	-0.236	11045.4	-116594.5	68.43	57.40	
-27.350	-0.091	-0.188	10750.5	-105690.1	64.93	54.93	
-28.350	-0.107	-0.144	10386.8	-95116.4	61.53	52.53	
-29.350	-0.120	-0.104	9970.5	-84934.0	58.26	50.22	
-30.350	-0.128	-0.070	9515.9	-75188.2	55.12	48.01	
-31.350	-0.134	-0.039	9035.7	-65910.7	52.14	45.91	
-32.350	-0.136	-0.012	8541.3	-57121.4	49.32	43.91	
-33.350	-0.136	0.011	8042.4	-48829.5	46.65	42.03	
-34.350	-0.134	0.031	7547.6	-41035.2	44.15	40.27	
-35.350	-0.130	0.047	7063.9	-33730.6	41.80	38.61	
-36.350	-0.125	0.060	6597.3	-26901.7	39.60	37.06	
-37.350	-0.118	0.071	6152.7	-20528.6	37.56	35.61	
-38.350	-0.111	0.078	5733.9	-14587.6	35.65	34.27	
-39.350	-0.103	0.084	5343.7	-9051.2	33.87	33.01	
-39.416	-0.102	0.084	5319.0	-8699.3	33.75	32.93	
-40.350	-0.094	0.086	4457.4	-4139.2	32.29	31.90	
-41.350	-0.085	0.087	3613.2	-110.7	30.99	30.98	
-42.350	-0.077	0.087	2851.0	3114.6	31.96	31.66	
-43.350	-0.068	0.085	2170.1	5618.4	32.76	32.23	
-44.350	-0.060	0.082	1568.6	7481.2	33.36	32.66	
-45.350	-0.052	0.078	1043.9	8781.2	33.78	32.95	
-46.350	-0.044	0.074	592.7	9593.6	34.04	33.13	
-47.350	-0.037	0.070	211.2	9989.9	34.17	33.22	
-48.350	-0.030	0.065	-104.7	10037.8	34.18	33.23	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.024	0.061	-358.9	9801.1	34.11	33.18	
-50.350	-0.018	0.057	-555.8	9339.1	33.96	33.08	
-51.350	-0.013	0.053	-699.0	8707.4	33.76	32.93	
-52.350	-0.007	0.049	-792.4	7957.7	33.52	32.76	
-53.350	-0.003	0.046	-839.3	7138.1	33.25	32.58	
-54.350	0.002	0.043	-842.9	6293.5	32.98	32.39	
-54.416	0.002	0.043	-841.7	6237.9	32.96	32.37	
-55.350	0.006	0.041	-742.4	5490.7	32.72	32.20	
-56.350	0.010	0.038	-533.7	4844.1	32.52	32.06	
-56.660	0.011	0.038	-448.4	4691.6	32.47	32.02	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	1.782	-1.653	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	87.85	-14.350
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	70.01	-14.350
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 4691.6 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)
periphery n1 = 32 (number) IB1 = 322.82 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 4 (number) IB1 = 10.76 (m^2) Ao1 = 0.0446 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.668
maximum Rmax = 1433 (kN/number)
minimum Rmin = 1330 (kN/number)

(2)perpendicular direction
1)Oridinary(high tide)

working force	vertical force	Vo	kN	53875.1
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	3100.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.012

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1151	2573
2	1534	3431
3	6648	14866
4	8055	18011
5	6265	14008
6	16109	36021
7	44748	100059

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-6.350	0.012	-0.009	0.0	-3100.0	29.91	29.48	*
-7.350	0.011	-0.008	2.5	-3098.7	29.91	29.48	
-7.416	0.011	-0.008	2.7	-3098.5	29.91	29.48	
-8.350	0.010	-0.008	5.6	-3094.6	29.91	29.48	
-9.350	0.010	-0.008	8.5	-3087.5	29.91	29.48	
-10.350	0.009	-0.007	11.2	-3077.6	29.90	29.47	
-11.350	0.008	-0.007	13.7	-3065.1	29.90	29.47	
-11.416	0.008	-0.007	13.9	-3064.2	29.90	29.47	
-12.350	0.007	-0.007	23.0	-3046.9	29.90	29.47	
-12.850	0.007	-0.007	27.6	-3034.2	29.89	29.47	
-13.350	0.007	-0.006	32.0	-3019.3	29.89	29.47	
-14.350	0.006	-0.006	40.2	-2983.1	29.88	29.47	
-15.350	0.006	-0.006	47.6	-2939.1	29.87	29.46	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-16.350	0.005	-0.005	54.3	-2888.1	29.86	29.46	
-17.350	0.004	-0.005	60.3	-2830.8	29.85	29.46	
-18.350	0.004	-0.005	65.6	-2767.7	29.84	29.45	
-18.416	0.004	-0.005	65.9	-2763.4	29.84	29.45	
-19.350	0.003	-0.005	71.2	-2699.3	29.82	29.45	
-20.350	0.003	-0.004	76.2	-2625.5	29.81	29.44	
-21.350	0.003	-0.004	80.5	-2547.1	29.79	29.44	
-22.350	0.002	-0.004	84.2	-2464.6	29.77	29.43	
-22.416	0.002	-0.004	84.4	-2459.1	29.77	29.43	
-22.660	0.002	-0.004	85.1	-2438.4	29.77	29.43	
-22.660	0.002	-0.004	85.1	-2438.4	34.13	33.73	
-23.350	0.002	-0.004	86.7	-2379.1	34.12	33.73	
-24.350	0.001	-0.003	88.6	-2291.4	34.09	33.72	
-25.350	0.001	-0.003	90.2	-2202.0	34.07	33.71	
-26.350	0.001	-0.003	91.5	-2111.1	34.05	33.71	
-27.350	0.001	-0.003	92.3	-2019.2	34.03	33.70	
-28.350	0.000	-0.002	92.9	-1926.5	34.00	33.69	
-29.350	0.000	-0.002	93.2	-1833.4	33.98	33.68	
-30.350	0.000	-0.002	93.3	-1740.1	33.96	33.68	
-31.350	0.000	-0.002	93.1	-1646.9	33.93	33.67	
-32.350	0.000	-0.001	92.8	-1553.9	33.91	33.66	
-33.350	-0.001	-0.001	92.2	-1461.4	33.89	33.65	
-34.350	-0.001	-0.001	91.5	-1369.5	33.87	33.64	
-35.350	-0.001	-0.001	90.7	-1278.3	33.84	33.64	
-36.350	-0.001	-0.001	89.8	-1188.1	33.82	33.63	
-37.350	-0.001	-0.001	88.7	-1098.8	33.80	33.62	
-38.350	-0.001	-0.001	87.6	-1010.7	33.78	33.61	
-39.350	-0.001	0.000	86.4	-923.6	33.76	33.61	
-39.416	-0.001	0.000	86.3	-917.9	33.75	33.61	
-40.350	-0.001	0.000	83.3	-838.7	33.73	33.60	
-41.350	-0.001	0.000	80.0	-757.0	33.71	33.59	
-42.350	-0.001	0.000	76.6	-678.7	33.70	33.59	
-43.350	-0.001	0.000	73.2	-603.8	33.68	33.58	
-44.350	-0.001	0.000	69.7	-532.4	33.66	33.57	
-45.350	-0.001	0.000	66.2	-464.5	33.64	33.57	
-46.350	-0.001	0.000	62.7	-400.1	33.63	33.56	
-47.350	-0.001	0.000	59.2	-339.1	33.61	33.56	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-48.350	-0.001	0.000	55.8	-281.6	33.60	33.55	
-49.350	-0.001	0.000	52.4	-227.4	33.58	33.55	
-50.350	-0.001	0.000	49.1	-176.7	33.57	33.54	
-51.350	-0.001	0.000	45.9	-129.2	33.56	33.54	
-52.350	-0.001	0.000	42.7	-84.9	33.55	33.53	
-53.350	-0.001	0.000	39.6	-43.7	33.54	33.53	
-54.350	-0.001	0.000	36.6	-5.6	33.53	33.53	
-54.416	-0.001	0.000	36.4	-3.2	33.53	33.53	
-55.350	-0.001	0.000	28.8	27.2	33.53	33.53	
-56.350	-0.001	0.000	20.8	52.0	33.54	33.53	
-56.660	-0.001	0.000	18.4	58.0	33.54	33.53	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.012	-0.009	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.13	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	33.73	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 58.0 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 56.053 (m^4)
periphery n1 = 32 (number) IB1 = 1255.78 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 4 (number) IB1 = 0.00 (m^2) Ao1 = 0.0446 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 9.459
maximum Rmax = 1497 (kN/number)
minimum Rmin = 1496 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	55939.9
	horizontal force	Ho	kN	0.0
	moment	Mo	kN.m	3100.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.012

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1151	2573
2	1534	3431
3	6648	14866
4	8055	18011
5	6265	14008
6	16109	36021
7	44748	100059

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.012	-0.009	0.0	-3100.0	31.03	30.60	*
-7.350	0.011	-0.008	2.5	-3098.7	31.03	30.60	
-7.416	0.011	-0.008	2.7	-3098.5	31.03	30.60	
-8.350	0.010	-0.008	5.6	-3094.6	31.03	30.60	
-9.350	0.010	-0.008	8.5	-3087.5	31.03	30.60	
-10.350	0.009	-0.007	11.2	-3077.6	31.02	30.60	
-11.350	0.008	-0.007	13.7	-3065.1	31.02	30.59	
-11.416	0.008	-0.007	13.9	-3064.2	31.02	30.59	
-12.350	0.007	-0.007	23.0	-3046.9	31.02	30.59	
-12.850	0.007	-0.007	27.6	-3034.2	31.01	30.59	
-13.350	0.007	-0.006	32.0	-3019.3	31.01	30.59	
-14.350	0.006	-0.006	40.2	-2983.1	31.00	30.59	
-15.350	0.006	-0.006	47.6	-2939.1	30.99	30.59	
-16.350	0.005	-0.005	54.3	-2888.1	30.98	30.58	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.004	-0.005	60.3	-2830.8	30.97	30.58	
-18.350	0.004	-0.005	65.6	-2767.7	30.96	30.57	
-18.416	0.004	-0.005	65.9	-2763.4	30.96	30.57	
-19.350	0.003	-0.005	71.2	-2699.3	30.94	30.57	
-20.350	0.003	-0.004	76.2	-2625.5	30.93	30.56	
-21.350	0.003	-0.004	80.5	-2547.1	30.91	30.56	
-22.350	0.002	-0.004	84.2	-2464.6	30.89	30.55	
-22.416	0.002	-0.004	84.4	-2459.1	30.89	30.55	
-22.660	0.002	-0.004	85.1	-2438.4	30.89	30.55	
-22.660	0.002	-0.004	85.1	-2438.4	35.41	35.02	
-23.350	0.002	-0.004	86.7	-2379.1	35.40	35.01	
-24.350	0.001	-0.003	88.6	-2291.4	35.38	35.01	
-25.350	0.001	-0.003	90.2	-2202.0	35.36	35.00	
-26.350	0.001	-0.003	91.5	-2111.1	35.33	34.99	
-27.350	0.001	-0.003	92.3	-2019.2	35.31	34.98	
-28.350	0.000	-0.002	92.9	-1926.5	35.29	34.98	
-29.350	0.000	-0.002	93.2	-1833.4	35.27	34.97	
-30.350	0.000	-0.002	93.3	-1740.1	35.24	34.96	
-31.350	0.000	-0.002	93.1	-1646.9	35.22	34.95	
-32.350	0.000	-0.001	92.8	-1553.9	35.20	34.94	
-33.350	-0.001	-0.001	92.2	-1461.4	35.17	34.94	
-34.350	-0.001	-0.001	91.5	-1369.5	35.15	34.93	
-35.350	-0.001	-0.001	90.7	-1278.3	35.13	34.92	
-36.350	-0.001	-0.001	89.8	-1188.1	35.11	34.91	
-37.350	-0.001	-0.001	88.7	-1098.8	35.08	34.91	
-38.350	-0.001	-0.001	87.6	-1010.7	35.06	34.90	
-39.350	-0.001	0.000	86.4	-923.6	35.04	34.89	
-39.416	-0.001	0.000	86.3	-917.9	35.04	34.89	
-40.350	-0.001	0.000	83.3	-838.7	35.02	34.88	
-41.350	-0.001	0.000	80.0	-757.0	35.00	34.88	
-42.350	-0.001	0.000	76.6	-678.7	34.98	34.87	
-43.350	-0.001	0.000	73.2	-603.8	34.96	34.86	
-44.350	-0.001	0.000	69.7	-532.4	34.94	34.86	
-45.350	-0.001	0.000	66.2	-464.5	34.93	34.85	
-46.350	-0.001	0.000	62.7	-400.1	34.91	34.85	
-47.350	-0.001	0.000	59.2	-339.1	34.90	34.84	
-48.350	-0.001	0.000	55.8	-281.6	34.88	34.84	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.001	0.000	52.4	-227.4	34.87	34.83	
-50.350	-0.001	0.000	49.1	-176.7	34.86	34.83	
-51.350	-0.001	0.000	45.9	-129.2	34.84	34.82	
-52.350	-0.001	0.000	42.7	-84.9	34.83	34.82	
-53.350	-0.001	0.000	39.6	-43.7	34.82	34.82	
-54.350	-0.001	0.000	36.6	-5.6	34.81	34.81	
-54.416	-0.001	0.000	36.4	-3.2	34.81	34.81	
-55.350	-0.001	0.000	28.8	27.2	34.82	34.81	
-56.350	-0.001	0.000	20.8	52.0	34.83	34.82	
-56.660	-0.001	0.000	18.4	58.0	34.83	34.82	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.012	-0.009	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	35.41	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	35.02	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 58.0 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 56.053 (m^4)
periphery n1 = 32 (number) IB1 = 1255.78 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 4 (number) IB1 = 0.00 (m^2) Ao1 = 0.0446 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 9.459
maximum Rmax = 1554 (kN/number)
minimum Rmin = 1553 (kN/number)

3)Wind

working force	vertical force	Vo	kN	53204.1
	horizontal force	Ho	kN	1000.0
	moment	Mo	kN.m	24800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.190

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1151	2573
2	1534	3431
3	6648	14866
4	8055	18011
5	6265	14008
6	16109	36021
7	44748	100059

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.190	-0.107	-1000.0	-24800.0	34.17	30.72	
-7.350	0.179	-0.105	-959.4	-25779.5	34.38	30.80	
-7.416	0.179	-0.105	-956.8	-25842.7	34.40	30.80	
-8.350	0.169	-0.102	-909.3	-26714.0	34.58	30.87	
-9.350	0.159	-0.099	-861.2	-27599.0	34.77	30.93	
-10.350	0.149	-0.096	-816.1	-28437.4	34.95	31.00	
-11.350	0.140	-0.093	-773.8	-29232.1	35.12	31.05	
-11.416	0.139	-0.093	-771.1	-29283.1	35.13	31.06	
-12.350	0.131	-0.090	-611.3	-29927.9	35.27	31.11	
-12.850	0.126	-0.089	-529.8	-30213.0	35.33	31.13	
-13.350	0.122	-0.087	-451.2	-30458.2	35.38	31.15	
-14.350	0.113	-0.084	-302.3	-30834.0	35.46	31.17	
-15.350	0.105	-0.081	-164.1	-31066.4	35.51	31.19	
-16.350	0.097	-0.078	-36.2	-31165.6	35.53	31.20	*

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.089	-0.075	81.9	-31142.0	35.53	31.20	
-18.350	0.082	-0.072	190.4	-31005.1	35.50	31.19	
-18.416	0.081	-0.071	197.2	-30992.3	35.50	31.19	
-19.350	0.075	-0.069	309.4	-30754.9	35.45	31.17	
-20.350	0.068	-0.065	419.4	-30389.7	35.37	31.14	
-21.350	0.062	-0.062	519.2	-29919.6	35.27	31.11	
-22.350	0.056	-0.059	609.5	-29354.4	35.15	31.06	
-22.416	0.055	-0.059	615.1	-29314.0	35.14	31.06	
-22.660	0.054	-0.058	631.0	-29162.0	35.11	31.05	
-22.660	0.054	-0.058	631.0	-29162.0	40.31	35.59	
-23.350	0.050	-0.056	673.8	-28711.6	40.20	35.55	
-24.350	0.044	-0.053	730.2	-28009.0	40.03	35.49	
-25.350	0.039	-0.050	780.3	-27253.2	39.84	35.42	
-26.350	0.035	-0.046	824.5	-26450.3	39.64	35.36	
-27.350	0.030	-0.043	863.1	-25606.0	39.43	35.29	
-28.350	0.026	-0.040	896.6	-24725.7	39.22	35.21	
-29.350	0.022	-0.037	925.2	-23814.4	38.99	35.13	
-30.350	0.018	-0.035	949.4	-22876.7	38.76	35.05	
-31.350	0.015	-0.032	969.4	-21917.0	38.52	34.97	
-32.350	0.012	-0.029	985.6	-20939.2	38.28	34.89	
-33.350	0.009	-0.027	998.3	-19946.9	38.04	34.80	
-34.350	0.007	-0.025	1007.7	-18943.7	37.79	34.72	
-35.350	0.004	-0.023	1014.2	-17932.5	37.54	34.63	
-36.350	0.002	-0.021	1018.0	-16916.2	37.29	34.55	
-37.350	0.000	-0.019	1019.3	-15897.4	37.04	34.46	
-38.350	-0.002	-0.017	1018.4	-14878.4	36.78	34.37	
-39.350	-0.003	-0.015	1015.4	-13861.3	36.53	34.29	
-39.416	-0.003	-0.015	1015.2	-13794.3	36.52	34.28	
-40.350	-0.005	-0.013	1003.7	-12851.2	36.28	34.20	
-41.350	-0.006	-0.012	987.4	-11855.3	36.04	34.12	
-42.350	-0.007	-0.011	967.4	-10877.6	35.80	34.03	
-43.350	-0.008	-0.009	944.1	-9921.5	35.56	33.95	
-44.350	-0.009	-0.008	917.9	-8990.3	35.33	33.87	
-45.350	-0.010	-0.007	889.2	-8086.5	35.11	33.80	
-46.350	-0.010	-0.006	858.1	-7212.7	34.89	33.72	
-47.350	-0.011	-0.006	825.1	-6370.9	34.68	33.65	
-48.350	-0.012	-0.005	790.4	-5563.0	34.48	33.58	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.012	-0.004	754.1	-4790.6	34.29	33.52	
-50.350	-0.012	-0.004	716.5	-4055.2	34.11	33.45	
-51.350	-0.013	-0.003	677.8	-3357.9	33.94	33.40	
-52.350	-0.013	-0.003	638.0	-2700.0	33.78	33.34	
-53.350	-0.013	-0.003	597.3	-2082.3	33.62	33.29	
-54.350	-0.014	-0.003	555.7	-1505.7	33.48	33.24	
-54.416	-0.014	-0.002	552.9	-1469.2	33.47	33.23	
-55.350	-0.014	-0.002	443.0	-1003.9	33.36	33.20	
-56.350	-0.014	-0.002	323.4	-620.5	33.26	33.16	
-56.660	-0.014	-0.002	286.0	-526.0	33.24	33.15	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	0.190	-0.107	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	40.31	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	35.59	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -526.0 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 56.053 (m^4)

periphery	n1 = 32 (number)	IB1 = 1255.78 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 4 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0446 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 9.459
maximum Rmax = 1482 (kN/number)
minimum Rmin = 1474 (kN/number)

4)Ord+Collision

working force	vertical force	Vo	kN	53875.1
	horizontal force	Ho	kN	7500.0
	moment	Mo	kN.m	80600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.032
	calculation displacement	Del.	cm	1.028

convergence rate (Del.1 - Del.) / Del.1 = 0.38 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1151	2533
2	1534	3377
3	6648	14635
4	8055	17731
5	6265	13791
6	16109	35461
7	44748	98504

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-6.350	1.028	-0.516	-7500.0	-80600.0	46.45	35.24	
-7.350	0.977	-0.507	-7283.3	-87990.7	48.02	35.79	
-7.416	0.973	-0.507	-7269.4	-88470.9	48.13	35.82	
-8.350	0.926	-0.498	-7013.7	-95140.2	49.55	36.32	
-9.350	0.877	-0.488	-6753.7	-102022.7	51.02	36.83	
-10.350	0.829	-0.477	-6507.9	-108652.3	52.43	37.32	
-11.350	0.782	-0.466	-6275.8	-115043.0	53.80	37.80	
-11.416	0.779	-0.465	-6260.9	-115456.7	53.89	37.83	
-12.350	0.736	-0.454	-5377.7	-120888.1	55.04	38.23	
-12.850	0.713	-0.448	-4925.3	-123463.2	55.59	38.42	
-13.350	0.691	-0.442	-4486.8	-125815.7	56.10	38.60	
-14.350	0.647	-0.429	-3651.1	-129880.1	56.96	38.90	
-15.350	0.605	-0.415	-2869.0	-133135.8	57.66	39.14	
-16.350	0.564	-0.402	-2138.7	-135635.4	58.19	39.33	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.525	-0.388	-1458.6	-137429.9	58.57	39.46	
-18.350	0.487	-0.374	-826.8	-138568.6	58.82	39.54	
-18.416	0.484	-0.373	-786.8	-138621.9	58.83	39.55	
-19.350	0.450	-0.360	-126.5	-139044.7	58.92	39.58	*
-20.350	0.415	-0.346	527.8	-138839.6	58.88	39.56	
-21.350	0.381	-0.332	1129.8	-138006.5	58.70	39.50	
-22.350	0.349	-0.318	1681.7	-136596.6	58.40	39.40	
-22.416	0.346	-0.317	1716.4	-136484.5	58.37	39.39	
-22.660	0.339	-0.313	1814.8	-136053.6	58.28	39.36	
-22.660	0.339	-0.313	1814.8	-136053.6	67.12	45.08	
-23.350	0.318	-0.302	2081.3	-134708.5	66.79	44.97	
-24.350	0.288	-0.286	2437.6	-132446.1	66.23	44.78	
-25.350	0.260	-0.271	2760.2	-129844.5	65.59	44.56	
-26.350	0.234	-0.256	3050.9	-126936.4	64.87	44.31	
-27.350	0.209	-0.241	3311.4	-123752.8	64.09	44.04	
-28.350	0.186	-0.227	3543.6	-120322.9	63.24	43.75	
-29.350	0.164	-0.213	3749.2	-116674.4	62.34	43.44	
-30.350	0.143	-0.199	3929.7	-112833.0	61.39	43.11	
-31.350	0.124	-0.186	4086.7	-108822.9	60.40	42.77	
-32.350	0.106	-0.173	4221.9	-104666.8	59.37	42.42	
-33.350	0.089	-0.161	4336.7	-100385.9	58.32	42.05	
-34.350	0.074	-0.150	4432.5	-95999.7	57.23	41.68	
-35.350	0.059	-0.139	4510.7	-91526.7	56.13	41.30	
-36.350	0.046	-0.128	4572.6	-86983.8	55.01	40.92	
-37.350	0.034	-0.118	4619.4	-82386.5	53.87	40.53	
-38.350	0.022	-0.108	4652.4	-77749.5	52.73	40.13	
-39.350	0.012	-0.100	4672.5	-73086.1	51.58	39.74	
-39.416	0.011	-0.099	4673.4	-72777.7	51.50	39.71	
-40.350	0.002	-0.091	4692.8	-68401.7	50.42	39.34	
-41.350	-0.006	-0.083	4686.8	-63709.7	49.26	38.94	
-42.350	-0.014	-0.076	4655.6	-59036.5	48.11	38.54	
-43.350	-0.022	-0.069	4601.3	-54406.2	46.96	38.15	
-44.350	-0.028	-0.063	4526.0	-49840.8	45.84	37.76	
-45.350	-0.034	-0.058	4431.5	-45360.5	44.73	37.38	
-46.350	-0.040	-0.053	4319.6	-40983.6	43.65	37.01	
-47.350	-0.045	-0.048	4191.7	-36726.7	42.60	36.65	
-48.350	-0.049	-0.044	4049.2	-32605.1	41.58	36.30	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.054	-0.040	3893.5	-28632.6	40.60	35.96	
-50.350	-0.057	-0.037	3725.6	-24822.1	39.66	35.64	
-51.350	-0.061	-0.034	3546.4	-21185.2	38.76	35.33	
-52.350	-0.064	-0.032	3356.8	-17732.8	37.91	35.03	
-53.350	-0.067	-0.030	3157.4	-14474.9	37.10	34.76	
-54.350	-0.070	-0.029	2948.9	-11421.0	36.35	34.50	
-54.416	-0.071	-0.029	2934.8	-11226.8	36.30	34.48	
-55.350	-0.073	-0.028	2370.6	-8747.6	35.69	34.27	
-56.350	-0.076	-0.027	1744.1	-6688.4	35.18	34.10	
-56.660	-0.077	-0.026	1545.3	-6178.4	35.05	34.05	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	1.028	-0.516	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	67.12	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	45.08	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -6178.4 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 56.053 (m^4)

periphery	n1 = 32 (number)	IB1 =	1255.78 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 4 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0446 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 =	0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 9.459
maximum Rmax = 1543 (kN/number)
minimum Rmin = 1450 (kN/number)

5)Earthquake

working force	vertical force	Vo	kN	49746.4
	horizontal force	Ho	kN	13000.0
	moment	Mo	kN.m	219600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.748
	calculation displacement	Del.	cm	1.739

convergence rate (Del.1 - Del.) / Del.1 = 0.49 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	766	1296
2	1022	1728
3	13296	22490
4	16109	27248
5	12529	21193
6	32218	54496
7	89495	151377

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	1.739	-1.021	-13000.0	-219600.0	73.87	43.33	
-7.350	1.638	-0.998	-12813.2	-232505.7	76.62	44.28	
-7.416	1.632	-0.996	-12801.3	-233350.9	76.80	44.35	
-8.350	1.540	-0.973	-12582.8	-245204.3	79.33	45.23	
-9.350	1.443	-0.948	-12362.9	-257675.9	81.99	46.15	
-10.350	1.350	-0.921	-12156.9	-269934.6	84.61	47.07	
-11.350	1.259	-0.893	-11964.4	-281994.2	87.18	47.96	
-11.416	1.253	-0.891	-11952.2	-282783.4	87.35	48.02	
-12.350	1.171	-0.864	-9778.9	-292920.4	89.52	48.77	
-12.850	1.129	-0.849	-8675.2	-297532.2	90.50	49.12	
-13.350	1.087	-0.834	-7612.2	-301602.3	91.37	49.42	
-14.350	1.005	-0.803	-5605.5	-308198.1	92.78	49.91	
-15.350	0.926	-0.771	-3753.0	-312864.7	93.77	50.26	
-16.350	0.850	-0.739	-2048.4	-315753.3	94.39	50.47	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.350	0.778	-0.707	-485.9	-317008.9	94.66	50.56	*
-18.350	0.709	-0.675	941.0	-316770.3	94.61	50.55	
-18.416	0.705	-0.673	1030.5	-316705.3	94.59	50.54	
-19.350	0.643	-0.643	2493.7	-315049.1	94.24	50.42	
-20.350	0.580	-0.611	3915.8	-311832.2	93.55	50.18	
-21.350	0.521	-0.580	5195.7	-307264.9	92.58	49.84	
-22.350	0.464	-0.549	6340.8	-301485.8	91.34	49.41	
-22.416	0.461	-0.547	6411.8	-301064.9	91.25	49.38	
-22.660	0.448	-0.539	6612.2	-299475.9	90.92	49.26	
-22.660	0.448	-0.539	6612.2	-299475.9	104.91	56.40	
-23.350	0.411	-0.515	7147.9	-294726.0	103.74	55.99	
-24.350	0.361	-0.481	7846.1	-287221.5	101.88	55.36	
-25.350	0.315	-0.447	8457.2	-279062.9	99.87	54.66	
-26.350	0.272	-0.415	8987.4	-270334.1	97.71	53.92	
-27.350	0.232	-0.384	9442.6	-261113.1	95.44	53.14	
-28.350	0.195	-0.353	9828.3	-251472.1	93.06	52.32	
-29.350	0.161	-0.324	10150.1	-241477.8	90.59	51.47	
-30.350	0.130	-0.296	10413.3	-231191.4	88.05	50.60	
-31.350	0.102	-0.270	10622.8	-220669.1	85.45	49.70	
-32.350	0.076	-0.244	10783.6	-209962.0	82.81	48.79	
-33.350	0.053	-0.220	10900.2	-199116.6	80.13	47.87	
-34.350	0.032	-0.197	10977.0	-188174.9	77.43	46.94	
-35.350	0.014	-0.175	11018.2	-177174.4	74.71	46.01	
-36.350	-0.003	-0.155	11027.6	-166149.1	71.99	45.07	
-37.350	-0.017	-0.136	11008.9	-155128.7	69.27	44.14	
-38.350	-0.030	-0.119	10965.5	-144139.6	66.55	43.20	
-39.350	-0.041	-0.102	10900.7	-133204.8	63.85	42.27	
-39.416	-0.042	-0.101	10895.7	-132485.5	63.67	42.21	
-40.350	-0.051	-0.087	10694.2	-122400.1	61.18	41.36	
-41.350	-0.059	-0.073	10439.4	-111830.1	58.57	40.46	
-42.350	-0.065	-0.061	10150.5	-101532.6	56.03	39.58	
-43.350	-0.071	-0.049	9833.4	-91538.5	53.56	38.73	
-44.350	-0.075	-0.039	9493.3	-81873.5	51.18	37.91	
-45.350	-0.079	-0.030	9135.0	-72558.0	48.88	37.12	
-46.350	-0.081	-0.022	8762.8	-63608.0	46.67	36.36	
-47.350	-0.083	-0.015	8380.5	-55035.7	44.55	35.63	
-48.350	-0.084	-0.009	7991.2	-46849.4	42.53	34.94	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-49.350	-0.085	-0.004	7597.7	-39054.7	40.60	34.28	
-50.350	-0.085	0.000	7202.5	-31654.6	38.77	33.65	
-51.350	-0.085	0.004	6807.5	-24649.7	37.05	33.05	
-52.350	-0.084	0.006	6414.1	-18039.1	35.41	32.49	
-53.350	-0.084	0.008	6023.7	-11820.4	33.88	31.96	
-54.350	-0.083	0.009	5637.0	-5990.4	32.44	31.47	
-54.416	-0.083	0.009	5611.6	-5619.2	32.35	31.44	
-55.350	-0.082	0.009	4619.6	-842.0	31.17	31.03	
-56.350	-0.081	0.009	3569.2	3251.4	31.76	31.23	
-56.660	-0.081	0.009	3246.1	4307.7	32.02	31.32	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.350	1.739	-1.021	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	104.91	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	56.40	-22.660
separation wall sheet pile (SKY490)	------	--------

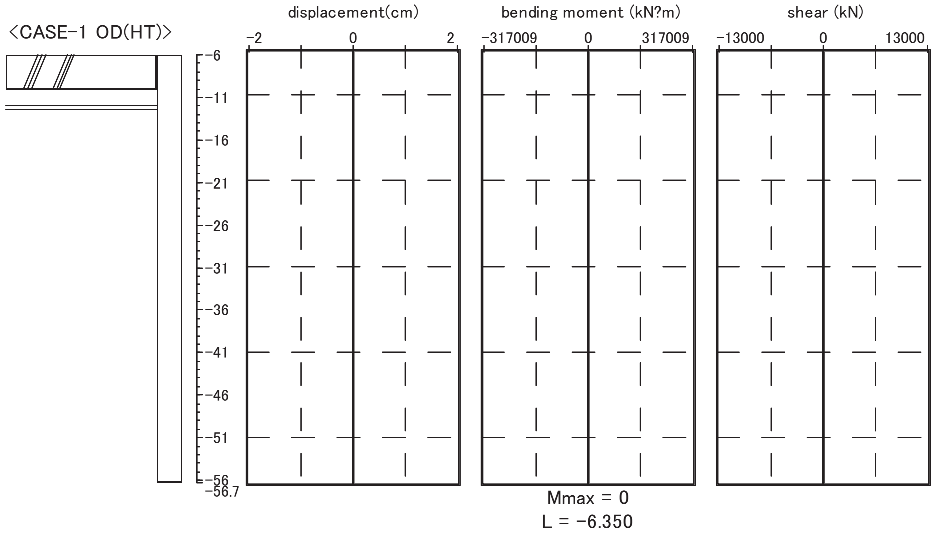
vertical reaction

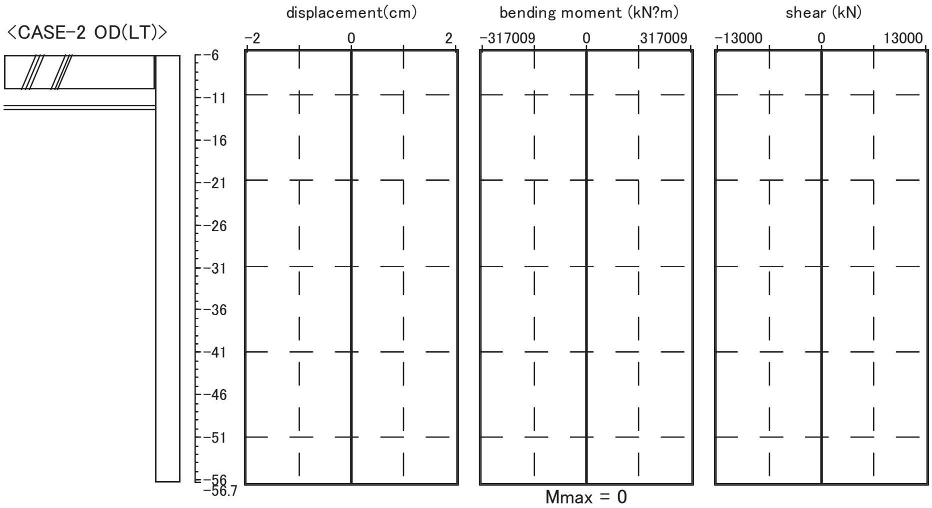
$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

```
MB             =      4307.7 (kN.m)
Sum(ni*Aoi)  =       1.607 (m²)
Sum(IBi*Aoi) =      56.053 (m⁴)
      periphery          n1  =  32 (number)   IB1 =       1255.78 (m²)   Ao1 =  0.0446 (m²/number)
      separation wall    n1  =   4 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0446 (m²/number)
      intermediate drive n1  =   0 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0000 (m²/number)
      x =   9.459
 maximum   Rmax =   1414 (kN/number)
 minimum   Rmin =   1349 (kN/number)
```

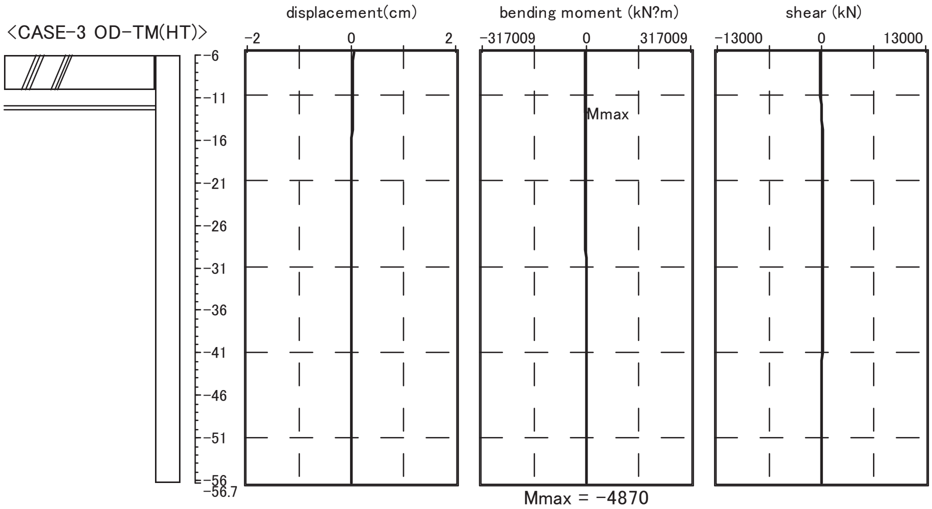

1.11 displacement / member force diagram

bridge axis direction



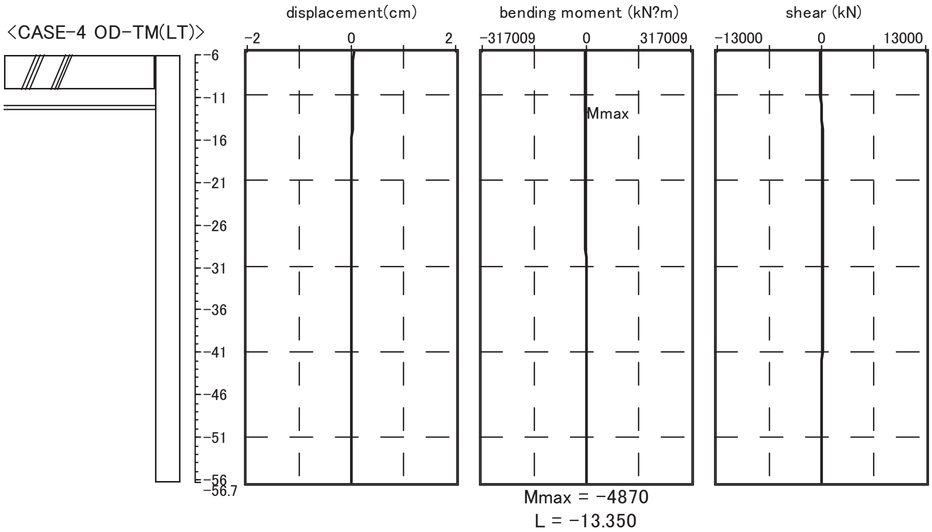


Mmax = 0
L = −6.350

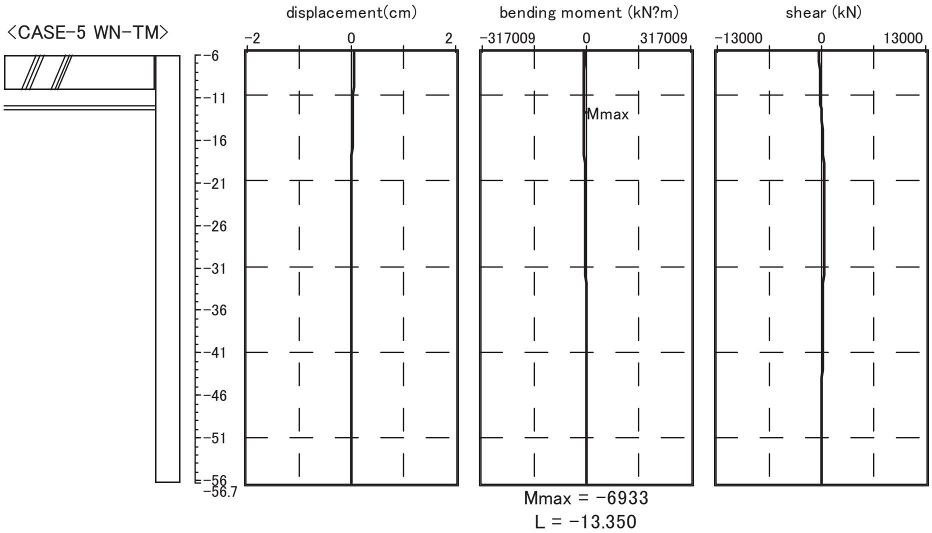


Mmax = −4870
L = −13.350

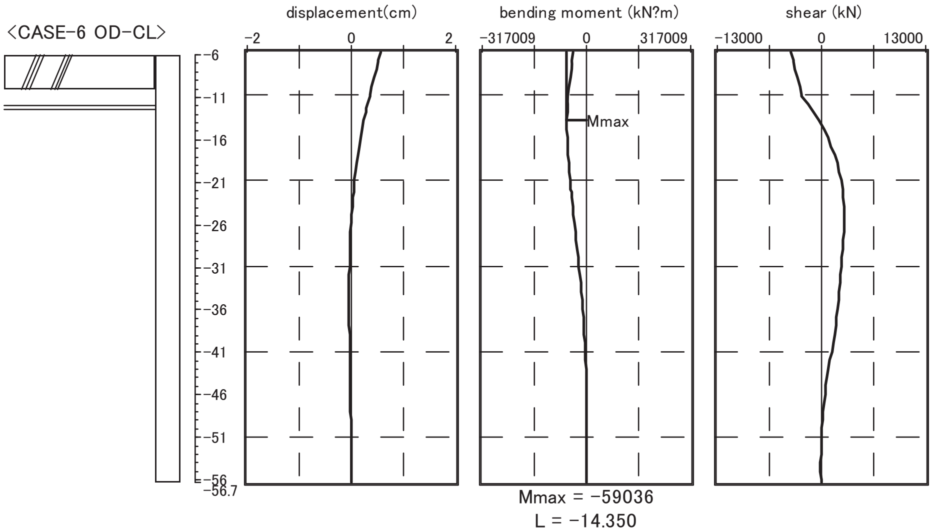
<CASE-4 OD-TM(LT)>



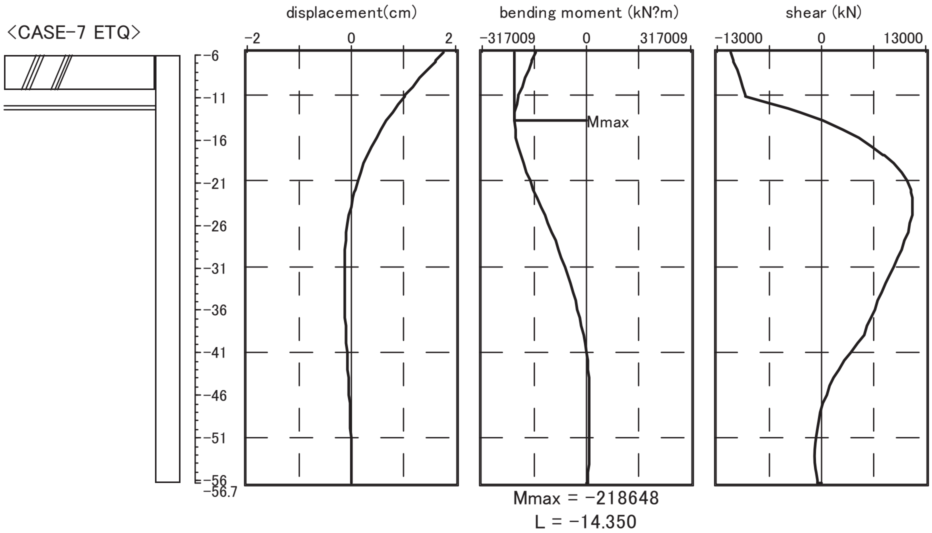
<CASE-5 WN-TM>



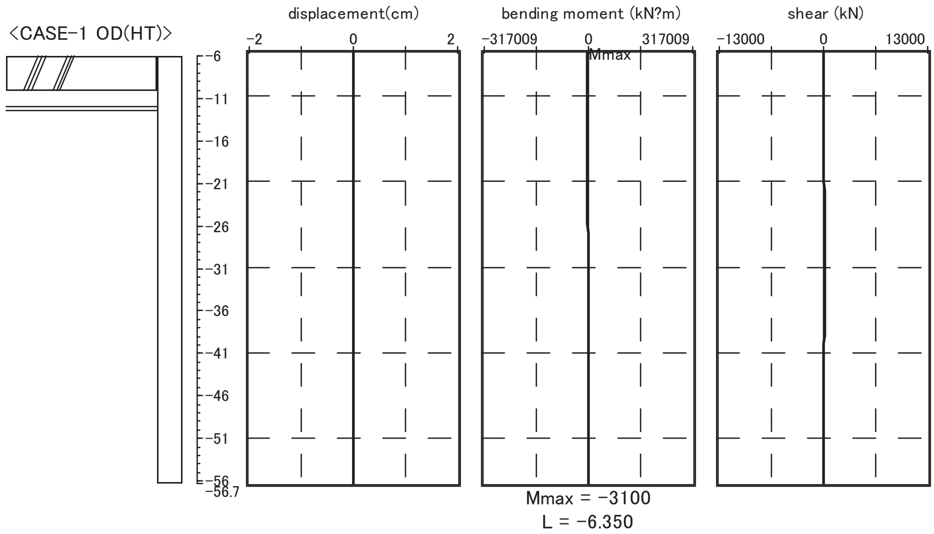
<CASE-6 OD-CL>

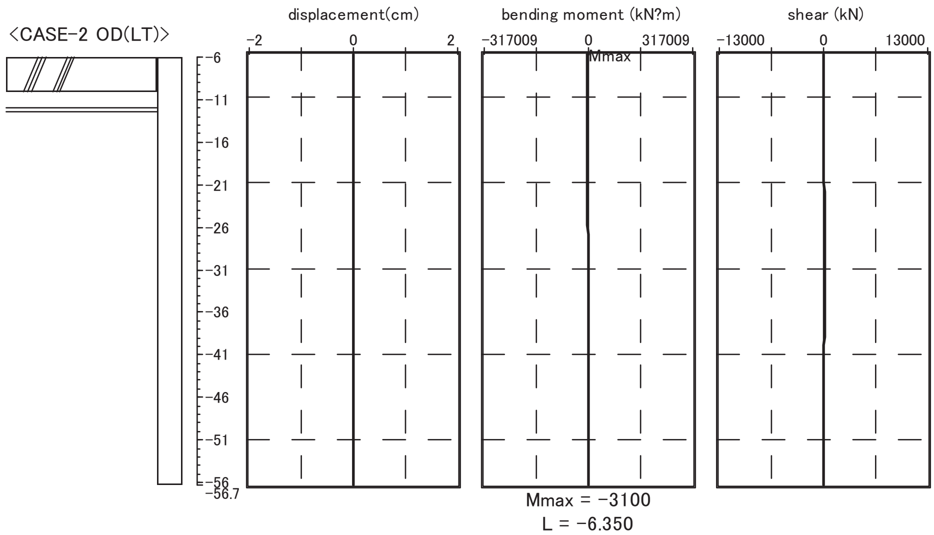


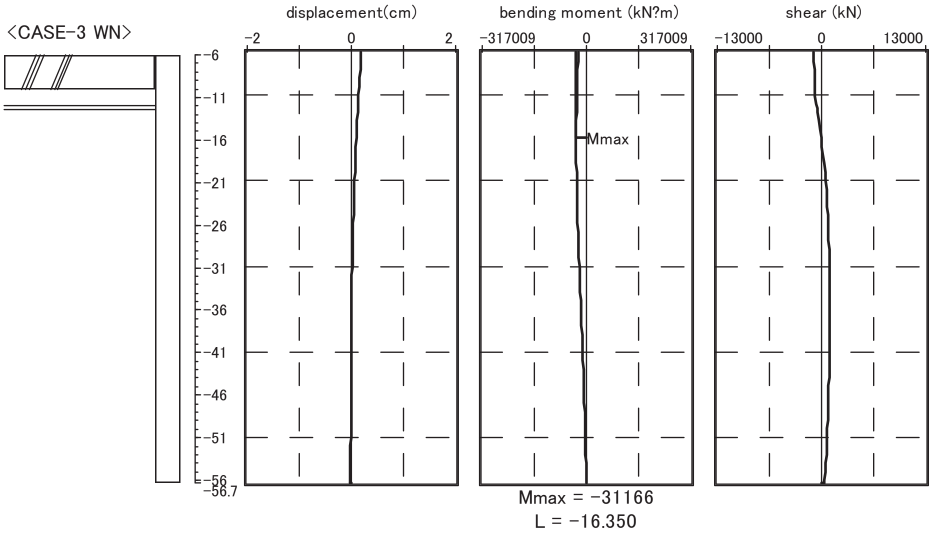
<CASE-7 ETQ>

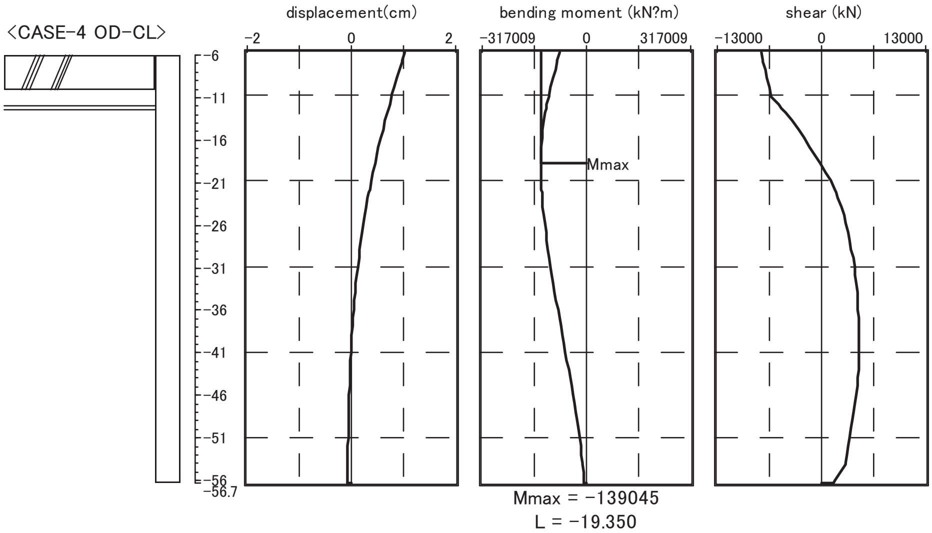


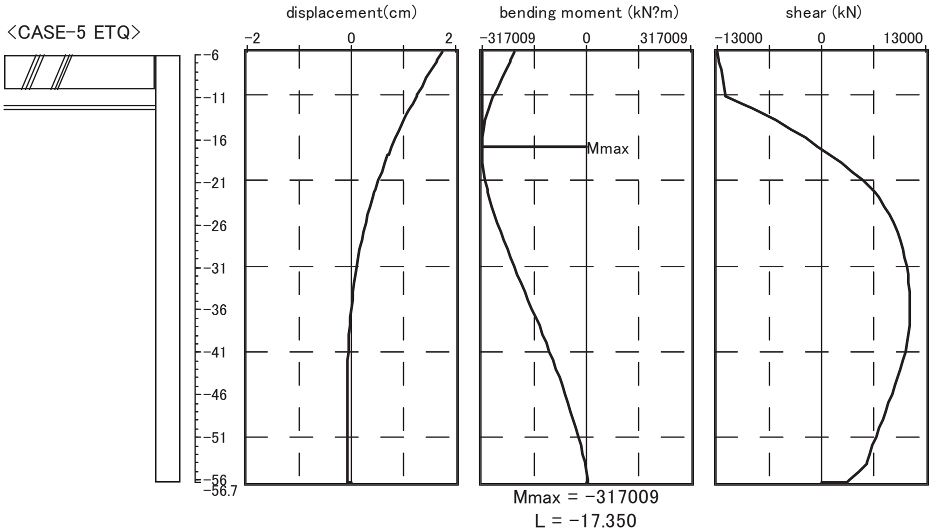
perpendicular direction





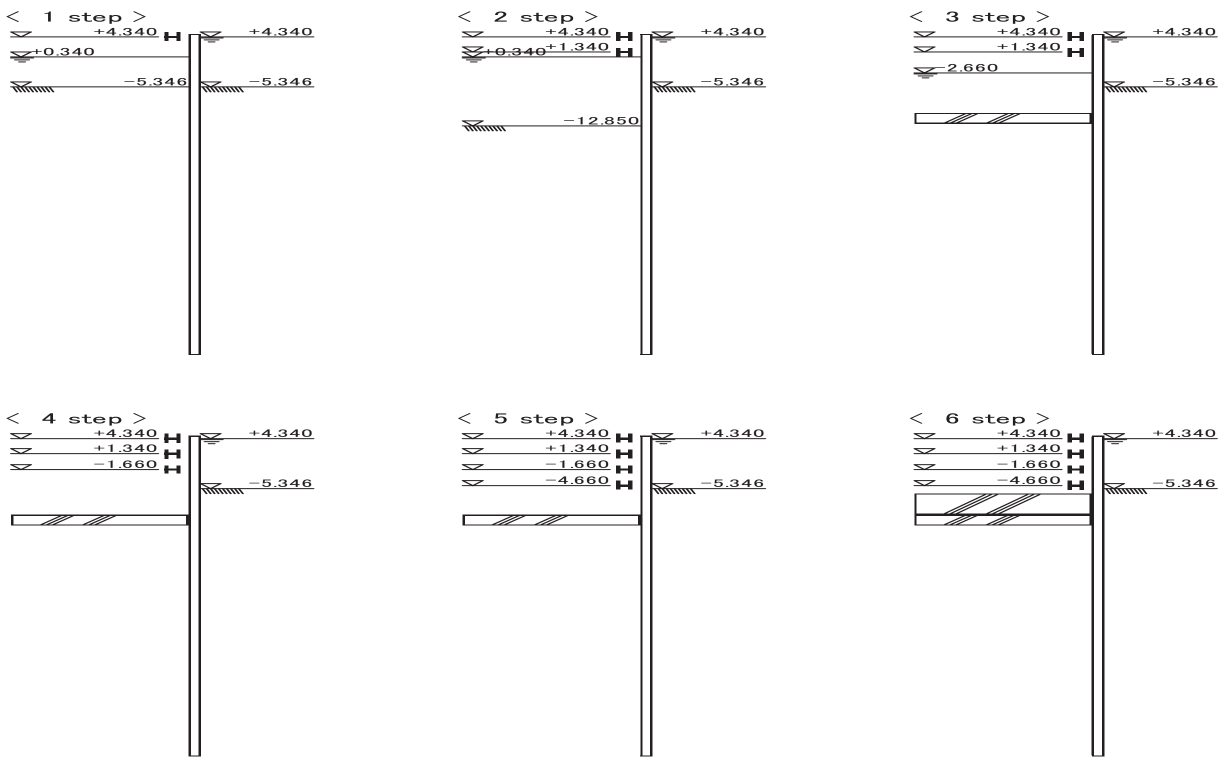

<CASE-3 WN>
displacement(cm)
bending moment (kN?m)
shear (kN)
-2
0
2
-317009
0
317009
-13000
0
13000
-6
-11
-16
-21
-26
-31
-36
-41
-46
-51
-56
-56.7
Mmax
Mmax = -31166
L = -16.350


<CASE-4 OD-CL>
displacement(cm)
bending moment (kN?m)
shear (kN)
-2
0
2
-317009
0
317009
-13000
0
13000
-6
-11
-16
-21
-26
-31
-36
-41
-46
-51
-56
-56.7
Mmax
Mmax = -139045
L = -19.350



2 coffering calculation

2.1 construction step diagram



2.2 section properties

steel pipe pile body external diameter Phi.1200.0 (mm)
errosion allowance external side = 0.0 (mm) internal side = 0.0 (mm)

No	L (m)	bridge axis direction		perpendicular direction		material
		I(cm⁴/m)	Z(cm³/m)	I(cm⁴/m)	Z(cm³/m)	
1	10.000	633569.6	10559.5	641007.8	10683.5	SKY400
2	17.500	720452.4	12007.5	728910.6	12148.5	SKY400
3	34.000	633569.6	10559.5	641007.8	10683.5	SKY400
Sig.= 61.500 (m)						

2.3 soil condition

current ground surface elevation -5.346 (m)
riverside water table elevation +4.340 (m)
boundary condition of steel pipe sheet pile tip :free

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m³)		c (kN/m²)	Phi. Deg.	elastic assing (*)
				Gam.	Gam.'			
1	cohesv	2.070	1.0	17.5	7.5	10.0	0.0	0
2	sandy	4.000	3.0	17.5	8.5	0.0	28.0	0
3	sandy	7.000	13.0	17.0	8.0	0.0	33.0	0
4	cohesv	4.000	9.0	17.5	7.5	54.0	0.0	0
5	cohesv	17.000	7.0	17.5	7.5	42.0	0.0	0
6	cohesv	15.000	18.0	18.0	8.0	108.0	0.0	0
7	sandy	2.244	50.0	19.0	10.0	0.0	35.0	0

(*)0:if subgrade reaction> upper limit of subgrade reaction plastic area, 1: always elastic area

horizontal modulus of subgrade reaction kH (kN/m³)

No	bridge axis direction		perpendicular direction		step
	KH1	KH2	KH1	KH2	
1	865	865	865	865	0

No	bridge axis direction		perpendicular direction		step
	KH1	KH2	KH1	KH2	
2	1153	1153	1153	1153	0
3	4998	4998	4998	4998	0
4	6055	6055	6055	6055	0
5	4710	4710	4710	4710	0
6	12110	12110	12110	12110	0
7	33639	33639	33639	33639	0

2.4 timbering, construction step

(1) timbering

row	installation level(m)	step No		support point condition (tensile)	H shaped steel		
		set	remove		arc part	linear part(wailing)	linear part(strut)
1	+4.340	1	0	invld	H-350*350*12*19	H-350*350*12*19	H-350*350*12*19
2	+1.340	2	0	invld	2H-350*350*12*19	2H-350*350*12*19	2H-350*350*12*19
3	-1.660	4	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15
4	-4.660	5	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15

(2)H shaped steel
1)linear
**wailing

row	H (cm)	B (cm)	A (cm²)	Aw (cm²)	Iy (cm⁴)	Zy (cm³)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

2) arc

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

(3) strut spacing/brace span

row	perpendicular direction	
	strut spacing L1(m)	brace span L2(m)
1	4.000	1.300
2	4.000	1.300
3	4.000	1.300
4	4.000	1.300

(4)construction step

step	excavation area(m)	inside water level(m)
1	-5.346	+0.340
2	-12.850	+0.340
3	-12.850	-2.660
4	-12.850	-12.850

step	excavation area(m)	inside water level(m)
5	-12.850	-12.850
6	-12.850	-12.850

footing concrete cast --- 3 step
pile capcast --- 6 step

2.5 arbitrary load

No	working elevation (m)	load type	working width (m)	load (kN,kN/m)		working step number	
				top end	bottom end	begin	end
1	+4.340	distributed	9.686	0.270	0.068	1	6

note: positive load is applied from back side, negative load is applied from excavation area side

2.6 support point spring

(1) spring constant of timbering

arc part

$$K = \frac{E*A1}{r^2} \text{ (kN/m/m)}$$

linear part

$$K = \frac{E*A2}{\frac{L1}{2}} * \frac{1}{L2} \text{ (kN/m/m)}$$

Here, E : Young's modulus of timbering = 2.00 * 10^8(kN/m^2)

A1 : sectional area of wailing(m^2)

A2 : sectional area of strut (m^2)

r : timbering radius in arc part (m)

L1 : strut length (m)

L2 : strut spacing (m)

1)bridge axis direction

linear part

row	A2 (cm^2)	L1 (m)	L2 (m)	K (kN/m/m)
1	171.90	5.785	4.000	2.9714E+005
2	343.80	5.785	4.000	5.9429E+005
3	118.40	5.835	4.000	2.0291E+005
4	118.40	5.835	4.000	2.0291E+005

arc part

row	A1 (cm^2)	r (m)	K (kN/m/m)
1	171.90	2.893	4.1091E+005
2	343.80	2.893	8.2183E+005
3	118.40	2.918	2.7820E+005
4	118.40	2.918	2.7820E+005

(2)footing concrete spring constant

$$K = \frac{Alp.*(Ec*Ac)}{\frac{B}{2}} \text{ (kN/m/m)}$$

where, Alp. : reduction coefficient of spring = 0.050

Ec : Young's modulus of concrete at bottom = 2.35 * 10^7(kN/m^2)

Ac : sectional area per unit width of footing concrete = 2.000 (m^2/m)

B : footing concrete width (m)

bridge axis direction B = 6.135

perpendicular direction B = 17.717

1)bridge axis direction

K = 7.6609E+005 (kN/m/m)

2)perpendicular direction

K = 2.6527E+005 (kN/m/m)

(4) using value

1)support point spring constant (kN/m/m)

	support point condition(tensile)	bridge axis direction	perpendicular direction
timbering 1row	invld	2.9715E+005	4.1091E+005
timbering 2row	invld	5.9429E+005	8.2183E+005
timbering 3row	invld	2.0291E+005	2.7820E+005
timbering 4row	invld	2.0291E+005	2.7820E+005
footing concrete	invld	7.6609E+005	2.6528E+005

2.7 side pressure

(1) active side pressure

sand soil

$$Pa = Ka(Gam.*h - pw1 + q) - 2c * \sqrt{Ka} + pw1$$

where,
- Pa : active side pressure (kN/m^2)
- Ka : active earth pressure coefficient Ka = tan^2(45Deg.- Phi. / 2)
- q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
- Gam. : unit weight of wet soil (kN/m^3)
- pw1 : backsides water pressure at depth h (kN/m^2)
- h : depth from ground surface (m)
- Phi. : internal friction angle of soil (Deg.)
- c : cohesion of soil (kN/m^2)

------

h<=H

$$Pa = Ka1(Gam.*h + q)$$

h>H

$$Pa = Ka1(Gam.*H + q) + Ka2*Gam.(h - H)$$

where, Ka1,Ka2 : active earth pressure coefficient for cohesive soil

cohesive soil N value	Ka1		Ka2
	presumption equation	minimum	
8 <= N	0.5 - 0.010H	0.3	0.5
4 <= N < 8	0.6 - 0.010H	0.4	0.6
2 <= N < 4	0.7 - 0.025H	0.5	0.7
N < 2	0.8 - 0.025H	0.6	0.8

H : excavation depth

(2)passive side pressure

sand soil

$$Pp = Kp(Gam.*h - pw2 + q) + 2c* \sqrt{Kp} + pw2$$

$$Pp = Kp(Gam.*h + q) + 2c*\sqrt{Kp}$$

where,
- Pp : passive side pressure (kN/m^2)
- Kp : passive earth pressure coefficient

$$Kp = \frac{\cos^2 Phi}{\left(1 - \sqrt{\sin(Phi - Del.)*\frac{\sin Phi}{\cos Del.}} \right)^2}$$

- pw2 : water pressure on excavation side at depth h (kN/m^2)
- Del. : friction angle between steel pipe sheet pile and soil (Deg.) (Del. = -Phi./3)
- q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
  (after concrete is casted to footing, includes weight of footing concrete and paving sand)

(3)at rest side pressure
use less value of either Po or Po'

1)before excavation
sand soil
Po = Ko(Gam.*h - pw1 + q) + pw1

cohesive soil
Po = ko(Gam.*h + q)

where, Po : side pressure at rest before excavation (kN/m^2)
Ko : at rest side pressure coefficient
Ko = 1 - sinPhi.(sand soil)
cohesive soil

N value of cohesive soil	Ko
8 <= N	0.5
4 <= N < 8	0.6
2 <= N < 4	0.7
N < 2	0.8

q : surcharge load (kN/m^2) (including weight of water upper than ground surface)

2)after excavation
sand soil

$$Po' = Ko(Gam.*h' - pw2 + q) + Ko*\frac{f*h'}{B} + pw2$$

cohesive soil

$$Po' = Ko(Gam.*h' + q) + Ko*\frac{f*h'}{B}$$

where, Po' : side pressure at rest after excavation (kN/m^2)
h' : depth from excavation areah (m)
q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
(after concrete is casted to footing, includes weight of footing concrete and paving sand)
B : range of friction influence (m)
(let B=5.0m, if excavation width is less than 10m, then let excavation width 1/2)
f : friction force between steel pipe sheet pile and ground (kN/m^2)
sand soil : 1 * N(<=50)
cohesive soil : 0.5 * c or 5 * N(<=100)
where, if N<=2 weak layer, then friction force is not considered

steel pipe sheet pile length L = 61.500 (m)
design water tableelevation +4.340 (m)
design ground elevation -5.346 (m)

(4)sum up
1) 1 step
excavation area elevation = -5.346 (m)
landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
3	-5.346 -7.416	2.070	77.49 106.47	76.86 113.09	45.49 74.47	32.00 32.00	31.37 38.62
4	-7.416 -11.416	4.000	123.17 174.00	134.06 283.23	85.80 143.79	37.37 30.21	48.26 139.44
5	-11.416 -18.416	7.000	170.98 255.43	340.27 649.99	140.07 245.89	30.91 9.54	200.20 404.10
6	-18.416 -19.146	0.730	161.04 167.42	390.09 402.86	157.83 167.42	3.21 0.00	232.26 235.43
7	-19.146 -22.009	2.863	167.42 192.48	402.86 452.96	167.42 192.48	0.00 0.00	235.43 260.49
8	-22.009 -22.416	0.407	192.48 196.04	452.96 460.09	192.48 196.04	0.00 0.00	260.49 264.05
9	-22.416 -39.416	17.000	235.25 413.75	436.09 733.58	235.25 413.75	0.00 0.00	200.84 319.83
10	-39.416 -54.416	15.000	344.79 479.79	865.58 1135.58	344.79 479.79	0.00 0.00	520.79 655.79
11	-54.416 -56.660	2.244	688.38 716.29	2434.56 2569.35	746.20 777.25	0.00 0.00	1688.36 1792.10

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00
3	-5.346 -7.416	2.070	77.49 106.47	76.86 113.09	45.49 74.47	32.00 32.00	31.37 38.62
4	-7.416 -11.416	4.000	123.17 174.00	134.06 283.23	85.80 142.99	37.37 31.01	48.26 140.24
5	-11.416 -18.416	7.000	170.98 255.43	340.27 649.99	139.38 239.98	31.60 15.45	200.89 410.01
6	-18.416 -19.146	0.730	161.04 167.42	390.09 402.86	151.34 159.69	9.70 7.73	238.75 243.16
7	-19.146 -22.009	2.863	167.42 192.48	402.86 452.96	159.69 192.48	7.73 0.00	243.16 260.49

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
8	-22.009 -22.416	0.407	192.48 196.04	452.96 460.09	192.48 196.04	0.00 0.00	260.49 264.05
9	-22.416 -39.416	17.000	235.25 413.75	436.09 733.58	235.25 413.75	0.00 0.00	200.84 319.83
10	-39.416 -54.416	15.000	344.79 479.79	865.58 1135.58	344.79 479.79	0.00 0.00	520.79 655.79
11	-54.416 -56.660	2.244	688.38 716.29	2434.56 2569.35	746.20 777.25	0.00 0.00	1688.36 1792.10

2) 2 step
excavation area elevation = -12.850 (m)
landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	56.86 77.56	56.86 77.56	2.46 3.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	77.56 117.56	77.56 117.56	45.61 56.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	117.56 131.90	117.56 131.90	53.42 56.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	131.90 378.17	131.90 216.04	56.38 39.38	0.00 162.12
7	-18.416 -22.416	4.000	143.97 178.97	334.52 404.52	125.06 177.66	18.92 1.31	209.47 226.86
8	-22.416 -23.631	1.215	218.18 230.94	380.52 401.79	213.19 230.94	4.99 0.00	167.33 170.85
9	-23.631 -27.787	4.155	230.94 274.57	401.79 474.51	230.94 291.64	0.00 0.00	170.85 182.87
10	-27.787 -29.807	2.021	274.57 295.79	474.51 509.87	291.64 312.86	0.00 0.00	182.87 197.01
11	-29.807 -36.581	6.773	295.79 366.91	509.87 628.40	312.86 383.98	0.00 0.00	197.01 244.42
12	-36.581 -39.416	2.835	366.91 396.68	628.40 678.02	383.98 413.75	0.00 0.00	244.42 264.27
13	-39.416 -54.416	15.000	327.72 462.72	810.02 1080.02	344.79 479.79	0.00 0.00	465.23 600.23
14	-54.416 -56.660	2.244	688.38 716.29	2125.47 2260.26	746.20 777.25	0.00 0.00	1379.27 1483.01

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	56.86 77.56	56.86 77.56	2.46 3.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	77.56 117.56	77.56 117.56	45.61 56.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	117.56 131.90	117.56 131.90	53.42 56.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	131.90 378.17	131.90 211.89	56.38 43.53	0.00 166.27
7	-18.416 -22.416	4.000	143.97 178.97	334.52 404.52	120.50 166.30	23.48 12.68	214.03 238.23
8	-22.416 -23.631	1.215	218.18 230.94	380.52 401.79	199.56 215.38	18.63 15.56	180.97 186.41
9	-23.631 -27.787	4.155	230.94 274.57	401.79 474.51	215.38 269.48	15.56 5.09	186.41 205.03
10	-27.787 -29.807	2.021	274.57 295.79	474.51 509.87	269.48 295.79	5.09 0.00	205.03 214.08
11	-29.807 -36.581	6.773	295.79 366.91	509.87 628.40	295.79 383.98	0.00 0.00	214.08 244.42
12	-36.581 -39.416	2.835	366.91 396.68	628.40 678.02	383.98 413.75	0.00 0.00	244.42 264.27
13	-39.416 -54.416	15.000	327.72 462.72	810.02 1080.02	344.79 479.79	0.00 0.00	465.23 600.23
14	-54.416 -56.660	2.244	688.38 716.29	2125.47 2260.26	746.20 777.25	0.00 0.00	1379.27 1483.01

3) 3 step

excavation area elevation = -12.850 (m)

landside water table elevation = -2.660 (m)

after footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -2.660	7.000	0.00 70.00	0.00 0.00	0.00 0.00	0.00 70.00	0.00 0.00
2	-2.660 -5.346	2.686	70.00 96.86	0.00 26.86	0.00 26.86	70.00 70.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	26.86 47.56	26.86 47.56	32.46 33.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	47.56 87.56	47.56 87.56	75.61 86.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	87.56 101.90	87.56 101.90	83.42 86.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	253.56 499.82	116.02 200.16	72.26 55.27	137.54 299.66
7	-18.416 -22.416	4.000	143.97 178.97	335.52 405.52	125.56 178.16	18.42 0.81	209.97 227.36
8	-22.416 -23.485	1.069	218.18 229.41	381.52 400.23	213.79 229.41	4.39 0.00	167.73 170.82
9	-23.485 -27.641	4.155	229.41 273.04	400.23 472.95	229.41 290.11	0.00 0.00	170.82 182.84
10	-27.641 -29.569	1.929	273.04 293.29	472.95 506.70	290.11 310.36	0.00 0.00	182.84 196.34
11	-29.569 -36.343	6.773	293.29 364.41	506.70 625.24	310.36 381.48	0.00 0.00	196.34 243.76
12	-36.343 -39.416	3.073	364.41 396.68	625.24 679.02	381.48 413.75	0.00 0.00	243.76 265.27
13	-39.416 -54.416	15.000	327.72 462.72	811.02 1081.02	344.79 479.79	0.00 0.00	466.23 601.23
14	-54.416 -56.660	2.244	688.38 716.29	2131.04 2265.82	746.20 777.25	0.00 0.00	1384.84 1488.57

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -2.660	7.000	0.00 70.00	0.00 0.00	0.00 0.00	0.00 70.00	0.00 0.00
2	-2.660 -5.346	2.686	70.00 96.86	0.00 26.86	0.00 26.86	70.00 70.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	26.86 47.56	26.86 47.56	32.46 33.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	47.56 87.56	47.56 87.56	75.61 86.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	87.56 101.90	87.56 101.90	83.42 86.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	253.56 499.82	116.02 196.01	72.26 59.42	137.54 303.81
7	-18.416 -22.416	4.000	143.97 178.97	335.52 405.52	121.00 166.80	22.98 12.18	214.53 238.73
8	-22.416 -23.485	1.069	218.18 229.41	381.52 400.23	200.16 214.08	18.03 15.33	181.37 186.16
9	-23.485 -27.641	4.155	229.41 273.04	400.23 472.95	214.08 268.18	15.33 4.86	186.16 204.77
10	-27.641 -29.569	1.929	273.04 293.29	472.95 506.70	268.18 293.29	4.86 0.00	204.77 213.41
11	-29.569 -36.343	6.773	293.29 364.41	506.70 625.24	293.29 381.48	0.00 0.00	213.41 243.76
12	-36.343 -39.416	3.073	364.41 396.68	625.24 679.02	381.48 413.75	0.00 0.00	243.76 265.27
13	-39.416 -54.416	15.000	327.72 462.72	811.02 1081.02	344.79 479.79	0.00 0.00	466.23 601.23
14	-54.416 -56.660	2.244	688.38 716.29	2131.04 2265.82	746.20 777.25	0.00 0.00	1384.84 1488.57

4) 4 step

excavation area elevation = -12.850 (m)

landside water table elevation = -12.850 (m)

after footing concrete cast, before pile cap cast

bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 98.26	174.16 157.17	137.54 299.66
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	74.61 127.21	69.37 51.76	159.02 176.41
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	152.65 385.70	65.53 0.00	126.97 173.12
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	385.70 400.98	0.00 0.00	173.12 176.14
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	334.15 355.68	0.00 0.00	374.97 375.21
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	355.68 390.50	0.00 0.00	375.21 410.04
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	390.50 418.95	0.00 0.00	410.04 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 94.11	174.16 161.32	137.54 303.81
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	70.05 115.85	73.93 63.13	163.58 187.78
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	139.02 346.74	79.17 38.96	140.61 212.08
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	346.74 360.36	38.96 36.33	212.08 216.77
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	300.30 317.71	27.43 20.90	408.83 413.18
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	317.71 373.44	20.90 0.00	413.18 427.11
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	373.44 418.95	0.00 0.00	427.11 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

5) 5 step
excavation area elevation = -12.850 (m)
landside water table elevation = -12.850 (m)

after footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 98.26	174.16 157.17	137.54 299.66
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	74.61 127.21	69.37 51.76	159.02 176.41
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	152.65 385.70	65.53 0.00	126.97 173.12
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	385.70 400.98	0.00 0.00	173.12 176.14
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	334.15 355.68	0.00 0.00	374.97 375.21
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	355.68 390.50	0.00 0.00	375.21 410.04
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	390.50 418.95	0.00 0.00	410.04 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 94.11	174.16 161.32	137.54 303.81
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	70.05 115.85	73.93 63.13	163.58 187.78
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	139.02 346.74	79.17 38.96	140.61 212.08
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	346.74 360.36	38.96 36.33	212.08 216.77
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	300.30 317.71	27.43 20.90	408.83 413.18
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	317.71 373.44	20.90 0.00	413.18 427.11
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	373.44 418.95	0.00 0.00	427.11 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

6) 6 step
excavation area elevation = -12.850 (m)
landside water table elevation = -12.850 (m)

after footing concrete cast, after pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 98.26	174.16 157.17	137.54 299.66
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	74.61 127.21	69.37 51.76	159.02 176.41
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	152.65 385.70	65.53 0.00	126.97 173.12
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	385.70 400.98	0.00 0.00	173.12 176.14
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	334.15 355.68	0.00 0.00	374.97 375.21
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	355.68 390.50	0.00 0.00	375.21 410.04
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	390.50 418.95	0.00 0.00	410.04 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 94.11	174.16 161.32	137.54 303.81
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	70.05 115.85	73.93 63.13	163.58 187.78
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	139.02 346.74	79.17 38.96	140.61 212.08
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	346.74 360.36	38.96 36.33	212.08 216.77
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	300.30 317.71	27.43 20.90	408.83 413.18
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	317.71 373.44	20.90 0.00	413.18 427.11
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	373.44 418.95	0.00 0.00	427.11 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

2.8 side pressure detail output

(1)construction step [1]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -5.346	5.686	----	----	----	----
3	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
4	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
5	sandy	-11.416 -18.416	7.000	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -19.146	0.730	17.5	54.0	0.00	9.0
7	cohesv	-19.146 -22.009	2.863	17.5	54.0	0.00	9.0
8	cohesv	-22.009 -22.416	0.407	17.5	54.0	0.00	9.0
9	cohesv	-22.416 -39.416	17.000	17.5	42.0	0.00	7.0
10	cohesv	-39.416 -54.416	15.000	18.0	108.0	0.00	18.0
11	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00
2	----	+0.340 -5.346	5.686	0.00 0.00	-------- --------	40.00 96.86	------- -------	------- -------	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	0.000 36.225	-------- --------	0.8000 0.8000	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	0.000 0.000	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
5	sandy	-11.416 -18.416	7.000	203.09 322.09	0.000 0.000	157.56 227.56	0.2948 0.2948	------- -------	13.42 27.87	170.98 255.43
6	cohesv	-18.416 -19.146	0.730	322.09 334.85	225.225 237.994	-------- --------	0.5000 0.5000	0.5000 0.5000	161.04 167.43	161.04 167.43
7	cohesv	-19.146 -22.009	2.863	334.85 384.96	237.994 288.095	-------- --------	0.5000 0.5000	0.5000 0.5000	167.43 192.48	167.43 192.48
8	cohesv	-22.009 -22.416	0.407	384.96 392.09	288.095 295.225	-------- --------	0.5000 0.5000	0.5000 0.5000	192.48 196.04	192.48 196.04
9	cohesv	-22.416 -39.416	17.000	392.09 689.58	295.225 592.725	-------- --------	0.6000 0.6000	0.6000 0.6000	235.25 413.75	235.25 413.75
10	cohesv	-39.416 -54.416	15.000	689.58 959.58	592.725 862.725	-------- --------	0.5000 0.5000	0.5000 0.5000	344.79 479.79	344.79 479.79
11	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

Pa1 = Ka1*$\Big\{$ Sum.$\big($(Gam.*h)$\big)$ + q - pw1 $\Big\}$ - 2 * c * $\sqrt{Ka1}$ (sand soil)

Pa = Pa1 + pw1   (sand soil)

Pa = Pa1 = Ka1*$\Big\{$ Sum.(Gam.*H) + q $\Big\}$ + Ka2*$\Big\{$ Sum.$\big($Gam.(h - H)$\big)$ $\Big\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	----	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	56.86 93.09	-------- --------	1.0000 1.0000	76.86 113.09	76.86 113.09
4	sandy	-7.416 -11.416	4.000	93.09 163.09	77.56 117.56	3.6391 3.6391	56.50 165.67	134.06 283.23
5	sandy	-11.416 -18.416	7.000	163.09 282.09	117.56 187.56	4.8921 4.8921	222.71 462.43	340.27 649.99
6	cohesv	-18.416 -19.146	0.730	282.09 294.85	-------- --------	1.0000 1.0000	390.09 402.85	390.09 402.85
7	cohesv	-19.146 -22.009	2.863	294.85 344.96	-------- --------	1.0000 1.0000	402.85 452.96	402.85 452.96

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
8	cohesv	-22.009 -22.416	0.407	344.96 352.09	-------- --------	1.0000 1.0000	452.96 460.09	452.96 460.09
9	cohesv	-22.416 -39.416	17.000	352.09 649.58	-------- --------	1.0000 1.0000	436.09 733.58	436.09 733.58
10	cohesv	-39.416 -54.416	15.000	649.58 919.58	-------- --------	1.0000 1.0000	865.58 1135.58	865.58 1135.58
11	sandy	-54.416 -56.660	2.244	919.58 962.22	587.56 610.00	5.5628 5.5628	1847.00 1959.35	2434.56 2569.35

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	40.00 96.86	0.0000 0.0000	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
5	sandy	-11.416 -18.416	7.000	203.09 322.09	157.56 227.56	0.4554 0.4554	20.73 43.04	178.29 270.60
6	cohesv	-18.416 -19.146	0.730	322.09 334.85	-------- --------	0.5000 0.5000	161.04 167.43	161.04 167.43
7	cohesv	-19.146 -22.009	2.863	334.85 384.96	-------- --------	0.5000 0.5000	167.43 192.48	167.43 192.48
8	cohesv	-22.009 -22.416	0.407	384.96 392.09	-------- --------	0.5000 0.5000	192.48 196.04	192.48 196.04
9	cohesv	-22.416 -39.416	17.000	392.09 689.58	-------- --------	0.6000 0.6000	235.25 413.75	235.25 413.75
10	cohesv	-39.416 -54.416	15.000	689.58 959.58	-------- --------	0.5000 0.5000	344.79 479.79	344.79 479.79

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
11	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (sand soil)

$Po = Po1 + pw1$ (sand soil)

$Po = Po1 = Ko * \left\{ Sum.(Gam.*h) + q \right\}$ (cohesive soil)

4)at rest side pressure (after excavation)
bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	56.86 93.09	-------- --------	0.00	0.00 0.00	0.8000 0.8000	45.49 74.47	45.49 74.47
4	sandy	-7.416 -11.416	4.000	93.09 163.09	77.56 117.56	3.00	0.00 12.00	0.5305 0.5305	8.24 26.23	85.80 143.79
5	sandy	-11.416 -18.416	7.000	163.09 282.09	117.56 187.56	13.00	12.00 103.00	0.4554 0.4554	22.51 58.33	140.07 245.89
6	cohesv	-18.416 -19.146	0.730	282.09 294.85	-------- --------	27.00	103.00 122.70	0.5000 0.5000	157.83 167.43	157.83 167.43
7	cohesv	-19.146 -22.009	2.863	294.85 344.96	-------- --------	27.00	122.70 200.00	0.5000 0.5000	167.43 205.08	167.43 205.08
8	cohesv	-22.009 -22.416	0.407	344.96 352.09	-------- --------	27.00	200.00 211.00	0.5000 0.5000	205.08 210.43	205.08 210.43
9	cohesv	-22.416 -39.416	17.000	352.09 649.58	-------- --------	21.00	211.00 568.00	0.6000 0.6000	252.52 500.85	252.52 500.85
10	cohesv	-39.416 -54.416	15.000	649.58 919.58	-------- --------	54.00	568.00 1378.00	0.5000 0.5000	417.38 684.40	417.38 684.40

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
11	sandy	-54.416 -56.660	2.244	919.58 962.22	587.56 610.00	50.00	1378.00 1490.20	0.4264 0.4264	333.14 357.35	920.70 967.35

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	56.86 93.09	-------- --------	0.00	0.00 0.00	0.8000 0.8000	45.49 74.47	45.49 74.47
4	sandy	-7.416 -11.416	4.000	93.09 163.09	77.56 117.56	3.00	0.00 12.00	0.5305 0.5305	8.24 25.43	85.80 142.99
5	sandy	-11.416 -18.416	7.000	163.09 282.09	117.56 187.56	13.00	12.00 103.00	0.4554 0.4554	21.82 52.42	139.38 239.98
6	cohesv	-18.416 -19.146	0.730	282.09 294.85	-------- --------	27.00	103.00 122.70	0.5000 0.5000	151.34 159.70	151.34 159.70
7	cohesv	-19.146 -22.009	2.863	294.85 344.96	-------- --------	27.00	122.70 200.00	0.5000 0.5000	159.70 192.48	159.70 192.48
8	cohesv	-22.009 -22.416	0.407	344.96 352.09	-------- --------	27.00	200.00 211.00	0.5000 0.5000	192.48 197.14	192.48 197.14
9	cohesv	-22.416 -39.416	17.000	352.09 649.58	-------- --------	21.00	211.00 568.00	0.6000 0.6000	236.57 457.91	236.57 457.91
10	cohesv	-39.416 -54.416	15.000	649.58 919.58	-------- --------	54.00	568.00 1378.00	0.5000 0.5000	381.59 597.59	381.59 597.59

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
11	sandy	-54.416 -56.660	2.244	919.58 962.22	587.56 610.00	50.00	1378.00 1490.20	0.4264 0.4264	259.11 277.29	846.67 887.29

friction force B7027influence range B = 5.000 (m)

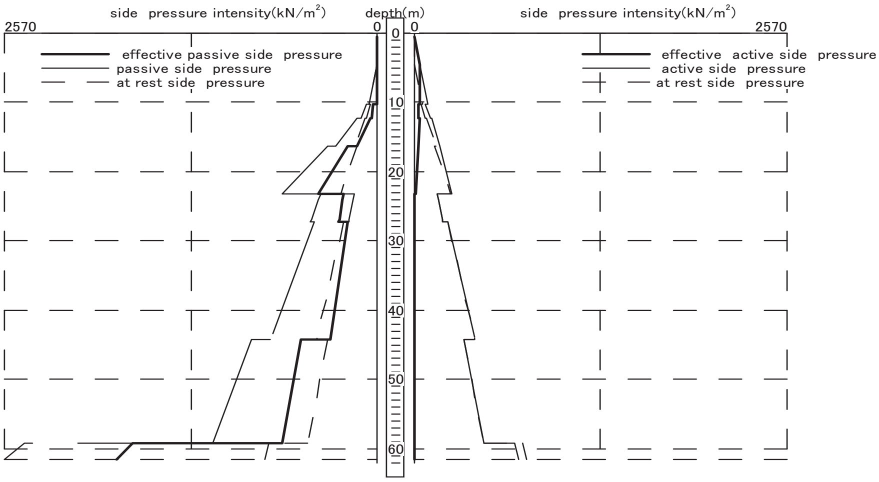
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

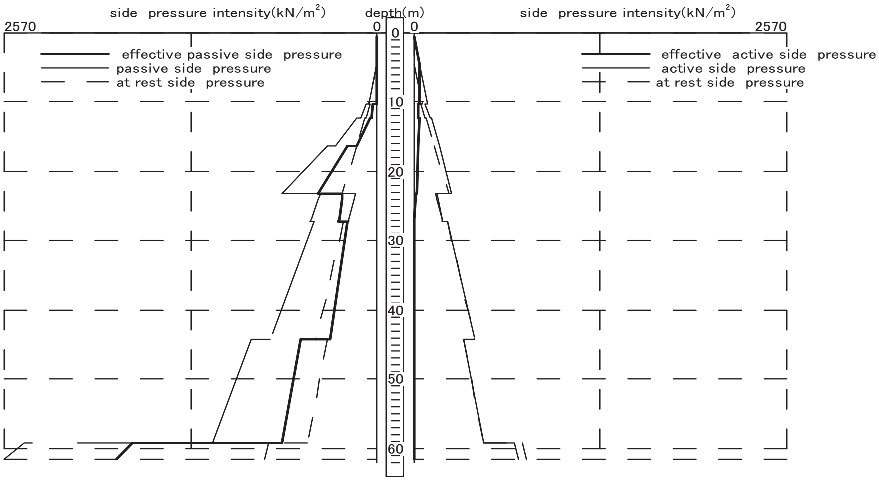
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(2)construction step [2]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -5.346	5.686	----	----	----	----
3	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
4	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
5	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
6	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
7	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
8	cohesv	-22.416 -23.631	1.215	17.5	42.0	0.00	7.0
9	cohesv	-23.631 -27.787	4.155	17.5	42.0	0.00	7.0
10	cohesv	-27.787 -29.807	2.021	17.5	42.0	0.00	7.0
11	cohesv	-29.807 -36.581	6.773	17.5	42.0	0.00	7.0
12	cohesv	-36.581 -39.416	2.835	17.5	42.0	0.00	7.0
13	cohesv	-39.416 -54.416	15.000	18.0	108.0	0.00	18.0
14	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
2	----	+0.340 -5.346	5.686	0.00 0.00	-------- --------	40.00 96.86	------- -------	------- -------	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50
4	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
5	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
6	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
8	cohesv	-22.416 -23.631	1.215	392.09 413.35	164.622 185.888	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 230.94	218.18 230.94
9	cohesv	-23.631 -27.787	4.155	413.35 486.07	185.888 258.609	-------- --------	0.5250 0.5250	0.6000 0.6000	230.94 274.57	230.94 274.57
10	cohesv	-27.787 -29.807	2.021	486.07 521.43	258.609 293.969	-------- --------	0.5250 0.5250	0.6000 0.6000	274.57 295.79	274.57 295.79
11	cohesv	-29.807 -36.581	6.773	521.43 639.97	293.969 412.503	-------- --------	0.5250 0.5250	0.6000 0.6000	295.79 366.91	295.79 366.91
12	cohesv	-36.581 -39.416	2.835	639.97 689.58	412.503 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	366.91 396.68	366.91 396.68
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	462.122 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 462.72	327.72 462.72
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \quad (\text{ sand soil })$$

$$Pa = Pa1 + pw1 \quad (\text{ sand soil })$$

$$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\} \quad (\text{ cohesive soil })$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
2	----	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	56.86 77.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	77.56 117.56	0.0000 0.0000	0.00 0.00	77.56 117.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	117.56 131.90	0.0000 0.0000	0.00 0.00	117.56 131.90
6	sandy	-12.850 -18.416	5.566	131.90 226.52	131.90 187.56	4.8921 4.8921	0.00 190.61	131.90 378.17
7	cohesv	-18.416 -22.416	4.000	226.52 296.52	-------- --------	1.0000 1.0000	334.52 404.52	334.52 404.52
8	cohesv	-22.416 -23.631	1.215	296.52 317.79	-------- --------	1.0000 1.0000	380.52 401.79	380.52 401.79
9	cohesv	-23.631 -27.787	4.155	317.79 390.51	-------- --------	1.0000 1.0000	401.79 474.51	401.79 474.51
10	cohesv	-27.787 -29.807	2.021	390.51 425.87	-------- --------	1.0000 1.0000	474.51 509.87	474.51 509.87
11	cohesv	-29.807 -36.581	6.773	425.87 544.40	-------- --------	1.0000 1.0000	509.87 628.40	509.87 628.40
12	cohesv	-36.581 -39.416	2.835	544.40 594.02	-------- --------	1.0000 1.0000	628.40 678.02	628.40 678.02
13	cohesv	-39.416 -54.416	15.000	594.02 864.02	-------- --------	1.0000 1.0000	810.02 1080.02	810.02 1080.02
14	sandy	-54.416 -56.660	2.244	864.02 906.66	587.56 610.00	5.5628 5.5628	1537.91 1650.26	2125.47 2260.26

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \quad (\text{ sand soil })$$

$$Pp = Pp1 + pw2 \quad (\text{ sand soil })$$

$$Pp = Pp1 - Kp * \left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{Kp} \quad (\text{cohesive soil })$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
2	-------	+0.340 -5.346	5.686	0.00 0.00	40.00 96.86	0.0000 0.0000	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
5	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20
6	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
8	cohesv	-22.416 -23.631	1.215	392.09 413.35	-------- --------	0.6000 0.6000	235.25 248.01	235.25 248.01
9	cohesv	-23.631 -27.787	4.155	413.35 486.07	-------- --------	0.6000 0.6000	248.01 291.64	248.01 291.64
10	cohesv	-27.787 -29.807	2.021	486.07 521.43	-------- --------	0.6000 0.6000	291.64 312.86	291.64 312.86
11	cohesv	-29.807 -36.581	6.773	521.43 639.97	-------- --------	0.6000 0.6000	312.86 383.98	312.86 383.98
12	cohesv	-36.581 -39.416	2.835	639.97 689.58	-------- --------	0.6000 0.6000	383.98 413.75	383.98 413.75
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	-------- --------	0.5000 0.5000	344.79 479.79	344.79 479.79
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	56.86 77.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	77.56 117.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	77.56 117.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	117.56 131.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	117.56 131.90
6	sandy	-12.850 -18.416	5.566	131.90 226.52	131.90 187.56	13.00	0.00 72.36	0.4554 0.4554	0.00 28.48	131.90 216.04
7	cohesv	-18.416 -22.416	4.000	226.52 296.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	125.06 177.66	125.06 177.66
8	cohesv	-22.416 -23.631	1.215	296.52 317.79	-------- --------	21.00	180.36 205.88	0.6000 0.6000	213.19 230.94	213.19 230.94
9	cohesv	-23.631 -27.787	4.155	317.79 390.51	-------- --------	21.00	205.88 293.14	0.6000 0.6000	230.94 291.64	230.94 291.64
10	cohesv	-27.787 -29.807	2.021	390.51 425.87	-------- --------	21.00	293.14 335.57	0.6000 0.6000	291.64 321.16	291.64 321.16
11	cohesv	-29.807 -36.581	6.773	425.87 544.40	-------- --------	21.00	335.57 477.81	0.6000 0.6000	321.16 420.10	321.16 420.10
12	cohesv	-36.581 -39.416	2.835	544.40 594.02	-------- --------	21.00	477.81 537.36	0.6000 0.6000	420.10 461.52	420.10 461.52
13	cohesv	-39.416 -54.416	15.000	594.02 864.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	384.60 651.63	384.60 651.63
14	sandy	-54.416 -56.660	2.244	864.02 906.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	305.19 329.40	892.75 939.40

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	56.86 77.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	77.56 117.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	77.56 117.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	117.56 131.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	117.56 131.90
6	sandy	-12.850 -18.416	5.566	131.90 226.52	131.90 187.56	13.00	0.00 72.36	0.4554 0.4554	0.00 24.33	131.90 211.89
7	cohesv	-18.416 -22.416	4.000	226.52 296.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	120.50 166.30	120.50 166.30
8	cohesv	-22.416 -23.631	1.215	296.52 317.79	-------- --------	21.00	180.36 205.88	0.6000 0.6000	199.56 215.38	199.56 215.38
9	cohesv	-23.631 -27.787	4.155	317.79 390.51	-------- --------	21.00	205.88 293.14	0.6000 0.6000	215.38 269.48	215.38 269.48
10	cohesv	-27.787 -29.807	2.021	390.51 425.87	-------- --------	21.00	293.14 335.57	0.6000 0.6000	269.48 295.79	269.48 295.79
11	cohesv	-29.807 -36.581	6.773	425.87 544.40	-------- --------	21.00	335.57 477.81	0.6000 0.6000	295.79 383.98	295.79 383.98
12	cohesv	-36.581 -39.416	2.835	544.40 594.02	-------- --------	21.00	477.81 537.36	0.6000 0.6000	383.98 420.90	383.98 420.90
13	cohesv	-39.416 -54.416	15.000	594.02 864.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	350.75 566.75	350.75 566.75
14	sandy	-54.416 -56.660	2.244	864.02 906.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	232.80 250.98	820.36 860.98

friction force B7027influence range B = 5.000 (m)

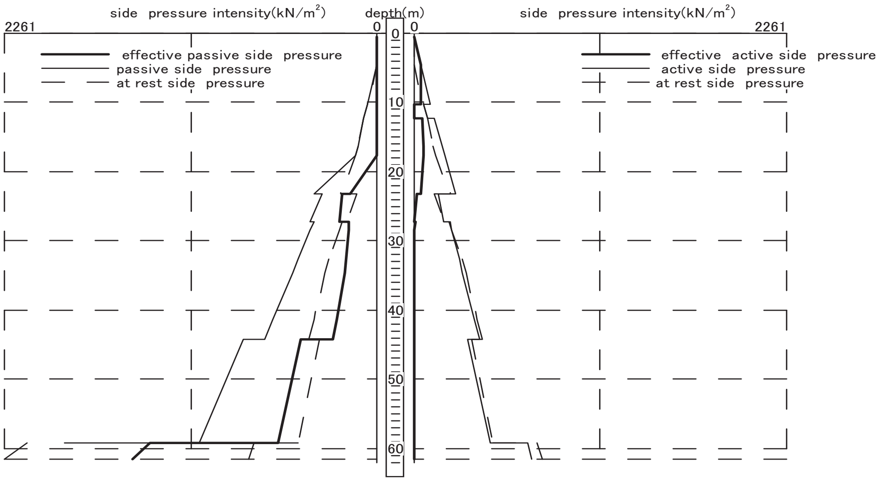
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

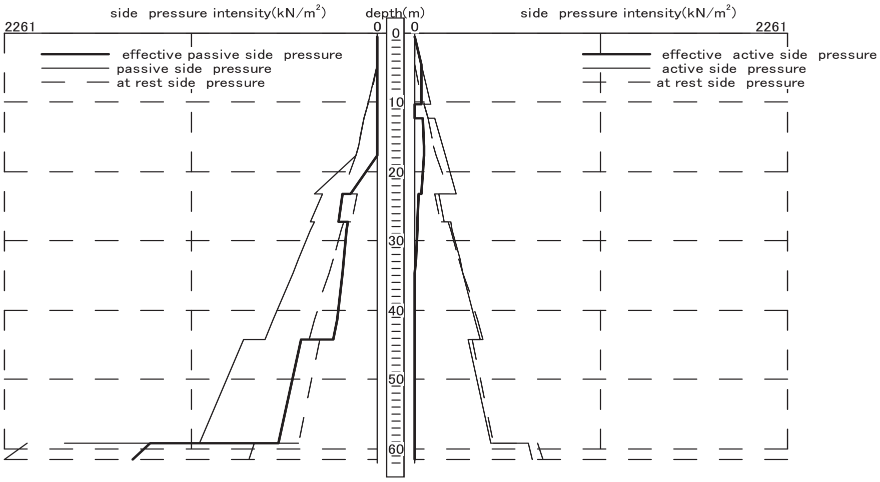
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(3)construction step [3]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -2.660	7.000	----	----	----	----
2	-------	-2.660 -5.346	2.686	----	----	----	----
3	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
4	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
5	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
6	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
7	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
8	cohesv	-22.416 -23.485	1.069	17.5	42.0	0.00	7.0
9	cohesv	-23.485 -27.641	4.155	17.5	42.0	0.00	7.0
10	cohesv	-27.641 -29.569	1.929	17.5	42.0	0.00	7.0
11	cohesv	-29.569 -36.343	6.773	17.5	42.0	0.00	7.0
12	cohesv	-36.343 -39.416	3.073	17.5	42.0	0.00	7.0
13	cohesv	-39.416 -54.416	15.000	18.0	108.0	0.00	18.0
14	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -2.660	7.000	0.00 0.00	-------- --------	0.00 70.00	------- -------	------- -------	0.00 0.00	0.00 70.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
2	----	-2.660 -5.346	2.686	0.00 0.00	-------- --------	70.00 96.86	------- -------	------- -------	0.00 0.00	70.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50
4	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
5	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
6	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
8	cohesv	-22.416 -23.485	1.069	392.09 410.79	164.622 183.332	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 229.41	218.18 229.41
9	cohesv	-23.485 -27.641	4.155	410.79 483.52	183.332 256.053	-------- --------	0.5250 0.5250	0.6000 0.6000	229.41 273.04	229.41 273.04
10	cohesv	-27.641 -29.569	1.929	483.52 517.27	256.053 289.803	-------- --------	0.5250 0.5250	0.6000 0.6000	273.04 293.29	273.04 293.29
11	cohesv	-29.569 -36.343	6.773	517.27 635.80	289.803 408.336	-------- --------	0.5250 0.5250	0.6000 0.6000	293.29 364.41	293.29 364.41
12	cohesv	-36.343 -39.416	3.073	635.80 689.58	408.336 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	364.41 396.68	364.41 396.68
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	462.122 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 462.72	327.72 462.72
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \quad (\text{ sand soil })$$

$$Pa = Pa1 + pw1 \quad (\text{ sand soil })$$

$$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\} \quad (\text{ cohesive soil })$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 -2.660	7.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
2	----	-2.660 -5.346	2.686	0.00 0.00	0.00 26.86	0.0000 0.0000	0.00 0.00	0.00 26.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	26.86 47.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	47.56 87.56	0.0000 0.0000	0.00 0.00	47.56 87.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	87.56 101.90	0.0000 0.0000	0.00 0.00	87.56 101.90
6	sandy	-12.850 -18.416	5.566	132.90 227.52	101.90 157.56	4.8921 4.8921	151.66 342.26	253.56 499.82
7	cohesv	-18.416 -22.416	4.000	227.52 297.52	-------- --------	1.0000 1.0000	335.52 405.52	335.52 405.52
8	cohesv	-22.416 -23.485	1.069	297.52 316.23	-------- --------	1.0000 1.0000	381.52 400.23	381.52 400.23
9	cohesv	-23.485 -27.641	4.155	316.23 388.95	-------- --------	1.0000 1.0000	400.23 472.95	400.23 472.95
10	cohesv	-27.641 -29.569	1.929	388.95 422.70	-------- --------	1.0000 1.0000	472.95 506.70	472.95 506.70
11	cohesv	-29.569 -36.343	6.773	422.70 541.24	-------- --------	1.0000 1.0000	506.70 625.24	506.70 625.24
12	cohesv	-36.343 -39.416	3.073	541.24 595.02	-------- --------	1.0000 1.0000	625.24 679.02	625.24 679.02
13	cohesv	-39.416 -54.416	15.000	595.02 865.02	-------- --------	1.0000 1.0000	811.02 1081.02	811.02 1081.02
14	sandy	-54.416 -56.660	2.244	865.02 907.66	587.56 610.00	5.5628 5.5628	1543.48 1655.82	2131.04 2265.82

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \quad (\text{ sand soil })$$

$$Pp = Pp1 + pw2 \quad (\text{ sand soil })$$

$$Pp = Pp1 - Kp * \left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{Kp} \quad (\text{cohesive soil })$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 -2.660	7.000	0.00 0.00	0.00 70.00	0.0000 0.0000	0.00 0.00	0.00 70.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
2	-------	-2.660 -5.346	2.686	0.00 0.00	70.00 96.86	0.0000 0.0000	0.00 0.00	70.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
5	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20
6	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
8	cohesv	-22.416 -23.485	1.069	392.09 410.79	-------- --------	0.6000 0.6000	235.25 246.48	235.25 246.48
9	cohesv	-23.485 -27.641	4.155	410.79 483.52	-------- --------	0.6000 0.6000	246.48 290.11	246.48 290.11
10	cohesv	-27.641 -29.569	1.929	483.52 517.27	-------- --------	0.6000 0.6000	290.11 310.36	290.11 310.36
11	cohesv	-29.569 -36.343	6.773	517.27 635.80	-------- --------	0.6000 0.6000	310.36 381.48	310.36 381.48
12	cohesv	-36.343 -39.416	3.073	635.80 689.58	-------- --------	0.6000 0.6000	381.48 413.75	381.48 413.75
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	-------- --------	0.5000 0.5000	344.79 479.79	344.79 479.79
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -2.660	7.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	-2.660 -5.346	2.686	0.00 0.00	0.00 26.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 26.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	26.86 47.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	47.56 87.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	47.56 87.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	87.56 101.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	87.56 101.90
6	sandy	-12.850 -18.416	5.566	132.90 227.52	101.90 157.56	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	116.02 200.16
7	cohesv	-18.416 -22.416	4.000	227.52 297.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	125.56 178.16	125.56 178.16
8	cohesv	-22.416 -23.485	1.069	297.52 316.23	-------- --------	21.00	180.36 202.81	0.6000 0.6000	213.79 229.41	213.79 229.41
9	cohesv	-23.485 -27.641	4.155	316.23 388.95	-------- --------	21.00	202.81 290.07	0.6000 0.6000	229.41 290.11	229.41 290.11
10	cohesv	-27.641 -29.569	1.929	388.95 422.70	-------- --------	21.00	290.07 330.57	0.6000 0.6000	290.11 318.28	290.11 318.28
11	cohesv	-29.569 -36.343	6.773	422.70 541.24	-------- --------	21.00	330.57 472.81	0.6000 0.6000	318.28 417.22	318.28 417.22
12	cohesv	-36.343 -39.416	3.073	541.24 595.02	-------- --------	21.00	472.81 537.36	0.6000 0.6000	417.22 462.12	417.22 462.12
13	cohesv	-39.416 -54.416	15.000	595.02 865.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	385.10 652.13	385.10 652.13
14	sandy	-54.416 -56.660	2.244	865.02 907.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	305.62 329.82	893.18 939.82

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -2.660	7.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	-2.660 -5.346	2.686	0.00 0.00	0.00 26.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 26.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	26.86 47.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	47.56 87.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	47.56 87.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	87.56 101.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	87.56 101.90
6	sandy	-12.850 -18.416	5.566	132.90 227.52	101.90 157.56	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	116.02 196.01
7	cohesv	-18.416 -22.416	4.000	227.52 297.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	121.00 166.80	121.00 166.80
8	cohesv	-22.416 -23.485	1.069	297.52 316.23	-------- --------	21.00	180.36 202.81	0.6000 0.6000	200.16 214.08	200.16 214.08
9	cohesv	-23.485 -27.641	4.155	316.23 388.95	-------- --------	21.00	202.81 290.07	0.6000 0.6000	214.08 268.18	214.08 268.18
10	cohesv	-27.641 -29.569	1.929	388.95 422.70	-------- --------	21.00	290.07 330.57	0.6000 0.6000	268.18 293.29	268.18 293.29
11	cohesv	-29.569 -36.343	6.773	422.70 541.24	-------- --------	21.00	330.57 472.81	0.6000 0.6000	293.29 381.48	293.29 381.48
12	cohesv	-36.343 -39.416	3.073	541.24 595.02	-------- --------	21.00	472.81 537.36	0.6000 0.6000	381.48 421.50	381.48 421.50
13	cohesv	-39.416 -54.416	15.000	595.02 865.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	351.25 567.25	351.25 567.25
14	sandy	-54.416 -56.660	2.244	865.02 907.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	233.23 251.41	820.79 861.41

friction force B7027influence range B = 5.000 (m)

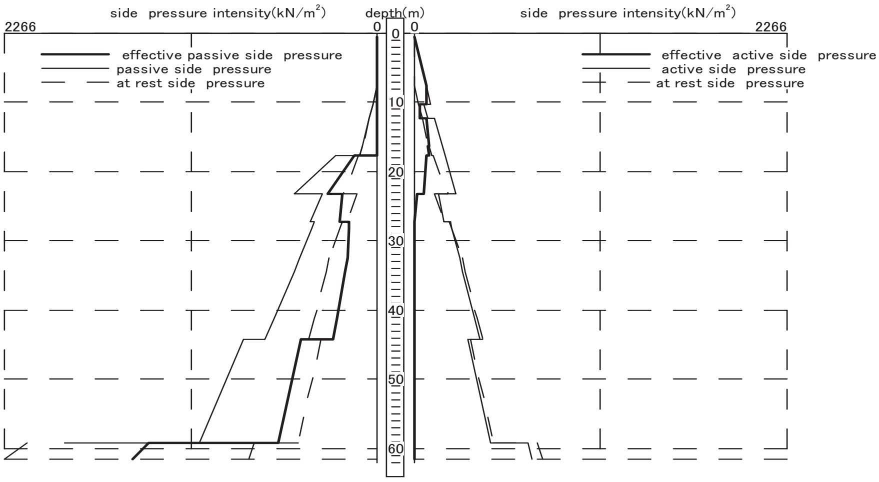
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

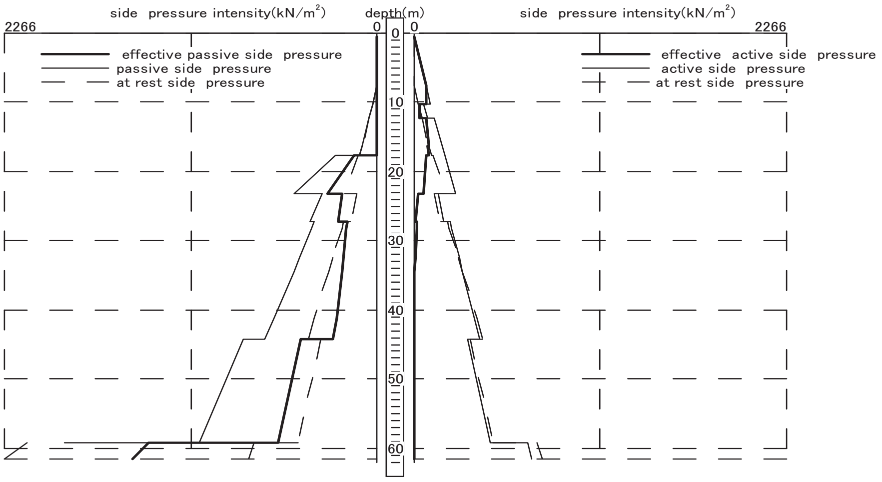
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(4)construction step [4]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.346	9.686	----	----	----	----
2	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
3	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
4	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
5	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
7	cohesv	-22.416 -38.370	15.954	17.5	42.0	0.00	7.0
8	cohesv	-38.370 -39.416	1.046	17.5	42.0	0.00	7.0
9	cohesv	-39.416 -40.625	1.209	18.0	108.0	0.00	18.0
10	cohesv	-40.625 -44.495	3.870	18.0	108.0	0.00	18.0
11	cohesv	-44.495 -47.656	3.161	18.0	108.0	0.00	18.0
12	cohesv	-47.656 -54.416	6.760	18.0	108.0	0.00	18.0
13	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	-------- --------	0.00 96.86	------- -------	------- -------	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
3	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
4	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
5	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	164.622 443.816	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 385.70	218.18 385.70
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	443.816 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	385.70 396.68	385.70 396.68
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	462.122 483.888	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 338.61	327.72 338.61
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	483.888 553.545	-------- --------	0.4250 0.4250	0.5000 0.5000	338.61 373.44	338.61 373.44
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	553.545 610.441	-------- --------	0.4250 0.4250	0.5000 0.5000	373.44 401.88	373.44 401.88
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	610.441 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	401.88 462.72	401.88 462.72
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \qquad (\text{ sand soil })$$

$$Pa = Pa1 + pw1 \qquad (\text{ sand soil })$$

$$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\} \quad (\text{ cohesive soil })$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	4.8921 4.8921	151.66 342.26	151.66 397.92
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	1.0000 1.0000	233.62 303.62	233.62 303.62
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	1.0000 1.0000	279.62 558.82	279.62 558.82
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	1.0000 1.0000	558.82 577.12	558.82 577.12
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	1.0000 1.0000	709.12 730.89	709.12 730.89
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	1.0000 1.0000	730.89 800.54	730.89 800.54
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	1.0000 1.0000	800.54 857.44	800.54 857.44
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	1.0000 1.0000	857.44 979.12	857.44 979.12
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	5.5628 5.5628	976.62 1088.97	1564.18 1698.97

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \qquad (\text{ sand soil })$$

$$Pp = Pp1 + pw2 \qquad (\text{ sand soil })$$

$$Pp = Pp1 - Kp * \left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{Kp} \qquad (\text{cohesive soil })$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 96.86	0.0000 0.0000	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
3	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
4	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
5	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	-------- --------	0.6000 0.6000	235.25 402.77	235.25 402.77
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	-------- --------	0.6000 0.6000	402.77 413.75	402.77 413.75
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	-------- --------	0.5000 0.5000	344.79 355.68	344.79 355.68
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	-------- --------	0.5000 0.5000	355.68 390.50	355.68 390.50
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	-------- --------	0.5000 0.5000	390.50 418.95	390.50 418.95
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	-------- --------	0.5000 0.5000	418.95 479.79	418.95 479.79
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	14.12 98.26
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	74.61 127.21	74.61 127.21
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	152.65 385.70	152.65 385.70
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	385.70 400.98	385.70 400.98
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	334.15 355.68	334.15 355.68
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	355.68 424.57	355.68 424.57
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	424.57 480.84	424.57 480.84
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	480.84 601.18	480.84 601.18
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	262.16 286.37	849.72 896.37

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	14.12 94.11
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	70.05 115.85	70.05 115.85
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	139.02 346.74	139.02 346.74
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	346.74 360.36	346.74 360.36
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	300.30 317.71	300.30 317.71
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	317.71 373.43	317.71 373.43
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	373.43 418.95	373.43 418.95
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	418.95 516.30	418.95 516.30
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	189.77 207.95	777.33 817.95

friction force B7027influence range B = 5.000 (m)

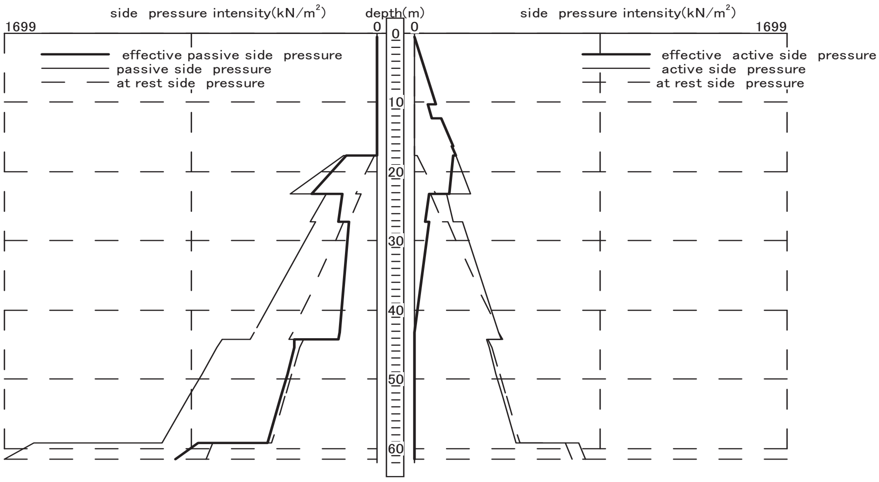
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

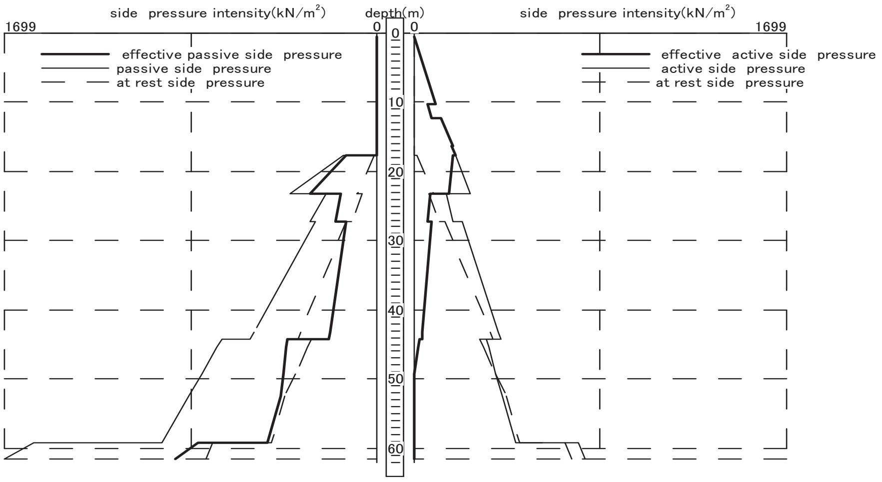
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(5)construction step [5]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.346	9.686	----	----	----	----
2	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
3	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
4	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
5	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
7	cohesv	-22.416 -38.370	15.954	17.5	42.0	0.00	7.0
8	cohesv	-38.370 -39.416	1.046	17.5	42.0	0.00	7.0
9	cohesv	-39.416 -40.625	1.209	18.0	108.0	0.00	18.0
10	cohesv	-40.625 -44.495	3.870	18.0	108.0	0.00	18.0
11	cohesv	-44.495 -47.656	3.161	18.0	108.0	0.00	18.0
12	cohesv	-47.656 -54.416	6.760	18.0	108.0	0.00	18.0
13	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	-------- --------	0.00 96.86	------- -------	------- -------	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
3	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
4	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
5	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	164.622 443.816	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 385.70	218.18 385.70
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	443.816 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	385.70 396.68	385.70 396.68
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	462.122 483.888	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 338.61	327.72 338.61
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	483.888 553.545	-------- --------	0.4250 0.4250	0.5000 0.5000	338.61 373.44	338.61 373.44
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	553.545 610.441	-------- --------	0.4250 0.4250	0.5000 0.5000	373.44 401.88	373.44 401.88
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	610.441 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	401.88 462.72	401.88 462.72
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	4.8921 4.8921	151.66 342.26	151.66 397.92
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	1.0000 1.0000	233.62 303.62	233.62 303.62
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	1.0000 1.0000	279.62 558.82	279.62 558.82
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	1.0000 1.0000	558.82 577.12	558.82 577.12
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	1.0000 1.0000	709.12 730.89	709.12 730.89
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	1.0000 1.0000	730.89 800.54	730.89 800.54
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	1.0000 1.0000	800.54 857.44	800.54 857.44
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	1.0000 1.0000	857.44 979.12	857.44 979.12
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	5.5628 5.5628	976.62 1088.97	1564.18 1698.97

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp * \left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 96.86	0.0000 0.0000	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
3	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
4	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	-------- --------	0.6000 0.6000	235.25 402.77	235.25 402.77
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	-------- --------	0.6000 0.6000	402.77 413.75	402.77 413.75
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	-------- --------	0.5000 0.5000	344.79 355.68	344.79 355.68
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	-------- --------	0.5000 0.5000	355.68 390.50	355.68 390.50
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	-------- --------	0.5000 0.5000	390.50 418.95	390.50 418.95
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	-------- --------	0.5000 0.5000	418.95 479.79	418.95 479.79
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	14.12 98.26
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	74.61 127.21	74.61 127.21
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	152.65 385.70	152.65 385.70
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	385.70 400.98	385.70 400.98
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	334.15 355.68	334.15 355.68
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	355.68 424.57	355.68 424.57
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	424.57 480.84	424.57 480.84
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	480.84 601.18	480.84 601.18
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	262.16 286.37	849.72 896.37

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	14.12 94.11
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	70.05 115.85	70.05 115.85
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	139.02 346.74	139.02 346.74
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	346.74 360.36	346.74 360.36
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	300.30 317.71	300.30 317.71
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	317.71 373.43	317.71 373.43
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	373.43 418.95	373.43 418.95
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	418.95 516.30	418.95 516.30
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	189.77 207.95	777.33 817.95

friction force B7027influence range B = 5.000 (m)

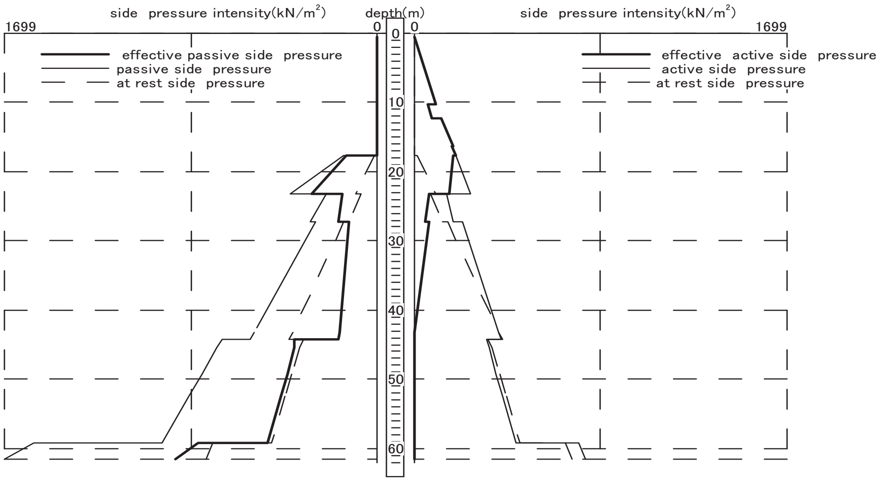
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

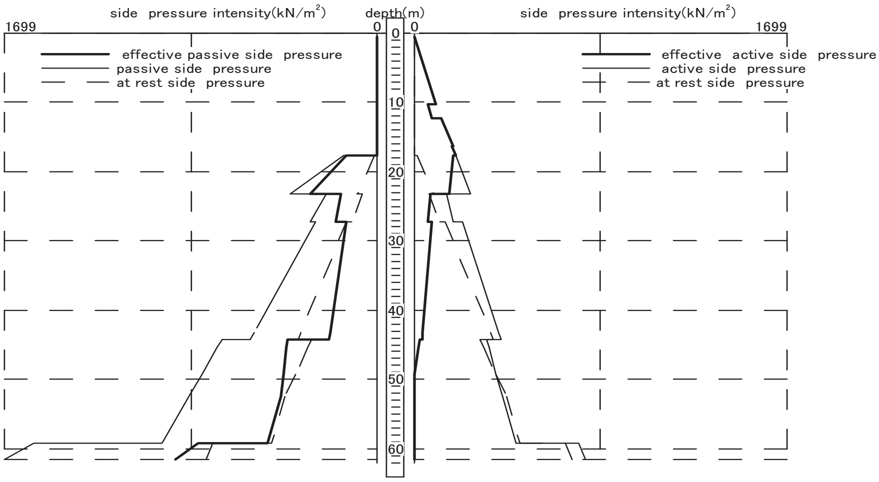
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(6)construction step [6]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.346	9.686	----	----	----	----
2	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
3	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
4	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
5	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
7	cohesv	-22.416 -38.370	15.954	17.5	42.0	0.00	7.0
8	cohesv	-38.370 -39.416	1.046	17.5	42.0	0.00	7.0
9	cohesv	-39.416 -40.625	1.209	18.0	108.0	0.00	18.0
10	cohesv	-40.625 -44.495	3.870	18.0	108.0	0.00	18.0
11	cohesv	-44.495 -47.656	3.161	18.0	108.0	0.00	18.0
12	cohesv	-47.656 -54.416	6.760	18.0	108.0	0.00	18.0
13	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	-------- --------	0.00 96.86	------- -------	------- -------	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
3	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
4	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
5	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	164.622 443.816	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 385.70	218.18 385.70
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	443.816 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	385.70 396.68	385.70 396.68
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	462.122 483.888	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 338.61	327.72 338.61
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	483.888 553.545	-------- --------	0.4250 0.4250	0.5000 0.5000	338.61 373.44	338.61 373.44
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	553.545 610.441	-------- --------	0.4250 0.4250	0.5000 0.5000	373.44 401.88	373.44 401.88
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	610.441 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	401.88 462.72	401.88 462.72
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \quad (\text{ sand soil })$$

$$Pa = Pa1 + pw1 \quad (\text{ sand soil })$$

$$Pa = Pa1 = Ka1*\left\{ Sum.(Gam.*H) + q \right\} + Ka2*\left\{ Sum.\left(Gam.(h - H)\right) \right\} \quad (\text{ cohesive soil })$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	4.8921 4.8921	151.66 342.26	151.66 397.92
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	1.0000 1.0000	233.62 303.62	233.62 303.62
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	1.0000 1.0000	279.62 558.82	279.62 558.82
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	1.0000 1.0000	558.82 577.12	558.82 577.12
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	1.0000 1.0000	709.12 730.89	709.12 730.89
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	1.0000 1.0000	730.89 800.54	730.89 800.54
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	1.0000 1.0000	800.54 857.44	800.54 857.44
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	1.0000 1.0000	857.44 979.12	857.44 979.12
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	5.5628 5.5628	976.62 1088.97	1564.18 1698.97

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \quad (\text{ sand soil })$$

$$Pp = Pp1 + pw2 \quad (\text{ sand soil })$$

$$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp} \quad (\text{cohesive soil })$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 96.86	0.0000 0.0000	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
3	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
4	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	-------- --------	0.6000 0.6000	235.25 402.77	235.25 402.77
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	-------- --------	0.6000 0.6000	402.77 413.75	402.77 413.75
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	-------- --------	0.5000 0.5000	344.79 355.68	344.79 355.68
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	-------- --------	0.5000 0.5000	355.68 390.50	355.68 390.50
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	-------- --------	0.5000 0.5000	390.50 418.95	390.50 418.95
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	-------- --------	0.5000 0.5000	418.95 479.79	418.95 479.79
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * $\{$ Sum.(Gam.*h) + q - pw1 $\}$ (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * $\{$ Sum.(Gam.*h) + q $\}$ (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	14.12 98.26
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	74.61 127.21	74.61 127.21
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	152.65 385.70	152.65 385.70
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	385.70 400.98	385.70 400.98
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	334.15 355.68	334.15 355.68
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	355.68 424.57	355.68 424.57
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	424.57 480.84	424.57 480.84
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	480.84 601.18	480.84 601.18
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	262.16 286.37	849.72 896.37

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * $\{$ Sum.(Gam.*h) + q - pw2 $\}$ + Ko * $\left\{ \text{Sum.(f*h)} — \text{B} \right\}$ (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * $\{$ Sum.(Gam.*h) + q $\}$+ Ko * $\left\{ \text{Sum.(f*h)} — \text{B} \right\}$ (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	14.12 94.11
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	70.05 115.85	70.05 115.85
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	139.02 346.74	139.02 346.74
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	346.74 360.36	346.74 360.36
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	300.30 317.71	300.30 317.71
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	317.71 373.43	317.71 373.43
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	373.43 418.95	373.43 418.95
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	418.95 516.30	418.95 516.30
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	189.77 207.95	777.33 817.95

friction force B7027influence range B = 5.000 (m)

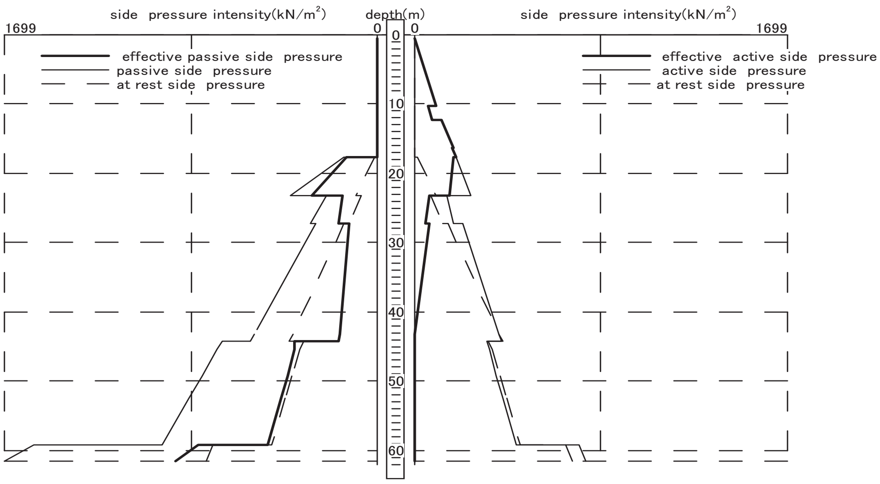
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

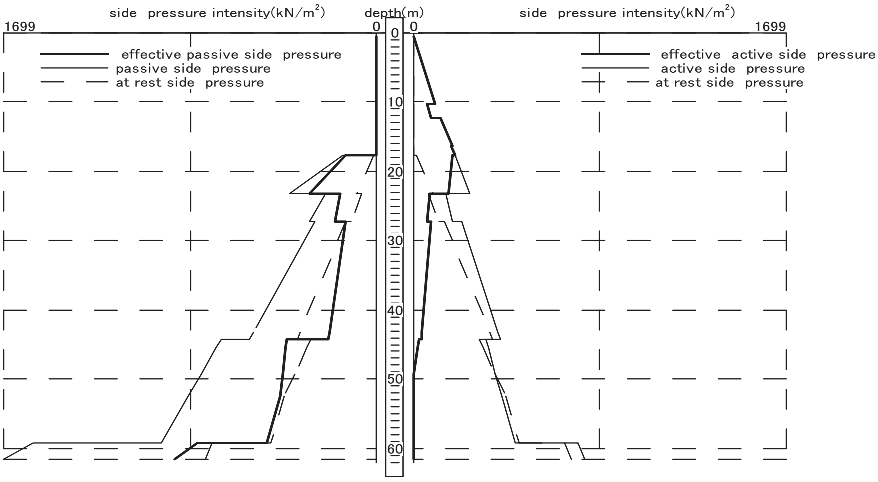
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



2.9 calculation result table

1)bridge axis direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	2.662	4.939	5.379	5.387
	accrue location	Lm	m	-4.660	-8.160	-7.160	-7.160
displace coffer displace part	max bending moment	Mmax	kN.m	932.0	1225.0	1657.0	1689.0
		Sig.	N/mm²	88.31	102.05	138.00	140.69
		Lm	m	-3.160	-6.350	-6.350	-5.346
	SKY400	M	kN.m	932.0	1168.0	1632.0	1684.0
		Sig.max	N/mm²	88.31	110.57	154.57	159.45
		Lm	m	-3.160	-5.160	-5.160	-5.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	706.0	1292.0	1657.0	1679.0
		Sig.	N/mm²	58.76	107.57	138.00	139.86
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY400	M	kN.m	706.0	1292.0	1657.0	1679.0
		Sig.max	N/mm²	58.76	107.57	138.00	139.86
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	209.4	0.0	0.0	0.0
		2nd row	kN/m	------	358.2	468.4	466.2
		3rd row	kN/m	------	------	------	26.1
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	93.4	921.3

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	5.387	5.382
	accrue location	Lm	m	-7.160	-7.160
displace coffer displace part	max bending moment	Mmax	kN.m	1689.0	1685.0
		Sig.	N/mm²	140.69	140.32
		Lm	m	-5.346	-5.346
	SKY400	M	kN.m	1684.0	1680.0
		Sig.max	N/mm²	159.45	159.06
		Lm	m	-5.160	-5.160
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm²	------	------
		Lm	m	------	------
displace celler displace part	max bending moment	Mmax	kN.m	1679.0	1673.0
		Sig.	N/mm²	139.86	139.32
		Lm	m	-6.350	-6.350
	SKY400	M	kN.m	1679.0	1673.0
		Sig.max	N/mm²	139.86	139.32
		Lm	m	-6.350	-6.350
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm²	------	------
		Lm	m	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	466.2	467.2
		3rd row	kN/m	26.1	23.1
		4th row	kN/m	0.0	0.0
		5th row	kN/m	------	------
		6th row	kN/m	------	------
		7th row	kN/m	------	------
		8th row	kN/m	------	------
		9th row	kN/m	------	------
		10th row	kN/m	------	------
	footing concrete reaction		kN/m	921.3	917.3

note)Lm shows elevation

2)perpendicular direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	2.667	4.955	5.405	5.547
	accrue location	Lm	m	-4.660	-8.160	-7.160	-7.416
displace coffer displace part	max bending moment	Mmax	kN.m	935.0	1227.0	1670.0	1713.0
		Sig.	N/mm²	87.52	101.02	137.43	141.02
		Lm	m	-3.160	-6.350	-6.350	-6.160
	SKY400	M	kN.m	935.0	1169.0	1643.0	1688.0
		Sig.max	N/mm²	87.52	109.44	153.77	157.96
		Lm	m	-3.160	-5.160	-5.160	-5.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	709.0	1294.0	1670.0	1711.0
		Sig.	N/mm²	58.37	106.51	137.43	140.80
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY400	M	kN.m	709.0	1294.0	1670.0	1711.0
		Sig.max	N/mm²	58.37	106.51	137.43	140.80
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	209.7	0.0	0.0	0.0
		2nd row	kN/m	------	358.5	470.0	440.7
		3rd row	kN/m	------	------	------	74.6
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	84.2	854.6

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	5.547	5.542
	accrue location	Lm	m	-7.416	-7.416
displace coffer displace part	max bending moment	Mmax	kN.m	1713.0	1707.0
		Sig.	N/mm²	141.02	140.52
		Lm	m	-6.160	-6.160
	SKY400	M	kN.m	1688.0	1684.0
		Sig.max	N/mm²	157.96	157.60
		Lm	m	-5.160	-5.160
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm²	------	------
		Lm	m	------	------
displace celler displace part	max bending moment	Mmax	kN.m	1711.0	1704.0
		Sig.	N/mm²	140.80	140.27
		Lm	m	-6.350	-6.350
	SKY400	M	kN.m	1711.0	1704.0
		Sig.max	N/mm²	140.80	140.27
		Lm	m	-6.350	-6.350
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm²	------	------
		Lm	m	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	440.7	442.0
		3rd row	kN/m	74.6	71.1
		4th row	kN/m	0.0	0.0
		5th row	kN/m	------	------
		6th row	kN/m	------	------
		7th row	kN/m	------	------
		8th row	kN/m	------	------
		9th row	kN/m	------	------
		10th row	kN/m	------	------
	footing concrete reaction		kN/m	854.6	852.1

note)Lm shows elevation

2.10 detail output

(1)bridge axis direction 1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.164	4.696	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.070	4.696	0.0	0.0	0.00	0.0	0.0	
209.4										
	+4.340	0.3	0.070	4.696	0.0	209.4	0.00	0.0	0.0	
	+3.840	5.3	0.305	4.676	104.4	208.0	9.89	0.0	0.0	
	+2.840	15.2	0.766	4.512	308.1	197.7	29.18	0.0	0.0	
	+1.840	25.2	1.202	4.193	496.6	177.5	47.03	0.0	0.0	
	+1.340	30.2	1.407	3.980	582.0	163.7	55.12	0.0	0.0	
	+0.840	35.2	1.600	3.735	659.8	147.3	62.49	0.0	0.0	
	+0.340	40.2	1.780	3.461	728.9	128.5	69.03	0.0	0.0	
	-0.160	40.2	1.945	3.161	788.1	108.4	74.63	0.0	0.0	
	-1.160	40.2	2.229	2.502	876.4	68.2	82.99	0.0	0.0	
	-1.660	40.1	2.345	2.150	905.5	48.1	85.75	0.0	0.0	
	-2.160	40.1	2.444	1.788	924.5	28.1	87.55	0.0	0.0	
	-3.160	40.1	2.586	1.053	932.5	-12.1	88.31	0.0	0.0	
	-4.160	40.1	2.655	0.327	900.4	-52.2	85.27	0.0	0.0	
	-4.660	40.1	2.662	-0.022	869.3	-72.2	82.32	0.0	0.0	
	-5.160	40.1	2.653	-0.358	828.2	-92.3	78.43	0.0	0.0	
	-5.160	40.1	2.653	-0.358	828.2	-92.3	68.97	0.0	0.0	
	-5.346	32.0	2.645	-0.463	810.3	-99.7	67.48	22.9	31.4	
	-6.160	32.0	2.589	-0.898	726.1	-107.3	60.47	22.4	34.2	
	-6.350	32.0	2.571	-0.992	705.5	-109.1	58.76	22.2	34.9	
	-7.160	32.0	2.476	-1.363	613.8	-117.4	51.12	21.4	37.7	
	-7.416	37.4	2.439	-1.470	583.4	-120.1	48.59	28.1	48.3	
	-8.160	36.0	2.319	-1.747	491.5	-127.0	40.93	26.7	65.2	
	-9.160	34.2	2.129	-2.043	359.8	-136.5	29.97	24.5	88.0	
	-10.160	32.5	1.914	-2.244	218.4	-146.5	18.19	22.1	110.8	
	-10.350	32.1	1.871	-2.271	190.4	-148.5	15.85	21.6	115.1	
	-11.160	30.7	1.684	-2.344	66.6	-157.3	5.54	19.4	133.6	
	-11.350	30.3	1.639	-2.351	36.5	-159.5	3.04	18.9	137.9	
	-11.416	30.9	1.624	-2.352	25.9	-160.2	2.16	81.1	200.2	
	-12.160	28.6	1.449	-2.337	-80.0	-125.2	6.66	72.4	221.9	
	-13.160	25.6	1.219	-2.243	-184.7	-85.7	15.39	60.9	251.0	
	-14.160	22.5	1.002	-2.089	-254.1	-54.3	21.16	50.1	280.1	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-14.350	22.0	0.963	-2.055	-264.0	-49.2	21.98	48.1	285.7	
	-15.160	19.5	0.803	-1.897	-295.9	-30.3	24.64	40.1	309.3	
	-16.160	16.4	0.624	-1.683	-316.9	-12.7	26.39	31.2	338.4	
	-17.160	13.4	0.466	-1.460	-323.1	-0.5	26.91	23.3	367.5	
	-18.160	10.3	0.332	-1.237	-319.3	7.5	26.59	16.6	396.6	
	-18.416	3.2	0.301	-1.180	-317.2	9.0	26.41	18.2	232.3	
	-19.146	0.0	0.220	-1.022	-306.7	19.3	25.55	13.3	235.4	
	-19.160	0.0	0.219	-1.019	-306.5	19.5	25.52	13.3	235.6	
	-20.160	0.0	0.127	-0.814	-281.3	29.9	23.43	7.7	244.3	
	-21.160	0.0	0.055	-0.630	-248.3	35.3	20.68	3.3	253.1	
	-22.009	0.0	0.008	-0.493	-217.5	36.9	18.12	0.5	260.5	
	-22.160	0.0	0.000	-0.470	-211.9	36.9	17.65	0.0	261.8	
	-22.416	0.0	-0.011	-0.434	-202.5	36.8	16.86	0.0	200.8	
	-22.660	0.0	-0.021	-0.400	-193.5	36.7	16.12	0.0	202.5	
	-22.660	0.0	-0.021	-0.400	-193.5	36.7	18.33	0.0	202.5	
	-23.160	0.0	-0.039	-0.327	-175.3	35.9	16.61	0.0	206.0	
	-24.160	0.0	-0.066	-0.203	-140.6	33.4	13.31	0.0	213.0	
	-25.160	0.0	-0.081	-0.105	-108.8	29.9	10.31	0.0	220.0	
	-26.160	0.0	-0.087	-0.030	-80.9	25.9	7.66	0.0	227.0	
	-27.160	0.0	-0.088	0.024	-57.0	21.8	5.40	0.0	234.0	
	-28.160	0.0	-0.083	0.061	-37.2	17.8	3.53	0.0	241.0	
	-29.160	0.0	-0.076	0.084	-21.4	14.0	2.02	0.0	248.0	
	-30.160	0.0	-0.067	0.096	-9.1	10.6	0.86	0.0	255.0	
	-31.160	0.0	-0.057	0.099	0.1	7.7	0.01	0.0	262.0	
	-32.160	0.0	-0.047	0.096	6.5	5.3	0.62	0.0	269.0	
	-33.160	0.0	-0.038	0.089	10.8	3.3	1.02	0.0	276.0	
	-34.160	0.0	-0.029	0.080	13.2	1.7	1.25	0.0	283.0	
	-35.160	0.0	-0.022	0.069	14.3	0.5	1.36	0.0	290.0	
	-36.160	0.0	-0.016	0.057	14.4	-0.4	1.36	0.0	297.0	
	-37.160	0.0	-0.010	0.046	13.7	-1.0	1.29	0.0	304.0	
	-38.160	0.0	-0.006	0.036	12.5	-1.4	1.18	0.0	311.0	
	-39.160	0.0	-0.003	0.027	11.0	-1.6	1.04	0.0	318.0	
	-39.416	0.0	-0.003	0.025	10.5	-1.6	1.00	0.0	520.8	
	-40.160	0.0	-0.001	0.019	9.3	-1.8	0.88	0.0	527.5	
	-41.160	0.0	0.001	0.012	7.5	-1.8	0.71	0.1	536.5	
	-42.160	0.0	0.002	0.007	5.7	-1.7	0.54	0.2	545.5	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-43.160	0.0	0.002	0.003	4.1	-1.5	0.39	0.2	554.5	
	-44.160	0.0	0.002	0.000	2.8	-1.2	0.26	0.3	563.5	
	-45.160	0.0	0.002	-0.001	1.7	-0.9	0.16	0.3	572.5	
	-46.160	0.0	0.002	-0.002	0.9	-0.7	0.09	0.2	581.5	
	-47.160	0.0	0.002	-0.003	0.3	-0.5	0.03	0.2	590.5	
	-48.160	0.0	0.001	-0.003	-0.1	-0.3	0.01	0.2	599.5	
	-49.160	0.0	0.001	-0.003	-0.3	-0.2	0.03	0.1	608.5	
	-50.160	0.0	0.001	-0.003	-0.4	-0.1	0.04	0.1	617.5	
	-51.160	0.0	0.001	-0.002	-0.4	0.0	0.04	0.1	626.5	
	-52.160	0.0	0.000	-0.002	-0.4	0.1	0.04	0.0	635.5	
	-53.160	0.0	0.000	-0.002	-0.3	0.1	0.03	0.0	644.5	
	-54.160	0.0	0.000	-0.001	-0.2	0.1	0.02	0.0	653.5	
	-54.416	0.0	0.000	-0.001	-0.2	0.1	0.02	0.0	1688.4	
	-55.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1722.8	
	-56.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1769.0	
	-56.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1792.1	

(2)bridge axis direction   2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.648	6.038	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.346	6.038	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.346	6.038	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.044	6.038	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.560	6.040	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.164	6.052	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.467	6.066	-46.1	-45.7	4.37	0.0	0.0	
358.2										
	+1.340	30.2	1.467	6.066	-46.1	312.5	4.37	0.0	0.0	
	+0.840	35.2	1.770	6.054	106.1	296.2	10.05	0.0	0.0	
	+0.340	40.2	2.071	5.983	249.6	277.3	23.64	0.0	0.0	
	-0.160	40.2	2.368	5.858	383.3	257.2	36.29	0.0	0.0	
	-1.160	40.2	2.935	5.459	620.4	217.1	58.75	0.0	0.0	
	-1.660	40.1	3.202	5.194	723.9	197.0	68.55	0.0	0.0	
	-2.160	40.1	3.454	4.889	817.4	176.9	77.41	0.0	0.0	
	-3.160	40.1	3.908	4.180	974.2	136.8	92.26	0.0	0.0	
	-4.160	40.1	4.286	3.362	1090.9	96.7	103.31	0.0	0.0	
	-4.660	40.1	4.443	2.923	1134.3	76.6	107.42	0.0	0.0	
	-5.160	40.1	4.578	2.469	1167.6	56.6	110.57	0.0	0.0	
	-5.160	40.1	4.578	2.469	1167.6	56.6	97.24	0.0	0.0	
	-5.346	2.5	4.623	2.317	1177.4	49.1	98.06	0.0	0.0	
	-6.160	3.0	4.784	1.641	1216.5	46.9	101.32	0.0	0.0	
	-6.350	3.2	4.814	1.480	1225.4	46.3	102.05	0.0	0.0	
	-7.160	3.8	4.905	0.781	1261.8	43.5	105.09	0.0	0.0	
	-7.416	45.6	4.922	0.556	1272.8	42.5	106.00	0.0	0.0	
	-8.160	47.6	4.939	-0.108	1291.7	7.8	107.57	0.0	0.0	
	-9.160	50.3	4.884	-1.001	1275.2	-41.1	106.20	0.0	0.0	
	-10.160	53.0	4.740	-1.866	1208.5	-92.8	100.65	0.0	0.0	
	-10.350	53.5	4.703	-2.024	1189.9	-102.9	99.10	0.0	0.0	
	-11.160	55.7	4.513	-2.666	1088.7	-147.2	90.67	0.0	0.0	
	-11.350	56.3	4.461	-2.808	1059.7	-157.8	88.26	0.0	0.0	
	-11.416	53.4	4.442	-2.856	1049.2	-161.6	87.38	0.0	0.0	
	-12.160	55.0	4.210	-3.364	914.1	-201.9	76.13	0.0	0.0	
	-12.850	56.4	3.964	-3.767	761.6	-240.3	63.43	0.0	0.0	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-12.850	56.4	3.964	-3.767	761.6	-240.3	63.43	0.0	0.0	*
	-13.160	55.4	3.844	-3.922	684.6	-256.2	57.01	9.0	9.0	*
	-14.160	52.4	3.431	-4.304	410.5	-286.5	34.19	38.2	38.2	*
	-14.350	51.8	3.349	-4.355	355.8	-288.7	29.63	43.7	43.7	*
	-15.160	49.3	2.990	-4.489	122.2	-284.7	10.18	67.3	67.3	*
	-16.160	46.3	2.540	-4.478	-148.1	-250.6	12.33	96.4	96.4	*
	-16.755	44.5	2.276	-4.387	-287.1	-215.1	23.91	113.7	113.7	*
	-16.755	44.5	2.276	-4.387	-287.1	-215.1	23.91	113.8	113.7	
	-17.160	43.2	2.100	-4.295	-368.8	-188.6	30.72	105.0	125.5	
	-18.160	40.2	1.686	-3.980	-529.5	-135.8	44.10	84.2	154.7	
	-18.416	18.9	1.585	-3.883	-562.9	-125.0	46.88	96.0	209.5	
	-19.160	15.6	1.307	-3.572	-635.9	-72.8	52.96	79.2	212.7	
	-20.160	11.2	0.973	-3.112	-679.7	-17.5	56.61	58.9	217.1	
	-21.160	6.8	0.685	-2.640	-675.6	23.4	56.27	41.5	221.4	
	-22.160	2.4	0.444	-2.182	-636.7	52.8	53.02	26.9	225.7	
	-22.416	5.0	0.390	-2.071	-622.4	58.8	51.83	18.4	167.3	
	-22.660	4.0	0.341	-1.966	-607.6	61.9	50.60	16.0	168.0	
	-22.660	4.0	0.341	-1.966	-607.6	61.9	57.54	16.0	168.0	
	-23.160	1.9	0.248	-1.733	-575.3	67.3	54.48	11.7	169.5	
	-23.631	0.0	0.172	-1.525	-542.6	71.5	51.38	8.1	170.8	
	-24.160	0.0	0.097	-1.307	-503.8	74.8	47.71	4.6	172.4	
	-25.160	0.0	-0.015	-0.939	-427.7	76.6	40.50	0.0	175.3	
	-26.160	0.0	-0.093	-0.631	-352.1	73.9	33.35	0.0	178.2	
	-27.160	0.0	-0.143	-0.382	-280.8	68.3	26.60	0.0	181.1	
	-27.787	0.0	-0.163	-0.254	-239.5	63.7	22.68	0.0	182.9	
	-28.160	0.0	-0.171	-0.186	-216.2	60.8	20.48	0.0	185.5	
	-29.160	0.0	-0.182	-0.039	-159.6	52.4	15.11	0.0	192.5	
	-29.807	0.0	-0.182	0.034	-127.5	46.8	12.07	0.0	197.0	
	-30.160	0.0	-0.180	0.068	-111.5	43.8	10.56	0.0	199.5	
	-31.160	0.0	-0.170	0.139	-71.8	35.6	6.80	0.0	206.5	
	-32.160	0.0	-0.153	0.183	-40.1	27.9	3.80	0.0	213.5	
	-33.160	0.0	-0.134	0.205	-15.7	21.2	1.48	0.0	220.5	
	-34.160	0.0	-0.113	0.210	2.5	15.3	0.24	0.0	227.5	
	-35.160	0.0	-0.092	0.202	15.3	10.5	1.45	0.0	234.5	
	-36.160	0.0	-0.073	0.186	23.8	6.6	2.26	0.0	241.5	
	-36.581	0.0	-0.065	0.178	26.3	5.3	2.49	0.0	244.4	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-37.160	0.0	-0.055	0.165	28.9	3.6	2.74	0.0	248.5	
	-38.160	0.0	-0.040	0.142	31.3	1.4	2.97	0.0	255.5	
	-39.160	0.0	-0.027	0.116	31.9	-0.2	3.02	0.0	262.5	
	-39.416	0.0	-0.024	0.110	31.8	-0.5	3.01	0.0	465.2	
	-40.160	0.0	-0.017	0.092	30.8	-2.3	2.91	0.0	471.9	
	-41.160	0.0	-0.009	0.068	27.6	-3.8	2.62	0.0	480.9	
	-42.160	0.0	-0.003	0.048	23.5	-4.4	2.22	0.0	489.9	
	-43.160	0.0	0.001	0.032	19.0	-4.5	1.80	0.1	498.9	
	-44.160	0.0	0.004	0.018	14.6	-4.2	1.38	0.4	507.9	
	-45.160	0.0	0.005	0.008	10.6	-3.7	1.01	0.6	516.9	
	-46.160	0.0	0.005	0.001	7.3	-3.0	0.69	0.7	525.9	
	-47.160	0.0	0.005	-0.003	4.6	-2.4	0.43	0.6	534.9	
	-48.160	0.0	0.005	-0.006	2.5	-1.7	0.24	0.6	543.9	
	-49.160	0.0	0.004	-0.007	1.1	-1.2	0.10	0.5	552.9	
	-50.160	0.0	0.003	-0.008	0.1	-0.7	0.01	0.4	561.9	
	-51.160	0.0	0.003	-0.008	-0.4	-0.4	0.04	0.3	570.9	
	-52.160	0.0	0.002	-0.007	-0.7	-0.1	0.06	0.2	579.9	
	-53.160	0.0	0.001	-0.007	-0.6	0.1	0.06	0.1	588.9	
	-54.160	0.0	0.001	-0.006	-0.5	0.2	0.05	0.1	597.9	
	-54.416	0.0	0.000	-0.006	-0.4	0.2	0.04	0.1	1379.3	
	-55.160	0.0	0.000	-0.006	-0.2	0.3	0.02	0.0	1413.7	
	-56.160	0.0	-0.001	-0.006	0.0	0.1	0.00	0.0	1459.9	
	-56.660	0.0	-0.001	-0.006	0.0	0.0	0.00	0.0	1483.0	

*showing plastic

(3)bridge axis direction   3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.121	7.442	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.749	7.442	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.749	7.442	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.377	7.442	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.368	7.443	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.112	7.455	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.469	-46.1	-45.7	4.37	0.0	0.0	
468.4										
	+1.340	30.2	1.485	7.469	-46.1	422.6	4.37	0.0	0.0	
	+0.840	35.2	1.859	7.446	161.2	406.3	15.27	0.0	0.0	
	-0.160	45.2	2.592	7.163	548.2	366.1	51.92	0.0	0.0	
	-1.160	55.2	3.282	6.593	890.1	315.9	84.29	0.0	0.0	
	-1.660	60.1	3.602	6.211	1041.0	287.1	98.58	0.0	0.0	
	-2.160	65.1	3.902	5.773	1176.8	255.8	111.44	0.0	0.0	
	-2.660	70.1	4.179	5.285	1296.3	222.0	122.77	0.0	0.0	
	-3.160	70.1	4.430	4.752	1398.6	186.9	132.45	0.0	0.0	
	-4.160	70.1	4.847	3.584	1550.4	116.8	146.83	0.0	0.0	
	-4.660	70.1	5.011	2.962	1600.1	81.8	151.53	0.0	0.0	
	-5.160	70.1	5.143	2.324	1632.2	46.7	154.57	0.0	0.0	
	-5.160	70.1	5.143	2.324	1632.2	46.7	135.93	0.0	0.0	
	-5.346	32.5	5.185	2.112	1639.7	33.7	136.55	0.0	0.0	
	-6.160	33.0	5.319	1.180	1656.3	7.0	137.94	0.0	0.0	
	-6.350	33.2	5.339	0.962	1657.0	0.8	138.00	0.0	0.0	
	-7.160	33.8	5.379	0.032	1646.7	-26.4	137.14	0.0	0.0	
	-7.416	75.6	5.376	-0.260	1638.8	-35.0	136.48	0.0	0.0	
	-8.160	77.6	5.326	-1.095	1591.7	-92.0	132.56	0.0	0.0	
	-9.160	80.3	5.162	-2.159	1460.4	-171.0	121.62	0.0	0.0	
	-10.160	83.0	4.898	-3.104	1248.8	-252.7	104.00	0.0	0.0	
	-10.350	83.5	4.838	-3.265	1199.3	-268.5	99.88	0.0	0.0	
	-11.160	85.7	4.547	-3.873	969.5	-337.1	80.74	0.0	0.0	
	-11.350	86.3	4.473	-3.995	911.9	-353.4	75.94	0.0	0.0	
93.4										
	-11.350	86.3	4.473	-3.995	911.9	-260.0	75.94	0.0	0.0	
	-11.416	83.4	4.446	-4.035	891.6	-265.7	74.25	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-12.160	85.0	4.131	-4.430	651.1	-328.3	54.23	0.0	0.0	
	-12.850	86.4	3.816	-4.684	403.4	-387.4	33.60	0.0	0.0	
	-12.850	72.3	3.816	-4.684	403.4	-387.4	33.60	137.5	137.5	*
	-13.160	71.3	3.669	-4.758	286.6	-365.6	23.87	146.6	146.6	*
	-13.852	69.2	3.336	-4.838	53.2	-305.8	4.43	166.7	166.7	*
	-13.852	69.2	3.336	-4.838	53.2	-305.8	4.43	166.7	166.7	
	-14.160	68.3	3.187	-4.839	-36.3	-276.8	3.02	159.3	175.7	
	-14.350	67.7	3.095	-4.831	-87.3	-259.9	7.27	154.7	181.2	
	-15.160	65.2	2.708	-4.728	-271.1	-196.3	22.58	135.3	204.8	
	-16.160	62.2	2.246	-4.479	-435.7	-136.3	36.29	112.3	234.0	
	-17.160	59.1	1.815	-4.135	-550.1	-95.6	45.81	90.7	263.1	
	-18.160	56.0	1.422	-3.723	-632.7	-72.4	52.69	71.0	292.2	
	-18.416	18.4	1.328	-3.609	-650.8	-69.1	54.20	80.4	210.0	
	-19.160	15.1	1.072	-3.263	-686.2	-27.6	57.15	64.9	213.2	
	-20.160	10.7	0.770	-2.782	-691.4	14.9	57.58	46.6	217.6	
	-21.160	6.3	0.515	-2.311	-660.5	45.1	55.01	31.2	221.9	
	-22.160	1.9	0.306	-1.871	-604.5	65.6	50.34	18.5	226.2	
	-22.416	4.4	0.260	-1.765	-587.2	69.6	48.90	12.2	167.7	
	-22.660	3.4	0.218	-1.667	-570.0	71.4	47.47	10.3	168.4	
	-22.660	3.4	0.218	-1.667	-570.0	71.4	53.98	10.3	168.4	
	-23.160	1.3	0.140	-1.450	-533.5	74.4	50.52	6.6	169.9	
	-23.485	0.0	0.095	-1.316	-509.0	76.0	48.21	4.5	170.8	
	-24.160	0.0	0.015	-1.059	-457.0	77.7	43.28	0.7	172.8	
	-25.160	0.0	-0.074	-0.728	-379.7	76.2	35.96	0.0	175.7	
	-26.160	0.0	-0.133	-0.458	-305.8	71.2	28.96	0.0	178.6	
	-27.160	0.0	-0.167	-0.244	-238.0	64.1	22.54	0.0	181.5	
	-27.641	0.0	-0.177	-0.160	-208.2	60.2	19.71	0.0	182.8	
	-28.160	0.0	-0.183	-0.081	-178.0	55.8	16.86	0.0	186.5	
	-29.160	0.0	-0.185	0.039	-126.6	47.1	11.99	0.0	193.5	
	-29.569	0.0	-0.182	0.077	-108.1	43.5	10.24	0.0	196.3	
	-30.160	0.0	-0.176	0.122	-83.9	38.5	7.94	0.0	200.5	
	-31.160	0.0	-0.161	0.174	-49.4	30.5	4.68	0.0	207.5	
	-32.160	0.0	-0.143	0.202	-22.5	23.4	2.13	0.0	214.5	
	-33.160	0.0	-0.122	0.211	-2.3	17.1	0.22	0.0	221.5	
	-34.160	0.0	-0.101	0.207	12.1	11.9	1.15	0.0	228.5	
	-35.160	0.0	-0.081	0.193	21.8	7.6	2.06	0.0	235.5	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	0.0	-0.062	0.173	27.7	4.3	2.62	0.0	242.5	
	-36.343	0.0	-0.059	0.169	28.4	3.7	2.69	0.0	243.8	
	-37.160	0.0	-0.046	0.150	30.6	1.7	2.90	0.0	249.5	
	-38.160	0.0	-0.032	0.126	31.3	-0.1	2.97	0.0	256.5	
	-39.160	0.0	-0.021	0.101	30.6	-1.4	2.89	0.0	263.5	
	-39.416	0.0	-0.019	0.095	30.2	-1.6	2.86	0.0	466.2	
	-40.160	0.0	-0.012	0.078	28.4	-3.0	2.69	0.0	472.9	
	-41.160	0.0	-0.005	0.057	24.9	-4.0	2.36	0.0	481.9	
	-42.160	0.0	-0.001	0.039	20.6	-4.4	1.95	0.0	490.9	
	-43.160	0.0	0.002	0.024	16.3	-4.3	1.54	0.3	499.9	
	-44.160	0.0	0.004	0.013	12.2	-3.8	1.16	0.5	508.9	
	-45.160	0.0	0.005	0.005	8.7	-3.3	0.82	0.6	517.9	
	-46.160	0.0	0.005	-0.001	5.7	-2.6	0.54	0.6	526.9	
	-47.160	0.0	0.005	-0.005	3.4	-2.0	0.32	0.6	535.9	
	-48.160	0.0	0.004	-0.006	1.7	-1.4	0.16	0.5	544.9	
	-49.160	0.0	0.004	-0.007	0.5	-1.0	0.05	0.4	553.9	
	-50.160	0.0	0.003	-0.007	-0.3	-0.5	0.02	0.4	562.9	
	-51.160	0.0	0.002	-0.007	-0.6	-0.2	0.06	0.3	571.9	
	-52.160	0.0	0.002	-0.006	-0.8	0.0	0.07	0.2	580.9	
	-53.160	0.0	0.001	-0.006	-0.7	0.1	0.06	0.1	589.9	
	-54.160	0.0	0.000	-0.005	-0.5	0.2	0.05	0.0	598.9	
	-54.416	0.0	0.000	-0.005	-0.4	0.2	0.04	0.1	1384.8	
	-55.160	0.0	0.000	-0.005	-0.2	0.3	0.02	0.0	1419.2	
	-56.160	0.0	-0.001	-0.005	0.0	0.1	0.00	0.0	1465.5	
	-56.660	0.0	-0.001	-0.005	0.0	0.0	0.00	0.0	1488.6	

*showing plastic

bending moment at support of footing concrete is reduced value

(4)bridge axis direction   4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.136	7.483	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.387	7.483	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.361	7.485	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.110	7.496	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.511	-46.1	-45.7	4.37	0.0	0.0	
466.2										
	+1.340	30.2	1.485	7.511	-46.1	420.5	4.37	0.0	0.0	
	+0.840	35.2	1.860	7.488	160.1	404.2	15.17	0.0	0.0	
	-0.160	45.2	2.598	7.207	545.0	364.0	51.62	0.0	0.0	
	-1.160	55.2	3.292	6.639	884.8	313.8	83.79	0.0	0.0	
	-1.660	60.1	3.615	6.260	1034.6	285.0	97.97	0.0	0.0	
26.1										
	-1.660	60.1	3.615	6.260	1034.6	311.1	97.97	0.0	0.0	
	-2.160	65.1	3.917	5.822	1182.4	279.8	111.97	0.0	0.0	
	-3.160	75.1	4.449	4.788	1427.9	209.6	135.23	0.0	0.0	
	-4.160	85.1	4.869	3.588	1598.3	129.5	151.37	0.0	0.0	
	-4.660	90.1	5.033	2.946	1652.3	85.8	156.47	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	159.45	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	140.22	0.0	0.0	
	-5.346	59.3	5.204	2.070	1689.4	21.6	140.69	0.0	0.0	
	-6.160	68.0	5.334	1.114	1686.3	-30.2	140.44	0.0	0.0	
	-6.350	70.1	5.353	0.892	1679.4	-43.3	139.86	0.0	0.0	
	-7.160	78.8	5.387	-0.037	1620.3	-103.6	134.94	0.0	0.0	
	-7.416	123.2	5.383	-0.323	1591.2	-124.1	132.51	0.0	0.0	
	-8.160	132.6	5.329	-1.115	1463.8	-219.3	121.91	0.0	0.0	
	-9.160	145.3	5.169	-2.039	1176.1	-358.3	97.95	0.0	0.0	
	-10.160	158.0	4.929	-2.713	743.1	-509.9	61.88	0.0	0.0	
	-10.350	160.4	4.877	-2.805	643.3	-540.2	53.58	0.0	0.0	
	-11.160	170.7	4.639	-3.034	303.1	-674.3	25.24	0.0	0.0	
	-11.350	173.2	4.581	-3.045	251.1	-707.0	20.91	0.0	0.0	
921.3										
	-11.350	173.2	4.581	-3.045	251.1	214.3	20.91	0.0	0.0	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-11.416	171.0	4.561	-3.046	235.5	202.8	19.61	0.0	0.0	
	-12.160	180.0	4.333	-3.095	145.6	72.3	12.13	0.0	0.0	
	-12.850	188.3	4.117	-3.166	143.7	-54.8	11.96	0.0	0.0	
	-12.850	174.2	4.117	-3.166	143.7	-54.8	11.96	137.5	137.5	*
	-13.160	173.2	4.018	-3.195	125.1	-64.6	10.42	146.6	146.6	*
	-14.160	170.2	3.695	-3.257	52.5	-75.1	4.37	175.7	175.7	*
	-14.350	169.6	3.633	-3.263	38.4	-73.5	3.20	181.2	181.2	*
	-14.350	169.6	3.633	-3.263	38.4	-73.5	3.20	181.6	181.2	
	-15.160	167.1	3.368	-3.268	-18.4	-68.1	1.53	168.3	204.8	
	-16.160	164.1	3.043	-3.232	-88.1	-73.5	7.34	152.1	234.0	
	-17.160	161.0	2.724	-3.143	-169.8	-92.0	14.14	136.1	263.1	
	-18.160	157.9	2.416	-2.990	-276.3	-123.1	23.01	120.8	292.2	
	-18.416	69.4	2.341	-2.938	-309.1	-133.0	25.74	141.7	159.0	
	-19.160	66.1	2.128	-2.756	-388.9	-82.8	32.39	128.9	162.3	
	-20.160	61.7	1.867	-2.465	-442.2	-25.8	36.83	113.1	166.6	
	-21.160	57.3	1.636	-2.154	-444.0	20.6	36.98	99.1	171.0	
	-22.160	52.9	1.436	-1.858	-403.9	58.3	33.64	86.9	175.3	
	-22.416	65.5	1.389	-1.788	-387.9	66.8	32.30	65.4	127.0	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	30.95	63.4	127.7	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	35.19	63.4	127.7	
	-23.160	62.5	1.264	-1.583	-338.5	65.7	32.05	59.5	129.1	
	-24.160	58.4	1.118	-1.342	-274.8	61.2	26.02	52.7	132.0	
	-25.160	54.3	0.994	-1.148	-216.7	54.6	20.53	46.8	134.9	
	-26.160	50.2	0.887	-0.998	-166.1	46.6	15.73	41.8	137.8	
	-27.160	46.0	0.793	-0.884	-123.8	38.0	11.72	37.4	140.7	
	-28.160	41.9	0.709	-0.800	-90.1	29.4	8.53	33.4	143.6	
	-29.160	37.8	0.632	-0.739	-65.0	21.0	6.15	29.8	146.5	
	-30.160	33.7	0.561	-0.695	-47.8	13.3	4.53	26.4	149.4	
	-31.160	29.6	0.493	-0.662	-38.0	6.5	3.60	23.2	152.3	
	-32.160	25.5	0.428	-0.634	-34.6	0.6	3.28	20.2	155.2	
	-33.160	21.4	0.366	-0.606	-36.5	-4.2	3.46	17.2	158.0	
	-34.160	17.3	0.307	-0.575	-42.5	-7.7	4.03	14.5	160.9	
	-35.160	13.2	0.251	-0.538	-51.4	-9.8	4.87	11.8	163.8	
	-36.160	9.1	0.200	-0.493	-61.6	-10.3	5.83	9.4	166.7	
	-37.160	5.0	0.153	-0.441	-71.4	-9.1	6.76	7.2	169.6	
	-38.160	0.9	0.112	-0.381	-79.0	-5.8	7.48	5.3	172.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-38.370	0.0	0.104	-0.368	-80.1	-4.8	7.59	4.9	173.1	
	-39.160	0.0	0.077	-0.317	-82.5	-1.4	7.81	3.6	175.4	
	-39.416	0.0	0.069	-0.301	-82.8	-0.6	7.84	8.3	375.0	
	-40.160	0.0	0.048	-0.252	-81.1	4.7	7.68	5.9	375.1	
	-40.625	0.0	0.037	-0.223	-78.3	7.1	7.42	4.5	375.2	
	-41.160	0.0	0.026	-0.191	-73.9	9.2	7.00	3.2	380.0	
	-42.160	0.0	0.010	-0.136	-63.5	11.3	6.02	1.2	389.0	
	-43.160	0.0	-0.001	-0.091	-51.9	11.8	4.91	0.0	398.0	
	-44.160	0.0	-0.008	-0.054	-40.3	11.2	3.82	0.0	407.0	
	-44.495	0.0	-0.010	-0.044	-36.7	10.8	3.47	0.0	410.0	
	-45.160	0.0	-0.012	-0.027	-29.8	9.9	2.82	0.0	416.0	
	-46.160	0.0	-0.014	-0.007	-20.7	8.2	1.96	0.0	425.0	
	-47.160	0.0	-0.014	0.006	-13.4	6.5	1.26	0.0	434.0	
	-47.656	0.0	-0.014	0.011	-10.3	5.7	0.98	0.0	438.5	
	-48.160	0.0	-0.013	0.014	-7.7	4.9	0.73	0.0	443.0	
	-49.160	0.0	-0.011	0.019	-3.6	3.4	0.34	0.0	452.0	
	-50.160	0.0	-0.009	0.020	-0.8	2.1	0.08	0.0	461.0	
	-51.160	0.0	-0.007	0.020	0.8	1.1	0.07	0.0	470.0	
	-52.160	0.0	-0.005	0.020	1.5	0.4	0.14	0.0	479.0	
	-53.160	0.0	-0.003	0.018	1.5	-0.2	0.15	0.0	488.0	
	-54.160	0.0	-0.002	0.017	1.2	-0.5	0.12	0.0	497.0	
	-54.416	0.0	-0.001	0.017	1.1	-0.5	0.10	0.0	818.0	
	-55.160	0.0	0.000	0.016	0.6	-0.6	0.06	0.0	852.4	
	-56.160	0.0	0.002	0.016	0.1	-0.4	0.01	0.6	898.6	
	-56.660	0.0	0.003	0.016	0.0	0.0	0.00	0.8	921.7	

*showing plastic

bending moment at support of footing concrete is reduced value

(5)bridge axis direction   5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.136	7.483	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.387	7.483	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.361	7.485	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.110	7.496	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.511	-46.1	-45.7	4.37	0.0	0.0	
466.2										
	+1.340	30.2	1.485	7.511	-46.1	420.5	4.37	0.0	0.0	
	+0.840	35.2	1.860	7.488	160.1	404.2	15.17	0.0	0.0	
	-0.160	45.2	2.598	7.207	545.0	364.0	51.62	0.0	0.0	
	-1.160	55.2	3.292	6.639	884.8	313.8	83.79	0.0	0.0	
	-1.660	60.1	3.615	6.260	1034.6	285.0	97.97	0.0	0.0	
26.1										
	-1.660	60.1	3.615	6.260	1034.6	311.1	97.97	0.0	0.0	
	-2.160	65.1	3.917	5.822	1182.4	279.8	111.97	0.0	0.0	
	-3.160	75.1	4.449	4.788	1427.9	209.6	135.23	0.0	0.0	
	-4.160	85.1	4.869	3.588	1598.3	129.5	151.37	0.0	0.0	
	-4.660	90.1	5.033	2.946	1652.3	85.8	156.47	0.0	0.0	
0.0										
	-4.660	90.1	5.033	2.946	1652.3	85.8	156.47	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	159.45	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	140.22	0.0	0.0	
	-5.346	59.3	5.204	2.070	1689.4	21.6	140.69	0.0	0.0	
	-6.160	68.0	5.334	1.114	1686.3	-30.2	140.44	0.0	0.0	
	-6.350	70.1	5.353	0.892	1679.4	-43.3	139.86	0.0	0.0	
	-7.160	78.8	5.387	-0.037	1620.3	-103.6	134.94	0.0	0.0	
	-7.416	123.2	5.383	-0.323	1591.2	-124.1	132.51	0.0	0.0	
	-8.160	132.6	5.329	-1.115	1463.8	-219.3	121.91	0.0	0.0	
	-9.160	145.3	5.169	-2.039	1176.1	-358.3	97.95	0.0	0.0	
	-10.160	158.0	4.929	-2.713	743.1	-509.9	61.88	0.0	0.0	
	-10.350	160.4	4.877	-2.805	643.3	-540.2	53.58	0.0	0.0	
	-11.160	170.7	4.639	-3.034	303.1	-674.3	25.24	0.0	0.0	
	-11.350	173.2	4.581	-3.045	251.1	-707.0	20.91	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
921.3										
	-11.350	173.2	4.581	-3.045	251.1	214.3	20.91	0.0	0.0	
	-11.416	171.0	4.561	-3.046	235.5	202.8	19.61	0.0	0.0	
	-12.160	180.0	4.333	-3.095	145.6	72.3	12.13	0.0	0.0	
	-12.850	188.3	4.117	-3.166	143.7	-54.8	11.96	0.0	0.0	
	-12.850	174.2	4.117	-3.166	143.7	-54.8	11.96	137.5	137.5	*
	-13.160	173.2	4.018	-3.195	125.1	-64.6	10.42	146.6	146.6	*
	-14.160	170.2	3.695	-3.257	52.5	-75.1	4.37	175.7	175.7	*
	-14.350	169.6	3.633	-3.263	38.4	-73.5	3.20	181.2	181.2	*
	-14.361	169.5	3.629	-3.263	37.6	-73.4	3.13	181.6	181.6	*
	-14.361	169.5	3.629	-3.263	37.6	-73.4	3.13	181.4	181.6	
	-15.160	167.1	3.368	-3.268	-18.4	-68.1	1.53	168.3	204.8	
	-16.160	164.1	3.043	-3.232	-88.1	-73.5	7.34	152.1	234.0	
	-17.160	161.0	2.724	-3.143	-169.8	-92.0	14.14	136.1	263.1	
	-18.160	157.9	2.416	-2.990	-276.3	-123.1	23.01	120.8	292.2	
	-18.416	69.4	2.341	-2.938	-309.1	-133.0	25.74	141.7	159.0	
	-19.160	66.1	2.128	-2.756	-388.9	-82.8	32.39	128.9	162.3	
	-20.160	61.7	1.867	-2.465	-442.2	-25.8	36.83	113.1	166.6	
	-21.160	57.3	1.636	-2.154	-444.0	20.6	36.98	99.1	171.0	
	-22.160	52.9	1.436	-1.858	-403.9	58.3	33.64	86.9	175.3	
	-22.416	65.5	1.389	-1.788	-387.9	66.8	32.30	65.4	127.0	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	30.95	63.4	127.7	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	35.19	63.4	127.7	
	-23.160	62.5	1.264	-1.583	-338.5	65.7	32.05	59.5	129.1	
	-24.160	58.4	1.118	-1.342	-274.8	61.2	26.02	52.7	132.0	
	-25.160	54.3	0.994	-1.148	-216.7	54.6	20.53	46.8	134.9	
	-26.160	50.2	0.887	-0.998	-166.1	46.6	15.73	41.8	137.8	
	-27.160	46.0	0.793	-0.884	-123.8	38.0	11.72	37.4	140.7	
	-28.160	41.9	0.709	-0.800	-90.1	29.4	8.53	33.4	143.6	
	-29.160	37.8	0.632	-0.739	-65.0	21.0	6.15	29.8	146.5	
	-30.160	33.7	0.561	-0.695	-47.8	13.3	4.53	26.4	149.4	
	-31.160	29.6	0.493	-0.662	-38.0	6.5	3.60	23.2	152.3	
	-32.160	25.5	0.428	-0.634	-34.6	0.6	3.28	20.2	155.2	
	-33.160	21.4	0.366	-0.606	-36.5	-4.2	3.46	17.2	158.0	
	-34.160	17.3	0.307	-0.575	-42.5	-7.7	4.03	14.5	160.9	
	-35.160	13.2	0.251	-0.538	-51.4	-9.8	4.87	11.8	163.8	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-36.160	9.1	0.200	-0.493	-61.6	-10.3	5.83	9.4	166.7	
	-37.160	5.0	0.153	-0.441	-71.4	-9.1	6.76	7.2	169.6	
	-38.160	0.9	0.112	-0.381	-79.0	-5.8	7.48	5.3	172.5	
	-38.370	0.0	0.104	-0.368	-80.1	-4.8	7.59	4.9	173.1	
	-39.160	0.0	0.077	-0.317	-82.5	-1.4	7.81	3.6	175.4	
	-39.416	0.0	0.069	-0.301	-82.8	-0.6	7.84	8.3	375.0	
	-40.160	0.0	0.048	-0.252	-81.1	4.7	7.68	5.9	375.1	
	-40.625	0.0	0.037	-0.223	-78.3	7.1	7.42	4.5	375.2	
	-41.160	0.0	0.026	-0.191	-73.9	9.2	7.00	3.2	380.0	
	-42.160	0.0	0.010	-0.136	-63.5	11.3	6.02	1.2	389.0	
	-43.160	0.0	-0.001	-0.091	-51.9	11.8	4.91	0.0	398.0	
	-44.160	0.0	-0.008	-0.054	-40.3	11.2	3.82	0.0	407.0	
	-44.495	0.0	-0.010	-0.044	-36.7	10.8	3.47	0.0	410.0	
	-45.160	0.0	-0.012	-0.027	-29.8	9.9	2.82	0.0	416.0	
	-46.160	0.0	-0.014	-0.007	-20.7	8.2	1.96	0.0	425.0	
	-47.160	0.0	-0.014	0.006	-13.4	6.5	1.26	0.0	434.0	
	-47.656	0.0	-0.014	0.011	-10.3	5.7	0.98	0.0	438.5	
	-48.160	0.0	-0.013	0.014	-7.7	4.9	0.73	0.0	443.0	
	-49.160	0.0	-0.011	0.019	-3.6	3.4	0.34	0.0	452.0	
	-50.160	0.0	-0.009	0.020	-0.8	2.1	0.08	0.0	461.0	
	-51.160	0.0	-0.007	0.020	0.8	1.1	0.07	0.0	470.0	
	-52.160	0.0	-0.005	0.020	1.5	0.4	0.14	0.0	479.0	
	-53.160	0.0	-0.003	0.018	1.5	-0.2	0.15	0.0	488.0	
	-54.160	0.0	-0.002	0.017	1.2	-0.5	0.12	0.0	497.0	
	-54.416	0.0	-0.001	0.017	1.1	-0.5	0.10	0.0	818.0	
	-55.160	0.0	0.000	0.016	0.6	-0.6	0.06	0.0	852.4	
	-56.160	0.0	0.002	0.016	0.1	-0.4	0.01	0.6	898.6	
	-56.660	0.0	0.003	0.016	0.0	0.0	0.00	0.8	921.7	

*showing plastic

bending moment at support of footing concrete is reduced value

(6)bridge axis direction　6 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.134	7.479	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.760	7.479	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.760	7.479	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.386	7.479	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.362	7.480	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.110	7.492	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.506	-46.1	-45.7	4.37	0.0	0.0	
467.2										
	+1.340	30.2	1.485	7.506	-46.1	421.5	4.37	0.0	0.0	
	+0.840	35.2	1.860	7.483	160.7	405.2	15.21	0.0	0.0	
	-0.160	45.2	2.597	7.202	546.6	365.0	51.76	0.0	0.0	
	-1.160	55.2	3.291	6.633	887.3	314.8	84.03	0.0	0.0	
	-1.660	60.1	3.613	6.252	1037.6	286.0	98.26	0.0	0.0	
23.1										
	-1.660	60.1	3.613	6.252	1037.6	309.1	98.26	0.0	0.0	
	-2.160	65.1	3.915	5.813	1184.4	277.7	112.17	0.0	0.0	
	-3.160	75.1	4.447	4.778	1427.9	207.6	135.23	0.0	0.0	
	-4.160	85.1	4.866	3.579	1596.3	127.5	151.17	0.0	0.0	
	-4.660	90.1	5.029	2.938	1649.2	83.7	156.18	0.0	0.0	
0.0										
	-4.660	90.1	5.029	2.938	1649.2	83.7	156.18	0.0	0.0	
	-5.160	95.1	5.159	2.281	1679.6	37.4	159.06	0.0	0.0	
	-5.160	95.1	5.159	2.281	1679.6	37.4	139.88	0.0	0.0	
	-5.346	59.3	5.199	2.064	1684.9	19.6	140.32	0.0	0.0	
	-6.160	68.0	5.329	1.111	1680.2	-32.3	139.93	0.0	0.0	
	-6.350	535355.2	5.348	0.890	1672.9	-45.4	139.32	0.0	0.0	
	-7.160	538803.6	5.382	-0.038	1648.0	-17.5	137.25	0.0	0.0	
	-7.416	538385.7	5.377	-0.330	1625.9	-155.7	135.41	0.0	0.0	
	-8.160	533007.3	5.323	-1.129	1458.5	-308.1	121.46	0.0	0.0	
	-9.160	517087.3	5.163	-2.025	1146.0	-327.5	95.44	0.0	0.0	
	-10.160	493088.9	4.925	-2.682	745.5	-442.5	62.09	0.0	0.0	
	-10.350	160.4	4.874	-2.774	652.2	-537.9	54.32	0.0	0.0	
	-11.160	170.7	4.638	-3.008	313.2	-672.0	26.08	0.0	0.0	
	-11.350	173.2	4.580	-3.021	261.3	-704.7	21.76	0.0	0.0	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
917.3										
	-11.350	173.2	4.580	-3.021	261.3	212.6	21.76	0.0	0.0	
	-11.416	171.0	4.560	-3.023	245.7	201.2	20.46	0.0	0.0	
	-12.160	180.0	4.334	-3.077	155.4	70.6	12.94	0.0	0.0	
	-12.850	188.3	4.119	-3.152	152.4	-56.4	12.69	0.0	0.0	
	-12.850	174.2	4.119	-3.152	152.4	-56.4	12.69	137.5	137.5	*
	-13.160	173.2	4.021	-3.183	133.3	-66.2	11.10	146.6	146.6	*
	-14.160	170.2	3.699	-3.250	59.1	-76.8	4.92	175.7	175.7	*
	-14.350	169.6	3.637	-3.257	44.6	-75.1	3.72	181.2	181.2	*
	-14.362	169.5	3.633	-3.257	43.8	-75.0	3.65	181.6	181.6	*
	-14.362	169.5	3.633	-3.257	43.8	-75.0	3.65	181.6	181.6	
	-15.160	167.1	3.372	-3.265	-13.4	-69.6	1.12	168.6	204.8	
	-16.160	164.1	3.047	-3.232	-84.5	-74.8	7.04	152.3	234.0	
	-17.160	161.0	2.728	-3.145	-167.4	-93.0	13.94	136.3	263.1	
	-18.160	157.9	2.420	-2.994	-274.8	-123.9	22.89	121.0	292.2	
	-18.416	69.4	2.344	-2.942	-307.8	-133.8	25.63	141.9	159.0	
	-19.160	66.1	2.132	-2.761	-388.2	-83.4	32.33	129.1	162.3	
	-20.160	61.7	1.870	-2.469	-442.1	-26.3	36.81	113.2	166.6	
	-21.160	57.3	1.639	-2.159	-444.3	20.3	37.00	99.2	171.0	
	-22.160	52.9	1.438	-1.862	-404.4	58.2	33.68	87.1	175.3	
	-22.416	65.5	1.391	-1.792	-388.4	66.7	32.35	65.5	127.0	
	-22.660	64.5	1.348	-1.728	-372.2	66.6	30.99	63.5	127.7	
	-22.660	64.5	1.348	-1.728	-372.2	66.6	35.24	63.5	127.7	
	-23.160	62.5	1.265	-1.587	-339.1	65.6	32.11	59.6	129.1	
	-24.160	58.4	1.119	-1.345	-275.5	61.2	26.09	52.7	132.0	
	-25.160	54.3	0.995	-1.151	-217.4	54.6	20.59	46.8	134.9	
	-26.160	50.2	0.887	-1.000	-166.8	46.6	15.79	41.8	137.8	
	-27.160	46.0	0.793	-0.886	-124.4	38.1	11.78	37.4	140.7	
	-28.160	41.9	0.709	-0.801	-90.7	29.4	8.58	33.4	143.6	
	-29.160	37.8	0.632	-0.740	-65.4	21.1	6.20	29.8	146.5	
	-30.160	33.7	0.561	-0.696	-48.2	13.4	4.57	26.4	149.4	
	-31.160	29.6	0.493	-0.662	-38.3	6.5	3.63	23.2	152.3	
	-32.160	25.5	0.428	-0.634	-34.8	0.6	3.30	20.2	155.2	
	-33.160	21.4	0.366	-0.606	-36.7	-4.1	3.47	17.2	158.0	
	-34.160	17.3	0.307	-0.575	-42.7	-7.6	4.04	14.5	160.9	
	-35.160	13.2	0.251	-0.538	-51.5	-9.7	4.88	11.8	163.8	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-36.160	9.1	0.200	-0.493	-61.6	-10.3	5.84	9.4	166.7	
	-37.160	5.0	0.153	-0.441	-71.4	-9.0	6.77	7.2	169.6	
	-38.160	0.9	0.112	-0.381	-79.0	-5.7	7.48	5.3	172.5	
	-38.370	0.0	0.104	-0.368	-80.1	-4.8	7.59	4.9	173.1	
	-39.160	0.0	0.077	-0.317	-82.5	-1.4	7.81	3.6	175.4	
	-39.416	0.0	0.069	-0.300	-82.7	-0.5	7.84	8.3	375.0	
	-40.160	0.0	0.048	-0.252	-81.1	4.7	7.68	5.9	375.1	
	-40.625	0.0	0.037	-0.223	-78.3	7.1	7.41	4.5	375.2	
	-41.160	0.0	0.026	-0.191	-73.9	9.2	7.00	3.2	380.0	
	-42.160	0.0	0.010	-0.136	-63.5	11.3	6.01	1.2	389.0	
	-43.160	0.0	-0.001	-0.091	-51.8	11.8	4.91	0.0	398.0	
	-44.160	0.0	-0.008	-0.054	-40.3	11.2	3.82	0.0	407.0	
	-44.495	0.0	-0.010	-0.044	-36.6	10.8	3.47	0.0	410.0	
	-45.160	0.0	-0.012	-0.027	-29.8	9.9	2.82	0.0	416.0	
	-46.160	0.0	-0.014	-0.007	-20.7	8.2	1.96	0.0	425.0	
	-47.160	0.0	-0.014	0.006	-13.3	6.5	1.26	0.0	434.0	
	-47.656	0.0	-0.014	0.011	-10.3	5.7	0.98	0.0	438.5	
	-48.160	0.0	-0.013	0.014	-7.7	4.9	0.73	0.0	443.0	
	-49.160	0.0	-0.011	0.019	-3.6	3.4	0.34	0.0	452.0	
	-50.160	0.0	-0.009	0.020	-0.8	2.1	0.08	0.0	461.0	
	-51.160	0.0	-0.007	0.020	0.8	1.1	0.07	0.0	470.0	
	-52.160	0.0	-0.005	0.020	1.5	0.4	0.14	0.0	479.0	
	-53.160	0.0	-0.003	0.018	1.6	-0.2	0.15	0.0	488.0	
	-54.160	0.0	-0.002	0.017	1.2	-0.5	0.12	0.0	497.0	
	-54.416	0.0	-0.001	0.017	1.1	-0.5	0.10	0.0	818.0	
	-55.160	0.0	0.000	0.016	0.6	-0.6	0.06	0.0	852.4	
	-56.160	0.0	0.002	0.016	0.1	-0.4	0.01	0.6	898.6	
	-56.660	0.0	0.003	0.016	0.0	0.0	0.00	0.8	921.7	

*showing plastic
bending moment at support of footing concrete is reduced value

(7)perpendicular direction   1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.184	4.706	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.051	4.706	0.0	0.0	0.00	0.0	0.0	
209.7										
	+4.340	0.3	0.051	4.706	0.0	209.7	0.00	0.0	0.0	
	+3.840	5.3	0.286	4.685	104.6	208.3	9.79	0.0	0.0	
	+2.840	15.2	0.748	4.524	308.6	198.1	28.89	0.0	0.0	
	+1.840	25.2	1.186	4.208	497.4	177.8	46.56	0.0	0.0	
	+1.340	30.2	1.391	3.997	583.0	164.0	54.57	0.0	0.0	
	+0.840	35.2	1.585	3.754	661.0	147.6	61.87	0.0	0.0	
	+0.340	40.2	1.766	3.482	730.2	128.8	68.35	0.0	0.0	
	-0.160	40.2	1.933	3.186	789.6	108.7	73.91	0.0	0.0	
	-1.160	40.2	2.219	2.533	878.2	68.5	82.20	0.0	0.0	
	-1.660	40.1	2.337	2.184	907.5	48.5	84.94	0.0	0.0	
	-2.160	40.1	2.437	1.826	926.7	28.4	86.74	0.0	0.0	
	-3.160	40.1	2.584	1.097	935.0	-11.7	87.52	0.0	0.0	
	-4.160	40.1	2.657	0.378	903.2	-51.8	84.55	0.0	0.0	
	-4.660	40.1	2.667	0.031	872.3	-71.9	81.65	0.0	0.0	
	-5.160	40.1	2.660	-0.301	831.4	-91.9	77.82	0.0	0.0	
	-5.160	40.1	2.660	-0.301	831.4	-91.9	68.43	0.0	0.0	
	-5.346	32.0	2.654	-0.406	813.6	-99.4	66.97	23.0	31.4	
	-6.160	32.0	2.603	-0.837	729.6	-106.9	60.06	22.5	34.2	
	-6.350	32.0	2.586	-0.931	709.2	-108.7	58.37	22.4	34.9	
	-7.160	32.0	2.495	-1.300	617.9	-116.8	50.86	21.6	37.7	
	-7.416	37.4	2.461	-1.406	587.6	-119.5	48.37	28.4	48.3	
	-8.160	36.2	2.346	-1.683	496.2	-126.2	40.85	27.1	65.4	
	-9.160	34.6	2.162	-1.979	365.3	-135.6	30.07	24.9	88.4	
	-10.160	33.0	1.953	-2.182	224.8	-145.7	18.50	22.5	111.4	
	-10.350	32.7	1.911	-2.209	196.9	-147.7	16.21	22.0	115.7	
	-11.160	31.4	1.729	-2.285	73.7	-156.6	6.07	19.9	134.4	
	-11.350	31.1	1.685	-2.292	43.7	-158.8	3.60	19.4	138.7	
	-11.416	31.6	1.670	-2.294	33.2	-159.6	2.74	83.5	200.9	
	-12.160	29.9	1.500	-2.283	-71.8	-123.5	5.91	74.9	223.1	
	-13.160	27.6	1.275	-2.196	-174.3	-83.0	14.35	63.7	253.0	
	-14.160	25.3	1.062	-2.052	-240.6	-51.1	19.81	53.1	282.9	
	-14.350	24.8	1.023	-2.020	-249.8	-45.9	20.56	51.2	288.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-15.160	23.0	0.866	-1.873	-279.1	-27.1	22.97	43.3	312.7	
	-16.160	20.7	0.688	-1.674	-297.1	-10.1	24.46	34.4	342.6	
	-17.160	18.3	0.531	-1.468	-301.3	0.8	24.81	26.5	372.5	
	-18.160	16.0	0.395	-1.263	-297.3	6.6	24.47	19.7	402.4	
	-18.416	9.7	0.363	-1.210	-295.5	7.4	24.32	22.0	238.8	
	-19.146	7.7	0.280	-1.064	-287.1	15.2	23.63	17.0	243.2	
	-19.160	7.7	0.278	-1.062	-286.9	15.4	23.61	16.9	243.3	
	-20.160	5.0	0.182	-0.871	-267.5	22.9	22.02	11.0	249.3	
	-21.160	2.3	0.104	-0.696	-242.0	27.8	19.92	6.3	255.4	
	-22.009	0.0	0.050	-0.562	-217.1	30.7	17.87	3.1	260.5	
	-22.160	0.0	0.042	-0.540	-212.5	31.1	17.49	2.5	261.8	
	-22.416	0.0	0.029	-0.503	-204.4	31.7	16.83	1.4	200.8	
	-22.660	0.0	0.017	-0.470	-196.7	31.9	16.19	0.8	202.5	
	-22.660	0.0	0.017	-0.470	-196.7	31.9	18.41	0.8	202.5	
	-23.160	0.0	-0.005	-0.396	-180.6	32.1	16.91	0.0	206.0	
	-24.160	0.0	-0.038	-0.268	-148.9	31.0	13.94	0.0	213.0	
	-25.160	0.0	-0.059	-0.163	-119.0	28.7	11.14	0.0	220.0	
	-26.160	0.0	-0.071	-0.081	-91.8	25.6	8.59	0.0	227.0	
	-27.160	0.0	-0.076	-0.019	-67.9	22.1	6.35	0.0	234.0	
	-28.160	0.0	-0.076	0.025	-47.6	18.5	4.45	0.0	241.0	
	-29.160	0.0	-0.071	0.056	-30.8	15.1	2.88	0.0	248.0	
	-30.160	0.0	-0.065	0.074	-17.4	11.8	1.62	0.0	255.0	
	-31.160	0.0	-0.057	0.084	-7.0	9.0	0.65	0.0	262.0	
	-32.160	0.0	-0.048	0.086	0.7	6.5	0.07	0.0	269.0	
	-33.160	0.0	-0.040	0.083	6.1	4.4	0.57	0.0	276.0	
	-34.160	0.0	-0.032	0.077	9.7	2.7	0.91	0.0	283.0	
	-35.160	0.0	-0.025	0.068	11.7	1.4	1.10	0.0	290.0	
	-36.160	0.0	-0.018	0.059	12.6	0.4	1.18	0.0	297.0	
	-37.160	0.0	-0.013	0.049	12.6	-0.3	1.18	0.0	304.0	
	-38.160	0.0	-0.008	0.039	12.0	-0.8	1.12	0.0	311.0	
	-39.160	0.0	-0.005	0.030	11.0	-1.1	1.03	0.0	318.0	
	-39.416	0.0	-0.004	0.028	10.7	-1.2	1.00	0.0	520.8	
	-40.160	0.0	-0.002	0.022	9.7	-1.5	0.90	0.0	527.5	
	-41.160	0.0	0.000	0.015	8.1	-1.7	0.76	0.0	536.5	
	-42.160	0.0	0.001	0.010	6.4	-1.6	0.60	0.1	545.5	
	-43.160	0.0	0.002	0.005	4.9	-1.5	0.45	0.2	554.5	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-44.160	0.0	0.002	0.002	3.5	-1.3	0.32	0.2	563.5	
	-45.160	0.0	0.002	0.000	2.3	-1.0	0.22	0.2	572.5	
	-46.160	0.0	0.002	-0.002	1.4	-0.8	0.13	0.2	581.5	
	-47.160	0.0	0.002	-0.002	0.7	-0.6	0.07	0.2	590.5	
	-48.160	0.0	0.001	-0.003	0.2	-0.4	0.02	0.2	599.5	
	-49.160	0.0	0.001	-0.003	-0.1	-0.2	0.01	0.1	608.5	
	-50.160	0.0	0.001	-0.003	-0.3	-0.1	0.03	0.1	617.5	
	-51.160	0.0	0.001	-0.002	-0.4	0.0	0.03	0.1	626.5	
	-52.160	0.0	0.000	-0.002	-0.3	0.0	0.03	0.1	635.5	
	-53.160	0.0	0.000	-0.002	-0.3	0.1	0.03	0.0	644.5	
	-54.160	0.0	0.000	-0.002	-0.2	0.1	0.02	0.0	653.5	
	-54.416	0.0	0.000	-0.002	-0.2	0.1	0.02	0.0	1688.4	
	-55.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1722.8	
	-56.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1769.0	
	-56.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1792.1	

(8)perpendicular direction   2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.690	6.065	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.387	6.065	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.387	6.065	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.083	6.065	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.523	6.066	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.130	6.078	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.434	6.092	-46.1	-45.7	4.32	0.0	0.0	
358.5										
	+1.340	30.2	1.434	6.092	-46.1	312.8	4.32	0.0	0.0	
	+0.840	35.2	1.739	6.080	106.3	296.4	9.95	0.0	0.0	
	+0.340	40.2	2.041	6.010	249.9	277.6	23.39	0.0	0.0	
	-0.160	40.2	2.339	5.886	383.6	257.5	35.91	0.0	0.0	
	-1.160	40.2	2.910	5.492	621.0	217.3	58.13	0.0	0.0	
	-1.660	40.1	3.178	5.229	724.6	197.2	67.83	0.0	0.0	
	-2.160	40.1	3.432	4.928	818.2	177.2	76.59	0.0	0.0	
	-3.160	40.1	3.891	4.226	975.3	137.0	91.29	0.0	0.0	
	-4.160	40.1	4.273	3.417	1092.3	96.9	102.24	0.0	0.0	
	-4.660	40.1	4.433	2.982	1135.7	76.9	106.31	0.0	0.0	
	-5.160	40.1	4.571	2.532	1169.2	56.8	109.44	0.0	0.0	
	-5.160	40.1	4.571	2.532	1169.2	56.8	96.24	0.0	0.0	
	-5.346	2.5	4.617	2.382	1179.0	49.4	97.05	0.0	0.0	
	-6.160	3.0	4.784	1.713	1218.4	47.2	100.29	0.0	0.0	
	-6.350	3.2	4.815	1.554	1227.3	46.6	101.02	0.0	0.0	
	-7.160	3.8	4.913	0.861	1263.9	43.8	104.04	0.0	0.0	
	-7.416	45.6	4.932	0.639	1275.0	42.8	104.95	0.0	0.0	
	-8.160	47.6	4.955	-0.018	1294.0	8.1	106.51	0.0	0.0	
	-9.160	50.3	4.909	-0.903	1277.8	-40.9	105.18	0.0	0.0	
	-10.160	53.0	4.776	-1.760	1211.3	-92.6	99.71	0.0	0.0	
	-10.350	53.5	4.741	-1.916	1192.7	-102.7	98.18	0.0	0.0	
	-11.160	55.7	4.559	-2.553	1091.8	-147.0	89.87	0.0	0.0	
	-11.350	56.3	4.509	-2.693	1062.8	-157.6	87.49	0.0	0.0	
	-11.416	53.4	4.492	-2.741	1052.3	-161.3	86.62	0.0	0.0	
	-12.160	55.0	4.268	-3.245	917.4	-201.6	75.51	0.0	0.0	
	-12.850	56.4	4.030	-3.644	765.0	-240.0	62.97	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-12.850	56.4	4.030	-3.644	765.0	-240.0	62.97	0.0	0.0	*
	-13.160	55.7	3.915	-3.799	688.1	-256.0	56.64	9.3	9.3	*
	-14.160	53.4	3.515	-4.178	414.3	-286.3	34.10	39.1	39.1	*
	-14.350	52.9	3.435	-4.229	359.7	-288.4	29.60	44.8	44.8	*
	-15.160	51.0	3.086	-4.364	126.2	-284.4	10.39	69.0	69.0	*
	-16.160	48.7	2.648	-4.356	-143.8	-250.4	11.84	98.9	98.9	*
	-16.810	47.2	2.368	-4.257	-294.5	-211.0	24.24	118.3	118.3	*
	-16.810	47.2	2.368	-4.257	-294.5	-211.0	24.24	118.4	118.3	
	-17.160	46.4	2.220	-4.178	-364.1	-187.2	29.97	111.0	128.8	
	-18.160	44.1	1.817	-3.871	-522.2	-131.8	42.98	90.8	158.6	
	-18.416	23.5	1.719	-3.776	-554.4	-120.4	45.64	104.1	214.0	
	-19.160	21.5	1.449	-3.474	-623.0	-65.8	51.28	87.8	218.5	
	-20.160	18.8	1.124	-3.031	-658.6	-8.2	54.21	68.0	224.6	
	-21.160	16.1	0.843	-2.582	-644.7	33.7	53.07	51.1	230.6	
	-22.160	13.4	0.607	-2.155	-595.6	62.6	49.02	36.7	236.7	
	-22.416	18.6	0.553	-2.051	-578.8	68.3	47.64	26.0	181.0	
	-22.660	18.0	0.504	-1.956	-561.9	69.9	46.26	23.7	182.1	
	-22.660	18.0	0.504	-1.956	-561.9	69.9	52.60	23.7	182.1	
	-23.160	16.8	0.412	-1.744	-526.4	72.0	49.27	19.4	184.3	
	-23.631	15.6	0.334	-1.556	-492.3	72.6	46.08	15.7	186.4	
	-24.160	14.2	0.257	-1.361	-454.0	72.1	42.50	12.1	188.8	
	-25.160	11.7	0.137	-1.035	-383.6	68.2	35.91	6.5	193.3	
	-26.160	9.2	0.048	-0.762	-318.3	62.0	29.80	2.3	197.7	
	-27.160	6.7	-0.016	-0.536	-259.9	54.8	24.32	0.0	202.2	
	-27.787	5.1	-0.046	-0.418	-227.0	50.1	21.25	0.0	205.0	
	-28.160	4.2	-0.061	-0.354	-208.8	47.5	19.54	0.0	206.7	
	-29.160	1.6	-0.089	-0.209	-164.6	41.0	15.41	0.0	211.2	
	-29.807	0.0	-0.099	-0.132	-139.2	37.6	13.03	0.0	214.1	
	-30.160	0.0	-0.104	-0.096	-126.3	35.9	11.82	0.0	215.7	
	-31.160	0.0	-0.109	-0.011	-92.8	30.9	8.69	0.0	220.1	
	-32.160	0.0	-0.106	0.050	-64.5	25.8	6.04	0.0	224.6	
	-33.160	0.0	-0.099	0.091	-41.1	20.9	3.85	0.0	229.1	
	-34.160	0.0	-0.089	0.116	-22.5	16.5	2.10	0.0	233.6	
	-35.160	0.0	-0.077	0.127	-7.9	12.6	0.74	0.0	238.1	
	-36.160	0.0	-0.064	0.129	3.0	9.3	0.28	0.0	242.5	
	-36.581	0.0	-0.058	0.127	6.6	8.1	0.62	0.0	244.4	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-37.160	0.0	-0.051	0.123	10.9	6.6	1.02	0.0	248.5	
	-38.160	0.0	-0.039	0.113	16.4	4.5	1.53	0.0	255.5	
	-39.160	0.0	-0.029	0.098	20.0	2.9	1.88	0.0	262.5	
	-39.416	0.0	-0.026	0.094	20.7	2.6	1.94	0.0	465.2	
	-40.160	0.0	-0.020	0.082	21.9	0.5	2.05	0.0	471.9	
	-41.160	0.0	-0.012	0.065	21.4	-1.4	2.00	0.0	480.9	
	-42.160	0.0	-0.007	0.049	19.4	-2.5	1.82	0.0	489.9	
	-43.160	0.0	-0.002	0.035	16.6	-3.0	1.55	0.0	498.9	
	-44.160	0.0	0.001	0.023	13.5	-3.1	1.27	0.1	507.9	
	-45.160	0.0	0.002	0.014	10.5	-2.9	0.98	0.3	516.9	
	-46.160	0.0	0.003	0.007	7.7	-2.6	0.73	0.4	525.9	
	-47.160	0.0	0.004	0.002	5.4	-2.1	0.51	0.5	534.9	
	-48.160	0.0	0.004	-0.002	3.5	-1.7	0.33	0.5	543.9	
	-49.160	0.0	0.003	-0.004	2.1	-1.2	0.19	0.4	552.9	
	-50.160	0.0	0.003	-0.005	1.0	-0.8	0.10	0.4	561.9	
	-51.160	0.0	0.002	-0.006	0.3	-0.5	0.03	0.3	570.9	
	-52.160	0.0	0.002	-0.006	0.0	-0.3	0.00	0.2	579.9	
	-53.160	0.0	0.001	-0.006	-0.2	-0.1	0.02	0.1	588.9	
	-54.160	0.0	0.001	-0.006	-0.2	0.0	0.02	0.1	597.9	
	-54.416	0.0	0.001	-0.005	-0.2	0.1	0.02	0.2	1379.3	
	-55.160	0.0	0.000	-0.005	-0.2	0.1	0.01	0.0	1413.7	
	-56.160	0.0	0.000	-0.005	0.0	0.1	0.00	0.0	1459.9	
	-56.660	0.0	-0.001	-0.005	0.0	0.0	0.00	0.0	1483.0	

*showing plastic

(9)perpendicular direction 3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.178	7.498	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.803	7.498	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.803	7.498	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.428	7.498	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.322	7.500	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.072	7.511	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.448	7.525	-46.1	-45.7	4.32	0.0	0.0	
470.0										
	+1.340	30.2	1.448	7.525	-46.1	424.3	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.502	162.0	407.9	15.17	0.0	0.0	
	-0.160	45.2	2.563	7.222	550.7	367.7	51.55	0.0	0.0	
	-1.160	55.2	3.259	6.655	894.2	317.6	83.70	0.0	0.0	
	-1.660	60.1	3.582	6.276	1045.8	288.7	97.89	0.0	0.0	
	-2.160	65.1	3.886	5.841	1182.5	257.4	110.68	0.0	0.0	
	-2.660	70.1	4.166	5.356	1302.8	223.6	121.95	0.0	0.0	
	-3.160	70.1	4.420	4.827	1405.9	188.5	131.59	0.0	0.0	
	-4.160	70.1	4.846	3.666	1559.4	118.4	145.96	0.0	0.0	
	-4.660	70.1	5.014	3.048	1609.8	83.4	150.68	0.0	0.0	
	-5.160	70.1	5.151	2.413	1642.8	48.4	153.77	0.0	0.0	
	-5.160	70.1	5.151	2.413	1642.8	48.4	135.22	0.0	0.0	
	-5.346	32.5	5.193	2.203	1650.5	35.3	135.86	0.0	0.0	
	-6.160	33.0	5.335	1.275	1668.5	8.7	137.34	0.0	0.0	
	-6.350	33.2	5.357	1.057	1669.5	2.4	137.43	0.0	0.0	
	-7.160	33.8	5.405	0.131	1660.5	-24.7	136.68	0.0	0.0	
	-7.416	75.6	5.405	-0.160	1653.1	-33.4	136.07	0.0	0.0	
	-8.160	77.6	5.362	-0.993	1607.1	-90.4	132.29	0.0	0.0	
	-9.160	80.3	5.209	-2.056	1477.5	-169.4	121.62	0.0	0.0	
	-10.160	83.0	4.955	-3.002	1267.5	-251.1	104.33	0.0	0.0	
	-10.350	83.5	4.896	-3.164	1218.3	-266.9	100.28	0.0	0.0	
	-11.160	85.7	4.614	-3.776	988.3	-335.4	81.35	0.0	0.0	
	-11.350	86.3	4.541	-3.898	930.2	-351.8	76.57	0.0	0.0	
84.2										
	-11.350	86.3	4.541	-3.898	930.2	-267.6	76.57	0.0	0.0	
	-11.416	83.4	4.515	-3.939	909.7	-273.3	74.88	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-12.160	85.0	4.207	-4.338	665.5	-336.0	54.78	0.0	0.0	
	-12.850	86.4	3.898	-4.595	412.6	-395.1	33.96	0.0	0.0	
	-12.850	72.3	3.898	-4.595	412.6	-395.1	33.96	137.5	137.5	*
	-13.160	71.5	3.754	-4.670	293.4	-373.3	24.15	146.8	146.8	*
	-13.940	69.7	3.386	-4.753	27.6	-304.8	2.27	170.1	170.1	*
	-13.940	69.7	3.386	-4.753	27.6	-304.8	2.27	169.2	170.1	
	-14.160	69.2	3.281	-4.753	-37.0	-283.4	3.05	164.0	176.7	
	-14.350	68.8	3.191	-4.744	-89.2	-265.8	7.34	159.5	182.3	
	-15.160	66.9	2.810	-4.640	-276.6	-199.4	22.77	140.4	206.5	
	-16.160	64.6	2.358	-4.390	-442.7	-136.1	36.44	117.8	236.4	
	-17.160	62.3	1.935	-4.045	-555.4	-92.4	45.71	96.7	266.3	
	-18.160	60.0	1.551	-3.636	-633.5	-66.7	52.15	77.5	296.2	
	-18.416	23.0	1.459	-3.523	-650.0	-62.7	53.51	88.4	214.5	
	-19.160	21.0	1.210	-3.182	-679.8	-19.0	55.96	73.2	219.0	
	-20.160	18.3	0.915	-2.715	-675.3	25.5	55.59	55.4	225.1	
	-21.160	15.6	0.666	-2.264	-633.5	56.2	52.15	40.3	231.1	
	-22.160	12.9	0.461	-1.852	-566.7	75.9	46.65	27.9	237.2	
	-22.416	18.0	0.415	-1.754	-546.8	79.4	45.01	19.5	181.4	
	-22.660	17.4	0.373	-1.664	-527.4	79.6	43.41	17.6	182.5	
	-22.660	17.4	0.373	-1.664	-527.4	79.6	49.36	17.6	182.5	
	-23.160	16.2	0.295	-1.466	-487.6	79.1	45.65	13.9	184.7	
	-23.485	15.3	0.249	-1.346	-462.1	78.1	43.25	11.7	186.2	
	-24.160	13.6	0.166	-1.116	-410.4	74.9	38.41	7.8	189.2	
	-25.160	11.1	0.069	-0.824	-338.8	68.0	31.71	3.3	193.7	
	-26.160	8.6	-0.001	-0.586	-274.9	59.6	25.73	0.0	198.1	
	-27.160	6.1	-0.049	-0.393	-219.6	51.1	20.55	0.0	202.6	
	-27.641	4.9	-0.066	-0.315	-196.0	47.1	18.35	0.0	204.8	
	-28.160	3.6	-0.081	-0.241	-172.6	43.1	16.15	0.0	207.1	
	-29.160	1.0	-0.098	-0.122	-132.9	36.6	12.44	0.0	211.6	
	-29.569	0.0	-0.103	-0.082	-118.3	34.4	11.08	0.0	213.4	
	-30.160	0.0	-0.106	-0.032	-98.9	31.5	9.25	0.0	216.1	
	-31.160	0.0	-0.106	0.033	-69.8	26.5	6.54	0.0	220.5	
	-32.160	0.0	-0.100	0.078	-45.8	21.7	4.29	0.0	225.0	
	-33.160	0.0	-0.091	0.106	-26.4	17.2	2.47	0.0	229.5	
	-34.160	0.0	-0.079	0.121	-11.3	13.1	1.06	0.0	234.0	
	-35.160	0.0	-0.067	0.125	0.1	9.7	0.01	0.0	238.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	0.0	-0.054	0.121	8.3	6.9	0.78	0.0	242.9	
	-36.343	0.0	-0.052	0.120	9.5	6.4	0.89	0.0	243.8	
	-37.160	0.0	-0.043	0.112	14.0	4.6	1.31	0.0	249.5	
	-38.160	0.0	-0.032	0.100	17.6	2.8	1.65	0.0	256.5	
	-39.160	0.0	-0.023	0.085	19.7	1.5	1.85	0.0	263.5	
	-39.416	0.0	-0.021	0.081	20.1	1.3	1.88	0.0	466.2	
	-40.160	0.0	-0.015	0.070	20.4	-0.4	1.91	0.0	472.9	
	-41.160	0.0	-0.009	0.054	19.3	-1.8	1.80	0.0	481.9	
	-42.160	0.0	-0.004	0.040	17.0	-2.6	1.59	0.0	490.9	
	-43.160	0.0	-0.001	0.028	14.3	-2.9	1.34	0.0	499.9	
	-44.160	0.0	0.001	0.018	11.4	-2.8	1.07	0.2	508.9	
	-45.160	0.0	0.003	0.010	8.6	-2.6	0.81	0.3	517.9	
	-46.160	0.0	0.003	0.004	6.2	-2.2	0.58	0.4	526.9	
	-47.160	0.0	0.004	0.000	4.2	-1.8	0.39	0.4	535.9	
	-48.160	0.0	0.003	-0.003	2.6	-1.4	0.24	0.4	544.9	
	-49.160	0.0	0.003	-0.004	1.4	-1.0	0.13	0.4	553.9	
	-50.160	0.0	0.003	-0.005	0.6	-0.7	0.06	0.3	562.9	
	-51.160	0.0	0.002	-0.005	0.1	-0.4	0.01	0.2	571.9	
	-52.160	0.0	0.002	-0.005	-0.2	-0.2	0.02	0.2	580.9	
	-53.160	0.0	0.001	-0.005	-0.3	0.0	0.03	0.1	589.9	
	-54.160	0.0	0.001	-0.005	-0.3	0.1	0.02	0.1	598.9	
	-54.416	0.0	0.000	-0.005	-0.2	0.1	0.02	0.1	1384.8	
	-55.160	0.0	0.000	-0.005	-0.2	0.1	0.01	0.0	1419.2	
	-56.160	0.0	0.000	-0.005	0.0	0.1	0.00	0.0	1465.5	
	-56.660	0.0	-0.001	-0.005	0.0	0.0	0.00	0.0	1488.6	

*showing plastic

bending moment at support of footing concrete is reduced value

(10)perpendicular direction   4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.205	7.565	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.448	7.565	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.308	7.567	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.065	7.578	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.444	7.592	-46.1	-45.7	4.32	0.0	0.0	
440.7										
	+1.340	30.2	1.444	7.592	-46.1	395.0	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.572	147.4	378.7	13.80	0.0	0.0	
	-0.160	45.2	2.571	7.314	506.8	338.5	47.44	0.0	0.0	
	-1.160	55.2	3.278	6.793	821.0	288.3	76.85	0.0	0.0	
	-1.660	60.1	3.609	6.446	958.1	259.5	89.68	0.0	0.0	
74.6										
	-1.660	60.1	3.609	6.446	958.1	334.0	89.68	0.0	0.0	
	-2.160	65.1	3.922	6.041	1117.4	302.7	104.59	0.0	0.0	
	-3.160	75.1	4.478	5.060	1385.9	232.6	129.72	0.0	0.0	
	-4.160	85.1	4.928	3.898	1579.3	152.5	147.82	0.0	0.0	
	-4.660	90.1	5.107	3.269	1644.7	108.7	153.95	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	157.96	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	138.91	0.0	0.0	
	-5.346	59.3	5.301	2.402	1697.5	44.6	139.73	0.0	0.0	
	-6.160	68.0	5.457	1.448	1713.2	-7.3	141.02	0.0	0.0	
	-6.350	70.1	5.483	1.225	1710.6	-20.4	140.80	0.0	0.0	
	-7.160	78.8	5.544	0.283	1670.1	-80.7	137.47	0.0	0.0	
	-7.416	123.2	5.547	-0.008	1646.8	-101.2	135.56	0.0	0.0	
	-8.160	132.6	5.516	-0.823	1536.6	-196.3	126.49	0.0	0.0	
	-9.160	145.3	5.384	-1.794	1271.8	-335.3	104.69	0.0	0.0	
	-10.160	158.0	5.165	-2.535	861.8	-487.0	70.93	0.0	0.0	
	-10.350	160.4	5.116	-2.641	766.4	-517.2	63.08	0.0	0.0	
	-11.160	170.7	4.888	-2.941	433.8	-651.4	35.71	0.0	0.0	
	-11.350	173.2	4.832	-2.971	380.4	-684.0	31.31	0.0	0.0	
854.6										
	-11.350	173.2	4.832	-2.971	380.4	170.6	31.31	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-11.416	171.0	4.812	-2.978	364.0	159.1	29.96	0.0	0.0	
	-12.160	180.0	4.586	-3.091	255.6	28.6	21.04	0.0	0.0	
	-12.850	188.3	4.369	-3.206	224.1	-98.5	18.44	0.0	0.0	
	-12.850	174.2	4.369	-3.206	224.1	-98.5	18.44	137.5	137.5	*
	-13.160	173.4	4.269	-3.251	191.9	-108.3	15.80	146.8	146.8	*
	-14.160	171.1	3.939	-3.343	75.7	-118.9	6.23	176.7	176.7	*
	-14.350	170.7	3.875	-3.351	53.2	-117.2	4.38	182.3	182.3	*
	-14.593	170.1	3.794	-3.358	25.2	-113.4	2.07	189.6	189.6	*
	-14.593	170.1	3.794	-3.358	25.2	-113.4	2.07	189.6	189.6	
	-15.160	168.8	3.603	-3.356	-36.5	-104.7	3.00	180.1	206.5	
	-16.160	166.5	3.270	-3.295	-138.0	-100.7	11.36	163.4	236.4	
	-17.160	164.2	2.946	-3.166	-242.6	-110.8	19.97	147.3	266.3	
	-18.160	161.9	2.639	-2.959	-364.0	-134.3	29.97	131.9	296.2	
	-18.416	73.9	2.565	-2.892	-399.5	-142.4	32.88	155.3	163.6	
	-19.160	71.9	2.358	-2.665	-483.9	-85.9	39.83	142.8	168.1	
	-20.160	69.2	2.108	-2.311	-536.5	-21.4	44.16	127.7	174.1	
	-21.160	66.5	1.896	-1.942	-530.5	31.8	43.67	114.8	180.2	
	-22.160	63.8	1.719	-1.594	-476.0	75.9	39.18	104.1	186.2	
	-22.416	79.2	1.680	-1.512	-455.3	86.0	37.48	79.1	140.6	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	35.75	77.4	141.7	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	40.65	77.4	141.7	
	-23.160	77.3	1.576	-1.277	-391.6	84.7	36.66	74.2	143.9	
	-24.160	74.8	1.462	-1.004	-308.9	80.2	28.92	68.9	148.4	
	-25.160	72.3	1.373	-0.793	-232.1	73.3	21.72	64.7	152.9	
	-26.160	69.7	1.302	-0.640	-162.7	65.3	15.23	61.3	157.4	
	-27.160	67.2	1.243	-0.537	-101.7	56.7	9.52	58.6	161.9	
	-28.160	64.7	1.193	-0.479	-49.4	48.1	4.62	56.2	166.3	
	-29.160	62.2	1.146	-0.458	-5.5	39.7	0.52	54.0	170.8	
	-30.160	59.7	1.100	-0.468	30.1	31.7	2.82	51.8	175.3	
	-31.160	57.1	1.052	-0.503	57.9	24.0	5.42	49.5	179.8	
	-32.160	54.6	0.999	-0.557	78.1	16.4	7.31	47.0	184.3	
	-33.160	52.1	0.940	-0.623	90.7	8.7	8.49	44.3	188.7	
	-34.160	49.6	0.874	-0.696	95.4	0.6	8.93	41.2	193.2	
	-35.160	47.1	0.801	-0.770	91.8	-8.2	8.59	37.7	197.7	
	-36.160	44.5	0.720	-0.837	78.7	-18.1	7.36	33.9	202.2	
	-37.160	42.0	0.634	-0.890	55.0	-29.5	5.15	29.8	206.7	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-38.160	39.5	0.543	-0.919	19.1	-42.5	1.79	25.6	211.1	
	-38.370	39.0	0.524	-0.922	9.9	-45.5	0.92	24.7	212.1	
	-39.160	37.0	0.451	-0.916	-30.7	-57.4	2.87	21.2	215.6	
	-39.416	27.4	0.428	-0.908	-45.9	-61.5	4.30	51.8	408.8	
	-40.160	23.4	0.361	-0.870	-85.3	-44.8	7.98	43.8	411.5	
	-40.625	20.9	0.322	-0.835	-104.0	-35.9	9.74	39.0	413.2	
	-41.160	18.0	0.278	-0.788	-120.7	-26.9	11.30	33.7	415.1	
	-42.160	12.6	0.204	-0.685	-140.4	-13.1	13.15	24.8	418.7	
	-43.160	7.2	0.142	-0.572	-147.9	-2.2	13.84	17.1	422.3	
	-44.160	1.8	0.090	-0.457	-145.3	7.2	13.60	10.9	425.9	
	-44.495	0.0	0.075	-0.420	-142.3	10.3	13.32	9.1	427.1	
	-45.160	0.0	0.050	-0.348	-133.7	15.3	12.52	6.0	429.5	
	-46.160	0.0	0.020	-0.250	-116.0	19.4	10.86	2.4	433.1	
	-47.160	0.0	-0.001	-0.168	-95.8	20.5	8.97	0.0	436.7	
	-47.656	0.0	-0.008	-0.132	-85.7	20.3	8.02	0.0	438.5	
	-48.160	0.0	-0.014	-0.101	-75.6	19.6	7.08	0.0	443.0	
	-49.160	0.0	-0.021	-0.049	-57.1	17.4	5.34	0.0	452.0	
	-50.160	0.0	-0.024	-0.011	-41.1	14.6	3.84	0.0	461.0	
	-51.160	0.0	-0.024	0.016	-27.9	11.7	2.61	0.0	470.0	
	-52.160	0.0	-0.021	0.033	-17.7	8.9	1.65	0.0	479.0	
	-53.160	0.0	-0.017	0.044	-10.0	6.5	0.93	0.0	488.0	
	-54.160	0.0	-0.013	0.049	-4.4	4.7	0.41	0.0	497.0	
	-54.416	0.0	-0.011	0.050	-3.2	4.3	0.30	0.0	818.0	
	-55.160	0.0	-0.008	0.051	-1.0	1.9	0.09	0.0	852.4	
	-56.160	0.0	-0.003	0.052	0.0	0.2	0.00	0.0	898.6	
	-56.660	0.0	0.000	0.052	0.0	0.0	0.00	0.0	921.7	

*showing plastic

bending moment at support of footing concrete is reduced value

(11)perpendicular direction   5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.205	7.565	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.448	7.565	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.308	7.567	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.065	7.578	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.444	7.592	-46.1	-45.7	4.32	0.0	0.0	
440.7										
	+1.340	30.2	1.444	7.592	-46.1	395.0	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.572	147.4	378.7	13.80	0.0	0.0	
	-0.160	45.2	2.571	7.314	506.8	338.5	47.44	0.0	0.0	
	-1.160	55.2	3.278	6.793	821.0	288.3	76.85	0.0	0.0	
	-1.660	60.1	3.609	6.446	958.1	259.5	89.68	0.0	0.0	
74.6										
	-1.660	60.1	3.609	6.446	958.1	334.0	89.68	0.0	0.0	
	-2.160	65.1	3.922	6.041	1117.4	302.7	104.59	0.0	0.0	
	-3.160	75.1	4.478	5.060	1385.9	232.6	129.72	0.0	0.0	
	-4.160	85.1	4.928	3.898	1579.3	152.5	147.82	0.0	0.0	
	-4.660	90.1	5.107	3.269	1644.7	108.7	153.95	0.0	0.0	
0.0										
	-4.660	90.1	5.107	3.269	1644.7	108.7	153.95	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	157.96	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	138.91	0.0	0.0	
	-5.346	59.3	5.301	2.402	1697.5	44.6	139.73	0.0	0.0	
	-6.160	68.0	5.457	1.448	1713.2	-7.3	141.02	0.0	0.0	
	-6.350	70.1	5.483	1.225	1710.6	-20.4	140.80	0.0	0.0	
	-7.160	78.8	5.544	0.283	1670.1	-80.7	137.47	0.0	0.0	
	-7.416	123.2	5.547	-0.008	1646.8	-101.2	135.56	0.0	0.0	
	-8.160	132.6	5.516	-0.823	1536.6	-196.3	126.49	0.0	0.0	
	-9.160	145.3	5.384	-1.794	1271.8	-335.3	104.69	0.0	0.0	
	-10.160	158.0	5.165	-2.535	861.8	-487.0	70.93	0.0	0.0	
	-10.350	160.4	5.116	-2.641	766.4	-517.2	63.08	0.0	0.0	
	-11.160	170.7	4.888	-2.941	433.8	-651.4	35.71	0.0	0.0	
	-11.350	173.2	4.832	-2.971	380.4	-684.0	31.31	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
854.6										
	-11.350	173.2	4.832	-2.971	380.4	170.6	31.31	0.0	0.0	
	-11.416	171.0	4.812	-2.978	364.0	159.1	29.96	0.0	0.0	
	-12.160	180.0	4.586	-3.091	255.6	28.6	21.04	0.0	0.0	
	-12.850	188.3	4.369	-3.206	224.1	-98.5	18.44	0.0	0.0	
	-12.850	174.2	4.369	-3.206	224.1	-98.5	18.44	137.5	137.5	*
	-13.160	173.4	4.269	-3.251	191.9	-108.3	15.80	146.8	146.8	*
	-14.160	171.1	3.939	-3.343	75.7	-118.9	6.23	176.7	176.7	*
	-14.350	170.7	3.875	-3.351	53.2	-117.2	4.38	182.3	182.3	*
	-14.596	170.1	3.793	-3.358	24.9	-113.4	2.05	189.7	189.7	*
	-14.596	170.1	3.793	-3.358	24.9	-113.4	2.05	189.6	189.7	
	-15.160	168.8	3.603	-3.356	-36.5	-104.7	3.00	180.1	206.5	
	-16.160	166.5	3.270	-3.295	-138.0	-100.7	11.36	163.4	236.4	
	-17.160	164.2	2.946	-3.166	-242.6	-110.8	19.97	147.3	266.3	
	-18.160	161.9	2.639	-2.959	-364.0	-134.3	29.97	131.9	296.2	
	-18.416	73.9	2.565	-2.892	-399.5	-142.4	32.88	155.3	163.6	
	-19.160	71.9	2.358	-2.665	-483.9	-85.9	39.83	142.8	168.1	
	-20.160	69.2	2.108	-2.311	-536.5	-21.4	44.16	127.7	174.1	
	-21.160	66.5	1.896	-1.942	-530.5	31.8	43.67	114.8	180.2	
	-22.160	63.8	1.719	-1.594	-476.0	75.9	39.18	104.1	186.2	
	-22.416	79.2	1.680	-1.512	-455.3	86.0	37.48	79.1	140.6	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	35.75	77.4	141.7	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	40.65	77.4	141.7	
	-23.160	77.3	1.576	-1.277	-391.6	84.7	36.66	74.2	143.9	
	-24.160	74.8	1.462	-1.004	-308.9	80.2	28.92	68.9	148.4	
	-25.160	72.3	1.373	-0.793	-232.1	73.3	21.72	64.7	152.9	
	-26.160	69.7	1.302	-0.640	-162.7	65.3	15.23	61.3	157.4	
	-27.160	67.2	1.243	-0.537	-101.7	56.7	9.52	58.6	161.9	
	-28.160	64.7	1.193	-0.479	-49.4	48.1	4.62	56.2	166.3	
	-29.160	62.2	1.146	-0.458	-5.5	39.7	0.52	54.0	170.8	
	-30.160	59.7	1.100	-0.468	30.1	31.7	2.82	51.8	175.3	
	-31.160	57.1	1.052	-0.503	57.9	24.0	5.42	49.5	179.8	
	-32.160	54.6	0.999	-0.557	78.1	16.4	7.31	47.0	184.3	
	-33.160	52.1	0.940	-0.623	90.7	8.7	8.49	44.3	188.7	
	-34.160	49.6	0.874	-0.696	95.4	0.6	8.93	41.2	193.2	
	-35.160	47.1	0.801	-0.770	91.8	-8.2	8.59	37.7	197.7	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	44.5	0.720	-0.837	78.7	-18.1	7.36	33.9	202.2	
	-37.160	42.0	0.634	-0.890	55.0	-29.5	5.15	29.8	206.7	
	-38.160	39.5	0.543	-0.919	19.1	-42.5	1.79	25.6	211.1	
	-38.370	39.0	0.524	-0.922	9.9	-45.5	0.92	24.7	212.1	
	-39.160	37.0	0.451	-0.916	-30.7	-57.4	2.87	21.2	215.6	
	-39.416	27.4	0.428	-0.908	-45.9	-61.5	4.30	51.8	408.8	
	-40.160	23.4	0.361	-0.870	-85.3	-44.8	7.98	43.8	411.5	
	-40.625	20.9	0.322	-0.835	-104.0	-35.9	9.74	39.0	413.2	
	-41.160	18.0	0.278	-0.788	-120.7	-26.9	11.30	33.7	415.1	
	-42.160	12.6	0.204	-0.685	-140.4	-13.1	13.15	24.8	418.7	
	-43.160	7.2	0.142	-0.572	-147.9	-2.2	13.84	17.1	422.3	
	-44.160	1.8	0.090	-0.457	-145.3	7.2	13.60	10.9	425.9	
	-44.495	0.0	0.075	-0.420	-142.3	10.3	13.32	9.1	427.1	
	-45.160	0.0	0.050	-0.348	-133.7	15.3	12.52	6.0	429.5	
	-46.160	0.0	0.020	-0.250	-116.0	19.4	10.86	2.4	433.1	
	-47.160	0.0	-0.001	-0.168	-95.8	20.5	8.97	0.0	436.7	
	-47.656	0.0	-0.008	-0.132	-85.7	20.3	8.02	0.0	438.5	
	-48.160	0.0	-0.014	-0.101	-75.6	19.6	7.08	0.0	443.0	
	-49.160	0.0	-0.021	-0.049	-57.1	17.4	5.34	0.0	452.0	
	-50.160	0.0	-0.024	-0.011	-41.1	14.6	3.84	0.0	461.0	
	-51.160	0.0	-0.024	0.016	-27.9	11.7	2.61	0.0	470.0	
	-52.160	0.0	-0.021	0.033	-17.7	8.9	1.65	0.0	479.0	
	-53.160	0.0	-0.017	0.044	-10.0	6.5	0.93	0.0	488.0	
	-54.160	0.0	-0.013	0.049	-4.4	4.7	0.41	0.0	497.0	
	-54.416	0.0	-0.011	0.050	-3.2	4.3	0.30	0.0	818.0	
	-55.160	0.0	-0.008	0.051	-1.0	1.9	0.09	0.0	852.4	
	-56.160	0.0	-0.003	0.052	0.0	0.2	0.00	0.0	898.6	
	-56.660	0.0	0.000	0.052	0.0	0.0	0.00	0.0	921.7	

*showing plastic

bending moment at support of footing concrete is reduced value

(12)perpendicular direction 6 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.204	7.562	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.826	7.562	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.826	7.562	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.448	7.562	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.309	7.564	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.066	7.575	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.445	7.589	-46.1	-45.7	4.32	0.0	0.0	
442.0										
	+1.340	30.2	1.445	7.589	-46.1	396.3	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.569	148.0	379.9	13.86	0.0	0.0	
	-0.160	45.2	2.570	7.310	508.7	339.7	47.62	0.0	0.0	
	-1.160	55.2	3.277	6.787	824.2	289.6	77.15	0.0	0.0	
	-1.660	60.1	3.608	6.438	961.9	260.8	90.04	0.0	0.0	
71.1										
	-1.660	60.1	3.608	6.438	961.9	331.9	90.04	0.0	0.0	
	-2.160	65.1	3.920	6.032	1120.1	300.5	104.84	0.0	0.0	
	-3.160	75.1	4.476	5.050	1386.4	230.4	129.77	0.0	0.0	
	-4.160	85.1	4.924	3.888	1577.6	150.3	147.67	0.0	0.0	
	-4.660	90.1	5.103	3.260	1641.9	106.5	153.69	0.0	0.0	
0.0										
	-4.660	90.1	5.103	3.260	1641.9	106.5	153.69	0.0	0.0	
	-5.160	95.1	5.250	2.611	1683.7	60.2	157.60	0.0	0.0	
	-5.160	95.1	5.250	2.611	1683.7	60.2	138.60	0.0	0.0	
	-5.346	59.3	5.296	2.395	1693.3	42.4	139.38	0.0	0.0	
	-6.160	68.0	5.452	1.444	1707.2	-9.5	140.52	0.0	0.0	
	-6.350	548356.3	5.478	1.221	1704.1	-22.6	140.27	0.0	0.0	
	-7.160	554458.2	5.539	0.281	1699.1	7.7	139.86	0.0	0.0	
	-7.416	554854.3	5.542	-0.016	1683.1	-133.3	138.55	0.0	0.0	
	-8.160	551736.9	5.510	-0.839	1531.4	-289.9	126.06	0.0	0.0	
	-9.160	538509.7	5.377	-1.782	1239.7	-306.3	102.05	0.0	0.0	
	-10.160	516641.3	5.160	-2.503	864.7	-412.6	71.17	0.0	0.0	
	-10.350	160.4	5.112	-2.610	776.3	-516.2	63.90	0.0	0.0	
	-11.160	170.7	4.886	-2.915	444.1	-650.4	36.56	0.0	0.0	
	-11.350	173.2	4.831	-2.947	390.7	-683.0	32.16	0.0	0.0	

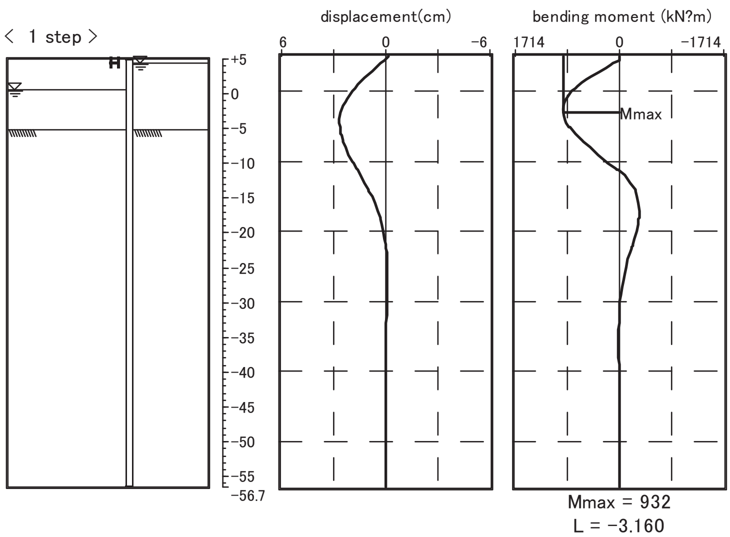
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
852.1										
	-11.350	173.2	4.831	-2.947	390.7	169.0	32.16	0.0	0.0	
	-11.416	171.0	4.811	-2.955	374.3	157.6	30.81	0.0	0.0	
	-12.160	180.0	4.587	-3.073	265.2	27.0	21.83	0.0	0.0	
	-12.850	188.3	4.371	-3.192	232.6	-100.0	19.15	0.0	0.0	
	-12.850	174.2	4.371	-3.192	232.6	-100.0	19.15	137.5	137.5	*
	-13.160	173.4	4.271	-3.238	200.0	-109.8	16.47	146.8	146.8	*
	-14.160	171.1	3.942	-3.336	82.2	-120.4	6.77	176.7	176.7	*
	-14.350	170.7	3.878	-3.345	59.5	-118.8	4.90	182.3	182.3	*
	-14.596	170.1	3.796	-3.353	30.7	-114.9	2.53	189.7	189.7	*
	-14.596	170.1	3.796	-3.353	30.7	-114.9	2.53	189.7	189.7	
	-15.160	168.8	3.607	-3.352	-31.4	-106.2	2.59	180.3	206.5	
	-16.160	166.5	3.274	-3.295	-134.3	-101.9	11.05	163.6	236.4	
	-17.160	164.2	2.950	-3.167	-240.0	-111.8	19.76	147.4	266.3	
	-18.160	161.9	2.643	-2.962	-362.5	-135.2	29.84	132.1	296.2	
	-18.416	73.9	2.568	-2.895	-398.1	-143.2	32.77	155.5	163.6	
	-19.160	71.9	2.361	-2.669	-483.1	-86.5	39.76	142.9	168.1	
	-20.160	69.2	2.111	-2.315	-536.3	-21.9	44.14	127.8	174.1	
	-21.160	66.5	1.898	-1.946	-530.6	31.4	43.68	114.9	180.2	
	-22.160	63.8	1.721	-1.598	-476.4	75.7	39.21	104.2	186.2	
	-22.416	79.2	1.681	-1.517	-455.7	85.8	37.51	79.2	140.6	
	-22.660	78.6	1.645	-1.442	-434.8	85.7	35.79	77.5	141.7	
	-22.660	78.6	1.645	-1.442	-434.8	85.7	40.70	77.5	141.7	
	-23.160	77.3	1.577	-1.281	-392.2	84.6	36.71	74.3	143.9	
	-24.160	74.8	1.463	-1.007	-309.6	80.1	28.98	68.9	148.4	
	-25.160	72.3	1.374	-0.796	-232.7	73.3	21.78	64.7	152.9	
	-26.160	69.7	1.302	-0.642	-163.3	65.3	15.29	61.3	157.4	
	-27.160	67.2	1.244	-0.539	-102.3	56.7	9.58	58.6	161.9	
	-28.160	64.7	1.193	-0.481	-49.9	48.1	4.67	56.2	166.3	
	-29.160	62.2	1.146	-0.459	-6.0	39.8	0.56	54.0	170.8	
	-30.160	59.7	1.100	-0.469	29.7	31.8	2.78	51.8	175.3	
	-31.160	57.1	1.052	-0.504	57.6	24.0	5.39	49.5	179.8	
	-32.160	54.6	0.999	-0.557	77.9	16.5	7.29	47.0	184.3	
	-33.160	52.1	0.940	-0.623	90.5	8.8	8.47	44.3	188.7	
	-34.160	49.6	0.874	-0.696	95.3	0.7	8.92	41.2	193.2	
	-35.160	47.1	0.801	-0.770	91.7	-8.2	8.58	37.7	197.7	

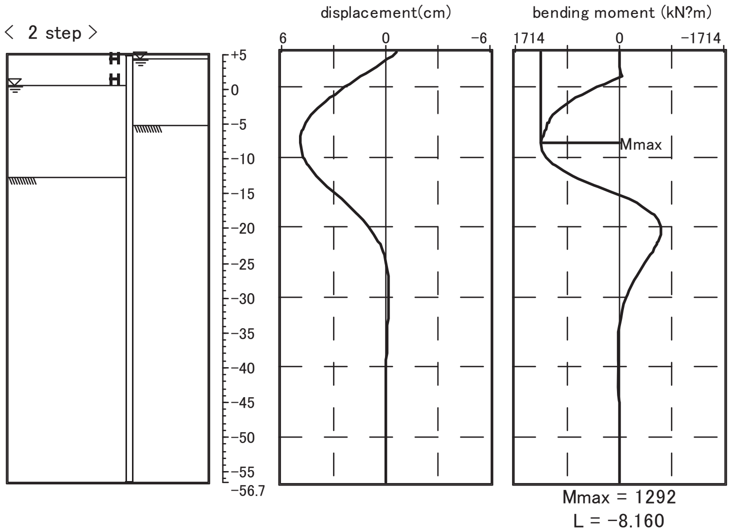
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	44.5	0.720	-0.837	78.6	-18.1	7.36	33.9	202.2	
	-37.160	42.0	0.634	-0.890	55.0	-29.5	5.14	29.8	206.7	
	-38.160	39.5	0.543	-0.919	19.1	-42.5	1.79	25.6	211.1	
	-38.370	39.0	0.524	-0.922	9.9	-45.5	0.92	24.7	212.1	
	-39.160	37.0	0.451	-0.916	-30.7	-57.3	2.87	21.2	215.6	
	-39.416	27.4	0.428	-0.908	-45.9	-61.4	4.30	51.8	408.8	
	-40.160	23.4	0.361	-0.869	-85.2	-44.8	7.98	43.8	411.5	
	-40.625	20.9	0.322	-0.835	-104.0	-35.9	9.73	39.0	413.2	
	-41.160	18.0	0.278	-0.788	-120.7	-26.9	11.30	33.7	415.1	
	-42.160	12.6	0.204	-0.685	-140.4	-13.1	13.14	24.8	418.7	
	-43.160	7.2	0.142	-0.572	-147.8	-2.2	13.84	17.1	422.3	
	-44.160	1.8	0.090	-0.457	-145.2	7.2	13.59	10.9	425.9	
	-44.495	0.0	0.075	-0.420	-142.3	10.3	13.32	9.1	427.1	
	-45.160	0.0	0.050	-0.348	-133.7	15.3	12.51	6.0	429.5	
	-46.160	0.0	0.020	-0.250	-116.0	19.4	10.86	2.4	433.1	
	-47.160	0.0	-0.001	-0.168	-95.8	20.5	8.97	0.0	436.7	
	-47.656	0.0	-0.008	-0.132	-85.7	20.3	8.02	0.0	438.5	
	-48.160	0.0	-0.014	-0.101	-75.6	19.6	7.08	0.0	443.0	
	-49.160	0.0	-0.021	-0.049	-57.1	17.4	5.34	0.0	452.0	
	-50.160	0.0	-0.024	-0.011	-41.0	14.6	3.84	0.0	461.0	
	-51.160	0.0	-0.024	0.016	-27.9	11.7	2.61	0.0	470.0	
	-52.160	0.0	-0.021	0.033	-17.7	8.9	1.65	0.0	479.0	
	-53.160	0.0	-0.017	0.044	-10.0	6.5	0.93	0.0	488.0	
	-54.160	0.0	-0.013	0.049	-4.4	4.7	0.41	0.0	497.0	
	-54.416	0.0	-0.011	0.050	-3.2	4.3	0.30	0.0	818.0	
	-55.160	0.0	-0.008	0.051	-1.0	1.9	0.09	0.0	852.4	
	-56.160	0.0	-0.003	0.052	0.0	0.2	0.00	0.0	898.6	
	-56.660	0.0	0.000	0.052	0.0	0.0	0.00	0.0	921.7	

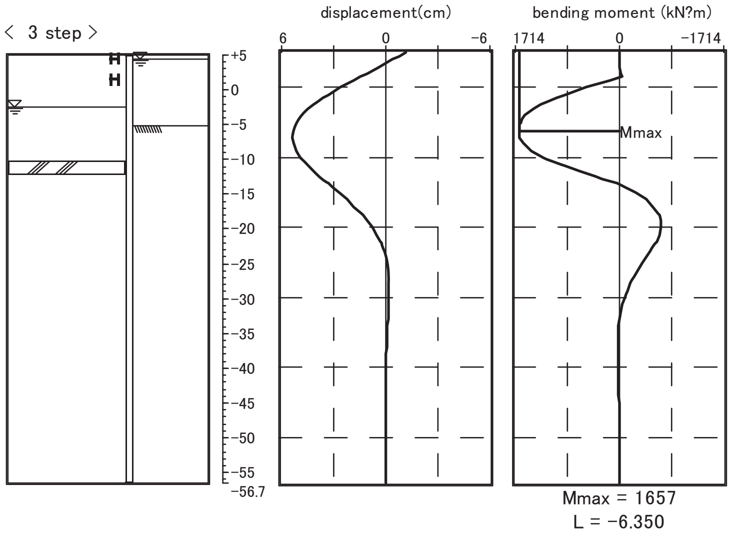
*showing plastic
bending moment at support of footing concrete is reduced value

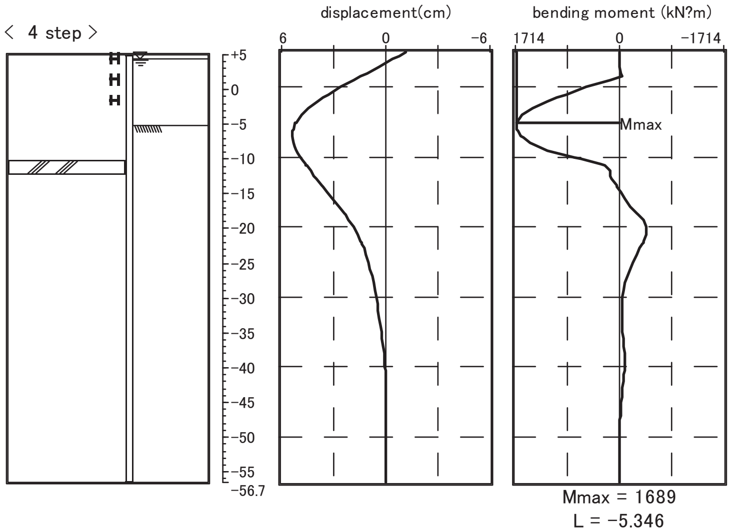
2.11 displacement / member force diagram

bridge axis direction

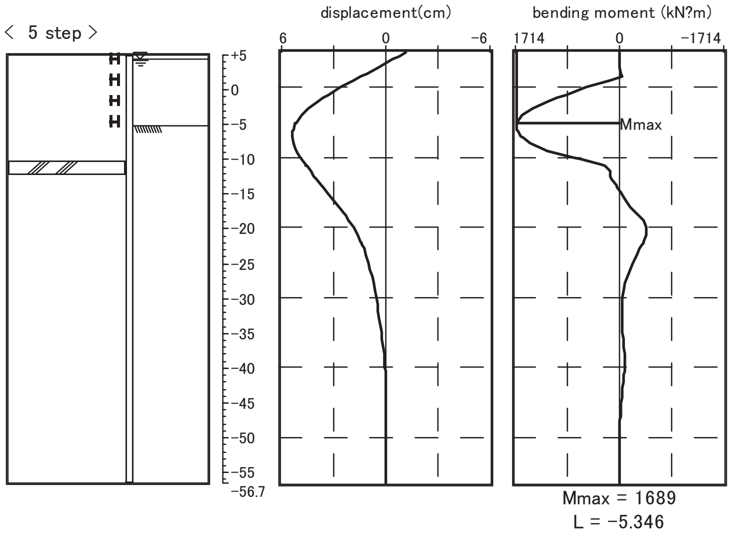



< 2 step >
displacement(cm)
bending moment (kN?m)
6
0
−6
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
Mmax
Mmax = 1292
L = −8.160

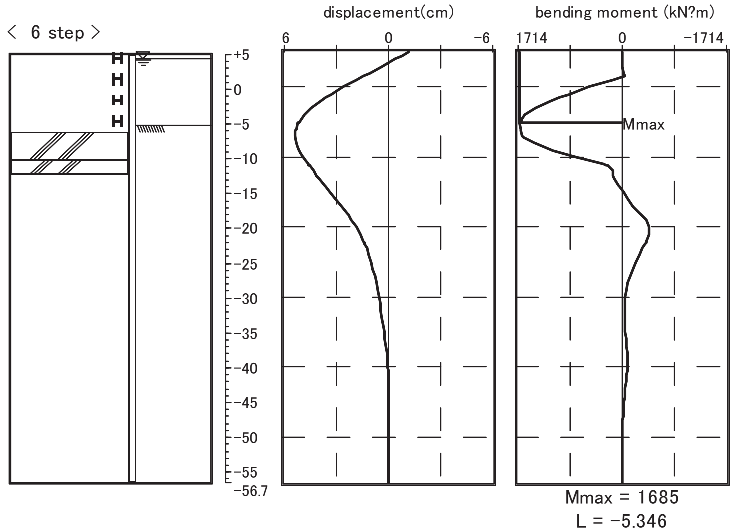

< 3 step >
displacement(cm)
bending moment (kN?m)
6
0
−6
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
Mmax
Mmax = 1657
L = −6.350



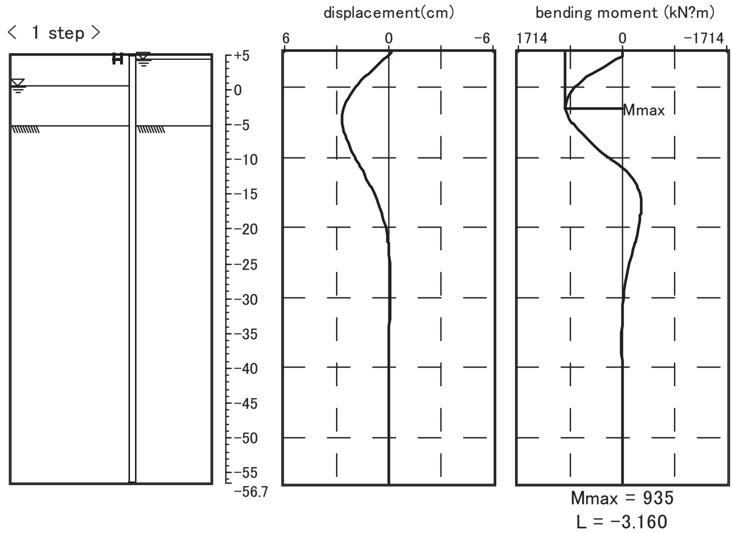
< 4 step >
displacement(cm)
6
0
-6
bending moment (kN?m)
1714
0
-1714
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-56.7
Mmax
Mmax = 1689
L = -5.346

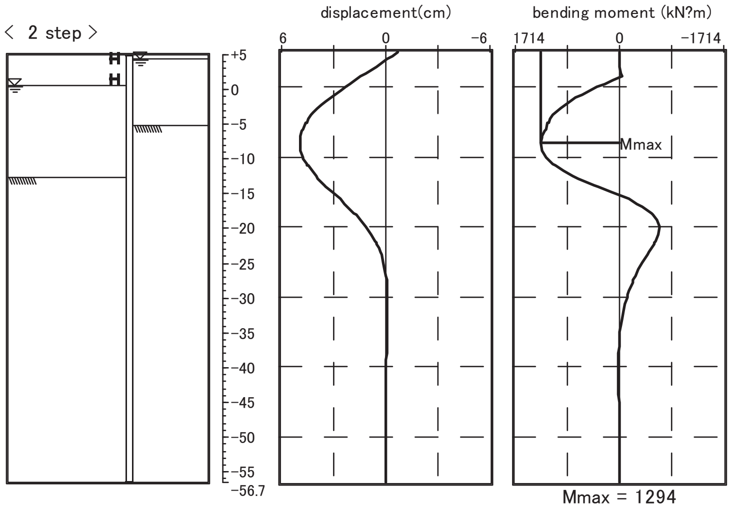


< 5 step >
displacement(cm)
6
0
-6
bending moment (kN?m)
1714
0
-1714
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-56.7
Mmax
Mmax = 1689
L = -5.346

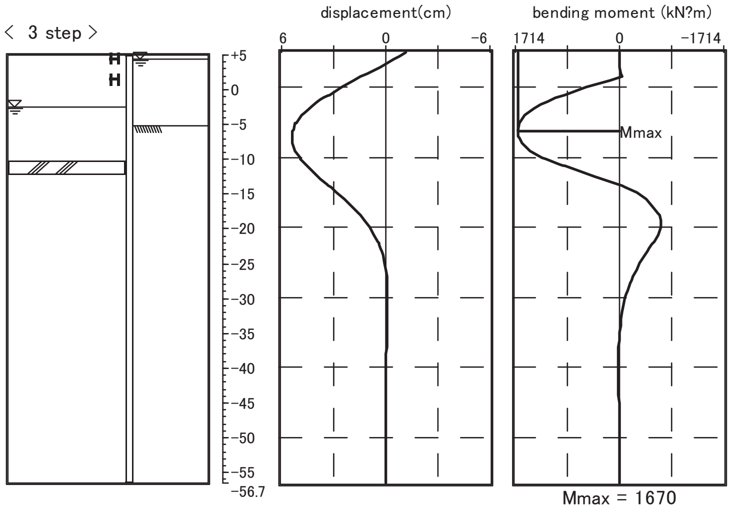


perpendicular direction

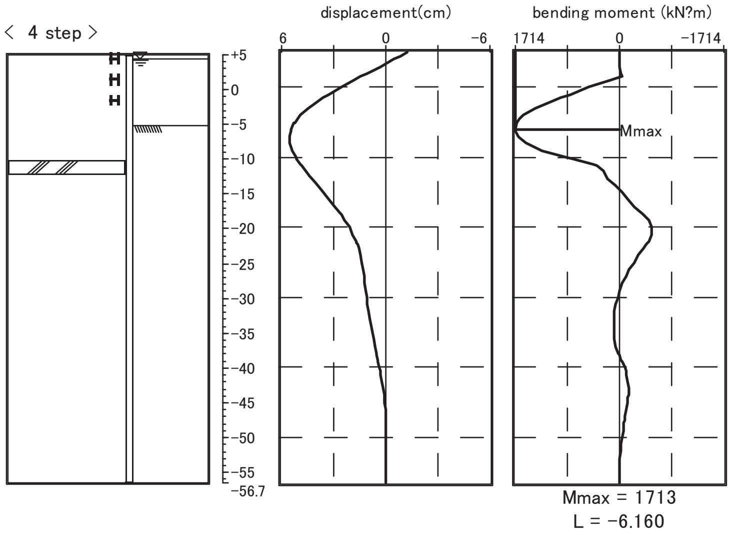


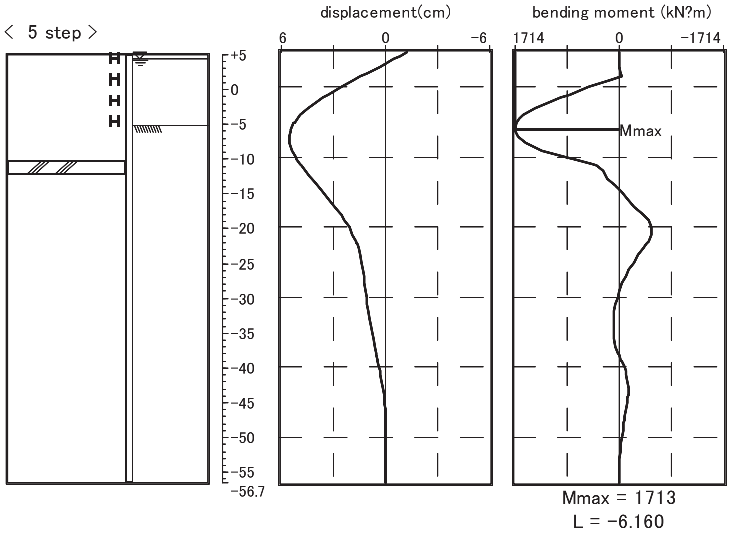


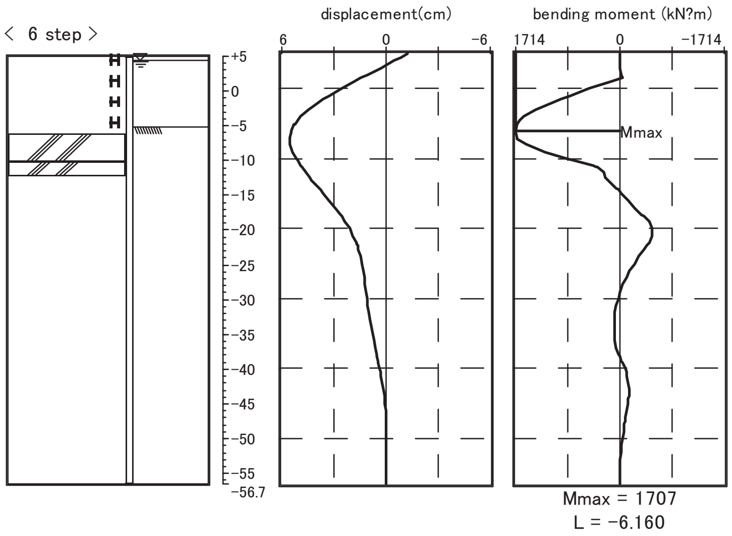
Mmax = 1294
L = −8.160



Mmax = 1670
L = −6.350


< 4 step >
displacement(cm)
bending moment (kN?m)
6
0
-6
1714
0
-1714
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-56.7
Mmax
Mmax = 1713
L = -6.160


< 5 step >
displacement(cm)
bending moment (kN?m)
6
0
-6
1714
0
-1714
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-56.7
Mmax
Mmax = 1713
L = -6.160



2.12 check timbering

(1) section performance

1)bridge axis direction (linear)

**wailing

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

2)perpendicular direction (arc)

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

(2) maximum timbering reaction Rmax (kN/m)

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
1	H-350*350*12*19	209.37	H-350*350*12*19	209.71
2	2H-350*350*12*19	234.18	2H-350*350*12*19	234.99

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
3	H-300*300*10*15	26.12	H-300*300*10*15	74.56
4	H-300*300*10*15	0.00	H-300*300*10*15	0.00

note)double timbering is 1/2 value

(3)arc part

1)check of ring buckling

about buckling of arc wailing, following equation to calculate allowable timbering reaction in considertaion of ring buckling safety is checked

$$Ra = \frac{2*E*Iy}{r^3} >= R1max$$

where, Ra : allowable timbering reaction (N/mm)

E : Young's modulus of wailing = 2.00 * 10^5(N/mm^2)

Iy : moment of inertia of wailing(mm^4)

r : radius of circular timbering (mm)

R1max : maximum timbering reaction (N/mm) ------ perpendicular direction(arc part)

row	section	r (cm)	Iy (cm^4)	Ra (kN/m)	R1max (kN/m)	judge
1	H-350*350*12*19	289.25	39800	6578.22	209.71	OK
2	2H-350*350*12*19	289.25	39800	6578.22	234.99	OK
3	H-300*300*10*15	291.75	20200	3253.60	74.56	OK
4	H-300*300*10*15	291.75	20200	3253.60	0.00	OK

2)wailing stress check

arc wailing may be calculated as an axial compression member under uniformly distributed pressure

Acutually, irregular shape of timbering and precision to cast steel pipe sheet pile (actual observation, radius in oval part about 1 to 2%), because imbalanced pressure induced moment is observed,

for safety, following procedure is taken to consider influence of ovalization in principle

stress working at wailing is given by the following equation.

$$Sig.s = \frac{N}{A} + \frac{M1 + M2}{Z} <= Sig.sa$$

where, Sig.s : stress of wailing(N/mm^2)

Sig.sa : allowable stress of wailing (N/mm^2)

A : sectional area of wailing (mm^2)

Z : section coefficient of wailing (mm^3)

N : axial force (N) = R1max * r

R1max : maximum timbering reaction (N/mm)

r : radius of wailing (mm)

M1 : bending moment in consideration of ovalization (N.mm) = R1max * r^2* Del.

Del. : ovalization rate, 2% wailing radius is supposed to be standard.

M2 : support point bending moment in linear part (N.mm) = (R2max.L1^2) / 12

R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)

L1 : effective span in linear part of wailing (mm)

row	section	A (cm^2)	Z (cm^3)	R1max (kN/m)	R2max (kN/m)	r (cm)
1	H-350*350*12*19	171.90	2280	209.71	209.37	289.25
2	2H-350*350*12*19	171.90	2280	234.99	234.18	289.25
3	H-300*300*10*15	118.40	1350	74.56	26.12	291.75
4	H-300*300*10*15	118.40	1350	0.00	0.00	291.75

row	L1 (m)	N (kN)	M1 (kN.m)	M2 (kN.m)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	judge
1	2.700	606.6	35.1	127.2	106.46	210.00	OK
2	2.700	679.7	39.3	142.3	119.18	210.00	OK
3	2.700	217.5	12.7	15.9	39.53	210.00	OK
4	2.700	0.0	0.0	0.0	0.00	210.00	OK

(4)linear part

1)check of wailing

wailing in linear part is a member which receives both axial compressive force and bending moment together are supposed to be checked using the following equation

besides, as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy * \left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0 \quad \text{--- check1}$$

$$Sig.c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} <= Sig.cal \quad \text{--- check2}$$

where, Sig.c : compressive stress by axial force acting on check section (N/mm^2)

Sig.bcy : bending compressive stress by bending moment about strong axis (N/mm^2)

Sig.caz : about weak axis allowable axial direction compressive stress (N/mm^2)

$$\frac{L5}{rz} <= 18 : Sig.caz = 210.0$$

$$18 < \frac{L5}{rz} <= 92 : Sig.caz = 1.5*\left\{ 140.0 - 0.82\left(\frac{L5}{rz} - 18\right) \right\}$$

$$92 < \frac{L5}{rz} \quad : Sig.caz = \frac{1.5*1,200,000}{6700 + \left(\frac{L5}{rz}\right)^2}$$

L5 : about weak axis effective buckling length (mm)

rz : about weak axis section second radius (mm)

Sig.bagy : without considering local tbuckling, allowable bending compressive stress about strong axis (N/mm^2)

$$\frac{L2}{b} <= 4.5 \quad : Sig.bagy = 210.0$$

$$4.5 < \frac{L2}{b} <= 30 \quad : Sig.bagy = 1.5*\left\{ 140.0 - 2.4\left(\frac{L2}{b} - 4.5 \right) \right\}$$

L2 : distance between fixed flange (mm)

b : compressive flange width (mm)

Sig.cal : allowable stress for local buckling of protrusion under compressive force (N/mm^2)

(= 210.0 (N/mm^2))

Sig.eay : Euler buckling stress about strong axis(N/mm^2) = $\frac{1,200,000}{\left(\frac{L4}{ry}\right)^2}$

L4 : effective buckling length about strong axis (mm)

ry : section second radius about strong axis (mm)

a)stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0$$

$$N = R1max*r + Del.N$$

$$M = \frac{R2max*L1^2}{8}$$

$$sc = \frac{N}{A}, \qquad sbcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \qquad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, R1max : maximum timbering reaction (N/mm) perpendicular direction(arc part)

R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)

N : axial force (N)

L : maximum strut spacing (mm)

L' : brace setting length (mm)

L1 : effective buckling length (mm) = L - L'

L2 : distance between fixed flange (mm)

L4 : effective buckling length about strong axis (mm)

L5 : effective buckling length about weak axis (mm)

row	section	A (cm^2)	Z (cm^3)	r (cm)	L (m)	L' (m)	L1 (m)	L2 (m)	L4 (m)	L5 (m)
1	H-350*350*12*19	171.90	2280	289.25	4.000	1.300	2.700	2.700	2.700	2.700
2	2H-350*350*12*19	171.90	2280	289.25	4.000	1.300	2.700	2.700	2.700	2.700
3	H-300*300*10*15	118.40	1350	291.75	4.000	1.300	2.700	2.700	2.700	2.700
4	H-300*300*10*15	118.40	1350	291.75	4.000	1.300	2.700	2.700	2.700	2.700

row	L5/rz	Sig.caz (N/mm²)	L2/b	Sig.bagy (N/mm²)	L4/ry (m)	Sig.eay (N/mm²)
1	30.37	194.78	7.71	198.43	17.76	3803.13
2	30.37	194.78	7.71	198.43	17.76	3803.13
3	35.76	188.15	9.00	193.80	20.61	2824.86
4	35.76	188.15	9.00	193.80	20.61	2824.86

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	209.71	209.37	756.59	190.79	44.01	83.68
2	234.99	234.18	829.72	213.39	48.27	93.59
3	74.56	26.12	367.52	23.80	31.04	17.63
4	0.00	0.00	150.00	0.00	12.67	0.00

row	Alp.	Beta	Alp.+Beta	judgement
1	0.226	0.427	0.653	OK
2	0.248	0.478	0.726	OK
3	0.165	0.092	0.257	OK
4	0.067	0.000	0.067	OK

b)stability check2

$$\text{Sig..c} + \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}} \le \text{Sig.cal}$$

$$\text{Gam.} = \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	44.01	83.68	3803.13	84.66	128.67	210.00	OK
2	48.27	93.59	3803.13	94.80	143.06	210.00	OK
3	31.04	17.63	2824.86	17.82	48.87	210.00	OK
4	12.67	0.00	2824.86	0.00	12.67	210.00	OK

c) check of shear stress

$$\text{Smax} = \frac{\text{R2max*L1}}{2}$$

$$\text{Tau.s} = \frac{\text{Smax}}{\text{Aw}} \le \text{Tau.sa}$$

where, Smax : maximum shear force (N)
Aw : web sectional area (mm^2)
Tau.s : accrue shear stress (N/mm^2)
Tau.sa : allowable shear stress (N/mm^2)

row	R2max (kN/m)	L1 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	209.37	2.700	282.65	37.44	75.49	120.00	OK
2	234.18	2.700	316.14	37.44	84.44	120.00	OK
3	26.12	2.700	35.26	27.00	13.06	120.00	OK
4	0.00	2.700	0.00	27.00	0.00	120.00	OK

2) check of strut

strut is a member which receives both axial compression force and bending moment with wailing likewise check. vertical load working at strut is sume of strut dead weight+surcharge load (w = 5.0 kN/m) as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

a) stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0$$

$$N = R2max*L1 + Del.N$$

$$M = \frac{w*L3^2}{8}$$

$$Sig.c = \frac{N}{A}, \quad Sig.bcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \quad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, L1 : axial force sharing width of strut (mm)
L2 : distance between fixed flange (mm)
L3 : strut bending span (mm)
L4 : effective buckling length about strong axis (mm)
L5 : effective buckling length about weak axis (mm)

row	section	A (cm2)	Z (cm3)	L1 (m)	L2 (m)	L3 (m)	L4 (m)	L5 (m)
1	H-350*350*12*19	171.90	2280	4.000	2.835	5.435	5.435	2.835
2	2H-350*350*12*19	171.90	2280	4.000	2.835	5.435	5.435	2.835
3	H-300*300*10*15	118.40	1350	4.000	2.935	5.535	5.535	2.935
4	H-300*300*10*15	118.40	1350	4.000	2.935	5.535	5.535	2.935

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	31.89	192.92	8.10	197.04	35.76	938.58
2	31.89	192.92	8.10	197.04	35.76	938.58

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
3	38.87	184.32	9.78	190.98	42.25	672.18
4	38.87	184.32	9.78	190.98	42.25	672.18

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	209.71	209.37	987.48	18.46	57.45	8.10
2	234.99	234.18	1086.71	18.46	63.22	8.10
3	74.56	26.12	254.46	19.15	21.49	14.18
4	0.00	0.00	150.00	19.15	12.67	14.18

row	Alp.	Beta	Alp.+Beta	judgement
1	0.298	0.044	0.342	OK
2	0.328	0.044	0.372	OK
3	0.117	0.077	0.193	OK
4	0.069	0.076	0.144	OK

b)stability check2

$$Sig..c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} <= Sig.cal$$

$$Gam. = \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	57.45	8.10	938.58	8.63	66.07	210.00	OK
2	63.22	8.10	938.58	8.68	71.90	210.00	OK
3	21.49	14.18	672.18	14.65	36.14	210.00	OK
4	12.67	14.18	672.18	14.46	27.12	210.00	OK

c) check of shear stress

$$Smax = \frac{5.0*L3}{2}$$

$$Tau.s = \frac{Smax}{Aw} <= Tau.sa$$

row	L3 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	5.435	13.59	37.44	3.63	120.00	OK
2	5.435	13.59	37.44	3.63	120.00	OK
3	5.535	13.84	27.00	5.13	120.00	OK
4	5.535	13.84	27.00	5.13	120.00	OK

3)check of brace beam

brace beam is a member which receives only axial compression force from wailing and use the following equation are supposed to be checked

$$Sig.c = \frac{N}{A} <= Sig.caz$$

$$N = \frac{(L1 + L2)*R2max}{2*cosTheta}$$

where, L : brace length (mm)

L1 : brace setting length (mm)

L2 : strut spacing - 2 * brace span (mm)

Theta : brace setting angle (Deg.)

row	section	A (cm2)	Theta (Deg.)	L (m)	L1 (m)	L2 (m)
1	H-350*350*12*19	171.90	45.0	1.838	1.300	1.400
2	2H-350*350*12*19	171.90	45.0	1.838	1.300	1.400
3	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400
4	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400

row	L/rz	R2max (kN/m)	N (kN)	Sig.c (N/mm2)	Sig.caz (N/mm2)	judgement
1	20.68	209.37	399.73	23.25	206.70	OK
2	20.68	234.18	447.09	26.01	206.70	OK
3	24.35	26.12	49.86	4.21	202.19	OK
4	24.35	0.00	0.00	0.00	202.19	OK

2.13 check of embedment length

current ground surface elevation -5.346 (m)
riverside water table elevation +4.340 (m)
steel pipe sheet pile length 61.500 (m)

(1)final excavation time (5 step)
observing strut elevation = -4.660 (m)
coffered landside excavation area elevation = -12.850 (m)
coffered landside water table elevation = -12.850 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	-4.660 -5.346	0.686	------- -------	0.00 0.00	90.00 96.86
2	-5.346 -7.416	2.070	------- -------	0.00 0.00	96.86 117.56
3	-7.416 -11.416	4.000	------- -------	5.61 17.88	117.56 157.56
4	-11.416 -12.850	1.434	------- -------	14.60 17.98	157.56 171.90
5	-12.850 -18.416	5.566	0.00 151.04	17.98 31.11	171.90 89.10
6	-18.416 -18.746	0.330	152.53 155.00	0.00 0.00	89.10 84.19
7	-18.746 -22.416	3.670	155.00 182.53	0.00 27.53	84.19 29.59
8	-22.416 -24.405	1.989	158.53 173.45	51.52 66.44	29.59 0.00

active earth pressure /water pressure Pa = 2440.5 (kN/m)
ya = 8.932 (m)
Ma = 21797 (kN.m/m)
passive earth pressure Pp = 1420.7 (kN/m)
yp = 15.343 (m)
Mp = 21797 (kN.m/m)
balanced depth Z = 11.555 (m) (elevation = -24.405 (m))
embedment length D = 13.866 (m) (elevation = -26.716 (m))

required sheet pile length L = 31.556 (m)

(2)before installation of the lower strut (4 step)
observing strut elevation = -1.660 (m)
coffered landside excavation area elevation = -12.850 (m)
coffered landside water table elevation = -12.850 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	-1.660 -5.346	3.686	------- -------	0.00 0.00	60.00 96.86
2	-5.346 -7.416	2.070	------- -------	0.00 0.00	96.86 117.56
3	-7.416 -11.416	4.000	------- -------	5.61 17.88	117.56 157.56
4	-11.416 -12.850	1.434	------- -------	14.60 17.98	157.56 171.90
5	-12.850 -18.416	5.566	0.00 151.04	17.98 31.11	171.90 109.52
6	-18.416 -18.746	0.330	152.53 155.00	0.00 0.00	109.52 105.82
7	-18.746 -22.416	3.670	155.00 182.53	0.00 27.53	105.82 64.69
8	-22.416 -28.188	5.772	158.53 201.82	51.52 94.82	64.69 0.00

active earth pressure /water pressure Pa = 3295.6 (kN/m)
ya = 13.224 (m)
Ma = 43580 (kN.m/m)
passive earth pressure Pp = 2130.5 (kN/m)
yp = 20.456 (m)
Mp = 43580 (kN.m/m)
balanced depth Z = 15.338 (m) (elevation = -28.188 (m))
embedment length D = 18.406 (m) (elevation = -31.256 (m))
required sheet pile length L = 36.096 (m)

3 composite stress calculation

3.1 maximum stress table

(1)bridge axis direction

1) material :SKY400

Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Oridinary(high tide)	-10.350	29.25	53.58	82.82	140.00
2	Oridinary(low tide)	-10.350	30.37	53.58	83.94	140.00
3	Ord+Temp(high tide)	-10.350	30.54	53.58	84.12	161.00
4	Ord+Temp(low tide)	-10.350	31.66	53.58	85.24	161.00
5	Wind+Temp	-10.350	30.71	53.58	84.29	189.00
6	Ord+Collision	-10.350	43.82	53.58	97.39	210.00
7	Earthquake	-10.350	81.50	53.58	135.07	210.00

(2)perpendicular direction

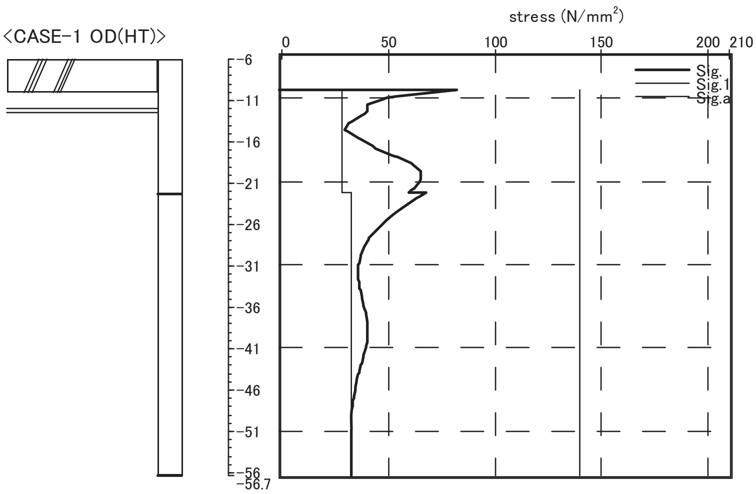
1) material :SKY400

Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Oridinary(high tide)	-10.350	29.90	63.08	92.99	140.00
2	Oridinary(low tide)	-10.350	31.02	63.08	94.11	140.00
3	Wind	-10.350	34.95	63.08	98.03	175.00
4	Ord+Collision	-10.350	52.43	63.08	115.52	210.00
5	Earthquake	-10.350	84.61	63.08	147.69	210.00

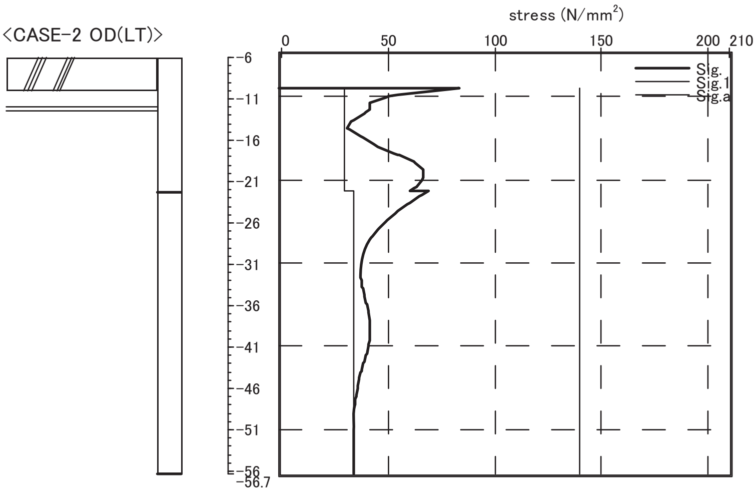
occurence location shows elevation
Sig.1 : stress after completion by design external force
Sig.2 : resultant stress(5 step)
Sig.max: composite stress
Sig.a : allowabe stress of steel pipe sheet pile

3.2 stress distribution diagram

(1)bridge axis direction



<CASE-2 OD(LT)>



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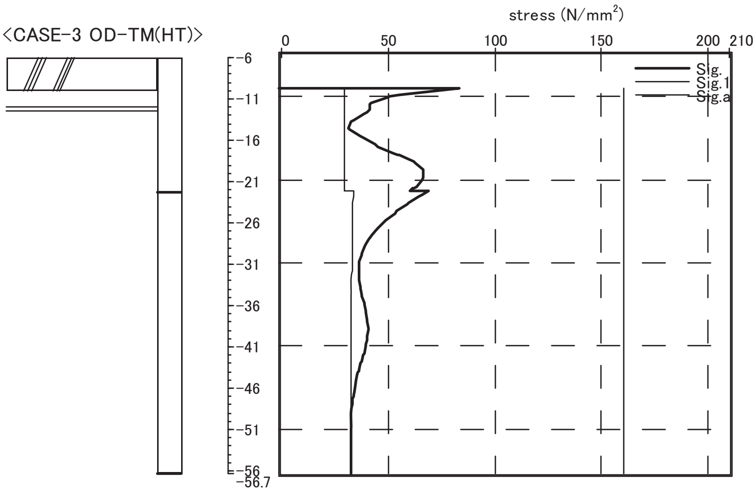
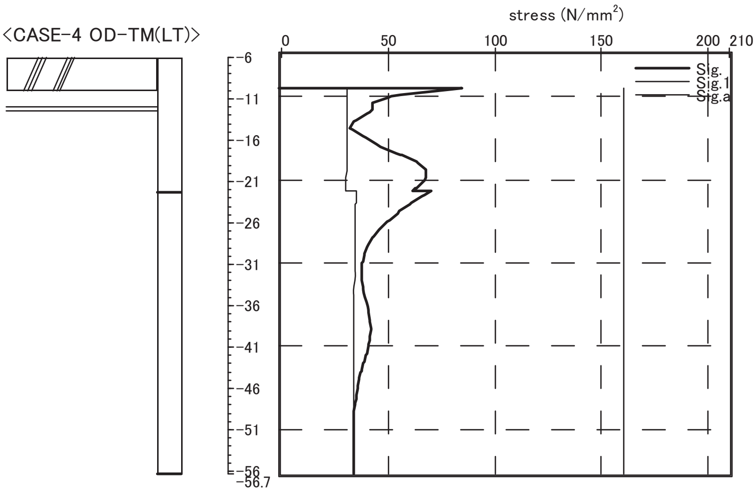
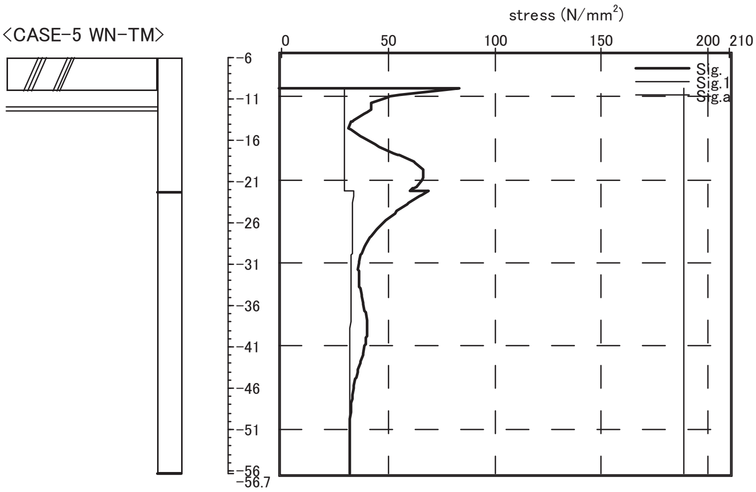
<CASE-3 OD-TM(HT)>



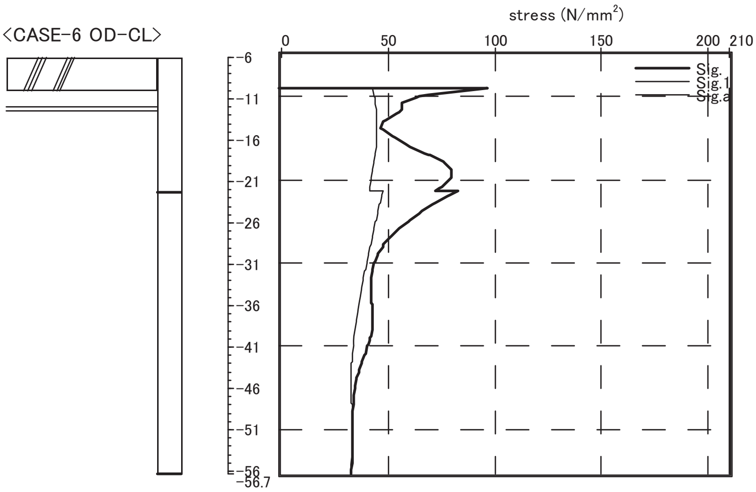
<CASE-4 OD-TM(LT)>



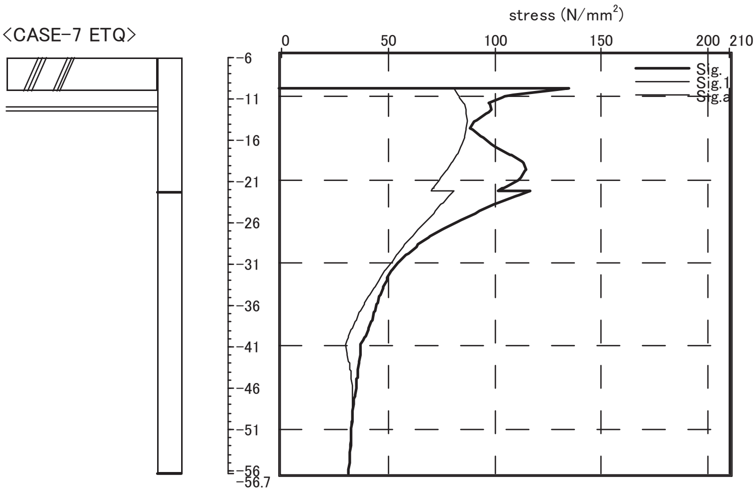
<CASE-5 WN-TM>



<CASE-6 OD-CL>

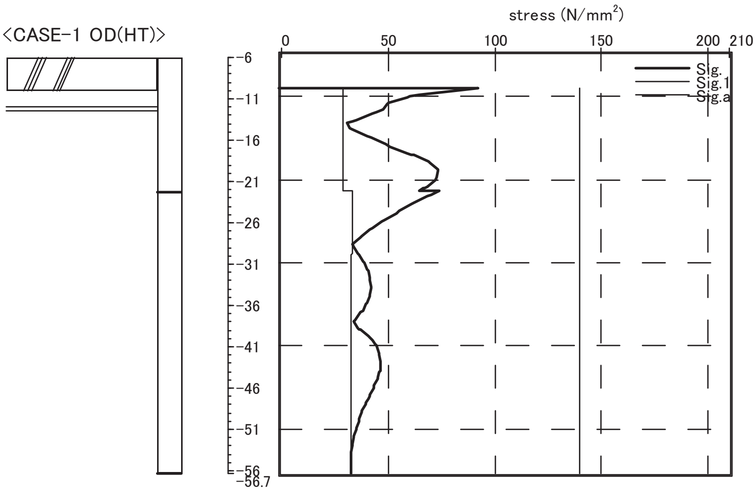


<CASE-7 ETQ>

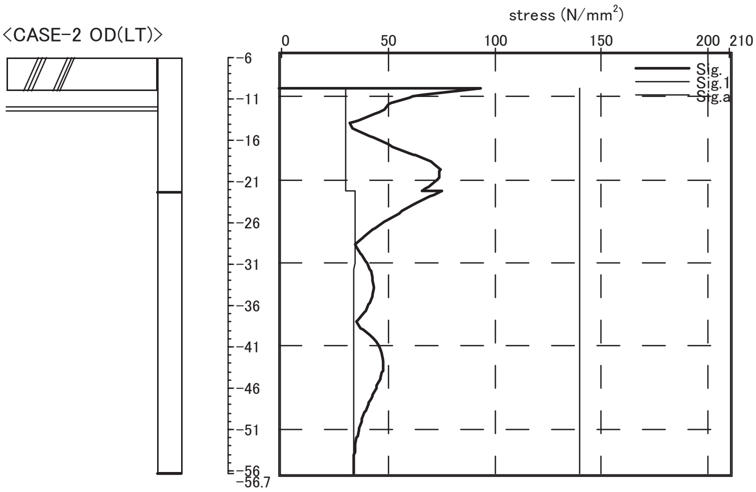


(2)perpendicular direction

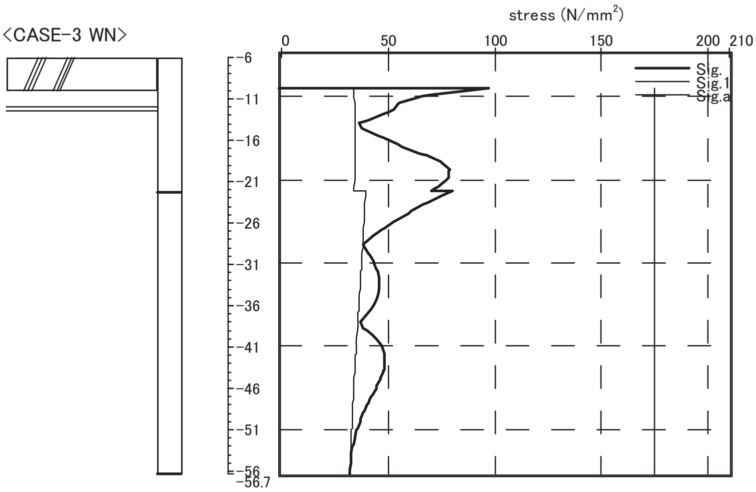
<CASE-1 OD(HT)>



<CASE-2 OD(LT)>



<CASE-3 WN>



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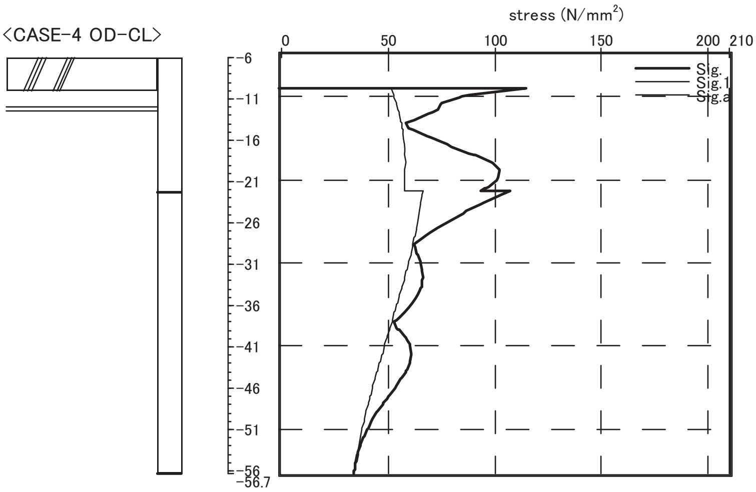

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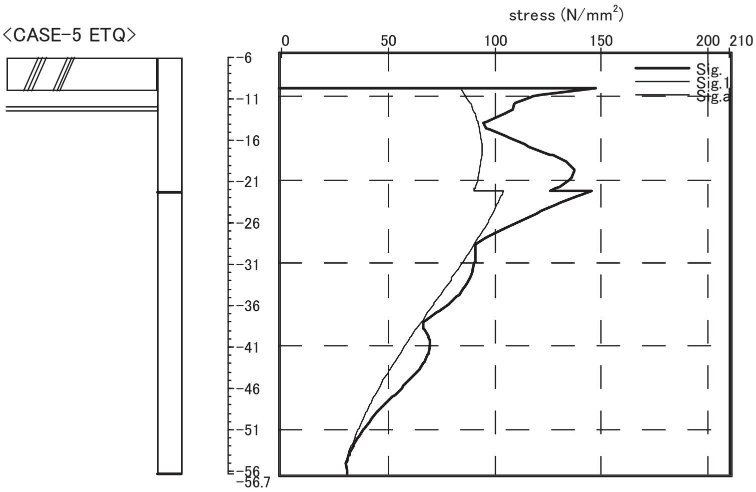

3.3 detail output

(1)bridge axis direction

1)Oridinary(high tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	29.25	53.58	82.82	**
-11.160	29.25	25.24	54.49	
-11.350	29.25	20.91	50.16	
-11.416	29.25	19.61	48.86	
-12.160	29.25	12.13	41.37	
-12.350	29.25	12.08	41.33	
-12.850	29.25	11.96	41.21	
-13.160	29.25	10.42	39.66	
-13.350	29.25	9.27	38.51	
-14.160	29.25	4.37	33.62	
-14.350	29.25	3.20	32.44	
-14.361	29.25	3.13	32.38	
-15.160	29.25	1.53	30.78	
-15.350	29.25	2.64	31.88	
-16.160	29.25	7.34	36.59	
-16.350	29.25	8.63	37.88	
-17.160	29.25	14.14	43.39	
-17.350	29.25	15.83	45.07	
-18.160	29.25	23.01	52.26	
-18.350	29.25	25.04	54.28	
-18.416	29.25	25.74	54.99	
-19.160	29.25	32.39	61.63	
-19.350	29.25	33.23	62.48	
-20.160	29.25	36.83	66.07	
-20.350	29.25	36.86	66.10	
-21.160	29.25	36.98	66.23	
-21.350	29.25	36.34	65.59	
-22.160	29.25	33.64	62.89	
-22.350	29.25	32.65	61.89	
-22.416	29.25	32.30	61.55	
-22.660	29.25	30.95	60.19	
-22.660	33.53	35.19	68.72	
-23.160	33.53	32.05	65.58	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-23.350	33.53	30.91	64.43	
-24.160	33.53	26.02	59.55	
-24.350	33.53	24.98	58.51	
-25.160	33.53	20.53	54.05	
-25.350	33.53	19.62	53.14	
-26.160	33.53	15.73	49.26	
-26.350	33.53	14.97	48.50	
-27.160	33.53	11.72	45.25	
-27.350	33.53	11.12	44.64	
-28.160	33.53	8.53	42.06	
-28.350	33.53	8.08	41.61	
-29.160	33.53	6.15	39.68	
-29.350	33.53	5.84	39.37	
-30.160	33.53	4.53	38.06	
-30.350	33.53	4.35	37.88	
-31.160	33.53	3.60	37.13	
-31.350	33.53	3.54	37.07	
-32.160	33.53	3.28	36.80	
-32.350	33.53	3.31	36.84	
-33.160	33.53	3.46	36.98	
-33.350	33.53	3.56	37.09	
-34.160	33.53	4.03	37.56	
-34.350	33.53	4.19	37.71	
-35.160	33.53	4.87	38.39	
-35.350	33.53	5.05	38.58	
-36.160	33.53	5.83	39.36	
-36.350	33.53	6.01	39.54	
-37.160	33.53	6.76	40.29	
-37.350	33.53	6.90	40.43	
-38.160	33.53	7.48	41.01	
-38.350	33.53	7.58	41.11	
-38.370	33.53	7.59	41.12	
-39.160	33.53	7.81	41.34	
-39.350	33.53	7.83	41.36	
-39.416	33.53	7.84	41.37	
-40.160	33.53	7.68	41.21	
-40.350	33.53	7.57	41.10	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-40.625	33.53	7.42	40.95	
-41.160	33.53	7.00	40.53	
-41.350	33.53	6.82	40.34	
-42.160	33.53	6.02	39.55	
-42.350	33.53	5.81	39.34	
-43.160	33.53	4.91	38.44	
-43.350	33.53	4.71	38.23	
-44.160	33.53	3.82	37.35	
-44.350	33.53	3.62	37.15	
-44.495	33.53	3.47	37.00	
-45.160	33.53	2.82	36.35	
-45.350	33.53	2.66	36.19	
-46.160	33.53	1.96	35.49	
-46.350	33.53	1.83	35.36	
-47.160	33.53	1.26	34.79	
-47.350	33.53	1.16	34.68	
-47.656	33.53	0.98	34.51	
-48.160	33.53	0.73	34.26	
-48.350	33.53	0.65	34.18	
-49.160	33.53	0.34	33.87	
-49.350	33.53	0.29	33.82	
-50.160	33.53	0.08	33.61	
-50.350	33.53	0.08	33.61	
-51.160	33.53	0.07	33.60	
-51.350	33.53	0.08	33.61	
-52.160	33.53	0.14	33.67	
-52.350	33.53	0.14	33.67	
-53.160	33.53	0.15	33.67	
-53.350	33.53	0.14	33.67	
-54.160	33.53	0.12	33.64	
-54.350	33.53	0.11	33.63	
-54.416	33.53	0.10	33.63	
-55.160	33.53	0.06	33.59	
-55.350	33.53	0.05	33.58	
-56.160	33.53	0.01	33.54	
-56.350	33.53	0.01	33.53	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	33.53	0.00	33.53	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

2)Oridinary(low tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	30.37	53.58	83.94	**
-11.160	30.37	25.24	55.61	
-11.350	30.37	20.91	51.28	
-11.416	30.37	19.61	49.98	
-12.160	30.37	12.13	42.49	
-12.350	30.37	12.08	42.45	
-12.850	30.37	11.96	42.33	
-13.160	30.37	10.42	40.78	
-13.350	30.37	9.27	39.64	
-14.160	30.37	4.37	34.74	
-14.350	30.37	3.20	33.56	
-14.361	30.37	3.13	33.50	
-15.160	30.37	1.53	31.90	
-15.350	30.37	2.64	33.00	
-16.160	30.37	7.34	37.71	
-16.350	30.37	8.63	39.00	
-17.160	30.37	14.14	44.51	
-17.350	30.37	15.83	46.19	
-18.160	30.37	23.01	53.38	
-18.350	30.37	25.04	55.40	
-18.416	30.37	25.74	56.11	
-19.160	30.37	32.39	62.75	
-19.350	30.37	33.23	63.60	
-20.160	30.37	36.83	67.19	
-20.350	30.37	36.86	67.22	
-21.160	30.37	36.98	67.35	
-21.350	30.37	36.34	66.71	
-22.160	30.37	33.64	64.01	
-22.350	30.37	32.65	63.01	
-22.416	30.37	32.30	62.67	
-22.660	30.37	30.95	61.31	
-22.660	34.81	35.19	70.00	
-23.160	34.81	32.05	66.87	
-23.350	34.81	30.91	65.72	
-24.160	34.81	26.02	60.84	
-24.350	34.81	24.98	59.79	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	34.81	20.53	55.34	
-25.350	34.81	19.62	54.43	
-26.160	34.81	15.73	50.54	
-26.350	34.81	14.97	49.78	
-27.160	34.81	11.72	46.53	
-27.350	34.81	11.12	45.93	
-28.160	34.81	8.53	43.35	
-28.350	34.81	8.08	42.89	
-29.160	34.81	6.15	40.96	
-29.350	34.81	5.84	40.66	
-30.160	34.81	4.53	39.34	
-30.350	34.81	4.35	39.17	
-31.160	34.81	3.60	38.41	
-31.350	34.81	3.54	38.35	
-32.160	34.81	3.28	38.09	
-32.350	34.81	3.31	38.12	
-33.160	34.81	3.46	38.27	
-33.350	34.81	3.56	38.38	
-34.160	34.81	4.03	38.84	
-34.350	34.81	4.19	39.00	
-35.160	34.81	4.87	39.68	
-35.350	34.81	5.05	39.86	
-36.160	34.81	5.83	40.64	
-36.350	34.81	6.01	40.82	
-37.160	34.81	6.76	41.58	
-37.350	34.81	6.90	41.71	
-38.160	34.81	7.48	42.30	
-38.350	34.81	7.58	42.39	
-38.370	34.81	7.59	42.40	
-39.160	34.81	7.81	42.63	
-39.350	34.81	7.83	42.64	
-39.416	34.81	7.84	42.65	
-40.160	34.81	7.68	42.49	
-40.350	34.81	7.57	42.39	
-40.625	34.81	7.42	42.23	
-41.160	34.81	7.00	41.82	
-41.350	34.81	6.82	41.63	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	34.81	6.02	40.83	
-42.350	34.81	5.81	40.62	
-43.160	34.81	4.91	39.73	
-43.350	34.81	4.71	39.52	
-44.160	34.81	3.82	38.63	
-44.350	34.81	3.62	38.44	
-44.495	34.81	3.47	38.28	
-45.160	34.81	2.82	37.63	
-45.350	34.81	2.66	37.47	
-46.160	34.81	1.96	36.78	
-46.350	34.81	1.83	36.64	
-47.160	34.81	1.26	36.08	
-47.350	34.81	1.16	35.97	
-47.656	34.81	0.98	35.79	
-48.160	34.81	0.73	35.54	
-48.350	34.81	0.65	35.47	
-49.160	34.81	0.34	35.15	
-49.350	34.81	0.29	35.10	
-50.160	34.81	0.08	34.89	
-50.350	34.81	0.08	34.89	
-51.160	34.81	0.07	34.88	
-51.350	34.81	0.08	34.90	
-52.160	34.81	0.14	34.95	
-52.350	34.81	0.14	34.95	
-53.160	34.81	0.15	34.96	
-53.350	34.81	0.14	34.95	
-54.160	34.81	0.12	34.93	
-54.350	34.81	0.11	34.92	
-54.416	34.81	0.10	34.92	
-55.160	34.81	0.06	34.87	
-55.350	34.81	0.05	34.86	
-56.160	34.81	0.01	34.82	
-56.350	34.81	0.01	34.82	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	34.81	0.00	34.81	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

3)Ord+Temp(high tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	30.54	53.58	84.12	**
-11.160	30.57	25.24	55.81	
-11.350	30.57	20.91	51.48	
-11.416	30.57	19.61	50.18	
-12.160	30.59	12.13	42.72	
-12.350	30.59	12.08	42.68	
-12.850	30.60	11.96	42.56	
-13.160	30.60	10.42	41.02	
-13.350	30.60	9.27	39.87	
-14.160	30.60	4.37	34.97	
-14.350	30.59	3.20	33.79	
-14.361	30.59	3.13	33.72	
-15.160	30.58	1.53	32.11	
-15.350	30.58	2.64	33.21	
-16.160	30.55	7.34	37.89	
-16.350	30.55	8.63	39.18	
-17.160	30.52	14.14	44.66	
-17.350	30.51	15.83	46.34	
-18.160	30.48	23.01	53.49	
-18.350	30.47	25.04	55.51	
-18.416	30.47	25.74	56.21	
-19.160	30.43	32.39	62.82	
-19.350	30.42	33.23	63.65	
-20.160	30.38	36.83	67.20	
-20.350	30.37	36.86	67.22	
-21.160	30.32	36.98	67.30	
-21.350	30.31	36.34	66.65	
-22.160	30.26	33.64	63.90	
-22.350	30.25	32.65	62.89	
-22.416	30.24	32.30	62.54	
-22.660	30.23	30.95	61.17	
-22.660	34.66	35.19	69.85	
-23.160	34.62	32.05	66.68	
-23.350	34.61	30.91	65.52	
-24.160	34.55	26.02	60.57	
-24.350	34.54	24.98	59.51	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	34.48	20.53	55.00	
-25.350	34.46	19.62	54.08	
-26.160	34.40	15.73	50.13	
-26.350	34.39	14.97	49.36	
-27.160	34.33	11.72	46.05	
-27.350	34.32	11.12	45.43	
-28.160	34.26	8.53	42.80	
-28.350	34.25	8.08	42.33	
-29.160	34.19	6.15	40.35	
-29.350	34.18	5.84	40.02	
-30.160	34.13	4.53	38.66	
-30.350	34.12	4.35	38.47	
-31.160	34.06	3.60	37.66	
-31.350	34.05	3.54	37.59	
-32.160	34.00	3.28	37.28	
-32.350	33.99	3.31	37.30	
-33.160	33.95	3.46	37.40	
-33.350	33.94	3.56	37.50	
-34.160	33.89	4.03	37.92	
-34.350	33.88	4.19	38.07	
-35.160	33.84	4.87	38.71	
-35.350	33.83	5.05	38.88	
-36.160	33.79	5.83	39.62	
-36.350	33.78	6.01	39.79	
-37.160	33.74	6.76	40.51	
-37.350	33.73	6.90	40.63	
-38.160	33.70	7.48	41.18	
-38.350	33.69	7.58	41.27	
-38.370	33.69	7.59	41.28	
-39.160	33.66	7.81	41.47	
-39.350	33.65	7.83	41.48	
-39.416	33.65	7.84	41.48	
-40.160	33.62	7.68	41.30	
-40.350	33.61	7.57	41.19	
-40.625	33.60	7.42	41.02	
-41.160	33.59	7.00	40.59	
-41.350	33.58	6.82	40.40	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	33.56	6.02	39.58	
-42.350	33.55	5.81	39.36	
-43.160	33.54	4.91	38.45	
-43.350	33.53	4.71	38.24	
-44.160	33.54	3.82	37.36	
-44.350	33.54	3.62	37.16	
-44.495	33.54	3.47	37.01	
-45.160	33.55	2.82	36.37	
-45.350	33.55	2.66	36.21	
-46.160	33.56	1.96	35.52	
-46.350	33.56	1.83	35.39	
-47.160	33.57	1.26	34.83	
-47.350	33.57	1.16	34.73	
-47.656	33.57	0.98	34.55	
-48.160	33.57	0.73	34.30	
-48.350	33.57	0.65	34.23	
-49.160	33.58	0.34	33.91	
-49.350	33.58	0.29	33.87	
-50.160	33.58	0.08	33.66	
-50.350	33.58	0.08	33.65	
-51.160	33.57	0.07	33.65	
-51.350	33.57	0.08	33.66	
-52.160	33.57	0.14	33.71	
-52.350	33.57	0.14	33.71	
-53.160	33.57	0.15	33.72	
-53.350	33.57	0.14	33.71	
-54.160	33.57	0.12	33.68	
-54.350	33.57	0.11	33.67	
-54.416	33.56	0.10	33.67	
-55.160	33.56	0.06	33.62	
-55.350	33.56	0.05	33.61	
-56.160	33.56	0.01	33.57	
-56.350	33.56	0.01	33.56	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	33.56	0.00	33.56	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4)Ord+Temp(low tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	31.66	53.58	85.24	**
-11.160	31.69	25.24	56.93	
-11.350	31.69	20.91	52.60	
-11.416	31.69	19.61	51.30	
-12.160	31.71	12.13	43.84	
-12.350	31.71	12.08	43.80	
-12.850	31.72	11.96	43.68	
-13.160	31.72	10.42	42.14	
-13.350	31.72	9.27	40.99	
-14.160	31.72	4.37	36.09	
-14.350	31.72	3.20	34.91	
-14.361	31.72	3.13	34.84	
-15.160	31.70	1.53	33.23	
-15.350	31.70	2.64	34.33	
-16.160	31.68	7.34	39.01	
-16.350	31.67	8.63	40.30	
-17.160	31.64	14.14	45.78	
-17.350	31.63	15.83	47.46	
-18.160	31.60	23.01	54.61	
-18.350	31.59	25.04	56.63	
-18.416	31.59	25.74	57.33	
-19.160	31.55	32.39	63.94	
-19.350	31.54	33.23	64.77	
-20.160	31.50	36.83	68.32	
-20.350	31.49	36.86	68.34	
-21.160	31.44	36.98	68.42	
-21.350	31.43	36.34	67.77	
-22.160	31.38	33.64	65.02	
-22.350	31.37	32.65	64.01	
-22.416	31.36	32.30	63.67	
-22.660	31.35	30.95	62.29	
-22.660	35.94	35.19	71.13	
-23.160	35.91	32.05	67.96	
-23.350	35.89	30.91	66.80	
-24.160	35.83	26.02	61.86	
-24.350	35.82	24.98	60.80	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	35.76	20.53	56.29	
-25.350	35.75	19.62	55.36	
-26.160	35.69	15.73	51.42	
-26.350	35.67	14.97	50.64	
-27.160	35.62	11.72	47.34	
-27.350	35.60	11.12	46.72	
-28.160	35.55	8.53	44.08	
-28.350	35.53	8.08	43.61	
-29.160	35.48	6.15	41.63	
-29.350	35.47	5.84	41.31	
-30.160	35.41	4.53	39.94	
-30.350	35.40	4.35	39.75	
-31.160	35.35	3.60	38.95	
-31.350	35.34	3.54	38.88	
-32.160	35.29	3.28	38.56	
-32.350	35.28	3.31	38.59	
-33.160	35.23	3.46	38.69	
-33.350	35.22	3.56	38.78	
-34.160	35.18	4.03	39.20	
-34.350	35.17	4.19	39.35	
-35.160	35.12	4.87	39.99	
-35.350	35.11	5.05	40.16	
-36.160	35.07	5.83	40.91	
-36.350	35.07	6.01	41.07	
-37.160	35.03	6.76	41.79	
-37.350	35.02	6.90	41.92	
-38.160	34.98	7.48	42.47	
-38.350	34.98	7.58	42.55	
-38.370	34.97	7.59	42.56	
-39.160	34.94	7.81	42.76	
-39.350	34.93	7.83	42.77	
-39.416	34.93	7.84	42.77	
-40.160	34.90	7.68	42.58	
-40.350	34.90	7.57	42.47	
-40.625	34.89	7.42	42.31	
-41.160	34.87	7.00	41.87	
-41.350	34.87	6.82	41.68	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	34.84	6.02	40.86	
-42.350	34.84	5.81	40.65	
-43.160	34.82	4.91	39.73	
-43.350	34.82	4.71	39.52	
-44.160	34.82	3.82	38.64	
-44.350	34.83	3.62	38.45	
-44.495	34.83	3.47	38.30	
-45.160	34.84	2.82	37.66	
-45.350	34.84	2.66	37.50	
-46.160	34.85	1.96	36.81	
-46.350	34.85	1.83	36.68	
-47.160	34.85	1.26	36.12	
-47.350	34.86	1.16	36.01	
-47.656	34.86	0.98	35.84	
-48.160	34.86	0.73	35.59	
-48.350	34.86	0.65	35.51	
-49.160	34.86	0.34	35.20	
-49.350	34.86	0.29	35.15	
-50.160	34.86	0.08	34.94	
-50.350	34.86	0.08	34.94	
-51.160	34.86	0.07	34.93	
-51.350	34.86	0.08	34.94	
-52.160	34.86	0.14	35.00	
-52.350	34.86	0.14	35.00	
-53.160	34.85	0.15	35.00	
-53.350	34.85	0.14	34.99	
-54.160	34.85	0.12	34.97	
-54.350	34.85	0.11	34.96	
-54.416	34.85	0.10	34.95	
-55.160	34.85	0.06	34.91	
-55.350	34.85	0.05	34.90	
-56.160	34.84	0.01	34.85	
-56.350	34.84	0.01	34.85	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	34.84	0.00	34.84	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

5)Wind+Temp

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	30.71	53.58	84.29	**
-11.160	30.75	25.24	56.00	
-11.350	30.76	20.91	51.67	
-11.416	30.77	19.61	50.37	
-12.160	30.79	12.13	42.92	
-12.350	30.80	12.08	42.88	
-12.850	30.81	11.96	42.77	
-13.160	30.81	10.42	41.23	
-13.350	30.81	9.27	40.08	
-14.160	30.81	4.37	35.18	
-14.350	30.80	3.20	34.00	
-14.361	30.80	3.13	33.93	
-15.160	30.79	1.53	32.32	
-15.350	30.78	2.64	33.42	
-16.160	30.75	7.34	38.09	
-16.350	30.74	8.63	39.38	
-17.160	30.70	14.14	44.84	
-17.350	30.69	15.83	46.52	
-18.160	30.64	23.01	53.66	
-18.350	30.63	25.04	55.67	
-18.416	30.63	25.74	56.37	
-19.160	30.58	32.39	62.96	
-19.350	30.56	33.23	63.79	
-20.160	30.50	36.83	67.33	
-20.350	30.49	36.86	67.34	
-21.160	30.42	36.98	67.40	
-21.350	30.40	36.34	66.75	
-22.160	30.33	33.64	63.97	
-22.350	30.32	32.65	62.96	
-22.416	30.31	32.30	62.61	
-22.660	30.29	30.95	61.24	
-22.660	34.74	35.19	69.93	
-23.160	34.68	32.05	66.74	
-23.350	34.66	30.91	65.57	
-24.160	34.58	26.02	60.60	
-24.350	34.56	24.98	59.54	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	34.47	20.53	55.00	
-25.350	34.46	19.62	54.07	
-26.160	34.37	15.73	50.10	
-26.350	34.35	14.97	49.32	
-27.160	34.27	11.72	45.99	
-27.350	34.25	11.12	45.37	
-28.160	34.17	8.53	42.70	
-28.350	34.15	8.08	42.23	
-29.160	34.07	6.15	40.22	
-29.350	34.05	5.84	39.90	
-30.160	33.98	4.53	38.51	
-30.350	33.96	4.35	38.31	
-31.160	33.89	3.60	37.49	
-31.350	33.87	3.54	37.41	
-32.160	33.80	3.28	37.07	
-32.350	33.78	3.31	37.09	
-33.160	33.72	3.46	37.17	
-33.350	33.70	3.56	37.27	
-34.160	33.64	4.03	37.67	
-34.350	33.62	4.19	37.81	
-35.160	33.56	4.87	38.43	
-35.350	33.55	5.05	38.60	
-36.160	33.49	5.83	39.32	
-36.350	33.48	6.01	39.49	
-37.160	33.42	6.76	40.19	
-37.350	33.41	6.90	40.31	
-38.160	33.36	7.48	40.84	
-38.350	33.35	7.58	40.93	
-38.370	33.35	7.59	40.93	
-39.160	33.30	7.81	41.11	
-39.350	33.29	7.83	41.12	
-39.416	33.29	7.84	41.12	
-40.160	33.25	7.68	40.93	
-40.350	33.24	7.57	40.81	
-40.625	33.22	7.42	40.64	
-41.160	33.20	7.00	40.20	
-41.350	33.19	6.82	40.01	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	33.16	6.02	39.18	
-42.350	33.15	5.81	38.96	
-43.160	33.13	4.91	38.04	
-43.350	33.12	4.71	37.83	
-44.160	33.12	3.82	36.94	
-44.350	33.12	3.62	36.75	
-44.495	33.13	3.47	36.60	
-45.160	33.14	2.82	35.96	
-45.350	33.14	2.66	35.80	
-46.160	33.16	1.96	35.12	
-46.350	33.16	1.83	34.99	
-47.160	33.17	1.26	34.43	
-47.350	33.17	1.16	34.32	
-47.656	33.17	0.98	34.15	
-48.160	33.17	0.73	33.90	
-48.350	33.18	0.65	33.83	
-49.160	33.18	0.34	33.52	
-49.350	33.18	0.29	33.47	
-50.160	33.18	0.08	33.26	
-50.350	33.18	0.08	33.26	
-51.160	33.18	0.07	33.25	
-51.350	33.18	0.08	33.26	
-52.160	33.17	0.14	33.31	
-52.350	33.17	0.14	33.31	
-53.160	33.17	0.15	33.32	
-53.350	33.17	0.14	33.31	
-54.160	33.16	0.12	33.28	
-54.350	33.16	0.11	33.27	
-54.416	33.16	0.10	33.27	
-55.160	33.16	0.06	33.22	
-55.350	33.16	0.05	33.21	
-56.160	33.15	0.01	33.16	
-56.350	33.15	0.01	33.16	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	33.15	0.00	33.15	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

6)Ord+Collision

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	43.82	53.58	97.39	**
-11.160	44.41	25.24	69.65	
-11.350	44.55	20.91	65.46	
-11.416	44.59	19.61	64.20	
-12.160	45.03	12.13	57.15	
-12.350	45.14	12.08	57.22	
-12.850	45.35	11.96	57.31	
-13.160	45.45	10.42	55.86	
-13.350	45.51	9.27	54.77	
-14.160	45.64	4.37	50.02	
-14.350	45.67	3.20	48.87	
-14.361	45.67	3.13	48.80	
-15.160	45.67	1.53	47.20	
-15.350	45.67	2.64	48.30	
-16.160	45.54	7.34	52.88	
-16.350	45.51	8.63	54.14	
-17.160	45.28	14.14	59.42	
-17.350	45.23	15.83	61.05	
-18.160	44.91	23.01	67.92	
-18.350	44.83	25.04	69.87	
-18.416	44.80	25.74	70.54	
-19.160	44.43	32.39	76.82	
-19.350	44.34	33.23	77.57	
-20.160	43.86	36.83	80.69	
-20.350	43.75	36.86	80.61	
-21.160	43.22	36.98	80.20	
-21.350	43.10	36.34	79.44	
-22.160	42.52	33.64	76.16	
-22.350	42.39	32.65	75.04	
-22.416	42.34	32.30	74.64	
-22.660	42.16	30.95	73.11	
-22.660	48.44	35.19	83.63	
-23.160	48.01	32.05	80.07	
-23.350	47.85	30.91	78.76	
-24.160	47.13	26.02	73.16	
-24.350	46.97	24.98	71.94	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	46.24	20.53	66.77	
-25.350	46.07	19.62	65.69	
-26.160	45.35	15.73	61.08	
-26.350	45.18	14.97	60.14	
-27.160	44.45	11.72	56.18	
-27.350	44.29	11.12	55.40	
-28.160	43.57	8.53	52.11	
-28.350	43.41	8.08	51.49	
-29.160	42.71	6.15	48.86	
-29.350	42.55	5.84	48.39	
-30.160	41.87	4.53	46.40	
-30.350	41.71	4.35	46.06	
-31.160	41.05	3.60	44.65	
-31.350	40.90	3.54	44.44	
-32.160	40.27	3.28	43.54	
-32.350	40.12	3.31	43.43	
-33.160	39.51	3.46	42.96	
-33.350	39.37	3.56	42.93	
-34.160	38.78	4.03	42.81	
-34.350	38.65	4.19	42.83	
-35.160	38.09	4.87	42.96	
-35.350	37.96	5.05	43.01	
-36.160	37.43	5.83	43.26	
-36.350	37.31	6.01	43.32	
-37.160	36.80	6.76	43.57	
-37.350	36.69	6.90	43.59	
-38.160	36.21	7.48	43.69	
-38.350	36.10	7.58	43.68	
-38.370	36.09	7.59	43.67	
-39.160	35.65	7.81	43.46	
-39.350	35.54	7.83	43.37	
-39.416	35.50	7.84	43.34	
-40.160	35.13	7.68	42.81	
-40.350	35.03	7.57	42.60	
-40.625	34.91	7.42	42.33	
-41.160	34.67	7.00	41.68	
-41.350	34.59	6.82	41.41	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	34.29	6.02	40.31	
-42.350	34.22	5.81	40.03	
-43.160	33.97	4.91	38.88	
-43.350	33.91	4.71	38.61	
-44.160	33.70	3.82	37.52	
-44.350	33.65	3.62	37.27	
-44.495	33.64	3.47	37.12	
-45.160	33.62	2.82	36.44	
-45.350	33.61	2.66	36.27	
-46.160	33.74	1.96	35.70	
-46.350	33.77	1.83	35.60	
-47.160	33.86	1.26	35.13	
-47.350	33.88	1.16	35.04	
-47.656	33.91	0.98	34.89	
-48.160	33.95	0.73	34.68	
-48.350	33.97	0.65	34.62	
-49.160	34.01	0.34	34.35	
-49.350	34.02	0.29	34.31	
-50.160	34.04	0.08	34.12	
-50.350	34.04	0.08	34.12	
-51.160	34.05	0.07	34.12	
-51.350	34.05	0.08	34.13	
-52.160	34.04	0.14	34.18	
-52.350	34.04	0.14	34.18	
-53.160	34.02	0.15	34.17	
-53.350	34.02	0.14	34.16	
-54.160	33.99	0.12	34.11	
-54.350	33.99	0.11	34.09	
-54.416	33.98	0.10	34.09	
-55.160	33.96	0.06	34.02	
-55.350	33.95	0.05	34.00	
-56.160	33.93	0.01	33.94	
-56.350	33.92	0.01	33.93	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	33.91	0.00	33.91	

*   :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

7)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	81.50	53.58	135.07	**
-11.160	83.67	25.24	108.91	
-11.350	84.17	20.91	105.09	
-11.416	84.35	19.61	103.96	
-12.160	85.93	12.13	98.06	
-12.350	86.34	12.08	98.42	
-12.850	87.04	11.96	99.01	
-13.160	87.34	10.42	97.75	
-13.350	87.52	9.27	96.79	
-14.160	87.79	4.37	92.16	
-14.350	87.85	3.20	91.05	
-14.361	87.84	3.13	90.97	
-15.160	87.52	1.53	89.06	
-15.350	87.45	2.64	90.08	
-16.160	86.62	7.34	93.96	
-16.350	86.42	8.63	95.06	
-17.160	85.18	14.14	99.32	
-17.350	84.88	15.83	100.71	
-18.160	83.29	23.01	106.30	
-18.350	82.92	25.04	107.95	
-18.416	82.77	25.74	108.51	
-19.160	81.03	32.39	113.41	
-19.350	80.58	33.23	113.81	
-20.160	78.43	36.83	115.26	
-20.350	77.93	36.86	114.79	
-21.160	75.59	36.98	112.57	
-21.350	75.04	36.34	111.39	
-22.160	72.58	33.64	106.21	
-22.350	72.00	32.65	104.64	
-22.416	71.79	32.30	104.09	
-22.660	71.03	30.95	101.98	
-22.660	81.81	35.19	117.00	
-23.160	79.99	32.05	112.05	
-23.350	79.30	30.91	110.21	
-24.160	76.35	26.02	102.37	
-24.350	75.65	24.98	100.63	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	72.71	20.53	93.24	
-25.350	72.02	19.62	91.63	
-26.160	69.11	15.73	84.84	
-26.350	68.43	14.97	83.40	
-27.160	65.59	11.72	77.32	
-27.350	64.93	11.12	76.04	
-28.160	62.17	8.53	70.71	
-28.350	61.53	8.08	69.61	
-29.160	58.88	6.15	65.03	
-29.350	58.26	5.84	64.10	
-30.160	55.72	4.53	60.25	
-30.350	55.12	4.35	59.48	
-31.160	52.71	3.60	56.31	
-31.350	52.14	3.54	55.68	
-32.160	49.85	3.28	53.13	
-32.350	49.32	3.31	52.63	
-33.160	47.16	3.46	50.61	
-33.350	46.65	3.56	50.22	
-34.160	44.62	4.03	48.65	
-34.350	44.15	4.19	48.33	
-35.160	42.25	4.87	47.11	
-35.350	41.80	5.05	46.85	
-36.160	40.02	5.83	45.85	
-36.350	39.60	6.01	45.61	
-37.160	37.95	6.76	44.71	
-37.350	37.56	6.90	44.46	
-38.160	36.01	7.48	43.49	
-38.350	35.65	7.58	43.22	
-38.370	35.61	7.59	43.20	
-39.160	34.21	7.81	42.02	
-39.350	33.87	7.83	41.70	
-39.416	33.75	7.84	41.59	
-40.160	32.59	7.68	40.27	
-40.350	32.29	7.57	39.86	
-40.625	31.93	7.42	39.35	
-41.160	31.24	7.00	38.24	
-41.350	30.99	6.82	37.81	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	31.78	6.02	37.79	
-42.350	31.96	5.81	37.77	
-43.160	32.61	4.91	37.52	
-43.350	32.76	4.71	37.47	
-44.160	33.25	3.82	37.07	
-44.350	33.36	3.62	36.99	
-44.495	33.42	3.47	36.90	
-45.160	33.70	2.82	36.52	
-45.350	33.78	2.66	36.44	
-46.160	33.99	1.96	35.95	
-46.350	34.04	1.83	35.87	
-47.160	34.14	1.26	35.41	
-47.350	34.17	1.16	35.32	
-47.656	34.17	0.98	35.15	
-48.160	34.18	0.73	34.91	
-48.350	34.18	0.65	34.84	
-49.160	34.12	0.34	34.46	
-49.350	34.11	0.29	34.40	
-50.160	33.99	0.08	34.07	
-50.350	33.96	0.08	34.04	
-51.160	33.80	0.07	33.87	
-51.350	33.76	0.08	33.84	
-52.160	33.56	0.14	33.70	
-52.350	33.52	0.14	33.66	
-53.160	33.30	0.15	33.45	
-53.350	33.25	0.14	33.39	
-54.160	33.03	0.12	33.15	
-54.350	32.98	0.11	33.09	
-54.416	32.96	0.10	33.07	
-55.160	32.77	0.06	32.83	
-55.350	32.72	0.05	32.77	
-56.160	32.55	0.01	32.56	
-56.350	32.52	0.01	32.52	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	32.47	0.00	32.47	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

(2)perpendicular direction

1)Oridinary(high tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	29.90	63.08	92.99	**
-11.160	29.90	35.71	65.61	
-11.350	29.90	31.31	61.21	
-11.416	29.90	29.96	59.86	
-12.160	29.90	21.04	50.94	
-12.350	29.90	20.32	50.22	
-12.850	29.89	18.44	48.34	
-13.160	29.89	15.80	45.69	
-13.350	29.89	13.98	43.87	
-14.160	29.88	6.23	36.11	
-14.350	29.88	4.38	34.26	
-14.596	29.88	2.05	31.93	
-15.160	29.88	3.00	32.88	
-15.350	29.87	4.59	34.46	
-16.160	29.86	11.36	41.22	
-16.350	29.86	12.99	42.86	
-17.160	29.85	19.97	49.82	
-17.350	29.85	21.87	51.72	
-18.160	29.84	29.97	59.81	
-18.350	29.84	32.13	61.97	
-18.416	29.84	32.88	62.72	
-19.160	29.82	39.83	69.66	
-19.350	29.82	40.65	70.48	
-20.160	29.81	44.16	73.97	
-20.350	29.81	44.07	73.87	
-21.160	29.79	43.67	73.46	
-21.350	29.79	42.81	72.60	
-22.160	29.78	39.18	68.96	
-22.350	29.77	37.92	67.69	
-22.416	29.77	37.48	67.25	
-22.660	29.77	35.75	65.52	
-22.660	34.13	40.65	74.78	
-23.160	34.12	36.66	70.78	
-23.350	34.12	35.19	69.30	
-24.160	34.10	28.92	63.02	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-24.350	34.09	27.55	61.64	
-25.160	34.08	21.72	55.80	
-25.350	34.07	20.49	54.56	
-26.160	34.05	15.23	49.28	
-26.350	34.05	14.15	48.19	
-27.160	34.03	9.52	43.55	
-27.350	34.03	8.59	42.62	
-28.160	34.01	4.62	38.63	
-28.350	34.00	3.84	37.85	
-29.160	33.98	0.52	34.50	
-29.350	33.98	0.96	34.94	
-30.160	33.96	2.82	36.78	
-30.350	33.96	3.31	37.27	
-31.160	33.94	5.42	39.36	
-31.350	33.93	5.78	39.72	
-32.160	33.92	7.31	41.23	
-32.350	33.91	7.54	41.45	
-33.160	33.89	8.49	42.38	
-33.350	33.89	8.57	42.46	
-34.160	33.87	8.93	42.80	
-34.350	33.87	8.87	42.73	
-35.160	33.85	8.59	42.44	
-35.350	33.84	8.36	42.20	
-36.160	33.83	7.36	41.19	
-36.350	33.82	6.94	40.76	
-37.160	33.80	5.15	38.95	
-37.350	33.80	4.51	38.31	
-38.160	33.78	1.79	35.57	
-38.350	33.78	1.00	34.78	
-38.370	33.78	0.92	34.70	
-39.160	33.76	2.87	36.63	
-39.350	33.76	3.93	37.69	
-39.416	33.75	4.30	38.05	
-40.160	33.74	7.98	41.72	
-40.350	33.73	8.70	42.43	
-40.625	33.73	9.74	43.46	
-41.160	33.72	11.30	45.02	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-41.350	33.71	11.65	45.37	
-42.160	33.70	13.15	46.84	
-42.350	33.70	13.28	46.97	
-43.160	33.68	13.84	47.52	
-43.350	33.68	13.80	47.47	
-44.160	33.66	13.60	47.26	
-44.350	33.66	13.44	47.10	
-44.495	33.66	13.32	46.98	
-45.160	33.65	12.52	46.16	
-45.350	33.64	12.20	45.84	
-46.160	33.63	10.86	44.49	
-46.350	33.63	10.50	44.13	
-47.160	33.61	8.97	42.59	
-47.350	33.61	8.61	42.22	
-47.656	33.61	8.02	41.63	
-48.160	33.60	7.08	40.68	
-48.350	33.60	6.75	40.35	
-49.160	33.59	5.34	38.93	
-49.350	33.58	5.06	38.64	
-50.160	33.57	3.84	37.42	
-50.350	33.57	3.61	37.18	
-51.160	33.56	2.61	36.18	
-51.350	33.56	2.43	35.99	
-52.160	33.55	1.65	35.20	
-52.350	33.55	1.52	35.06	
-53.160	33.54	0.93	34.47	
-53.350	33.54	0.83	34.37	
-54.160	33.53	0.41	33.94	
-54.350	33.53	0.33	33.86	
-54.416	33.53	0.30	33.83	
-55.160	33.53	0.09	33.62	
-55.350	33.53	0.07	33.61	
-56.160	33.54	0.00	33.54	
-56.350	33.54	0.00	33.54	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	33.54	0.00	33.54	

* :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

2)Oridinary(low tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	31.02	63.08	94.11	**
-11.160	31.02	35.71	66.73	
-11.350	31.02	31.31	62.34	
-11.416	31.02	29.96	60.99	
-12.160	31.02	21.04	52.06	
-12.350	31.02	20.32	51.34	
-12.850	31.01	18.44	49.46	
-13.160	31.01	15.80	46.81	
-13.350	31.01	13.98	44.99	
-14.160	31.01	6.23	37.23	
-14.350	31.00	4.38	35.39	
-14.596	31.00	2.05	33.05	
-15.160	31.00	3.00	34.00	
-15.350	30.99	4.59	35.58	
-16.160	30.99	11.36	42.34	
-16.350	30.98	12.99	43.98	
-17.160	30.97	19.97	50.94	
-17.350	30.97	21.87	52.84	
-18.160	30.96	29.97	60.93	
-18.350	30.96	32.13	63.09	
-18.416	30.96	32.88	63.84	
-19.160	30.95	39.83	70.78	
-19.350	30.94	40.65	71.60	
-20.160	30.93	44.16	75.09	
-20.350	30.93	44.07	75.00	
-21.160	30.91	43.67	74.58	
-21.350	30.91	42.81	73.72	
-22.160	30.90	39.18	70.08	
-22.350	30.89	37.92	68.81	
-22.416	30.89	37.48	68.37	
-22.660	30.89	35.75	66.64	
-22.660	35.41	40.65	76.07	
-23.160	35.40	36.66	72.06	
-23.350	35.40	35.19	70.59	
-24.160	35.38	28.92	64.30	
-24.350	35.38	27.55	62.93	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-25.160	35.36	21.72	57.08	
-25.350	35.36	20.49	55.84	
-26.160	35.34	15.23	50.57	
-26.350	35.33	14.15	49.48	
-27.160	35.32	9.52	44.84	
-27.350	35.31	8.59	43.90	
-28.160	35.29	4.62	39.91	
-28.350	35.29	3.84	39.13	
-29.160	35.27	0.52	35.79	
-29.350	35.27	0.96	36.22	
-30.160	35.25	2.82	38.07	
-30.350	35.24	3.31	38.56	
-31.160	35.22	5.42	40.65	
-31.350	35.22	5.78	41.00	
-32.160	35.20	7.31	42.51	
-32.350	35.20	7.54	42.73	
-33.160	35.18	8.49	43.67	
-33.350	35.17	8.57	43.75	
-34.160	35.16	8.93	44.09	
-34.350	35.15	8.87	44.02	
-35.160	35.13	8.59	43.72	
-35.350	35.13	8.36	43.48	
-36.160	35.11	7.36	42.48	
-36.350	35.11	6.94	42.05	
-37.160	35.09	5.15	40.23	
-37.350	35.08	4.51	39.59	
-38.160	35.07	1.79	36.85	
-38.350	35.06	1.00	36.07	
-38.370	35.06	0.92	35.98	
-39.160	35.04	2.87	37.92	
-39.350	35.04	3.93	38.97	
-39.416	35.04	4.30	39.34	
-40.160	35.02	7.98	43.00	
-40.350	35.02	8.70	43.72	
-40.625	35.01	9.74	44.75	
-41.160	35.00	11.30	46.31	
-41.350	35.00	11.65	46.65	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-42.160	34.98	13.15	48.13	
-42.350	34.98	13.28	48.26	
-43.160	34.97	13.84	48.81	
-43.350	34.96	13.80	48.76	
-44.160	34.95	13.60	48.54	
-44.350	34.94	13.44	48.39	
-44.495	34.94	13.32	48.26	
-45.160	34.93	12.52	47.45	
-45.350	34.93	12.20	47.13	
-46.160	34.91	10.86	45.78	
-46.350	34.91	10.50	45.41	
-47.160	34.90	8.97	43.87	
-47.350	34.90	8.61	43.50	
-47.656	34.89	8.02	42.91	
-48.160	34.88	7.08	41.97	
-48.350	34.88	6.75	41.63	
-49.160	34.87	5.34	40.21	
-49.350	34.87	5.06	39.93	
-50.160	34.86	3.84	38.70	
-50.350	34.86	3.61	38.47	
-51.160	34.85	2.61	37.46	
-51.350	34.84	2.43	37.28	
-52.160	34.84	1.65	36.49	
-52.350	34.83	1.52	36.35	
-53.160	34.83	0.93	35.76	
-53.350	34.82	0.83	35.66	
-54.160	34.82	0.41	35.23	
-54.350	34.81	0.33	35.14	
-54.416	34.81	0.30	35.12	
-55.160	34.82	0.09	34.91	
-55.350	34.82	0.07	34.89	
-56.160	34.82	0.00	34.83	
-56.350	34.83	0.00	34.83	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	34.83	0.00	34.83	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

3)Wind

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	34.95	63.08	98.03	**
-11.160	35.09	35.71	70.80	
-11.350	35.12	31.31	66.43	
-11.416	35.13	29.96	65.10	
-12.160	35.24	21.04	56.28	
-12.350	35.27	20.32	55.59	
-12.850	35.33	18.44	53.77	
-13.160	35.36	15.80	51.16	
-13.350	35.38	13.98	49.36	
-14.160	35.45	6.23	41.68	
-14.350	35.46	4.38	39.84	
-14.596	35.47	2.05	37.52	
-15.160	35.50	3.00	38.50	
-15.350	35.51	4.59	40.10	
-16.160	35.53	11.36	46.89	
-16.350	35.53	12.99	48.53	
-17.160	35.53	19.97	55.50	
-17.350	35.53	21.87	57.39	
-18.160	35.50	29.97	65.47	
-18.350	35.50	32.13	67.63	
-18.416	35.50	32.88	68.38	
-19.160	35.46	39.83	75.29	
-19.350	35.45	40.65	76.10	
-20.160	35.38	44.16	79.54	
-20.350	35.37	44.07	79.44	
-21.160	35.29	43.67	78.95	
-21.350	35.27	42.81	78.08	
-22.160	35.17	39.18	74.35	
-22.350	35.15	37.92	73.06	
-22.416	35.14	37.48	72.61	
-22.660	35.11	35.75	70.86	
-22.660	40.31	40.65	80.96	
-23.160	40.23	36.66	76.89	
-23.350	40.20	35.19	75.39	
-24.160	40.06	28.92	68.98	
-24.350	40.03	27.55	67.58	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-25.160	39.88	21.72	61.60	
-25.350	39.84	20.49	60.33	
-26.160	39.68	15.23	54.91	
-26.350	39.64	14.15	53.79	
-27.160	39.47	9.52	48.99	
-27.350	39.43	8.59	48.02	
-28.160	39.26	4.62	43.88	
-28.350	39.22	3.84	43.06	
-29.160	39.03	0.52	39.55	
-29.350	38.99	0.96	39.95	
-30.160	38.80	2.82	41.62	
-30.350	38.76	3.31	42.07	
-31.160	38.57	5.42	43.99	
-31.350	38.52	5.78	44.30	
-32.160	38.33	7.31	45.64	
-32.350	38.28	7.54	45.82	
-33.160	38.08	8.49	46.57	
-33.350	38.04	8.57	46.61	
-34.160	37.83	8.93	46.77	
-34.350	37.79	8.87	46.66	
-35.160	37.59	8.59	46.17	
-35.350	37.54	8.36	45.89	
-36.160	37.33	7.36	44.70	
-36.350	37.29	6.94	44.23	
-37.160	37.08	5.15	42.23	
-37.350	37.04	4.51	41.54	
-38.160	36.83	1.79	38.62	
-38.350	36.78	1.00	37.79	
-38.370	36.78	0.92	37.70	
-39.160	36.58	2.87	39.45	
-39.350	36.53	3.93	40.46	
-39.416	36.52	4.30	40.81	
-40.160	36.33	7.98	44.31	
-40.350	36.28	8.70	44.98	
-40.625	36.22	9.74	45.95	
-41.160	36.08	11.30	47.39	
-41.350	36.04	11.65	47.69	

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elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-42.160	35.84	13.15	48.99	
-42.350	35.80	13.28	49.07	
-43.160	35.60	13.84	49.45	
-43.350	35.56	13.80	49.36	
-44.160	35.37	13.60	48.97	
-44.350	35.33	13.44	48.77	
-44.495	35.30	13.32	48.62	
-45.160	35.15	12.52	47.66	
-45.350	35.11	12.20	47.31	
-46.160	34.93	10.86	45.79	
-46.350	34.89	10.50	45.39	
-47.160	34.72	8.97	43.69	
-47.350	34.68	8.61	43.29	
-47.656	34.62	8.02	42.64	
-48.160	34.52	7.08	41.60	
-48.350	34.48	6.75	41.23	
-49.160	34.33	5.34	39.67	
-49.350	34.29	5.06	39.35	
-50.160	34.15	3.84	37.99	
-50.350	34.11	3.61	37.72	
-51.160	33.97	2.61	36.59	
-51.350	33.94	2.43	36.37	
-52.160	33.81	1.65	35.46	
-52.350	33.78	1.52	35.29	
-53.160	33.65	0.93	34.59	
-53.350	33.62	0.83	34.46	
-54.160	33.51	0.41	33.92	
-54.350	33.48	0.33	33.81	
-54.416	33.47	0.30	33.78	
-55.160	33.38	0.09	33.47	
-55.350	33.36	0.07	33.43	
-56.160	33.28	0.00	33.28	
-56.350	33.26	0.00	33.27	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	33.24	0.00	33.24	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4)Ord+Collision

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	52.43	63.08	115.52	**
-11.160	53.54	35.71	89.25	
-11.350	53.80	31.31	85.11	
-11.416	53.89	29.96	83.85	
-12.160	54.81	21.04	75.85	
-12.350	55.04	20.32	75.37	
-12.850	55.59	18.44	74.04	
-13.160	55.91	15.80	71.70	
-13.350	56.10	13.98	70.08	
-14.160	56.80	6.23	63.03	
-14.350	56.96	4.38	61.35	
-14.596	57.13	2.05	59.18	
-15.160	57.53	3.00	60.53	
-15.350	57.66	4.59	62.25	
-16.160	58.09	11.36	69.45	
-16.350	58.19	12.99	71.19	
-17.160	58.50	19.97	78.47	
-17.350	58.57	21.87	80.44	
-18.160	58.77	29.97	88.74	
-18.350	58.82	32.13	90.95	
-18.416	58.83	32.88	91.71	
-19.160	58.90	39.83	98.73	
-19.350	58.92	40.65	99.57	
-20.160	58.88	44.16	103.05	
-20.350	58.88	44.07	102.94	
-21.160	58.73	43.67	102.40	
-21.350	58.70	42.81	101.51	
-22.160	58.45	39.18	97.64	
-22.350	58.40	37.92	96.31	
-22.416	58.37	37.48	95.85	
-22.660	58.28	35.75	94.03	
-22.660	67.12	40.65	107.78	
-23.160	66.88	36.66	103.54	
-23.350	66.79	35.19	101.98	
-24.160	66.34	28.92	95.26	
-24.350	66.23	27.55	93.78	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	65.71	21.72	87.43	
-25.350	65.59	20.49	86.08	
-26.160	65.01	15.23	80.24	
-26.350	64.87	14.15	79.02	
-27.160	64.24	9.52	73.76	
-27.350	64.09	8.59	72.68	
-28.160	63.40	4.62	68.02	
-28.350	63.24	3.84	67.08	
-29.160	62.51	0.52	63.03	
-29.350	62.34	0.96	63.29	
-30.160	61.57	2.82	64.39	
-30.350	61.39	3.31	64.70	
-31.160	60.59	5.42	66.01	
-31.350	60.40	5.78	66.18	
-32.160	59.57	7.31	66.88	
-32.350	59.37	7.54	66.91	
-33.160	58.52	8.49	67.01	
-33.350	58.32	8.57	66.89	
-34.160	57.44	8.93	66.37	
-34.350	57.23	8.87	66.10	
-35.160	56.34	8.59	64.93	
-35.350	56.13	8.36	64.48	
-36.160	55.22	7.36	62.59	
-36.350	55.01	6.94	61.95	
-37.160	54.09	5.15	59.23	
-37.350	53.87	4.51	58.38	
-38.160	52.94	1.79	54.73	
-38.350	52.73	1.00	53.73	
-38.370	52.70	0.92	53.63	
-39.160	51.79	2.87	54.67	
-39.350	51.58	3.93	55.51	
-39.416	51.50	4.30	55.80	
-40.160	50.64	7.98	58.62	
-40.350	50.42	8.70	59.12	
-40.625	50.10	9.74	59.83	
-41.160	49.48	11.30	60.78	
-41.350	49.26	11.65	60.91	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	48.33	13.15	61.47	
-42.350	48.11	13.28	61.38	
-43.160	47.18	13.84	61.02	
-43.350	46.96	13.80	60.76	
-44.160	46.05	13.60	59.65	
-44.350	45.84	13.44	59.28	
-44.495	45.67	13.32	59.00	
-45.160	44.94	12.52	57.45	
-45.350	44.73	12.20	56.93	
-46.160	43.85	10.86	54.71	
-46.350	43.65	10.50	54.15	
-47.160	42.80	8.97	51.77	
-47.350	42.60	8.61	51.20	
-47.656	42.29	8.02	50.31	
-48.160	41.77	7.08	48.85	
-48.350	41.58	6.75	48.33	
-49.160	40.78	5.34	46.13	
-49.350	40.60	5.06	45.66	
-50.160	39.84	3.84	43.68	
-50.350	39.66	3.61	43.27	
-51.160	38.93	2.61	41.54	
-51.350	38.76	2.43	41.19	
-52.160	38.07	1.65	39.72	
-52.350	37.91	1.52	39.42	
-53.160	37.25	0.93	38.19	
-53.350	37.10	0.83	37.94	
-54.160	36.49	0.41	36.90	
-54.350	36.35	0.33	36.68	
-54.416	36.30	0.30	36.60	
-55.160	35.81	0.09	35.90	
-55.350	35.69	0.07	35.76	
-56.160	35.28	0.00	35.28	
-56.350	35.18	0.00	35.18	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	35.05	0.00	35.05	

* :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

5)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	84.61	63.08	147.69	**
-11.160	86.70	35.71	122.40	
-11.350	87.18	31.31	118.50	
-11.416	87.35	29.96	117.32	
-12.160	89.08	21.04	110.11	
-12.350	89.52	20.32	109.84	
-12.850	90.50	18.44	108.94	
-13.160	91.04	15.80	106.84	
-13.350	91.37	13.98	105.35	
-14.160	92.51	6.23	98.74	
-14.350	92.78	4.38	97.16	
-14.596	93.02	2.05	95.07	
-15.160	93.58	3.00	96.59	
-15.350	93.77	4.59	98.36	
-16.160	94.27	11.36	105.63	
-16.350	94.39	12.99	107.38	
-17.160	94.61	19.97	114.57	
-17.350	94.66	21.87	116.52	
-18.160	94.62	29.97	124.58	
-18.350	94.61	32.13	126.74	
-18.416	94.59	32.88	127.47	
-19.160	94.31	39.83	134.14	
-19.350	94.24	40.65	134.89	
-20.160	93.68	44.16	137.85	
-20.350	93.55	44.07	137.62	
-21.160	92.76	43.67	136.43	
-21.350	92.58	42.81	135.39	
-22.160	91.58	39.18	130.76	
-22.350	91.34	37.92	129.26	
-22.416	91.25	37.48	128.73	
-22.660	90.92	35.75	126.67	
-22.660	104.91	40.65	145.56	
-23.160	104.06	36.66	140.72	
-23.350	103.74	35.19	138.92	
-24.160	102.24	28.92	131.15	
-24.350	101.88	27.55	129.43	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	100.25	21.72	121.97	
-25.350	99.87	20.49	120.36	
-26.160	98.12	15.23	113.35	
-26.350	97.71	14.15	111.86	
-27.160	95.87	9.52	105.39	
-27.350	95.44	8.59	104.03	
-28.160	93.51	4.62	98.13	
-28.350	93.06	3.84	96.90	
-29.160	91.06	0.52	91.58	
-29.350	90.59	0.96	91.54	
-30.160	88.53	2.82	91.35	
-30.350	88.05	3.31	91.36	
-31.160	85.94	5.42	91.37	
-31.350	85.45	5.78	91.23	
-32.160	83.31	7.31	90.62	
-32.350	82.81	7.54	90.34	
-33.160	80.64	8.49	89.13	
-33.350	80.13	8.57	88.70	
-34.160	77.94	8.93	86.87	
-34.350	77.43	8.87	86.29	
-35.160	75.23	8.59	83.81	
-35.350	74.71	8.36	83.07	
-36.160	72.50	7.36	79.87	
-36.350	71.99	6.94	78.93	
-37.160	69.78	5.15	74.93	
-37.350	69.27	4.51	73.77	
-38.160	67.07	1.79	68.85	
-38.350	66.55	1.00	67.56	
-38.370	66.50	0.92	67.42	
-39.160	64.36	2.87	67.24	
-39.350	63.85	3.93	67.78	
-39.416	63.67	4.30	67.97	
-40.160	61.69	7.98	69.67	
-40.350	61.18	8.70	69.88	
-40.625	60.47	9.74	70.20	
-41.160	59.07	11.30	70.37	
-41.350	58.57	11.65	70.23	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	56.51	13.15	69.66	
-42.350	56.03	13.28	69.31	
-43.160	54.03	13.84	67.87	
-43.350	53.56	13.80	67.36	
-44.160	51.63	13.60	65.23	
-44.350	51.18	13.44	64.62	
-44.495	50.84	13.32	64.16	
-45.160	49.31	12.52	61.83	
-45.350	48.88	12.20	61.08	
-46.160	47.09	10.86	57.95	
-46.350	46.67	10.50	57.17	
-47.160	44.95	8.97	53.92	
-47.350	44.55	8.61	53.16	
-47.656	43.93	8.02	51.95	
-48.160	42.91	7.08	49.99	
-48.350	42.53	6.75	49.28	
-49.160	40.97	5.34	46.31	
-49.350	40.60	5.06	45.66	
-50.160	39.12	3.84	42.96	
-50.350	38.77	3.61	42.38	
-51.160	37.37	2.61	39.99	
-51.350	37.05	2.43	39.48	
-52.160	35.72	1.65	37.38	
-52.350	35.41	1.52	36.93	
-53.160	34.17	0.93	35.10	
-53.350	33.88	0.83	34.71	
-54.160	32.71	0.41	33.12	
-54.350	32.44	0.33	32.77	
-54.416	32.35	0.30	32.65	
-55.160	31.41	0.09	31.50	
-55.350	31.17	0.07	31.24	
-56.160	31.65	0.00	31.65	
-56.350	31.76	0.00	31.76	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-56.660	32.02	0.00	32.02	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4 member calculation

4.1 calculation of pile cap

4.1.1 design condition

(1) calculation method : cantilever
(2) concrete design standard strength : Sig.ck = 24 (N/mm^2)
(3) rebar in use : SD345(underwater member)
(4) shape dimension
pile cap thickness h = 4.000 (m)
center spacing of steel pipe sheet piles a = 1.4478 (m) (bridge axis direction)
1.4310 (m) (perpendicular direction)
(5) dead weight of pile cap and surcharge load
1)bridge axis direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m^2)
1	OD(HT)	-5.346	3.180	65.53
2	OD(LT)	-5.346	-2.390	65.53
3	OD-TM(HT)	-5.346	3.180	65.53
4	OD-TM(LT)	-5.346	-2.390	65.53
5	WN-TM	-5.346	4.990	65.53
6	OD-CL	-5.346	3.180	65.53
7	ETQ	-5.346	0.290	65.53

2)perpendicular direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m^2)
1	OD(HT)	-5.346	3.180	65.53
2	OD(LT)	-5.346	-2.390	65.53
3	WN	-5.346	4.990	65.53
4	OD-CL	-5.346	3.180	65.53
5	ETQ	-5.346	0.290	65.53

note: backfilling soil height , water table height is shown in elevation(crest of pile cap elevation = -6.350m)

4.1.2 external working force

pile cap is designed for external working force at bottom of pile cap

besides, in estimating vertical load, dead weight of pile cap upto celler part internal periphery and surcharge load are considered

(1) area of pile cap(let internal periphery sheet pile)

oval: $A1 = B^2 = PI /4 + B * (L-B)$

$= 6.135^2 * Pai/4 + 6.135*(17.717- 6.135) = 100.620\ (m^2)$

(2)area of backfilling soil

$A2 = A1 - Ap = 63.550\ (m^2)$

where, Ap:leg column cross sectional area = $37.07\ (m^2)$

(3)working force at leg column bottom

1)bridge axis direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	46500.0	0.0	0.0	0.0	0.0
2	OD(LT)	46500.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	46500.0	200.0	4000.0	800.0	4800.0
4	OD-TM(LT)	46500.0	200.0	4000.0	800.0	4800.0
5	WN-TM	46500.0	300.0	5600.0	1200.0	6800.0
6	OD-CL	46500.0	3800.0	39300.0	15200.0	54500.0
7	ETQ	41300.0	11400.0	153500.0	45600.0	199100.0

2)perpendicular direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	46500.0	0.0	3100.0	0.0	3100.0
2	OD(LT)	46500.0	0.0	3100.0	0.0	3100.0
3	WN	46500.0	1000.0	24800.0	4000.0	28800.0
4	OD-CL	46500.0	7500.0	80600.0	30000.0	110600.0
5	ETQ	41300.0	13000.0	219600.0	52000.0	271600.0

(4) pile cap, backfilling soil

V1 = A1*{ h1*Gam.c + h2*(Gam.c - Gam.w) }

V2 = A2*{ h1'*Gam.t + h2'*(Gam.sat - Gam.w) }

V3 = Ap*hw*Gam.w

where, V1 : weight of pile cap (kN)

V2 : weight of backfilling soil (kN)

V3 : buoyancy working at column (kN)

h1 : pile cap thickness upper than water table(m)

h2 : pile cap thickness lower than water table(m)

h1' : backfilling soil thickness upper than water table(m)

h2' : backfilling soil thickness lower than water table(m)

Gam.c : pile cap concrete unit weight = 24.5 (kN/m^3)

Gam.w : unit weight of water =10.00 (kN/m^3)

Gam.t : unit weight of backfilling soil(wet) = 17.5 (kN/m^3)

Gam.sat: unit weight of backfilling soil(saturated) = 17.5 (kN/m^3)

hw : water table (m)(height from crest of pile cap)

h' : backfilling soil thickness (m)

H1 : pile cap and filling concrete inertia force (kN)

y : pile cap inertia force working gravity location height (m)

1)bridge axis direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
2	OD(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54
3	OD-TM(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
4	OD-TM(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54
5	WN-TM	11.340	1.004	5835.98	478.53	4203.74	2110.78
6	OD-CL	9.530	1.004	5835.98	478.53	3532.77	2781.75
7	ETQ	6.640	1.004	5835.98	478.53	2461.45	3853.07

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
2	OD(LT)	0.00	0.000	0.00
3	OD-TM(HT)	0.00	0.000	0.00
4	OD-TM(LT)	0.00	0.000	0.00
5	WN-TM	0.00	0.000	0.00
6	OD-CL	0.00	0.000	0.00
7	ETQ	0.00	0.000	0.00

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
2	OD(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54
3	WN	11.340	1.004	5835.98	478.53	4203.74	2110.78
4	OD-CL	9.530	1.004	5835.98	478.53	3532.77	2781.75
5	ETQ	6.640	1.004	5835.98	478.53	2461.45	3853.07

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00
2	OD(LT)	0.00	0.000	0.00
3	WN	0.00	0.000	0.00
4	OD-CL	0.00	0.000	0.00
5	ETQ	0.00	0.000	0.00

(5)external force sum up

Vo = V + V1 + V2 - V3 + V4

Ho = H + H1

Mo = M + H*y + H1*y = SumM + H1*y

where, V4: other load (kN)

1)bridge axis direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	49281.7	0.0	0.0
2	OD(LT)	0.0	51346.5	0.0	0.0
3	OD-TM(HT)	0.0	49281.7	200.0	4800.0
4	OD-TM(LT)	0.0	51346.5	200.0	4800.0
5	WN-TM	0.0	48610.8	300.0	6800.0
6	OD-CL	0.0	49281.7	3800.0	54500.0
7	ETQ	0.0	45153.1	11400.0	199100.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	49281.7	0.0	3100.0
2	OD(LT)	0.0	51346.5	0.0	3100.0
3	WN	0.0	48610.8	1000.0	28800.0
4	OD-CL	0.0	49281.7	7500.0	110600.0
5	ETQ	0.0	45153.1	13000.0	271600.0

(6) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

	number ni (num)	sectional area Aoi (m^2/num)	IBi (m^2)	
			bridge axis direction	perpendicular direction
periphery sheet pile(1)	32	0.05199	322.82	1255.78
separation wall sheet pile(2)	4	0.04464	10.76	0.00
intermediate driven pile (3)	--	------	----------	----------

1)bridge axis direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	OD(HT)	1391	1391	1.00
2	OD(LT)	1449	1449	1.00
3	OD-TM(HT)	1444	1338	1.15
4	OD-TM(LT)	1502	1396	1.15
5	WN-TM	1447	1297	1.35
6	OD-CL	1993	789	1.50
7	ETQ	3473	-925	1.50

2)perpendicular direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	OD(HT)	1414	1367	1.00
2	OD(LT)	1472	1426	1.00
3	WN	1589	1155	1.25
4	OD-CL	2224	558	1.50
5	ETQ	3320	-771	1.50

4.1.3 calculation of member force

(1)section of leg column bottom external edge

pile cap shape : oval
pile cap dimension : external width By = 8.5351 (m) (bridge axis direction)
Bx = 20.1175 (m) (perpendicular direction)
periphery steel pipe pile body diameter Do = 1.2000 (m)
leg column shape : oval
leg column dimension : 3.000 (m) (bridge axis direction)
13.000 (m) (perpendicular direction)

(2) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

where, Ri : vertical reaction of i-th steel pipe sheet pile and intermediate driven single pile (kN/number)
Vo : vertical load working at bottom of pile cap (kN)
Mo : moment working at bottom of pile cap (kN.m)
n1 : number of periphery steel pipe sheet pile = 32 (number)
n2 : number of separation wall steel pipe sheet pile = 4 (number)
n3 : number of intermediate driven single pile = 0 (number)
Ao1 : pure cross sectional area of periphery steel pipe sheet pile = 0.05199 (m^2/number)
Ao2 : pure cross sectional area of separation wall steel pipe sheet pile = 0.04464 (m^2/number)
Ao3 : pure cross sectional area of intermediate driven single pile = 0.00000 (m^2/number)
IBi : sum of squared distance from centroid of steel pipe sheet to neutral axis of horizontal section of celler (m^2)

		bridge axis direction	perpendicular direction
periphery steel pipe sheet pile	IB1	322.82	1255.78
separation wall steel pipe sheet pile	IB2	10.76	0.00
intermediate driven single pile	IB3	0.00	0.00

1)bridge axis direction

1. check location
X1 = 3.6675 (m)
X2 = -3.6675 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Oridinary(high tide)	49281.7	0.0	1.00
2	Oridinary(low tide)	51346.5	0.0	1.00
3	Ord+Temp(high tide)	49281.7	4800.0	1.15
4	Ord+Temp(low tide)	51346.5	4800.0	1.15
5	Wind+Temp	48610.8	6800.0	1.35
6	Ord+Collision	49281.7	54500.0	1.50
7	Earthquake	45153.1	199100.0	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	3.6675	-3.6675
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Oridinary(high tide)	1390.8	1390.8
2	Oridinary(low tide)	1449.1	1449.1
3	Ord+Temp(high tide)	1443.8	1337.8
4	Ord+Temp(low tide)	1502.1	1396.0
5	Wind+Temp	1447.0	1296.7
6	Ord+Collision	1992.7	788.8
7	Earthquake	3473.3	-924.8

4.separation wall steel pipe sheet pile reaction

coordinated system of center of figure		
pile No	number	Xi (m)
1	1	2.2005

abbreviation	[1] OD(HT)		[2] OD(LT)		[3] OD-TM(HT)		[4] OD-TM(LT)	
pile No	R1	R2	R1	R2	R1	R2	R1	R2
1	1194.1	1194.1	1244.2	1244.2	1221.4	1166.8	1271.5	1216.8

abbreviation	[5] WN-TM		[6] OD-CL		[7] ETQ	
pile No	R1	R2	R1	R2	R1	R2
1	1216.6	1139.2	1504.2	884.0	2226.9	-38.8

2)perpendicular direction

1. check location

Y1 = 9.4587 (m)

Y2 = -9.4587 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Oridinary(high tide)	49281.7	3100.0	1.00
2	Oridinary(low tide)	51346.5	3100.0	1.00
3	Wind	48610.8	28800.0	1.25
4	Ord+Collision	49281.7	110600.0	1.50
5	Earthquake	45153.1	271600.0	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	9.4587	-9.4587
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Oridinary(high tide)	1414.1	1367.4
2	Oridinary(low tide)	1472.4	1425.7
3	Wind	1588.8	1154.9
4	Ord+Collision	2223.8	557.7
5	Earthquake	3320.0	-771.5

(3)section of leg column bottom external edge

calculate cantilever with leg column bottom external edge as fixed end

$$MA = \frac{Rmax}{Do'} * \left(L + \frac{Do}{2} \right) + \Sigma \left(Ri * \frac{Li}{ai} \right) - \frac{w*L^2}{2} \quad (kN.m/m)$$

$$MA' = \frac{Rmin}{Do'} * \left(L + \frac{Do}{2} \right) + \Sigma \left(Ri * \frac{Li}{ai} \right) - \frac{w*L^2}{2} \quad (kN.m/m)$$

where,

MA,MA': bending moment per unit width of external edge of leg column bottom (kN.m/m)

Rmaxi : maximum vertical reaction induced in single steel pipe sheet pile (kN/number)

Rmini : minimum vertical reaction induced in single steel pipe sheet pile(kN/number)

Ri : influence range of design cantilever at maximum or minimum vertical reaction of steel pipe sheet pile vertical reaction of separation wall steel pipe sheet pile, intermediate driven single pile (kN/number)

L : distance from external edge of body bottom to celler of internal celler periphery = 1.5675 (m)(bridge axis direction)
= 2.6587 (m)(perpendicular direction)

Li : distance from external edge of body bottom to center of separation wall steel pipe sheet pile, intermediate driven single pile within influence range(m)

w : dead weight of pile cap and surcharge load (kN/m^2)

Do : external diameter = 1.2000 (m) (periphery steel pipe sheet pile)
: = 1.2000 (m) (separation wall steel pipe sheet pile)
: = --- (m) (intermediate driven single pile)

Do' :center spacing of periphery steel pipe sheet piles = 1.4478 (m) (bridge axis direction)
= 1.4310 (m) (perpendicular direction)

d : effective height of pile cap = 3.6360 (m) (bridge axis direction)
= 3.6916 (m) (perpendicular direction)

ai : Do + d

		bridge axis direction	perpendicular direction
separation wall steel pipe sheet pile	ai	4.8360	4.8916

(4)periphery steel pipe sheet pile front section

$$QB = \frac{Rmax}{Do'} \quad (kN/m)$$

$$QB1 = \frac{Rmax}{Do' + \frac{Ri}{ai} - w\left(L - \frac{h}{2} \right)} \quad (kN/m)$$

where, QB : shear force per unit width in periphery steel pipe sheet pile front (kN/m)

QB1: shear force at location where is 1/2 of thickness of pile cap apart from external edge of body bottom (kN/m)

h : pile cap thickness = 4.0000 (m)

(5)member force sum up table

1)bridge axis direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
1	Oridinary(high tide)	2175	2175	961	961
2	Oridinary(low tide)	2269	2269	1001	1001
3	Ord+Temp(high tide)	2258	2091	997	997
4	Ord+Temp(low tide)	2352	2186	1037	1037
5	Wind+Temp	2262	2026	999	999
6	Ord+Collision	3121	1229	1376	1376
7	Earthquake	5442	-1471	2399	2399

2)perpendicular direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
1	Oridinary(high tide)	2989	2882	988	945
2	Oridinary(low tide)	3121	3015	1029	986
3	Wind	3386	2398	1110	1067
4	Ord+Collision	4833	1038	1554	1511
5	Earthquake	7329	-1988	2320	2277

4.1.4 stress calculation

(1)bridge axis direction

b = 100.0 (cm)   h = 400.0 (cm)

rebar in use

lower tensile (As = 98.718 (cm^2))

1 row   cover 290 (mm)   D38 @ 228

2 row   cover 440 (mm)   D38 @ 234

upper tensile (As = 45.569 (cm^2))

1 row   cover 150 (mm)   D29 @ 278

2 row   cover 300 (mm)   D29 @ 286

			unit	OD(HT)	OD(LT)	OD-TM(HT)
bottom side tensile	bending moment	MA	kN.m	2175.0	2269.0	2258.0
	required rebar amount	Asr	cm^2	40.528	42.342	36.482
	neutral axis	x	cm	90.0	90.0	90.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.45 67.79	1.51 70.73	1.50 70.38
	tensile resultant force required rebar amount	T As	kN cm^2	966.5 60.407	1008.5 63.031	1003.5 54.540
top side tensile	bending moment	MA'	kN.m	2175.0	2269.0	2091.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	12.0	12.0	12.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	0.00 0.00
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	0.0 0.000
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	8.00 160.00	8.00 160.00	9.20 184.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	961.0 0.26 0.96	1001.0 0.28 0.96	997.0 0.27 1.10
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	961.0 0.26 0.96	1001.0 0.28 0.96	997.0 0.27 1.10
shear force to share by concrete		SC a	kN	3474.0	3474.0	3996.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.172	0.172	0.172
	allowable tensile stress	Sig.sa	N/mm^2	160.00	160.00	160.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height   Ce = 0.668 : effective height   d = 363.60 (cm)

2) correction coefficient about tensile rebar percentage   Cpt = 0.972 : tensile rebar percentage   pt = 0.272 (%)

3) for shear span ratio increment coefficient   Cdc = 6.400 : shear span   a = 1.568 (m)

			unit	OD-TM(LT)	WN-TM	OD-CL
bottom side ten sile	bending moment	MA	kN.m	2352.0	2262.0	3121.0
	required rebar amount	Asr	cm^2	38.054	31.000	30.788
	neutral axis	x	cm	90.0	90.0	90.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.57 73.33	1.51 70.51	2.08 97.28
	tensile resultant force required rebar amount	T As	kN cm^2	1045.5 56.823	1005.3 46.543	1387.0 46.233
top side ten sile	bending moment	MA'	kN.m	2186.0	2026.0	1229.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	12.0	12.0	12.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	0.00 0.00
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	0.0 0.000
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	9.20 184.00	10.80 216.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1037.0 0.29 1.10	999.0 0.27 1.29	1376.0 0.38 1.45
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1037.0 0.29 1.10	999.0 0.27 1.29	1376.0 0.38 1.45
shear force to share by concrete		SC a	kN	3996.0	4690.0	5287.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.172	0.172	0.172
	allowable tensile stress	Sig.sa	N/mm^2	160.00	160.00	200.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc
1) correction coefficient about effective height Ce = 0.668 : effective height d = 363.60 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 0.972 : tensile rebar percentage pt = 0.272 (%)
3) for shear span ratio increment coefficient Cdc = 6.400 : shear span a = 1.568 (m)

			unit	ETQ
bottom side ten sile	bending moment	MA	kN.m	5442.0
	required rebar amount	Asr	cm^2	54.587
	neutral axis	x	cm	90.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	3.62 169.63
	tensile resultant force required rebar amount	T As	kN cm^2	2418.7 80.623
top side ten sile	bending moment	MA'	kN.m	-1471.0
	required rebar amount	Asr	cm^2	13.711
	neutral axis	x	cm	65.4
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.27 92.78
	tensile resultant force required rebar amount	T As	kN cm^2	653.6 21.787
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2399.0 0.66 1.45
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2399.0 0.66 1.45
shear force to share by concrete		SC a	kN	5287.0
rebar	shear force to share	Sh'	kN	0.0
	member axial direction spacing	s	cm	100.0
	reduction coefficient	Cds	----	0.172
	allowable tensile stress	Sig.sa	N/mm^2	200.00
	amount of rebar in use	Aw	cm^2	3.871
	required rebar amount	Awreq	cm^2	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc
1) correction coefficient about effective height Ce = 0.668 : effective height d = 363.60 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 0.972 : tensile rebar percentage pt = 0.272 (%)
3) for shear span ratio increment coefficient Cdc = 6.400 : shear span a = 1.568 (m)

(2)perpendicular direction
  b = 100.0 (cm)   h = 400.0 (cm)
  rebar in use
    lower tensile (As = 111.349 (cm^2))
      1 row cover 236 (mm) D38 @ 198
      2 row cover 386 (mm) D38 @ 212
    upper tensile (As = 48.113 (cm^2))
      1 row cover 121 (mm) D29 @ 198
      2 row cover 271 (mm) D29 @ 410

			unit	OD(HT)	OD(LT)	WN
bottom side ten sile	bending moment	MA	kN.m	2989.0	3121.0	3386.0
	required rebar amount	Asr	cm^2	55.316	57.861	49.977
	neutral axis	x	cm	95.6	95.6	95.6
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.85 81.65	1.93 85.27	2.10 92.51
	tensile resultant force required rebar amount	T As	kN cm^2	1328.3 83.020	1387.3 86.706	1505.1 75.254
top side ten sile	bending moment	MA'	kN.m	2882.0	3015.0	2398.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	10.0	10.0	10.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	0.00 0.00
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	0.0 0.000
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	8.00 160.00	8.00 160.00	10.00 200.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	988.0 0.27 0.82	1029.0 0.28 0.82	1110.0 0.30 1.02
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	945.0 0.26 0.82	986.0 0.27 0.82	1067.0 0.29 1.02
shear force to share by concrete		SC a	kN	3024.0	3024.0	3779.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.288	0.288	0.288
	allowable tensile stress	Sig.sa	N/mm^2	160.00	160.00	160.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc
  1) correction coefficient about effective height Ce = 0.665 : effective height d = 369.16 (cm)
  2) correction coefficient about tensile rebar percentage Cpt = 1.002 : tensile rebar percentage pt = 0.302 (%)
  3) for shear span ratio increment coefficient Cdc = 5.343 : shear span a = 2.659 (m)

			unit	OD-CL	ETQ
bottom side ten sile	bending moment	MA	kN.m	4833.0	7329.0
	required rebar amount	Asr	cm^2	47.475	73.051
	neutral axis	x	cm	95.6	95.6
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.99 132.02	4.54 200.21
	tensile resultant force required rebar amount	T As	kN cm^2	2147.8 71.594	3257.3 108.575
top side ten sile	bending moment	MA'	kN.m	1038.0	-1988.0
	required rebar amount	Asr	cm^2	0.000	18.231
	neutral axis	x	cm	10.0	67.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	1.63 116.34
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	883.7 29.458
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1554.0 0.42 1.25	2320.0 0.63 1.25
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1511.0 0.41 1.25	2277.0 0.62 1.25
shear force to share by concrete		SC a	kN	4601.0	4601.0
rebar	shear force to share	Sh'	kN	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0
	reduction coefficient	Cds	----	0.288	0.288
	allowable tensile stress	Sig.sa	N/mm^2	200.00	200.00
	amount of rebar in use	Aw	cm^2	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height Ce = 0.665 : effective height d = 369.16 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.002 : tensile rebar percentage pt = 0.302 (%)
3) for shear span ratio increment coefficient Cdc = 5.343 : shear span a = 2.659 (m)

(3) required thickness of pile cap

$$h >= 1.94 * \sqrt[3]{\frac{kp*Lambda^4}{E}} = 1.374 \text{ (m)}$$

where, h : required thickness of pile cap(m)

kp : equivalent modulus of subgrade reaction (kN/m^3)

$$kp = \frac{Kv1*n1 + Kv2*n2 + Kv3*n3}{A}$$

Kv : axial direction spring constant of steel pipe sheet pile or intermediate driven single pile (kN/m)

$$Kv = a * \frac{Ap*Ep}{L}$$

Ap : pure cross sectional area of steel pipe sheet pile or intermediate driven single pile (m^2)
Ep : Young's modulus of steel pipe sheet pile or 1 center pick single pile (kN/m^2)
L : pile length (m)
a : correction coefficient
a = 0.014*(L/D) + 0.72
Kv1(periphery steel pipe sheet pile) = 2.8296E+005
Kv2(separation wall steel pipe sheet pile) = 2.4294E+005
Kv3(intermediate driven single pile) = 0.0000E+000
n1 : number of periphery steel pipe sheet pile = 32
n2 : number of separation wall steel pipe sheet pile = 4
n3 : number of intermediate driven single pile = 0
A : area of pile cap (m^2) = 127.2
E : Young's modulus of pile cap (kN/m^2) = $2.50 * 10^7$
Lambda : protrusion length of pile cap (m) = 3.26

(4) minimum rebar amount check

		Mu(kN.m)	Mc(kN.m)	1.7M(kN.m)	As(mm^2/m)	judge
bridge axis direction	lower tensile	12091	5103	9251	9872	OK
	upper tensile	5874	5103	2500	4557	OK
perpendicular direction	lower tensile	13810	5103	12459	11135	OK
	upper tensile	6288	5103	3380	4811	OK

Note: 1)Mu>=Mc, 2)1.7M<=Mc, 3)As>=500(mm^2/m)
if either 1) or 2) and 3) are satisfied, it is OK
Note: 1.7M is the value against maximum moment in all cases.

4.2 calculation of pile cap / sheet pile joint part

4.2.1 design condition

(1) steel material in use :SS400,SM400
(2) rebar in use :SD345(underwater member)
(3) concrete design standard strength :Sig.ck = 24 (N/mm²)
(4) material of steel pipe sheet pile :SKY400
(5) diameter of steel material main body :D = 1200.0 (mm)
(6) section coefficient of steel pipe pile body :Z = 15184.5 (cm³)
(7) joint method :rebar stud welding method

4.2.2 external working force

pile cap / sheet pile joint part is designed for external working force at bottom of pile cap
besides, in estimating vertical load, dead weight of pile cap upto celler part internal periphery and surcharge load are considered

(1) area of pile cap(let internal periphery sheet pile)

oval: $A1 = B^2 = PI /4 + B * (L-B)$

$= 6.135^2*Pai/4 + 6.135*(17.717- 6.135) = 100.620\ (m^2)$

(2)area of backfilling soil

$A2 = A1 - Ap = 63.550\ (m^2)$

where, Ap:leg column cross sectional area = 37.07 (m²)

(3)working force at leg column bottom

1)bridge axis direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	46500.0	0.0	0.0	0.0	0.0
2	OD(LT)	46500.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	46500.0	200.0	4000.0	800.0	4800.0
4	OD-TM(LT)	46500.0	200.0	4000.0	800.0	4800.0
5	WN-TM	46500.0	300.0	5600.0	1200.0	6800.0
6	OD-CL	46500.0	3800.0	39300.0	15200.0	54500.0
7	ETQ	41300.0	11400.0	153500.0	45600.0	199100.0

2)perpendicular direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	46500.0	0.0	3100.0	0.0	3100.0
2	OD(LT)	46500.0	0.0	3100.0	0.0	3100.0
3	WN	46500.0	1000.0	24800.0	4000.0	28800.0
4	OD-CL	46500.0	7500.0	80600.0	30000.0	110600.0
5	ETQ	41300.0	13000.0	219600.0	52000.0	271600.0

(4) pile cap, backfilling soil

V1 = A1*{ h1*Gam.c + h2*(Gam.c - Gam.w) }
V2 = A2*{ h1'*Gam.t + h2'*(Gam.sat - Gam.w) }
V3 = Ap*hw*Gam.w

where, V1 : weight of pile cap (kN)
V2 : weight of backfilling soil (kN)
V3 : buoyancy working at column (kN)
h1 : pile cap thickness upper than water table(m)
h2 : pile cap thickness lower than water table(m)
h1' : backfilling soil thickness upper than water table(m)
h2' : backfilling soil thickness lower than water table(m)
Gam.c : pile cap concrete unit weight = 24.5 (kN/m³)
Gam.w : unit weight of water =10.00 (kN/m³)
Gam.t : unit weight of backfilling soil(wet) = 17.5 (kN/m³)
Gam.sat: unit weight of backfilling soil(saturated) = 17.5 (kN/m³)
hw : water table (m)(height from crest of pile cap)
h' : backfilling soil thickness (m)
H1 : pile cap and filling concrete inertia force (kN)
y : pile cap inertia force working gravity location height (m)

1)bridge axis direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
2	OD(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
3	OD-TM(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
4	OD-TM(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54
5	WN-TM	11.340	1.004	5835.98	478.53	4203.74	2110.78
6	OD-CL	9.530	1.004	5835.98	478.53	3532.77	2781.75
7	ETQ	6.640	1.004	5835.98	478.53	2461.45	3853.07

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00
2	OD(LT)	0.00	0.000	0.00
3	OD-TM(HT)	0.00	0.000	0.00
4	OD-TM(LT)	0.00	0.000	0.00
5	WN-TM	0.00	0.000	0.00
6	OD-CL	0.00	0.000	0.00
7	ETQ	0.00	0.000	0.00

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
2	OD(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54
3	WN	11.340	1.004	5835.98	478.53	4203.74	2110.78
4	OD-CL	9.530	1.004	5835.98	478.53	3532.77	2781.75
5	ETQ	6.640	1.004	5835.98	478.53	2461.45	3853.07

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00
2	OD(LT)	0.00	0.000	0.00
3	WN	0.00	0.000	0.00

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
4	OD-CL	0.00	0.000	0.00
5	ETQ	0.00	0.000	0.00

(5)external force sum up

Vo = V + V1 + V2 - V3 + V4

Ho = H + H1

Mo = M + H*y + H1*y = SumM + H1*y

where, V4: other load (kN)

1)bridge axis direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	49281.7	0.0	0.0
2	OD(LT)	0.0	51346.5	0.0	0.0
3	OD-TM(HT)	0.0	49281.7	200.0	4800.0
4	OD-TM(LT)	0.0	51346.5	200.0	4800.0
5	WN-TM	0.0	48610.8	300.0	6800.0
6	OD-CL	0.0	49281.7	3800.0	54500.0
7	ETQ	0.0	45153.1	11400.0	199100.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	49281.7	0.0	3100.0
2	OD(LT)	0.0	51346.5	0.0	3100.0
3	WN	0.0	48610.8	1000.0	28800.0
4	OD-CL	0.0	49281.7	7500.0	110600.0
5	ETQ	0.0	45153.1	13000.0	271600.0

(6) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

$$Hi = \frac{Ho}{n1}$$

	number ni (num)	sectional area Aoi (m^2/num)	IBi (m^2)	
			bridge axis direction	perpendicular direction
periphery sheet pile(1)	32	0.05199	322.82	1255.78
separation wall sheet pile(2)	4	0.04464	10.76	0.00
intermediate driven pile (3)	--	------	----------	----------

1)bridge axis direction

No	abbreviation	vertical reaction(kN/num)	horizontal react (kN/num)	increment coefficient
1	OD(HT)	1391	0	1.00
2	OD(LT)	1449	0	1.00
3	OD-TM(HT)	1444	6	1.15
4	OD-TM(LT)	1502	6	1.15
5	WN-TM	1447	9	1.35
6	OD-CL	1993	119	1.50
7	ETQ	3473	356	1.50

2)perpendicular direction

No	abbreviation	vertical reaction(kN/num)	horizontal react (kN/num)	increment coefficient
1	OD(HT)	1414	0	1.00
2	OD(LT)	1472	0	1.00
3	WN	1589	31	1.25
4	OD-CL	2224	234	1.50
5	ETQ	3320	406	1.50

4.2.3 reaction

(1)bridge axis direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Oridinary(high tide)	1391	0	1.00
2	Oridinary(low tide)	1449	0	1.00
3	Ord+Temp(high tide)	1444	6	1.15
4	Ord+Temp(low tide)	1502	6	1.15
5	Wind+Temp	1447	9	1.35
6	Ord+Collision	1993	119	1.50
7	Earthquake	3473	356	1.50

(2)perpendicular direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Oridinary(high tide)	1414	0	1.00
2	Oridinary(low tide)	1472	0	1.00
3	Wind	1589	31	1.25
4	Ord+Collision	2224	234	1.50
5	Earthquake	3320	406	1.50

4.2.4 rebar stud welding method

(1) design bending moment

Me = Rp*e

MFix = Sig.sa * Zo

where, Me : moment by eccentricity of reaction(kN.m)

MFix : constraining moment (kN.m)

Rp : vertical reaction per single steel pipe sheet pile(kN)

e : eccentricity (m) = 0.6000

Sig.sa: allowable stress of steel pipe sheet pile (kN/m^2) = 140.00 (N/mm^2)

Zo : section coefficient of steel pipe pile body (m^3) = 15184.5 (cm^3)

select bigger of either Me or MFix

(2) moment rebar design

1) tensile stress by moment

$$T1 = \frac{M}{h}$$

$$Sig.s1 = \frac{T1}{nb*Ab}$$

where, T1 : tensile force working at moment rebar row (N)
M : design moment (N.mm)
h : center spacing of moment rebar row (mm) = 2800.00
Sig.s1: moment rebar tensile stress (N/mm²)
nb : number of moment rebar (number/ row) = 16
Ab : cross sectional area of single moment rebar (mm²) = 387.1 (D22)

2)tensile stress by horizontal force

$$T2 = \frac{Ho}{n1}$$

$$Sig.s2 = \frac{T2}{2*nb*Ab}$$

where, T2 : horizontal tensile force working at moment rebar row (N)
Ho : horizontal force working at bottom of pile cap(N)
n1 : number of periphery steel pipe sheet pile
Sig.s2: moment rebar tensile stress (N/mm²)

3)composite

Sig.s = Sig.s1 + Sig.s2 <= Sig.sa

where, Sig.sa: moment rebar allowable tensile stress (N/mm²)

4)required number of rebar

$$nba >= \frac{2*T1 + T2}{2*Sig.sa*Ab}$$

where, nba: required number of moment rebar (rebar/ row)

(3) shear rebar design

1) shear stress

$$Tau_s = \frac{Rp}{ns*As} <= Tau.sa$$

where, Tau.s : shear rebar shear stress (N/mm²)
Rp : vertical reaction per single steel pipe sheet pile (N)
ns : number of shear rebar = 64
As : cross sectional area of single shear rebar (mm²) = 387.1 (D22)
Tau.sa: shear rebar allowable shear stress (N/mm²)

2)required number of rebar

$$nsa >= \frac{Rp}{Tau.sa*As}$$

where, nsa: required number of shear rebar (number)

bridge axis direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	OD(HT)	1391.0	835	2126	2126	759.2	0.0
2	OD(LT)	1449.0	869	2126	2126	759.2	0.0
3	OD-TM(HT)	1444.0	866	2445	2445	873.1	6.0
4	OD-TM(LT)	1502.0	901	2445	2445	873.1	6.0
5	WN-TM	1447.0	868	2870	2870	1025.0	9.0
6	OD-CL	1993.0	1196	3189	3189	1138.8	119.0
7	ETQ	3473.0	2084	3189	3189	1138.8	356.0

No	Sig.s1 (N/mm²)	Sig.s2 (N/mm²)	Sig.s (N/mm²)	Sig.sa (N/mm²)	nb nba (rebar/row)	Tau.s (N/mm²)	Tau.sa (N/mm²)	ns nsa (rebar)
1	122.58	0.00	122.58	160.00	16 >= 13	56.15	96.00	64 >= 38
2	122.58	0.00	122.58	160.00	16 >= 13	58.49	96.00	64 >= 39
3	140.97	0.48	141.45	184.00	16 >= 13	58.29	110.40	64 >= 34
4	140.97	0.48	141.45	184.00	16 >= 13	60.63	110.40	64 >= 36
5	165.49	0.73	166.21	216.00	16 >= 13	58.41	129.60	64 >= 29
6	183.87	9.61	193.48	300.00	16 >= 11	80.45	180.00	64 >= 29

No	Sig.s1 (N/mm²)	Sig.s2 (N/mm²)	Sig.s (N/mm²)	Sig.sa (N/mm²)	nb nba (rebar/row)	Tau.s (N/mm²)	Tau.sa (N/mm²)	ns nsa (rebar)
7	183.87	28.74	212.61	300.00	16 >= 12	140.19	180.00	64 >= 50

perpendicular direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	OD(HT)	1414.0	848	2126	2126	759.2	0.0
2	OD(LT)	1472.0	883	2126	2126	759.2	0.0
3	WN	1589.0	953	2657	2657	949.0	31.0
4	OD-CL	2224.0	1334	3189	3189	1138.8	234.0
5	ETQ	3320.0	1992	3189	3189	1138.8	406.0

No	Sig.s1 (N/mm²)	Sig.s2 (N/mm²)	Sig.s (N/mm²)	Sig.sa (N/mm²)	nb nba (rebar/row)	Tau.s (N/mm²)	Tau.sa (N/mm²)	ns nsa (rebar)
1	122.58	0.00	122.58	160.00	16 >= 13	57.08	96.00	64 >= 39
2	122.58	0.00	122.58	160.00	16 >= 13	59.42	96.00	64 >= 40
3	153.23	2.50	155.73	200.00	16 >= 13	64.14	120.00	64 >= 35
4	183.87	18.89	202.76	300.00	16 >= 11	89.77	180.00	64 >= 32
5	183.87	32.78	216.65	300.00	16 >= 12	134.01	180.00	64 >= 48

4.3 calculation of pile head joint part

4.3.1 design condition

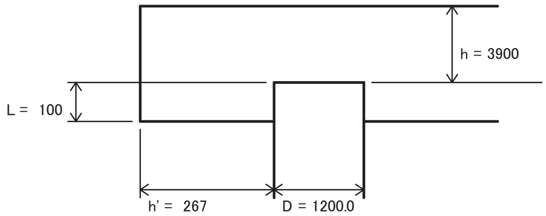
(1) design condition

1) joint method : method B

2) concrete design standard strength :Sig.ck = 24 (N/mm²)

3) rebar in use :SD345(underwater member)

(2) shape dimension



(3) pile head working force

1)bridge axis direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Oridinary(high tide)	1.00	1194	1194	0	0
2	Oridinary(low tide)	1.00	1244	1244	0	0
3	Ord+Temp(high tide)	1.15	1221	1167	5	5
4	Ord+Temp(low tide)	1.15	1271	1217	5	5
5	Wind+Temp	1.35	1217	1139	7	7
6	Ord+Collision	1.50	1504	884	92	53
7	Earthquake	1.50	2227	-39	277	194

2)perpendicular direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Oridinary(high tide)	1.00	1194	1194	0	3
2	Oridinary(low tide)	1.00	1244	1244	0	3
3	Wind	1.25	1178	1178	24	28
4	Ord+Collision	1.50	1194	1194	182	108
5	Earthquake	1.50	1094	1094	316	264

4.3.2 external working force

pile head joint part is designed for external working force at bottom of pile cap

besides, in estimating vertical load, dead weight of pile cap upto celler part internal periphery and surcharge load are considered

(1) area of pile cap(let internal periphery sheet pile)

oval: A1 = B^2= PI /4 + B * (L-B)

= 6.135^2*Pai/4 + 6.135*(17.717- 6.135) = 100.620 (m^2)

(2)area of backfilling soil

A2 = A1 - Ap = 63.550 (m^2)

where, Ap:leg column cross sectional area = 37.07 (m^2)

(3)working force at leg column bottom

1)bridge axis direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	46500.0	0.0	0.0	0.0	0.0
2	OD(LT)	46500.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	46500.0	200.0	4000.0	800.0	4800.0
4	OD-TM(LT)	46500.0	200.0	4000.0	800.0	4800.0
5	WN-TM	46500.0	300.0	5600.0	1200.0	6800.0
6	OD-CL	46500.0	3800.0	39300.0	15200.0	54500.0
7	ETQ	41300.0	11400.0	153500.0	45600.0	199100.0

2)perpendicular direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	OD(HT)	46500.0	0.0	3100.0	0.0	3100.0
2	OD(LT)	46500.0	0.0	3100.0	0.0	3100.0
3	WN	46500.0	1000.0	24800.0	4000.0	28800.0
4	OD-CL	46500.0	7500.0	80600.0	30000.0	110600.0
5	ETQ	41300.0	13000.0	219600.0	52000.0	271600.0

(4) pile cap, backfilling soil

V1 = A1*{ h1*Gam.c + h2*(Gam.c - Gam.w) }

V2 = A2*{ h1'*Gam.t + h2'*(Gam.sat - Gam.w) }

V3 = Ap*hw*Gam.w

where, V1 : weight of pile cap (kN)

V2 : weight of backfilling soil (kN)

V3 : buoyancy working at column (kN)

h1 : pile cap thickness upper than water table(m)

h2 : pile cap thickness lower than water table(m)

h1' : backfilling soil thickness upper than water table(m)

h2' : backfilling soil thickness lower than water table(m)

Gam.c : pile cap concrete unit weight = 24.5 (kN/m^3)

Gam.w : unit weight of water =10.00 (kN/m^3)

Gam.t : unit weight of backfilling soil(wet) = 17.5 (kN/m^3)

Gam.sat: unit weight of backfilling soil(saturated) = 17.5 (kN/m^3)

hw : water table (m)(height from crest of pile cap)

h' : backfilling soil thickness (m)

H1 : pile cap and filling concrete inertia force (kN)

y : pile cap inertia force working gravity location height (m)

1)bridge axis direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
2	OD(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
3	OD-TM(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
4	OD-TM(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54
5	WN-TM	11.340	1.004	5835.98	478.53	4203.74	2110.78
6	OD-CL	9.530	1.004	5835.98	478.53	3532.77	2781.75
7	ETQ	6.640	1.004	5835.98	478.53	2461.45	3853.07

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00
2	OD(LT)	0.00	0.000	0.00
3	OD-TM(HT)	0.00	0.000	0.00
4	OD-TM(LT)	0.00	0.000	0.00
5	WN-TM	0.00	0.000	0.00
6	OD-CL	0.00	0.000	0.00
7	ETQ	0.00	0.000	0.00

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	OD(HT)	9.530	1.004	5835.98	478.53	3532.77	2781.75
2	OD(LT)	3.960	1.004	5835.98	478.53	1467.97	4846.54
3	WN	11.340	1.004	5835.98	478.53	4203.74	2110.78
4	OD-CL	9.530	1.004	5835.98	478.53	3532.77	2781.75
5	ETQ	6.640	1.004	5835.98	478.53	2461.45	3853.07

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	OD(HT)	0.00	0.000	0.00
2	OD(LT)	0.00	0.000	0.00
3	WN	0.00	0.000	0.00

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
4	OD-CL	0.00	0.000	0.00
5	ETQ	0.00	0.000	0.00

(5)external force sum up

Vo = V + V1 + V2 - V3 + V4

Ho = H + H1

Mo = M + H*y + H1*y = SumM + H1*y

where, V4: other load (kN)

1)bridge axis direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	49281.7	0.0	0.0
2	OD(LT)	0.0	51346.5	0.0	0.0
3	OD-TM(HT)	0.0	49281.7	200.0	4800.0
4	OD-TM(LT)	0.0	51346.5	200.0	4800.0
5	WN-TM	0.0	48610.8	300.0	6800.0
6	OD-CL	0.0	49281.7	3800.0	54500.0
7	ETQ	0.0	45153.1	11400.0	199100.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	49281.7	0.0	3100.0
2	OD(LT)	0.0	51346.5	0.0	3100.0
3	WN	0.0	48610.8	1000.0	28800.0
4	OD-CL	0.0	49281.7	7500.0	110600.0
5	ETQ	0.0	45153.1	13000.0	271600.0

(6) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

	number ni (num)	sectional area Aoi (m^2/num)	IBi (m^2)	
			bridge axis direction	perpendicular direction
periphery sheet pile(1)	32	0.05199	322.82	1255.78
separation wall sheet pile(2)	4	0.04464	10.76	0.00
intermediate driven pile (3)	--	------	----------	----------

1)bridge axis direction

No	abbreviation	max vertical force (kN)	min vertical force (kN)	horizontal force(kN)	increment coefficient
1	OD(HT)	1194	1194	0	1.00
2	OD(LT)	1244	1244	0	1.00
3	OD-TM(HT)	1221	1167	5	1.15
4	OD-TM(LT)	1271	1217	5	1.15
5	WN-TM	1217	1139	7	1.35
6	OD-CL	1504	884	92	1.50
7	ETQ	2227	-39	277	1.50

2)perpendicular direction

No	abbreviation	max vertical force (kN)	min vertical force (kN)	horizontal force(kN)	increment coefficient
1	OD(HT)	1194	1194	0	1.00
2	OD(LT)	1244	1244	0	1.00
3	WN	1178	1178	24	1.25
4	OD-CL	1194	1194	182	1.50
5	ETQ	1094	1094	316	1.50

4.3.3 pile head joint part stress calculation

(1) pile cap concrete vertical bearing stress

$$Sig.cv = \frac{PNmax}{Pai*D^2/4} \le Sig.ca$$

where, PNmax : axial direction maximum compressive force (N)
D : pile external diameter (mm) = 120.00 (cm)
Sig.ca : concrete allowable bearing stress (N/mm^2)

(2) punching shear stress at pile cap concrete

$$Tau_v = \frac{PNmax}{Pai*(D + h)*h} \le Tau_a$$

where, h : effective thickness of pile cap to resist vertical punching shear force (mm) = 390.0 (cm)
Tau.a: concrete allowable punching shear stress (N/mm^2)

1)bridge axis direction

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
1	Oridinary(high tide)	1194	1.06	7.20	0.019	0.900
2	Oridinary(low tide)	1244	1.10	7.20	0.020	0.900
3	Ord+Temp(high tide)	1221	1.08	8.28	0.020	0.900
4	Ord+Temp(low tide)	1271	1.12	8.28	0.020	0.900
5	Wind+Temp	1217	1.08	9.72	0.019	0.900
6	Ord+Collision	1504	1.33	10.80	0.024	0.900
7	Earthquake	2227	1.97	10.80	0.036	0.900

2)perpendicular direction

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
1	Oridinary(high tide)	1194	1.06	7.20	0.019	0.900
2	Oridinary(low tide)	1244	1.10	7.20	0.020	0.900
3	Wind	1178	1.04	9.00	0.019	0.900

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
4	Ord+Collision	1194	1.06	10.80	0.019	0.900
5	Earthquake	1094	0.97	10.80	0.018	0.900

(3) horizontal bearing stress at pile cap concrete

$$Sig.ch = \frac{PHmax}{D*I} \leq Sig.ca$$

where, PHmax : axial orthogonal direction force (N)

I : pile embedment length (mm) = 10.0 (cm)

Sig.ca : concrete allowable bearing stress (N/mm^2)

1)bridge axis direction

No	load name	PHmax (kN)	Sig.ch (N/mm^2)	Sig.ca (N/mm^2)
1	Oridinary(high tide)	0	0.000	7.200
2	Oridinary(low tide)	0	0.000	7.200
3	Ord+Temp(high tide)	5	0.042	8.280
4	Ord+Temp(low tide)	5	0.042	8.280
5	Wind+Temp	7	0.058	9.720
6	Ord+Collision	92	0.767	10.800
7	Earthquake	277	2.308	10.800

2)perpendicular direction

No	load name	PHmax (kN)	Sig.ch (N/mm^2)	Sig.ca (N/mm^2)
1	Oridinary(high tide)	0	0.000	7.200
2	Oridinary(low tide)	0	0.000	7.200
3	Wind	24	0.200	9.000
4	Ord+Collision	182	1.517	10.800
5	Earthquake	316	2.633	10.800

4.3.4 pile head reinforcing rebar calculation

(1)calculation of imaginary rebar concrete section

sec	dia(cm)	cover(cm)	rebar	amount of used rebar(cm^2)
1row	160.00	26.0	D22 - 12 (@283)	46.452

1)bridge axis direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
1	OD(HT)	0.0	1194.0	0.000	0.00	0.57	8.00	-8.61	160.00
		0.0	1194.0	0.000	0.00	0.57	8.00	-8.61	160.00
2	OD(LT)	0.0	1244.0	0.000	0.00	0.60	8.00	-8.97	160.00
		0.0	1244.0	0.000	0.00	0.60	8.00	-8.97	160.00
3	OD-TM(HT)	5.0	1221.0	0.000	3975.66	0.60	9.20	-8.68	184.00
		5.0	1167.0	0.000	3803.37	0.57	9.20	-8.29	184.00
4	OD-TM(LT)	5.0	1271.0	0.000	4135.19	0.62	9.20	-9.04	184.00
		5.0	1217.0	0.000	3962.90	0.60	9.20	-8.65	184.00
5	WN-TM	7.0	1217.0	0.000	2853.48	0.60	10.80	-8.60	216.00
		7.0	1139.0	0.000	2675.72	0.56	10.80	-8.04	216.00
6	OD-CL	53.0	1504.0	0.000	532.69	0.85	12.00	-9.55	300.00
		53.0	884.0	0.000	346.07	0.55	12.00	-5.08	300.00
7	ETQ	194.0	2227.0	0.000	263.12	1.54	12.00	-11.32	300.00
		194.0	-39.0	14.615	29.04	1.87	12.00	101.25	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

2)perpendicular direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
1	OD(HT)	3.0	1194.0	0.000	6429.28	0.58	8.00	-8.54	160.00
		3.0	1194.0	0.000	6429.28	0.58	8.00	-8.54	160.00
2	OD(LT)	3.0	1244.0	0.000	6695.16	0.61	8.00	-8.90	160.00
		3.0	1244.0	0.000	6695.16	0.61	8.00	-8.90	160.00

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm^2)	neutral axis (cm)	Sig.c (N/mm^2)	Sig.ca (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)
3	WN	28.0	1178.0	0.000	751.14	0.63	10.00	-7.81	200.00
		28.0	1178.0	0.000	751.14	0.63	10.00	-7.81	200.00
4	OD-CL	108.0	1194.0	0.000	256.36	0.83	12.00	-5.97	300.00
		108.0	1194.0	0.000	256.36	0.83	12.00	-5.97	300.00
5	ETQ	264.0	1094.0	0.000	145.00	1.17	12.00	-1.33	300.00
		264.0	1094.0	0.000	145.00	1.17	12.00	-1.33	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

(2) pile head reinforcing rebar anchor length

$$Lo = \frac{Sig.sa}{4*Tau.oa} Phi = 687 \text{ (mm)}$$

Lo : rebaranchor length (mm)
Sig.sa : rebar allowable tensile stress = 200.00 (N/mm^2)
Tau.oa : allowable rebar bond stress = 1.600 (N/mm^2)
Phi. : pile head reinforcing rebar diameter = 22 (mm)

embedment length L >= Lo + 10 * Phi. = 908 (mm)

assure L from center of rebar in bottom of pile cap

(3) welding length of pile head supplemental rebar welding part by shear stress

$$Tau_s = \frac{Sig.sa*Ast}{1.4*Lambda*Ls} \le Tau.sa$$

$$Ls = \frac{Sig.s*Ast}{1.4*Lambda*Tau_{sa}}$$

where, Tau.sa: allowable shear stress of fillet welding = 72.00 (N/mm^2)
Sig.sa: rebar allowable tensile stress(to estimate anchor length) = 200.00 (N/mm^2)
Ast : sectional area of sigle pile head supplemental rebar = 3.871 (cm^2)
Lambda : fleg length of fillet welding (cm)
Ls : fillet welding length

welding leg length Lambda (cm)	0.6	0.7	0.8	0.9
welding length Ls (cm)	12.8	11.0	9.6	8.5

5 foundation spring calculation

subgrade reaction constant value used in calculation of natural period
It is calculated by the analysis model used in horizontal capacity method. But the upper limit of the subgrade reaction is not considered.

(1)Layer data

	type sand	thick(m) Layer	Nvalue	usual time	in quakes	calculation natural period	
				Alp.*Eo (kN/m^2)	Alp.*Eo (kN/m^2)	dyna.het.coef ED(kN/m)	dyna.pois.rate NyuD
1	clay	1.066	1.0	3600	7200	34286	0.50
2	sandy	4.000	3.0	4800	9600	45643	0.50
3	sandy	7.000	13.0	20800	41600	117855	0.50
4	clay	4.000	9.0	25200	50400	148348	0.50
5	clay	17.000	7.0	19600	39200	125458	0.50
6	clay	15.000	18.0	50400	100800	242205	0.50
7	sandy	2.244	50.0	140000	280000	323331	0.50

(2)modulus of subgrade reaction
1) foundation bottom spring

	vertical direction kv(kN/m^3)	horizontal direction shear ks(kN/m^3)
periphery sheet pile	381049	114315
separation wall sheet pile	381049	114315
intermediate driven pile	----------	----------

2) foundation front , side spring

usual time/ earthquake time　　kHo = Alp.*Eo/0.3
estimate natural period　　kHo = ED/0.3
foundation front horizontal direction　　kh = Alp.k*kHo*(Be/0.3)$^{(-3/4)}$(kN/m^3)
foundation front vertical direction　　kSVB = 0.3*Alp.k*kHo*(Be/0.3)$^{(-3/4)}$(kN/m^3)
foundation side horizontal direction　　kSHD = 0.6*Alp.k*kHo*(De/0.3)$^{(-3/4)}$(kN/m^3)
foundation side vertical direction　　kSVD = 0.3*Alp.k*kHo*(De/0.3)$^{(-3/4)}$(kN/m^3)

where Alp.k : modulus of subgrade reaction correction coefficient (= 1.50)
Alp. : modulus of elasticity in ground (kN/m^2)
Eo : dynamic modulus of elasticity in ground (kN/m^2)
ED : dynamic modulus of elasticity in ground (kN/m^2)
Nu.D: dynamic Poisson's ratio
Be : equivalent loading width in orthogonal direction to external force, foundation width (m)
De : equivalent loading width in external force direction, foundation width (m)
both Be,De are values which 0.2*D is deducted in case of circular and oval shape (D:circular diameter (m))

usual time
1.bridge axis direction(Be = 18.41045, De = 6.82805)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-6.350 - -7.416	821	246	1036	518
2	-7.416 - -10.350	1095	328	1382	691
3	-10.350 - -11.416	1095	328	1382	691
4	-11.416 - -18.416	4743	1423	5988	2994
5	-18.416 - -22.416	5747	1724	7255	3628
6	-22.416 - -39.416	4470	1341	5643	2821
7	-39.416 - -50.525	11493	3448	14510	7255
8	-50.525 - -54.416	11493	6896	14510	14510
9	-54.416 - -56.660	31926	19155	40306	40306

2.perpendicular direction(Be = 6.82805, De = 18.41045)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-6.350 - -7.416	1727	518	493	246
2	-7.416 - -10.350	2303	691	657	328
3	-10.350 - -11.416	2303	691	657	328
4	-11.416 - -18.416	9980	2994	2846	1423
5	-18.416 - -22.416	12092	3628	3448	1724
6	-22.416 - -39.416	9405	2821	2682	1341
7	-39.416 - -50.525	24183	7255	6896	3448
8	-50.525 - -54.416	24183	14510	6896	6896
9	-54.416 - -56.660	67176	40306	19155	19155

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -50.525(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

earthquake time

1.bridge axis direction(Be = 18.41045, De = 6.82805)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-6.350 - -7.416	547	164	690	345
2	-7.416 - -10.350	729	219	920	460
3	-10.350 - -11.416	729	219	920	460
4	-11.416 - -18.416	9486	2846	11977	5988
5	-18.416 - -22.416	11493	3448	14510	7255
6	-22.416 - -39.416	8939	2682	11286	5643
7	-39.416 - -50.525	22987	6896	29020	14510
8	-50.525 - -54.416	22987	13792	29020	29020
9	-54.416 - -56.660	63851	38311	80612	80612

2.perpendicular direction(Be = 6.82805, De = 18.41045)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-6.350 - -7.416	1150	345	328	164
2	-7.416 - -10.350	1534	460	437	219
3	-10.350 - -11.416	1534	460	437	219
4	-11.416 - -18.416	19961	5988	5692	2846
5	-18.416 - -22.416	24183	7255	6896	3448
6	-22.416 - -39.416	18809	5643	5364	2682
7	-39.416 - -50.525	48367	14510	13792	6896
8	-50.525 - -54.416	48367	29020	13792	13792
9	-54.416 - -56.660	134353	80612	38311	38311

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -50.525(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

to estimate natural period

1.bridge axis direction(Be = 18.41045, De = 6.82805)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-6.350 - -7.416	7819	2346	9871	4935
2	-7.416 - -10.350	10408	3123	13141	6570
3	-10.350 - -11.416	10408	3123	13141	6570
4	-11.416 - -18.416	26876	8063	33930	16965
5	-18.416 - -22.416	33829	10149	42709	21355
6	-22.416 - -39.416	28610	8583	36119	18060
7	-39.416 - -50.525	55233	16570	69730	34865
8	-50.525 - -54.416	55233	33140	69730	69730
9	-54.416 - -56.660	73733	44240	93087	93087

2.perpendicular direction(Be = 6.82805, De = 18.41045)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-6.350 - -7.416	16451	4935	4691	2346
2	-7.416 - -10.350	21901	6570	6245	3123
3	-10.350 - -11.416	21901	6570	6245	3123
4	-11.416 - -18.416	56550	16965	16125	8063
5	-18.416 - -22.416	71182	21355	20298	10149
6	-22.416 - -39.416	60199	18060	17166	8583
7	-39.416 - -50.525	116217	34865	33140	16570
8	-50.525 - -54.416	116217	69730	33140	33140
9	-54.416 - -56.660	155144	93087	44240	44240

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -50.525(m) evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

(3)joint pipe external diameter ,shear resistance of joint

joint pipe external diameter

- periphery :linear part = 0.1652 (m)
- periphery :curve part = 0.1652 (m)
- separation wall:Y direction = 0.1652 (m)
- separation wall:X direction = 0.1652 (m)

shear resistance of joint

- shear rigidity Gj = 1200000 (kN/m^2)
- shear capacity qju = 200 (kN/m)

(4) ground spring constant to estimate natural period

general equation

$$\begin{bmatrix} H \\ M \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del. \\ Theta \end{bmatrix}$$

hence

$$\begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}$$

$$\begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} = \begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}^{-1}$$

where Ho : unit horizontal force to apply at crest of foundation (kN)
Mo : unit moment to apply at crest of foundation (kN.m)
Del.oH : horizontal displacement at crest of foundation by Ho(m)
Theta$_{oH}$: rotational angle at crest of foundation by Ho (rad)
Del.oM : horizontal displacement at crest of foundation by Mo(m)
Theta$_{oM}$: rotational angle at crest of foundation by Mo (rad)
Ass : ground spring constant (kN/m)
Asr : ground spring constant (kN/rad)
Ars : ground spring constant (kN.m/m)
Arr : ground spring constant (kN.m/rad)

usual time

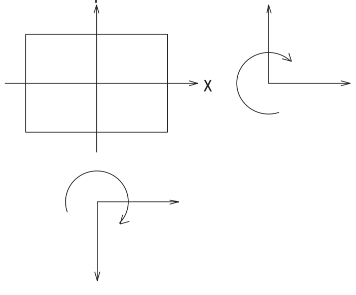
item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.1842E-001	7.3077E-002
ThetaoH	mrad	6.1744E-003	2.5375E-003
Del.oM	mm	6.1744E-002	2.5375E-002
ThetaoM	mrad	5.9902E-003	2.0713E-003
Ass	kN/m	1.8257E+006	2.3815E+006
Asr	kN/rad	-1.8818E+007	-2.9175E+007
Ars	kN.m/m	-1.8818E+007	-2.9175E+007
Arr	kN.m/rad	3.6091E+008	8.4021E+008

earthquake time

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	8.8600E-002	5.1546E-002
ThetaoH	mrad	5.2694E-003	1.9813E-003
Del.oM	mm	5.2694E-002	1.9813E-002
ThetaoM	mrad	5.5800E-003	1.8254E-003
Ass	kN/m	2.5748E+006	3.3288E+006
Asr	kN/rad	-2.4315E+007	-3.6131E+007
Ars	kN.m/m	-2.4315E+007	-3.6131E+007
Arr	kN.m/rad	4.0883E+008	9.3999E+008

to estimate natural period

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	3.1510E-002	1.8723E-002
ThetaoH	mrad	2.4294E-003	9.1921E-004
Del.oM	mm	2.4294E-002	9.1921E-003
ThetaoM	mrad	3.3633E-003	1.1016E-003
Ass	kN/m	7.1622E+006	9.0474E+006
Asr	kN/rad	-5.1734E+007	-7.5495E+007
Ars	kN.m/m	-5.1734E+007	-7.5495E+007
Arr	kN.m/rad	6.7101E+008	1.5377E+009



Y direction: bridge axis direction
X direction:perpendicular direction

3.5 DETAIL CALCULATION SHEET OF SPSP OF P7 (LOAD CASE-3)

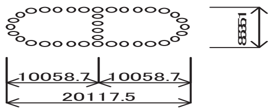
Load Case-3 is the case which considers:

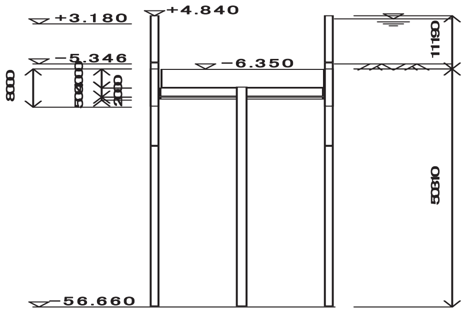
- with local scouring of 1/2 of maximum scouring depth, thus design elevation is set on the elevation of 1/2 of maximum scouring depth EL-6.51m.
- Load combinations of Extreme wind situation＋Effect of Temperature Change, Vessel Collision, Earthquake Condition

Contents

1 concrete body calculation

1.1 foundation shape dimension diagram





1.2 steel pipe sheet pile composing points

1)periphery sheet pile

external diameter = 1200.0(mm)
pile length = 61.500(m)
number = 32(number)

steel pipe thickness (mm)	length (m)	material
14.0	10.000	SKY400
16.0	17.500	SKY400
14.0	34.000	SKY400

2)separation wall sheet pile

external diameter = 1200.0(mm)
pile length = 46.410(m)
number = 4(number)

steel pipe thickness (mm)	length (m)	material
14.0	46.410	SKY400

1.3 ground condition

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m^3)		c (kN/m^2)	Phi. (angle)	modulus of elasticity Alp.*Eo(kN/m^2)		reduction coefficient		
				Gam.	Gam.'			usual	earthquake	DE	DE' Type1	DE' Type2
1	chsv	2.070	1.0	17.5	7.5	10.0	0.00	3600	7200	0.333	0.333	0.333
2	sand	4.000	3.0	17.5	8.5	0.0	28.00	4800	9600	0.333	0.333	0.333
3	sand	7.000	13.0	17.0	8.0	0.0	33.00	20800	41600	1.000	1.000	1.000
4	chsv	4.000	9.0	17.5	7.5	54.0	0.00	25200	50400	1.000	1.000	1.000
5	chsv	17.000	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
6	chsv	15.000	18.0	18.0	8.0	108.0	0.00	50400	100800	1.000	1.000	1.000
7	sand	5.400	50.0	19.0	10.0	0.0	35.00	140000	280000	1.000	1.000	1.000

1.4 section properties

(1)section properties of steel pipe pile body

errosion margin external side = 2.0 (mm) internal side = 0.0 (mm)

1)periphery sheet pile Do = 1200(mm) number = 32

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
16.0	16.310	519.9	908031	15184	SKY400
14.0	34.000	446.4	782242	13081	SKY400

2)separation wall sheet pile Do = 1200(mm) number = 4

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
14.0	46.310	446.4	782242	13081	SKY400

(2)sum of squared distance from centroid of steel pipe sheet to neutral axis of horizontal section of celler IB(m^2)

	bridge axis direction	perpendicular direction
periphery sheet pile	322.82	1255.78
separation wall sheet pile	10.76	0.00

(3)sum of moment of inertia in celler part I(m^4)

bridge axis direction $I = SumIoi + Mu * Sum(Aoi * Yi^2)$

perpendicular direction $I = SumIoi + Mu * Sum(Aoi * Xi^2)$

Mu : composite efficiency - 0.75

No	L(m)	bridge axis direction	perpendicular direction
1	16.310	13.268884	49.285200
2	34.000	11.448796	42.321287

foundation length = 50.310 (m)

(4)coordinates of cetroid of steel pipe sheet pile

1) periphery sheet pile

No	Y(m)	X(m)	number
1	3.6675	0.0000	2
2	3.6675	1.4478	4

No	Y(m)	X(m)	number
3	3.6675	2.8956	4
4	3.6675	4.3434	4
5	3.6675	5.7912	4
6	0.0000	9.4587	2
7	1.4035	9.1796	4
8	2.5933	8.3845	4
9	3.3884	7.1947	4

2) separation wall sheet pile

No	Y(m)	X(m)	number
1	2.2005	0.0000	2
2	0.7335	0.0000	2

1.5 ground constant

(1) ground modulus of elasticity

layer No	usual time		earthquake time		
	layer thickness (m)	Alp.*Eo(kN/m^2)	layer thickness (m)	Alp.*Eo(kN/m^2)	DE
protrusion length	0.160	------	0.160	------	----
1	0.906	3600	0.906	7200	0.333
2	4.000	4800	4.000	9600	0.333
3	7.000	20800	7.000	41600	1.000
4	4.000	25200	4.000	50400	1.000
5	17.000	19600	17.000	39200	1.000
6	15.000	50400	15.000	100800	1.000
7	2.244	140000	2.244	280000	1.000

(2)vertical modulus of subgrade reaction

$$kv = \frac{1}{0.3} * Alp. * Eo * \left(\frac{Bv}{0.3}\right)^{-3/4}$$

where kv : vertical modulus of subgrade reaction (kN/m^3)

Alp.*Eo: ground modulus of elasticity (kN/m^2)

usual time = 140000

earthquake time = 280000

Bv : foundation equivalent loading width of foundation (m) -- external diameter of steel pipe sheet pile main body

	Bv (mm)	kv(kN/m^3)	
		usual	earthquake
periphery sheet pile	1200.0	164992	329983
separation wall sheet pile	1200.0	164992	329983

(3)horizontal modulus of subgrade reaction

$$kH = \frac{1}{0.3} * Alp. * Eo * \left(\frac{BH}{0.3}\right)^{-3/4}$$

where kH : horizontal modulus of subgrade reaction (kN/m^3)

BH : equivalent loading width of foundation in orthogonal to load working direction (m)

$BH = \sqrt{D/Beta} \ <= \ \sqrt{De*Le}$

D : loading width of foundation in orthogonal to load working direction (m)

De : effective loading width of foundation in orthogonal to load working direction (m)

1/Beta : ground depth to relate with horizontal resistance, less than foundation length (m)

Beta : characteristic value of foundation(m^{-1})

$$Beta = \sqrt[4]{\frac{kH*D}{4*E*I}}$$

E : Young's modulus of foundation = 2.00 * 10^8(kN/m^2)

I : moment of inertia of foundation (m^4)

Le : effective embedment depth of foundation(m)

$$kH1 = (1 + Alp.H)*kH*\left(\frac{y}{yo}\right)^{-1/2}$$

where kH1 : in case of considering strain-dependance, standard modulus of subgrade reaction in horizontal direction (kN/m^3)
(assuming y = yo, standard value)

Alp.H : shear subgrade reaction on celler part side in horizontal direction and resistance of internal soil increment coefficient including sharing etc (= 1.00)

y : horizontal displacemen of foundation on design ground surfacet (m)

yo : standard displacement (m)

	bridge axis direction		perpendicular direction	
	usual time	earthquake time	usual time	earthquake time
I (cm^4)	1.3269E+009		4.9285E+009	
D (cm)	2011.75		853.51	
Beta(cm^{-1})	0.000464	0.000464	0.000288	0.000288
1/Beta(cm)	2157.3	2157.3	3468.6	3468.6
average Alp.*Eo (N/cm^2)	1761.2	1761.2	1994.4	1994.4
BH, $\sqrt{De*Le}$ (cm)	2083.3 < 3176.3	2083.3 < 3176.3	1720.6 < 2068.9	1720.6 < 2068.9

layer No	layer thickness (m)		Alp.*Eo(kN/m²)		bridge axis direction kH1(kN/m³)		perpendicular direction kH1(kN/m³)	
	usual	earthquake	usual	earthquake	usual	in earthquake	usual	in earthquake
protrusion length	0.160	0.160	------	------	------	------	------	------
1	0.906	0.906	3600	7200	998	664	1152	767
2	4.000	4.000	4800	9600	1330	886	1535	1023
3	7.000	7.000	20800	41600	5764	11529	6654	13307
4	4.000	4.000	25200	50400	6984	13968	8061	16122
5	17.000	17.000	19600	39200	5432	10864	6270	12539
6	15.000	15.000	50400	100800	13968	27935	16122	32244
7	2.244	2.244	140000	280000	38799	77598	44783	89567

horizontal modulus of subgrade reaction(using value)(kN/m³)

layer No	layer thickness (m)		bridge axis direction		perpendicular direction	
	usual time	in quakes	usual time	in quakes	usual time	in quakes
protrusion length	0.160	0.160	------	------	------	------
1	0.906	0.906	998	664	1152	767
2	4.000	4.000	1330	886	1535	1023
3	7.000	7.000	5764	11529	6654	13307
4	4.000	4.000	6984	13968	8061	16122
5	17.000	17.000	5432	10864	6270	12539
6	15.000	15.000	13968	27935	16122	32244
7	2.244	2.244	38799	77598	44783	89567

(4)horizontal direction shear modulus of subgrade reaction at bottom of celler

$ks = 0.3 * kv$

where ks :horizontal direction shear modulus of subgrade reaction at bottom of celler (kN/m³)

	usual time	in quakes
periphery sheet pile	49497	98995
separation wall sheet pile	49497	98995

(5)spring constant at bottom of celler

1)vertical spring constant

$$Kv = \sum_{i}^{3}((ni*kvi*A1i)) \text{ (kN/m)}$$

where A1i : close sectional area of steel pipe sheet pile and intermediate driven single pile (m²)

periphery sheet pile		separation wall sheet pile		intermediate driven pile		Kv (kN/m)	
A11(m²)	n1(number)	A12(m²)	n2(number)	A13(m²)	n3(number)	usual time	earthquake time
1.1310	32	1.1310	4	0.0000	0	6.7176E+006	1.3435E+007

2) shear spring constant

$$Ks = \sum_{i}^{2}((ni*ksi*A1i)) \text{ (kN/m)}$$

usual time	in quakes
2.0153E+006	4.0306E+006

3)rotational spring constant

$$Kr = \sum_{i}^{2}((kvi*A1i*IBi)) \text{ (kN.m/rad)}$$

where IB : celler composed with steel pipe sheet pile

sum of squared distance from centroid to neutral axis of horizontal section of celler (m²)

	periphery sheet pile IB1 (m²)	separation wall sheet pile IB2 (m²)	Kr (kN.m/rad)	
			usual time	in quakes
bridge axis direction	322.82	10.76	6.2246E+007	1.2449E+008
perpendicular direction	1255.78	0.00	2.3433E+008	4.6866E+008

spring constant at bottom of celler(using value)

		usual time	in quakes
vertical spring Kv (kN/m)		6.7176E+006	1.3435E+007
shear spring Ks (kN/m)		2.0153E+006	4.0306E+006
rotational spring Kr (kN.m/rad)	bridge axis direction	6.2246E+007	1.2449E+008
	perpendicular direction	2.3433E+008	4.6866E+008

1.6 allowable bearing capacity

(1)allowable compressive bearing capacity of steel pipe sheet pile

work method : driven construction method

steel pipe sheet pile main body external diameter :Phi.1200.0 (mm)

$$Ra = \frac{1}{n} * Ru$$

$$Ru = qd*A1 + \frac{1}{n1+n2+n3}*\{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

where Ra: allowable compressive bearing capacity of steel pipe sheet pile(kN/pile)

n : factor of safety usual time n = 3

earthquake time n = 2

Ru: ultimate bearing capacity of steel pipe sheet pile in lower ground (kN)

A1: close sectional area of steel pipe sheet pile body (m^2)

A1 = 1.131 (m^2)

qd: ultimate bearing capacity per unit area supporting steel pipe sheet pile tip (kN/m^2)

$$\frac{\text{equivalent embedment depth to bearing strata}}{\text{pile diameter}} = \frac{1.240}{1.2000} = 1.03$$

$qd / \bar{N} = 62$

$\bar{N}$:design N value in steel pipe sheet pile tip ground $\bar{N}$ = 40.0

qd = 62 * 40.0 = 2480 (kN/m^2)

n1 : celler part periphery steel pipe sheet pile number (number) n1 = 32

n2 : number of steel pipe sheet pile in separation wall part (number) n2 = 4

n3 : intermediate driven single pile number (number) n3 = 0

U1 : enveloping celler part periphery length (m) U1 = 49.978 (m)

U2 : enveloping celler part and separation wall part periphery length
and sum of perimeter of intermediate driven single pile U2 = 52.309 (m)

Li : thickness which celler skin friction of external periphery is considered (m)

fi : maximum skin friction angle of layer which celler skin friction of external periphery is considered (kN/m^2)

Lj : thickness which celler skin friction of internal periphery is considered (m)

fj : maximum skin friction angle of layer which celler skin friction of internal periphery is considered (kN/m^2)
range of internal soil short side length(Lo) from bottom is only considered

Lo = 6.135 (m)

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m²)		DEi	Li*fi(DEi) (kN/m)	
				usual time	in quakes		usual time	in quakes
1	cohesv	1.0	0.160	0.0	0.0	0.333	0.0	0.0
2	cohesv	1.0	0.906	10.0	10.0	0.333	9.1	3.0
3	sandy	3.0	4.000	0.0	0.0	0.333	0.0	0.0
4	sandy	13.0	7.000	26.0	26.0	1.000	182.0	182.0
5	cohesv	9.0	4.000	90.0	90.0	1.000	360.0	360.0
6	cohesv	7.0	17.000	70.0	70.0	1.000	1190.0	1190.0
7	cohesv	18.0	15.000	150.0	150.0	1.000	2250.0	2250.0
8	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			50.310				4215.5	4209.4

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m²)		DEj	Lj*fj(DEj) (kN/m)	
				usual time	in quakes		usual time	in quakes
7	cohesv	18.0	3.891	150.0	150.0	1.000	583.6	583.6
8	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			6.135				808.0	808.0

DE: reduction coefficient in earthquake time

ultimate bearing capacity

$$Ru = qd*A1 + \frac{1}{n1+n2+n3}*\{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

= 2805 + 7026 = 9831 (kN/number) (usual time)

= 2805 + 7018 = 9823 (kN/number) (earthquake time)

allowable compressive bearing capacity

usual time Ra = (1 / 3) * 9831 = 3277 (kN/number)

earthquake Ra = (1 / 2) * 9823 = 4911 (kN/number)

(2)allowable uplifting force of steel pipe sheet pile

$$Pa = \frac{1}{n} * Pu + W$$

$$Pu = \frac{1}{n1+n2+n3} * \{ U1*\Sigma(Li*fi) + U2*\Sigma(Lj*fj) \}$$

where, Pa: allowable uplifting force of steel pipe sheet pile(kN/number)
n : factor of safety usual time n = 6
earthquake time n = 3
Pu: determined from ground, ultimate uplifting force of steel pipe sheet pile (kN/number)
W : effective weight of steel pipe sheet pile(kN)

effective weight of steel pipe sheet pile W(= w1 + w2 + w3 + w4)

		usual time	earthquake time
steel pipe weight	w1 (kN) =	158.5	158.5
joint weight	w2 (kN) =	0.0	0.0
soil weight inside of pipe	w3 (kN) =	358.2	358.2
filling concrete weight	w4 (kN) =	0.0	0.0
	W (kN) =	516.7	516.7

skin friction of external periphery

No	soil	average N value	layer thick Li (m)	fi (kN/m²) usual time	fi (kN/m²) in quakes	DEi	Li*fi(DEi) (kN/m) usual time	Li*fi(DEi) (kN/m) in quakes
1	cohesv	1.0	0.160	0.0	0.0	0.333	0.0	0.0
2	cohesv	1.0	0.906	10.0	10.0	0.333	9.1	3.0
3	sandy	3.0	4.000	0.0	0.0	0.333	0.0	0.0
4	sandy	13.0	7.000	26.0	26.0	1.000	182.0	182.0
5	cohesv	9.0	4.000	90.0	90.0	1.000	360.0	360.0
6	cohesv	7.0	17.000	70.0	70.0	1.000	1190.0	1190.0
7	cohesv	18.0	15.000	150.0	150.0	1.000	2250.0	2250.0
8	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			50.310				4215.5	4209.4

DE: reduction coefficient in earthquake time

skin friction of internal periphery

No	soil	average N value	layer thick Lj (m)	fj (kN/m²) usual time	fj (kN/m²) in quakes	DEj	Lj*fj(DEj) (kN/m) usual time	Lj*fj(DEj) (kN/m) in quakes
7	cohesv	18.0	3.891	150.0	150.0	1.000	583.6	583.6
8	sandy	50.0	2.244	100.0	100.0	1.000	224.4	224.4
Sum			6.135				808.0	808.0

DE: reduction coefficient in earthquake time

ultimate uplifting force
Pu = 7026 (kN/number) (usual time time)
Pu = 7018 (kN/number) (earthquake time)

allowable uplifting force
usual time Pa - (1 / 6) * 7026 + 517 - 1688 (kN/number)
earthquake Pa - (1 / 3) * 7018 + 517 - 2856 (kN/number)

allowable compressive bearing capacity / uplifting force of steel pipe sheet pile(using value)(kN/number)

allowable compressive bearing capacity	usual time	3277
	in quakes	4911
allowable uplifting force bearing capacity	usual time	1688
	in quakes	2856

1.7 design force

in steel pipe sheet pile foundation, for coffering double use method, external force which works at the center of crest is considered.
yet, vertical load is sum of crest of pile cap load, pile cap weight, filling concrete weight and backfilling soil weight
consider

(1) input shape, unit weight and design seismic coefficient

pile cap shape :oval
pile cap dimension : 8.5351 (m) * 20.1175 (m)
pile cap thickness h1 = 4.000 (m)
steel pipe pile body external diameter Phi. = 1200.0 (mm)
number of external wallsteel pipe sheet pile n = 32
filling concrete cast height h2 = 8.000 (m)
leg column cross sectional area Ap = 37.070 (m^2)
shape : oval
dimension : a = 13.000 (m) perpendicular direction
: b = 3.000 (m) bridge axis direction
unit weight : backfilling soil(wet) Gam.t = 17.5 (kN/m^3)
backfilling soil(saturated) Gam.sat = 17.5 (kN/m^3)
pile cap concrete Gam.c1 = 24.5 (kN/m^3)
filling concrete Gam.c2 = 23.0 (kN/m^3)
footing concrete = 23.0 (kN/m^3)
paving sand (wet) = 19.0 (kN/m^3)
(saturated) = 20.0 (kN/m^3)
water Gam.w = 10.00 (kN/m^3)
design seismic coefficient : pile cap kh = 0.30 bridge axis direction
kh = 0.30 perpendicular direction
internal soil kh = 0.00 bridge axis direction
kh = 0.00 perpendicular direction
ground surface in seismic design = 0.160 (m) (depth from crest of)

1)bridge axis direction

No	load name	backfilling soil height (m)	water table height (m)
1	Wind+Temp	-6.350	4.990
2	Ord+Collision(scour)	-6.350	3.180
3	Earthquake(scour)	-6.350	0.290

2)perpendicular direction

No	load name	backfilling soil height (m)	water table height (m)
1	Wind	-6.350	4.990
2	Ord+Collision(scour)	-6.350	3.180
3	Earthquake(scour)	-6.350	0.290

(2) working force at leg column bottom

1)bridge axis direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Wind+Temp	46500.0	300.0	5600.0
2	Ord+Collision(scour)	46500.0	3800.0	39300.0
3	Earthquake(scour)	41300.0	11700.0	153600.0

2)perpendicular direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Wind	46500.0	1000.0	24800.0
2	Ord+Collision(scour)	46500.0	7500.0	80600.0
3	Earthquake(scour)	41300.0	13100.0	219800.0

(3) pile cap area

oval

$$A1 = \frac{Pai}{4} * (B-D)^2 + (B-D)*(L-B) - \frac{Pai}{4} * D^2 * \frac{n}{2} = 109.119\ (m^2)$$

filling concrete area

$$A2 = \frac{Pai}{4} * D^2 * n = 36.191\ (m^2)$$

backfilling soil area

$$A3 = A1 + A2 - Ap = 108.240\ (m^2)$$

1)bridge axis direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	WN-TM	11.340	0.000	6328.9	3763.9	0.0	4203.7	5889.0
2	OD-CL(SC)	9.530	0.000	6328.9	3763.9	0.0	3532.8	6560.0
3	ETQ(SC)	6.640	0.000	6328.9	3763.9	0.0	2461.4	7631.3

2)perpendicular direction

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
1	WN	11.340	0.000	6328.9	3763.9	0.0	4203.7	5889.0
2	OD-CL(SC)	9.530	0.000	6328.9	3763.9	0.0	3532.8	6560.0
3	ETQ(SC)	6.640	0.000	6328.9	3763.9	0.0	2461.4	7631.3

hw: water table(m), height upward from crest of pile cap
V1: weight of pile cap
V2: weight of filling concrete
V3: backfilling soil weight
Vp: buoyancy works at column
V1 = A1*{ h11*Gam.c1 + h21*(Gam.c1 - Gam.w) }
V2 = A2*{ h12*Gam.c2 + h22*(Gam.c2 - Gam.w) }
V3 = A3*{ h13*Gam.t + h23*(Gam.sat - Gam.w) }
h1i: thickness upper than water table(m)
h2i: thickness lower than water table(m)
Vp = Ap*hw*Gam.w
ƒ°V= V1 {V2 {V3 |Vp

(4) inertia force
The case that design ground face on earthquake locates lower than pile cap lower face, upper than design ground face on earthquake
inertia force of foundation main body is applied as distributed load
inertia force of foundation main body is shown below as distributed load

pile cap(working height 0.160 m)
1)bridge axis direction
w = A1*Gam.c1*kh = 802.02 (kN/m)
H = w* 0.160 = 128.32 (kN)
2)perpendicular direction
w = A1*Gam.c1*kh = 802.02 (kN/m)
H = w* 0.160 = 128.32 (kN)

filling concrete (working height 0.160 m)
1)bridge axis direction
w = A2*Gam.c2*kh = 249.72 (kN/m)
H = w* 0.160 = 39.96 (kN)
2)perpendicular direction
w = A2*Gam.c2*kh = 249.72 (kN/m)
H = w* 0.160 = 39.96 (kN)

(5) design external force sum up
1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind+Temp	52389.0	300.0	5600.0	1.35	usual time	usual time
2	Ord+Collision(scour)	53060.0	3800.0	39300.0	1.50	usual time	usual time
3	Earthquake(scour)	48931.3	11700.0	153600.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind	52389.0	1000.0	24800.0	1.25	usual time	usual time
2	Ord+Collision(scour)	53060.0	7500.0	80600.0	1.50	usual time	usual time
3	Earthquake(scour)	48931.3	13100.0	219800.0	1.50	earthquake time	earthquake time

1.8 design external force(using value)

1)bridge axis direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind+Temp	52389.0	300.0	5600.0	1.35	usual time	usual time
2	Ord+Collision(scour)	53060.0	3800.0	39300.0	1.50	usual time	usual time
3	Earthquake(scour)	48931.3	11700.0	153600.0	1.50	earthquake time	earthquake time

2)perpendicular direction

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
1	Wind	52389.0	1000.0	24800.0	1.25	usual time	usual time
2	Ord+Collision(scour)	53060.0	7500.0	80600.0	1.50	usual time	usual time
3	Earthquake(scour)	48931.3	13100.0	219800.0	1.50	earthquake time	earthquake time

1.9 calculation result table

1)bridge axis direction

item			unit	WN-TM	OD-CL(SC)	ETQ(SC)
working force		Vo	kN	52389.0	53060.0	48931.3
		Ho	kN	300.0	3800.0	11700.0
		Mo	kN.m	5600.0	39300.0	153600.0
foundation crest	displacement	Del.1	cm	0.060	0.576	1.829
	deflexion angle	Theta.1	mrad	-0.055	-0.489	-1.687
design ground surface	displacement	Del.2	cm	0.060	0.568	1.802
	deflexion angle	Theta.2	mrad	-0.055	-0.487	-1.677
celler part maximum bending moment		Mmax	kN.m	-6957.0	-59287.0	-222356.0
Mmax accrue location		Lm	m	-13.350	-14.350	-14.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	34.24	48.02	88.44
		Lm	m	-22.660	-22.660	-14.350
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	33.76	43.61	70.30
		Lm	m	-22.660	-22.660	-14.350
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------	--------
celler partbottom bending moment		MB	kN.m	134.0	1210.0	4837.0
vertical reaction	maximum	Rmax	kN/num	1457	1487	1412
	minimum	Rmin	kN/num	1454	1461	1306
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3277	3277	4911
	uplifting force	Pa	kN/num	-1688	-1688	-2856
	stress(SKY400)	Sig.a	N/mm²	189.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------	--------

note)Lm is elevation

2)perpendicular direction

item			unit	WN	OD-CL(SC)	ETQ(SC)
working force		Vo	kN	52389.0	53060.0	48931.3
		Ho	kN	1000.0	7500.0	13100.0
		Mo	kN.m	24800.0	80600.0	219800.0
foundation crest	displacement	Del.1	cm	0.191	1.028	1.764
	deflexion angle	Theta.1	mrad	-0.107	-0.516	-1.032
design ground surface	displacement	Del.2	cm	0.189	1.020	1.748
	deflexion angle	Theta.2	mrad	-0.107	-0.515	-1.028
celler part maximum bending moment		Mmax	kN.m	-31218.0	-139321.0	-319847.0
Mmax accrue location		Lm	m	-16.350	-19.350	-17.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	39.82	66.68	105.18
		Lm	m	-22.660	-22.660	-22.660
	periphery sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	35.09	44.60	56.16
		Lm	m	-22.660	-22.660	-22.660
	separation wall sheet pile(SKY490)	Sigmax	N/mm²	--------	--------	--------
		Lm	m	--------	--------	--------
	intermediate driven pile (SKK400)	Sig.max	N/mm²	--------	--------	--------
	intermediate driven pile (SKK490)	Sig.max	N/mm²	--------	--------	--------
celler partbottom bending moment		MB	kN.m	-530.0	-6137.0	4119.0
vertical reaction	maximum	Rmax	kN/num	1459	1520	1390
	minimum	Rmin	kN/num	1451	1428	1328
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	3277	3277	4911
	uplifting force	Pa	kN/num	-1688	-1688	-2856
	stress(SKY400)	Sig.a	N/mm²	175.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	--------	--------	--------

note)Lm is elevation

1.10 detail output

(1)bridge axis direction

1)Wind+Temp

working force	vertical force	Vo	kN	52389.0
	horizontal force	Ho	kN	300.0
	moment	Mo	kN.m	5600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.060

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	998	2231
2	1330	2975
3	5764	12890
4	6984	15616
5	5432	12146
6	13968	31232
7	38799	86757

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-6.350	0.060	-0.055	-300.0	-5600.0	30.00	29.54	
-6.510	0.060	-0.055	-300.0	-5648.0	30.01	29.55	
-7.350	0.055	-0.053	-278.4	-5890.8	30.08	29.60	
-7.416	0.055	-0.053	-276.8	-5909.1	30.08	29.60	
-8.350	0.050	-0.051	-247.6	-6153.8	30.15	29.65	
-9.350	0.045	-0.049	-219.3	-6387.0	30.22	29.70	
-10.350	0.040	-0.046	-193.9	-6593.4	30.27	29.74	
-11.350	0.036	-0.044	-171.3	-6775.8	30.32	29.77	
-11.416	0.035	-0.043	-169.9	-6787.1	30.33	29.77	
-12.350	0.031	-0.041	-89.1	-6907.3	30.36	29.80	
-12.850	0.029	-0.040	-49.7	-6941.9	30.37	29.80	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-13.350	0.027	-0.038	-12.9	-6957.5	30.38	29.81	*
-14.350	0.024	-0.036	53.3	-6936.5	30.37	29.80	
-15.350	0.020	-0.033	110.3	-6853.9	30.35	29.79	
-16.350	0.017	-0.031	158.7	-6718.7	30.31	29.76	
-17.350	0.014	-0.028	199.2	-6539.1	30.26	29.73	
-18.350	0.011	-0.026	232.4	-6322.7	30.20	29.68	
-18.416	0.011	-0.025	234.4	-6307.3	30.19	29.68	
-19.350	0.009	-0.023	264.2	-6073.9	30.13	29.63	
-20.350	0.007	-0.021	289.0	-5796.8	30.05	29.58	
-21.350	0.005	-0.019	307.2	-5498.1	29.97	29.52	
-22.350	0.003	-0.017	319.5	-5184.2	29.88	29.46	
-22.416	0.003	-0.017	320.1	-5163.1	29.88	29.45	
-22.660	0.003	-0.016	321.8	-5084.8	29.85	29.44	
-22.660	0.003	-0.016	321.8	-5084.8	34.24	33.76	
-23.350	0.001	-0.015	325.1	-4861.6	34.17	33.71	
-24.350	0.000	-0.013	326.9	-4535.3	34.06	33.63	
-25.350	-0.001	-0.011	325.5	-4208.9	33.96	33.56	
-26.350	-0.002	-0.009	321.5	-3885.2	33.85	33.48	
-27.350	-0.003	-0.007	315.3	-3566.6	33.75	33.41	
-28.350	-0.004	-0.006	307.3	-3255.1	33.65	33.34	
-29.350	-0.004	-0.005	297.8	-2952.5	33.55	33.27	
-30.350	-0.005	-0.003	287.1	-2660.0	33.46	33.21	
-31.350	-0.005	-0.002	275.6	-2378.5	33.37	33.14	
-32.350	-0.005	-0.001	263.6	-2108.9	33.28	33.08	
-33.350	-0.005	0.000	251.2	-1851.4	33.20	33.02	
-34.350	-0.005	0.000	238.8	-1606.4	33.12	32.97	
-35.350	-0.005	0.001	226.4	-1373.9	33.04	32.91	
-36.350	-0.005	0.002	214.2	-1153.6	32.97	32.86	
-37.350	-0.005	0.002	202.4	-945.3	32.91	32.82	
-38.350	-0.005	0.002	191.0	-748.7	32.84	32.77	
-39.350	-0.004	0.003	180.3	-563.1	32.78	32.73	
-39.416	-0.004	0.003	179.6	-551.2	32.78	32.73	
-40.350	-0.004	0.003	155.3	-394.9	32.73	32.69	
-41.350	-0.004	0.003	131.0	-251.9	32.68	32.66	
-42.350	-0.003	0.003	108.6	-132.2	32.65	32.63	
-43.350	-0.003	0.003	88.1	-34.0	32.61	32.61	
-44.350	-0.003	0.003	69.6	44.7	32.62	32.61	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-45.350	-0.002	0.003	52.9	105.8	32.64	32.63	
-46.350	-0.002	0.003	38.2	151.2	32.65	32.64	
-47.350	-0.002	0.003	25.4	182.8	32.66	32.64	
-48.350	-0.002	0.003	14.3	202.5	32.67	32.65	
-49.350	-0.001	0.003	5.1	212.1	32.67	32.65	
-50.350	-0.001	0.003	-2.4	213.3	32.67	32.65	
-51.350	-0.001	0.003	-8.3	207.8	32.67	32.65	
-52.350	-0.001	0.002	-12.5	197.3	32.67	32.65	
-53.350	0.000	0.002	-15.2	183.3	32.66	32.64	
-54.350	0.000	0.002	-16.4	167.3	32.66	32.64	
-54.416	0.000	0.002	-16.4	166.2	32.66	32.64	
-55.350	0.000	0.002	-15.7	151.0	32.65	32.64	
-56.350	0.000	0.002	-11.1	137.3	32.65	32.63	
-56.660	0.000	0.002	-8.9	134.2	32.65	32.63	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.510	0.060	-0.055	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	34.24	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	33.76	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 134.2 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)

periphery	n1 =	32 (number)	IB1 =	322.82 (m^2)	Ao1 =	0.0446	(m^2/number)
separation wall	n1 =	4 (number)	IB1 =	10.76 (m^2)	Ao1 =	0.0446	(m^2/number)
intermediate drive	n1 =	0 (number)	IB1 =	0.00 (m^2)	Ao1 =	0.0000	(m^2/number)

x = 3.668
maximum Rmax = 1457 (kN/number)
minimum Rmin = 1454 (kN/number)

2)Ord+Collision(scour)

working force	vertical force	Vo	kN	53060.0
	horizontal force	Ho	kN	3800.0
	moment	Mo	kN.m	39300.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.568

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	998	2231
2	1330	2975
3	5764	12890
4	6984	15616
5	5432	12146
6	13968	31232
7	38799	86757

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.576	-0.489	-3800.0	-39300.0	39.74	36.53	
-6.510	0.568	-0.487	-3800.0	-39908.0	39.91	36.65	
-7.350	0.528	-0.474	-3593.3	-43012.1	40.77	37.26	
-7.416	0.525	-0.473	-3577.7	-43248.8	40.84	37.31	
-8.350	0.482	-0.457	-3296.5	-46457.2	41.73	37.94	
-9.350	0.437	-0.439	-3021.9	-49614.2	42.61	38.56	
-10.350	0.394	-0.420	-2773.5	-52509.7	43.42	39.13	
-11.350	0.353	-0.399	-2550.2	-55169.5	44.16	39.66	
-11.416	0.350	-0.398	-2536.3	-55337.4	44.20	39.69	
-12.350	0.314	-0.378	-1732.4	-57324.0	44.76	40.08	
-12.850	0.295	-0.367	-1337.5	-58090.5	44.97	40.23	
-13.350	0.277	-0.356	-966.3	-58665.4	45.13	40.34	
-14.350	0.243	-0.334	-292.6	-59287.5	45.30	40.47	*
-15.350	0.210	-0.312	294.4	-59279.6	45.30	40.46	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-16.350	0.180	-0.289	800.7	-58725.5	45.15	40.35	
-17.350	0.153	-0.267	1232.0	-57703.1	44.86	40.15	
-18.350	0.127	-0.246	1593.9	-56284.7	44.47	39.87	
-18.416	0.125	-0.245	1615.4	-56178.8	44.44	39.85	
-19.350	0.103	-0.225	1950.5	-54508.5	43.97	39.53	
-20.350	0.082	-0.205	2240.9	-52407.2	43.39	39.11	
-21.350	0.062	-0.186	2466.9	-50048.2	42.73	38.65	
-22.350	0.045	-0.167	2634.7	-47492.8	42.02	38.15	
-22.416	0.044	-0.166	2643.8	-47318.6	41.97	38.11	
-22.660	0.040	-0.162	2668.6	-46670.4	41.79	37.98	
-22.660	0.040	-0.162	2668.6	-46670.4	48.02	43.61	
-23.350	0.029	-0.148	2726.3	-44808.1	47.42	43.18	
-24.350	0.015	-0.129	2779.8	-42052.3	46.54	42.56	
-25.350	0.003	-0.111	2801.7	-39259.1	45.64	41.93	
-26.350	-0.007	-0.095	2796.4	-36458.0	44.74	41.29	
-27.350	-0.016	-0.079	2768.0	-33674.0	43.84	40.66	
-28.350	-0.023	-0.065	2720.1	-30928.6	42.96	40.04	
-29.350	-0.029	-0.052	2656.3	-28239.2	42.10	39.43	
-30.350	-0.034	-0.041	2579.7	-25620.2	41.25	38.83	
-31.350	-0.037	-0.030	2493.1	-23083.1	40.44	38.26	
-32.350	-0.040	-0.020	2399.2	-20636.5	39.65	37.70	
-33.350	-0.041	-0.012	2300.3	-18286.4	38.90	37.17	
-34.350	-0.042	-0.004	2198.5	-16036.8	38.17	36.66	
-35.350	-0.042	0.002	2095.6	-13889.7	37.48	36.17	
-36.350	-0.042	0.008	1993.2	-11845.5	36.83	35.71	
-37.350	-0.041	0.012	1892.6	-9902.8	36.20	35.27	
-38.350	-0.039	0.016	1795.1	-8059.2	35.61	34.85	
-39.350	-0.037	0.020	1701.6	-6311.2	35.05	34.45	
-39.416	-0.037	0.020	1695.6	-6199.1	35.01	34.43	
-40.350	-0.035	0.022	1482.8	-4715.7	34.54	34.09	
-41.350	-0.033	0.024	1268.3	-3341.3	34.09	33.78	
-42.350	-0.031	0.025	1068.7	-2174.1	33.72	33.51	
-43.350	-0.028	0.026	884.7	-1198.6	33.41	33.29	
-44.350	-0.025	0.026	716.8	-399.2	33.15	33.11	
-45.350	-0.023	0.026	565.2	240.4	33.10	33.07	
-46.350	-0.020	0.026	429.9	736.6	33.26	33.19	
-47.350	-0.018	0.025	310.8	1105.6	33.38	33.27	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-48.350	-0.015	0.025	207.6	1363.4	33.46	33.33	
-49.350	-0.013	0.024	120.0	1525.9	33.51	33.37	
-50.350	-0.010	0.024	47.6	1608.4	33.54	33.39	
-51.350	-0.008	0.023	-10.1	1626.0	33.54	33.39	
-52.350	-0.006	0.022	-53.4	1593.1	33.53	33.38	
-53.350	-0.004	0.021	-82.8	1523.9	33.51	33.37	
-54.350	-0.001	0.021	-98.8	1432.0	33.48	33.35	
-54.416	-0.001	0.021	-99.4	1425.5	33.48	33.34	
-55.350	0.001	0.020	-105.8	1327.2	33.45	33.32	
-56.350	0.003	0.020	-78.8	1232.0	33.42	33.30	
-56.660	0.003	0.019	-63.4	1209.9	33.41	33.29	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.510	0.568	-0.487	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	48.02	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	43.61	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 1209.9 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)

periphery	n1 = 32 (number)	IB1 = 322.82 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 4 (number)	IB1 = 10.76 (m^2)	Ao1 = 0.0446 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 3.668
maximum Rmax = 1487 (kN/number)
minimum Rmin = 1461 (kN/number)

3)Earthquake(scour)

working force	vertical force	Vo	kN	48931.3
	horizontal force	Ho	kN	11700.0
	moment	Mo	kN.m	153600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.808
	calculation displacement	Del.	cm	1.802

convergence rate (Del.1 - Del.) / Del.1 = 0.29 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	664	1105
2	886	1473
3	11529	19174
4	13968	23230
5	10864	18068
6	27935	46460
7	77598	129055

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	1.829	-1.687	-11700.0	-153600.0	69.31	56.77	
-6.510	1.802	-1.677	-11868.3	-155485.5	69.83	57.15	
-7.350	1.664	-1.627	-11544.7	-165317.1	72.57	59.08	
-7.416	1.653	-1.622	-11520.4	-166078.3	72.78	59.23	
-8.350	1.504	-1.562	-11083.5	-176631.1	75.71	61.30	
-9.350	1.351	-1.494	-10660.5	-187499.3	78.74	63.44	
-10.350	1.206	-1.421	-10281.7	-197966.7	81.65	65.50	
-11.350	1.067	-1.344	-9945.0	-208076.6	84.46	67.49	
-11.416	1.058	-1.339	-9924.2	-208732.3	84.65	67.62	
-12.350	0.937	-1.264	-6332.2	-216290.0	86.75	69.10	
-12.850	0.875	-1.223	-4585.7	-219014.4	87.51	69.64	
-13.350	0.814	-1.182	-2957.2	-220895.3	88.03	70.01	
-14.350	0.700	-1.098	-38.0	-222356.2	88.44	70.30	*
-15.350	0.595	-1.015	2457.5	-221112.5	88.09	70.05	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-16.350	0.498	-0.932	4561.7	-217571.6	87.11	69.36	
-17.350	0.408	-0.851	6306.3	-212109.0	85.59	68.28	
-18.350	0.327	-0.772	7722.7	-205068.4	83.63	66.90	
-18.416	0.322	-0.767	7805.3	-204556.0	83.49	66.80	
-19.350	0.254	-0.697	9060.1	-196656.6	81.29	65.24	
-20.350	0.188	-0.624	10089.5	-187056.1	78.62	63.35	
-21.350	0.129	-0.556	10826.9	-176574.9	75.70	61.29	
-22.350	0.077	-0.491	11304.6	-165488.8	72.61	59.11	
-22.416	0.073	-0.487	11327.7	-164741.9	72.41	58.97	
-22.660	0.062	-0.472	11387.6	-161970.4	71.63	58.42	
-22.660	0.062	-0.472	11387.6	-161970.4	82.51	67.19	
-23.350	0.031	-0.424	11502.8	-154068.8	79.97	65.40	
-24.350	-0.008	-0.360	11541.4	-142534.8	76.26	62.78	
-25.350	-0.041	-0.300	11449.2	-131029.5	72.56	60.17	
-26.350	-0.069	-0.245	11247.8	-119672.8	68.91	57.59	
-27.350	-0.091	-0.195	10957.1	-108563.7	65.34	55.08	
-28.350	-0.108	-0.150	10595.3	-97782.3	61.88	52.63	
-29.350	-0.121	-0.110	10178.7	-87391.4	58.54	50.27	
-30.350	-0.130	-0.074	9722.0	-77438.3	55.34	48.02	
-31.350	-0.136	-0.042	9238.3	-67956.5	52.29	45.86	
-32.350	-0.138	-0.014	8739.1	-58966.9	49.40	43.83	
-33.350	-0.139	0.009	8234.6	-50480.0	46.68	41.90	
-34.350	-0.137	0.030	7733.4	-42496.6	44.11	40.09	
-35.350	-0.133	0.047	7242.8	-35009.7	41.70	38.39	
-36.350	-0.128	0.060	6769.1	-28005.4	39.45	36.80	
-37.350	-0.121	0.071	6317.2	-21464.2	37.35	35.32	
-38.350	-0.113	0.079	5891.1	-15362.4	35.39	33.94	
-39.350	-0.105	0.085	5493.7	-9672.5	33.56	32.64	
-39.416	-0.105	0.085	5468.5	-9310.7	33.44	32.56	
-40.350	-0.097	0.088	4590.1	-4618.8	31.94	31.50	
-41.350	-0.088	0.089	3728.8	-466.2	30.60	30.56	
-42.350	-0.079	0.088	2950.4	2866.5	31.37	31.10	
-43.350	-0.070	0.086	2254.2	5462.0	32.21	31.69	
-44.350	-0.062	0.084	1638.7	7401.8	32.83	32.13	
-45.350	-0.053	0.080	1101.2	8765.4	33.27	32.44	
-46.350	-0.046	0.076	638.4	9629.2	33.55	32.64	
-47.350	-0.038	0.072	246.6	10065.9	33.69	32.73	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-48.350	-0.031	0.067	-78.3	10144.7	33.71	32.75	
-49.350	-0.025	0.063	-340.4	9930.3	33.64	32.70	
-50.350	-0.019	0.059	-543.7	9483.5	33.50	32.60	
-51.350	-0.013	0.055	-692.4	8861.1	33.30	32.46	
-52.350	-0.008	0.051	-790.0	8115.8	33.06	32.29	
-53.350	-0.003	0.047	-840.0	7296.9	32.80	32.11	
-54.350	0.002	0.044	-845.7	6450.5	32.52	31.91	
-54.416	0.002	0.044	-844.6	6394.7	32.51	31.90	
-55.350	0.006	0.042	-747.9	5643.4	32.26	31.73	
-56.350	0.010	0.040	-539.5	4991.0	32.06	31.58	
-56.660	0.011	0.039	-453.7	4836.8	32.01	31.55	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.510	1.802	-1.677	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	88.44	-14.350
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	70.30	-14.350
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = 4836.8 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 14.890 (m^4)

periphery n1 = 32 (number) IB1 = 322.82 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 4 (number) IB1 = 10.76 (m^2) Ao1 = 0.0446 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 3.668

maximum Rmax = 1412 (kN/number)
minimum Rmin = 1306 (kN/number)

(2)perpendicular direction

1)Wind

working force	vertical force	Vo	kN	52389.0
	horizontal force	Ho	kN	1000.0
	moment	Mo	kN.m	24800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.189

if Del.< 1.000 cm, let Del.1 = 1.000 cm

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1152	2575
2	1535	3433
3	6654	14878
4	8061	18025
5	6270	14019
6	16122	36050
7	44783	100138

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	0.191	-0.107	-1000.0	-24800.0	33.73	30.28	
-6.510	0.189	-0.107	-1000.0	-24960.0	33.77	30.29	
-7.350	0.180	-0.105	-966.0	-25785.6	33.94	30.36	
-7.416	0.179	-0.105	-963.3	-25849.3	33.96	30.36	
-8.350	0.170	-0.102	-915.6	-26726.5	34.14	30.43	
-9.350	0.160	-0.099	-867.4	-27617.8	34.33	30.49	
-10.350	0.150	-0.097	-822.1	-28462.3	34.51	30.55	
-11.350	0.140	-0.094	-779.6	-29262.9	34.68	30.61	
-11.416	0.140	-0.094	-776.9	-29314.2	34.70	30.62	
-12.350	0.131	-0.091	-616.5	-29964.1	34.83	30.67	
-12.850	0.126	-0.089	-534.7	-30251.8	34.90	30.69	
-13.350	0.122	-0.088	-455.8	-30499.3	34.95	30.71	
-14.350	0.113	-0.085	-306.3	-30879.5	35.03	30.73	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.350	0.105	-0.081	-167.5	-31115.5	35.08	30.75	
-16.350	0.097	-0.078	-39.1	-31218.0	35.10	30.76	*
-17.350	0.090	-0.075	79.4	-31197.0	35.10	30.76	
-18.350	0.082	-0.072	188.4	-31062.3	35.07	30.75	
-18.416	0.082	-0.072	195.3	-31049.7	35.07	30.75	
-19.350	0.075	-0.069	307.9	-30813.9	35.02	30.73	
-20.350	0.068	-0.066	418.3	-30449.9	34.94	30.70	
-21.350	0.062	-0.063	518.6	-29980.6	34.84	30.67	
-22.350	0.056	-0.060	609.3	-29415.9	34.72	30.63	
-22.416	0.056	-0.059	615.0	-29375.5	34.71	30.62	
-22.660	0.054	-0.059	631.0	-29223.5	34.68	30.61	
-22.660	0.054	-0.059	631.0	-29223.5	39.82	35.09	
-23.350	0.050	-0.056	674.0	-28773.1	39.71	35.05	
-24.350	0.045	-0.053	730.6	-28070.2	39.53	34.99	
-25.350	0.040	-0.050	781.0	-27313.9	39.35	34.92	
-26.350	0.035	-0.046	825.3	-26510.3	39.15	34.85	
-27.350	0.030	-0.043	864.2	-25665.1	38.94	34.78	
-28.350	0.026	-0.040	897.8	-24783.7	38.72	34.71	
-29.350	0.022	-0.038	926.6	-23871.1	38.50	34.63	
-30.350	0.019	-0.035	950.9	-22932.0	38.27	34.55	
-31.350	0.015	-0.032	971.1	-21970.6	38.03	34.47	
-32.350	0.012	-0.030	987.4	-20991.1	37.79	34.39	
-33.350	0.009	-0.027	1000.1	-19997.1	37.54	34.30	
-34.350	0.007	-0.025	1009.7	-18991.9	37.29	34.22	
-35.350	0.004	-0.023	1016.2	-17978.7	37.04	34.13	
-36.350	0.002	-0.021	1020.0	-16960.4	36.79	34.04	
-37.350	0.000	-0.019	1021.4	-15939.5	36.54	33.96	
-38.350	-0.002	-0.017	1020.5	-14918.4	36.29	33.87	
-39.350	-0.003	-0.015	1017.6	-13899.2	36.04	33.78	
-39.416	-0.003	-0.015	1017.4	-13832.0	36.02	33.78	
-40.350	-0.005	-0.014	1005.9	-12886.8	35.79	33.70	
-41.350	-0.006	-0.012	989.7	-11888.7	35.54	33.61	
-42.350	-0.007	-0.011	969.7	-10908.7	35.30	33.53	
-43.350	-0.008	-0.010	946.4	-9950.4	35.06	33.45	
-44.350	-0.009	-0.008	920.2	-9016.8	34.83	33.37	
-45.350	-0.010	-0.007	891.4	-8110.8	34.61	33.29	
-46.350	-0.010	-0.006	860.3	-7234.8	34.39	33.22	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.350	-0.011	-0.006	827.3	-6390.8	34.18	33.15	
-48.350	-0.012	-0.005	792.5	-5580.8	33.98	33.08	
-49.350	-0.012	-0.004	756.1	-4806.4	33.79	33.01	
-50.350	-0.012	-0.004	718.4	-4069.0	33.61	32.95	
-51.350	-0.013	-0.003	679.6	-3369.9	33.43	32.89	
-52.350	-0.013	-0.003	639.7	-2710.2	33.27	32.83	
-53.350	-0.013	-0.003	598.9	-2090.8	33.12	32.78	
-54.350	-0.014	-0.003	557.2	-1512.7	32.98	32.73	
-54.416	-0.014	-0.003	554.4	-1476.0	32.97	32.73	
-55.350	-0.014	-0.002	444.2	-1009.6	32.85	32.69	
-56.350	-0.014	-0.002	324.2	-625.2	32.76	32.66	
-56.660	-0.014	-0.002	286.6	-530.5	32.73	32.65	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.510	0.189	-0.107	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	39.82	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	35.09	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -530.5 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 56.053 (m^4)
periphery n1 = 32 (number) IB1 = 1255.78 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 4 (number) IB1 = 0.00 (m^2) Ao1 = 0.0446 (m^2/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m^2) Ao1 = 0.0000 (m^2/number)
x = 9.459
maximum Rmax = 1459 (kN/number)
minimum Rmin = 1451 (kN/number)

2)Ord+Collision(scour)

working force	vertical force	Vo	kN	53060.0
	horizontal force	Ho	kN	7500.0
	moment	Mo	kN.m	80600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.024
	calculation displacement	Del.	cm	1.020

convergence rate (Del.1 - Del.) / Del.1 = 0.38 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1152	2545
2	1535	3393
3	6654	14703
4	8061	17813
5	6270	13855
6	16122	35627
7	44783	98963

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	1.028	-0.516	-7500.0	-80600.0	46.00	34.79	
-6.510	1.020	-0.515	-7500.0	-81800.0	46.26	34.88	
-7.350	0.977	-0.508	-7317.8	-88022.9	47.59	35.35	
-7.416	0.974	-0.507	-7303.9	-88505.5	47.69	35.38	
-8.350	0.927	-0.499	-7046.9	-95206.3	49.12	35.88	
-9.350	0.877	-0.489	-6785.7	-102121.4	50.60	36.39	
-10.350	0.829	-0.478	-6538.6	-108782.3	52.02	36.89	
-11.350	0.782	-0.467	-6305.4	-115203.2	53.39	37.37	
-11.416	0.779	-0.466	-6290.5	-115618.9	53.48	37.40	
-12.350	0.736	-0.455	-5403.1	-121075.8	54.64	37.80	
-12.850	0.713	-0.448	-4948.5	-123663.2	55.19	37.99	
-13.350	0.691	-0.442	-4508.1	-126026.7	55.70	38.17	
-14.350	0.647	-0.429	-3668.5	-130110.5	56.57	38.47	
-15.350	0.605	-0.416	-2882.8	-133381.8	57.27	38.72	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-16.350	0.564	-0.402	-2149.3	-135893.5	57.80	38.90	
-17.350	0.525	-0.388	-1466.2	-137697.1	58.19	39.04	
-18.350	0.487	-0.374	-831.7	-138842.0	58.43	39.12	
-18.416	0.484	-0.373	-791.5	-138895.6	58.45	39.13	
-19.350	0.450	-0.360	-128.5	-139321.5	58.54	39.16	*
-20.350	0.415	-0.346	528.6	-139117.0	58.49	39.14	
-21.350	0.381	-0.332	1133.0	-138281.9	58.31	39.08	
-22.350	0.348	-0.318	1687.0	-136867.7	58.01	38.98	
-22.416	0.346	-0.317	1721.9	-136755.3	57.99	38.97	
-22.660	0.338	-0.313	1820.7	-136323.0	57.90	38.93	
-22.660	0.338	-0.313	1820.7	-136323.0	66.68	44.60	
-23.350	0.317	-0.302	2088.1	-134973.5	66.35	44.49	
-24.350	0.288	-0.287	2445.7	-132703.7	65.79	44.29	
-25.350	0.260	-0.271	2769.4	-130093.3	65.15	44.07	
-26.350	0.234	-0.256	3061.1	-127175.5	64.42	43.82	
-27.350	0.209	-0.241	3322.4	-123981.3	63.64	43.55	
-28.350	0.185	-0.227	3555.3	-120540.1	62.79	43.26	
-29.350	0.163	-0.213	3761.4	-116879.6	61.88	42.95	
-30.350	0.143	-0.199	3942.3	-113025.7	60.93	42.62	
-31.350	0.124	-0.186	4099.7	-109002.8	59.94	42.28	
-32.350	0.106	-0.173	4235.2	-104833.5	58.91	41.93	
-33.350	0.089	-0.161	4350.1	-100539.3	57.85	41.56	
-34.350	0.073	-0.149	4446.0	-96139.7	56.76	41.19	
-35.350	0.059	-0.138	4524.2	-91653.1	55.65	40.81	
-36.350	0.046	-0.128	4586.1	-87096.7	54.53	40.42	
-37.350	0.033	-0.118	4632.8	-82486.0	53.39	40.03	
-38.350	0.022	-0.108	4665.6	-77835.8	52.24	39.63	
-39.350	0.012	-0.099	4685.6	-73159.2	51.09	39.23	
-39.416	0.011	-0.099	4686.4	-72849.9	51.01	39.21	
-40.350	0.002	-0.091	4705.3	-68462.0	49.93	38.84	
-41.350	-0.006	-0.083	4698.7	-63757.8	48.76	38.44	
-42.350	-0.014	-0.076	4666.8	-59073.0	47.61	38.04	
-43.350	-0.022	-0.069	4611.8	-54431.8	46.46	37.64	
-44.350	-0.028	-0.063	4535.8	-49856.3	45.33	37.26	
-45.350	-0.034	-0.057	4440.5	-45366.7	44.22	36.87	
-46.350	-0.040	-0.052	4327.8	-40981.1	43.14	36.50	
-47.350	-0.045	-0.048	4199.1	-36716.5	42.09	36.14	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-48.350	-0.049	-0.044	4055.8	-32587.9	41.07	35.79	
-49.350	-0.054	-0.040	3899.3	-28609.3	40.09	35.45	
-50.350	-0.057	-0.037	3730.5	-24793.4	39.14	35.13	
-51.350	-0.061	-0.034	3550.6	-21151.9	38.24	34.82	
-52.350	-0.064	-0.032	3360.2	-17695.7	37.39	34.52	
-53.350	-0.067	-0.030	3160.1	-14434.8	36.58	34.25	
-54.350	-0.070	-0.029	2950.8	-11378.6	35.83	33.99	
-54.416	-0.070	-0.028	2936.7	-11184.3	35.78	33.97	
-55.350	-0.073	-0.027	2370.6	-8704.2	35.17	33.76	
-56.350	-0.076	-0.026	1742.1	-6646.0	34.66	33.58	
-56.660	-0.077	-0.026	1542.8	-6136.8	34.54	33.54	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.510	1.020	-0.515	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	66.68	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	44.60	-22.660
separation wall sheet pile (SKY490)	------	--------

vertical reaction

$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} +/- \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

MB = -6136.8 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 56.053 (m^4)

periphery	n1 = 32 (number)	IB1 = 1255.78 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 4 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0446 (m^2/number)
intermediate drive	n1 = 0 (number)	IB1 = 0.00 (m^2)	Ao1 = 0.0000 (m^2/number)

x = 9.459
maximum Rmax = 1520 (kN/number)
minimum Rmin = 1428 (kN/number)

3)Earthquake(scour)

working force	vertical force	Vo	kN	48931.3
	horizontal force	Ho	kN	13100.0
	moment	Mo	kN.m	219800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.756
	calculation displacement	Del.	cm	1.748

convergence rate (Del.1 - Del.) / Del.1 = 0.50 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	767	1294
2	1023	1725
3	13307	22452
4	16122	27202
5	12539	21157
6	32244	54404
7	89567	151122

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-6.350	1.764	-1.032	-13100.0	-219800.0	73.47	42.90	
-6.510	1.748	-1.028	-13268.3	-221909.5	73.92	43.05	
-7.350	1.662	-1.009	-13110.1	-232987.8	76.28	43.88	
-7.416	1.655	-1.007	-13098.0	-233852.8	76.47	43.94	
-8.350	1.562	-0.985	-12876.8	-245982.0	79.06	44.84	
-9.350	1.465	-0.959	-12653.9	-258746.2	81.78	45.79	
-10.350	1.371	-0.932	-12445.1	-271294.5	84.46	46.72	
-11.350	1.279	-0.904	-12250.1	-283641.0	87.09	47.64	
-11.416	1.273	-0.902	-12237.7	-284449.2	87.27	47.70	
-12.350	1.190	-0.875	-10034.2	-294838.6	89.48	48.47	
-12.850	1.146	-0.859	-8915.0	-299574.2	90.49	48.83	
-13.350	1.104	-0.844	-7837.0	-303760.4	91.39	49.14	
-14.350	1.021	-0.813	-5801.5	-310566.4	92.84	49.64	
-15.350	0.941	-0.781	-3921.8	-315415.3	93.87	50.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-16.350	0.865	-0.749	-2191.8	-318459.9	94.52	50.23	
-17.350	0.791	-0.717	-605.3	-319846.7	94.82	50.33	*
-18.350	0.721	-0.684	843.8	-319716.2	94.79	50.32	
-18.416	0.717	-0.682	934.8	-319657.5	94.78	50.32	
-19.350	0.655	-0.652	2421.4	-318079.7	94.44	50.20	
-20.350	0.591	-0.620	3866.9	-314923.2	93.77	49.97	
-21.350	0.531	-0.588	5168.5	-310393.8	92.80	49.63	
-22.350	0.473	-0.557	6333.5	-304631.8	91.57	49.20	
-22.416	0.470	-0.555	6405.8	-304211.4	91.48	49.17	
-22.660	0.456	-0.547	6609.8	-302623.3	91.14	49.05	
-22.660	0.456	-0.547	6609.8	-302623.3	105.18	56.16	
-23.350	0.419	-0.523	7155.2	-297871.8	104.01	55.75	
-24.350	0.369	-0.488	7866.5	-290353.3	102.15	55.11	
-25.350	0.322	-0.454	8489.6	-282168.1	100.13	54.42	
-26.350	0.278	-0.421	9030.7	-273401.4	97.96	53.67	
-27.350	0.237	-0.390	9495.7	-264132.1	95.68	52.89	
-28.350	0.200	-0.359	9890.3	-254433.5	93.28	52.06	
-29.350	0.166	-0.329	10220.0	-244373.2	90.80	51.21	
-30.350	0.134	-0.301	10490.3	-234013.3	88.24	50.33	
-31.350	0.105	-0.274	10706.1	-223410.7	85.62	49.43	
-32.350	0.079	-0.248	10872.4	-212617.5	82.95	48.51	
-33.350	0.056	-0.224	10993.9	-201680.8	80.25	47.58	
-34.350	0.034	-0.201	11074.8	-190643.2	77.53	46.64	
-35.350	0.015	-0.179	11119.5	-179543.2	74.79	45.70	
-36.350	-0.001	-0.158	11131.8	-168415.0	72.04	44.76	
-37.350	-0.016	-0.139	11115.6	-157289.0	69.29	43.81	
-38.350	-0.029	-0.121	11074.2	-146192.2	66.55	42.87	
-39.350	-0.041	-0.105	11010.8	-135148.0	63.82	41.93	
-39.416	-0.041	-0.104	11006.0	-134421.5	63.64	41.87	
-40.350	-0.050	-0.089	10807.1	-124231.8	61.13	41.00	
-41.350	-0.058	-0.075	10554.1	-113548.0	58.49	40.10	
-42.350	-0.065	-0.062	10266.2	-103135.2	55.92	39.21	
-43.350	-0.071	-0.051	9949.2	-93025.3	53.42	38.35	
-44.350	-0.076	-0.040	9608.6	-83244.7	51.01	37.52	
-45.350	-0.079	-0.031	9249.2	-73814.4	48.68	36.72	
-46.350	-0.082	-0.023	8875.2	-64751.2	46.44	35.95	
-47.350	-0.084	-0.016	8490.5	-56067.6	44.30	35.21	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-48.350	-0.085	-0.010	8098.5	-47772.6	42.25	34.51	
-49.350	-0.086	-0.005	7701.9	-39872.1	40.30	33.84	
-50.350	-0.086	0.000	7303.1	-32369.6	38.44	33.20	
-51.350	-0.086	0.003	6904.2	-25266.0	36.69	32.60	
-52.350	-0.085	0.006	6506.7	-18560.7	35.03	32.03	
-53.350	-0.085	0.008	6111.8	-12251.7	33.48	31.49	
-54.350	-0.084	0.009	5720.4	-6335.9	32.02	30.99	
-54.416	-0.084	0.009	5694.7	-5959.2	31.92	30.96	
-55.350	-0.083	0.009	4689.9	-1110.4	30.73	30.55	
-56.350	-0.082	0.009	3625.3	3046.2	31.20	30.71	
-56.660	-0.082	0.009	3297.6	4119.2	31.47	30.80	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-6.510	1.748	-1.028	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	105.18	-22.660
periphery sheet pile (SKY490)	------	--------
separation wall sheet pile (SKY400)	56.16	-22.660
separation wall sheet pile (SKY490)	------	--------

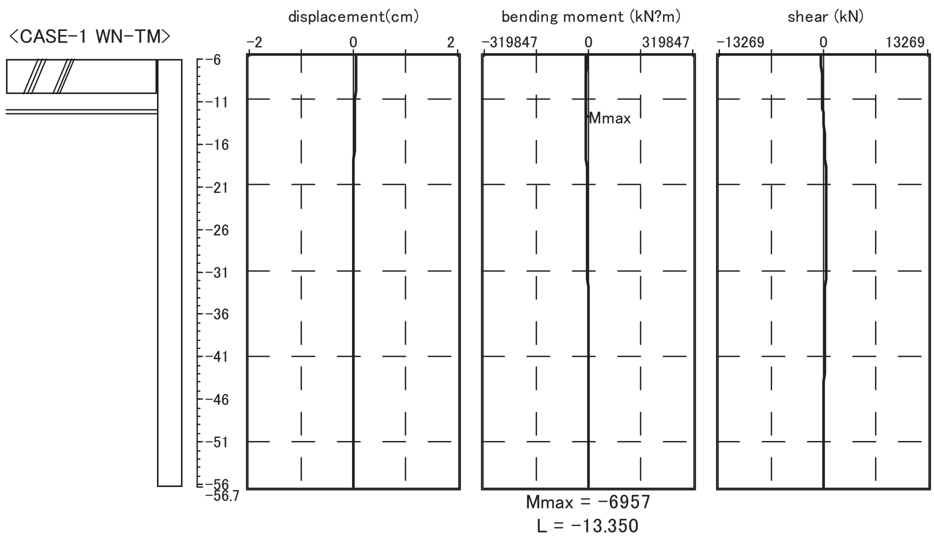
vertical reaction

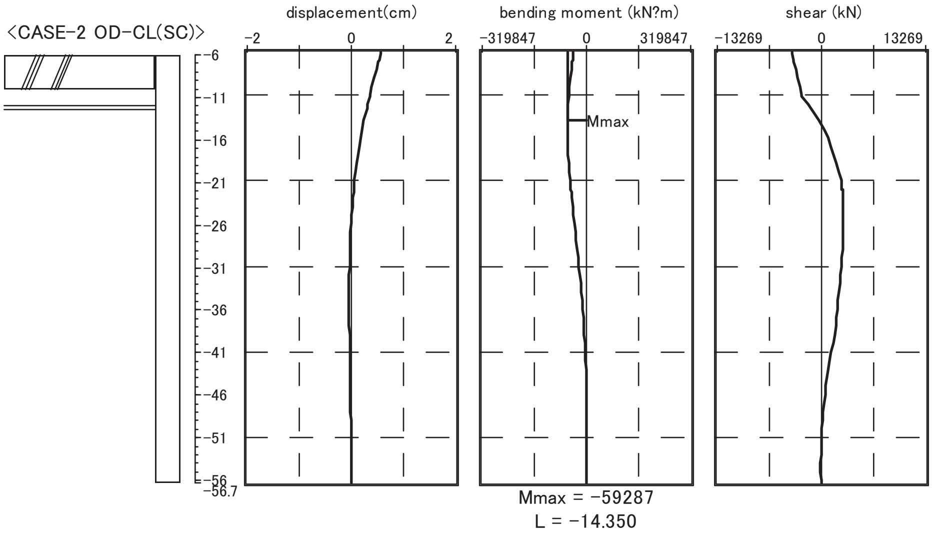
$$R = \frac{Vo*Ao1}{\Sigma(ni*Aoi)} + / - \frac{(MB*Ao1)*xi}{\Sigma(IBi*Aoi)}$$

```
MB             =      4119.2 (kN.m)
Sum(ni*Aoi)  =       1.607 (m²)
Sum(IBi*Aoi) =      56.053 (m⁴)
      periphery          n1  =  32 (number)   IB1 =       1255.78 (m²)   Ao1 =  0.0446 (m²/number)
      separation wall    n1  =   4 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0446 (m²/number)
      intermediate drive n1  =   0 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0000 (m²/number)
      x =   9.459
 maximum   Rmax =   1390 (kN/number)
 minimum   Rmin =   1328 (kN/number)
```

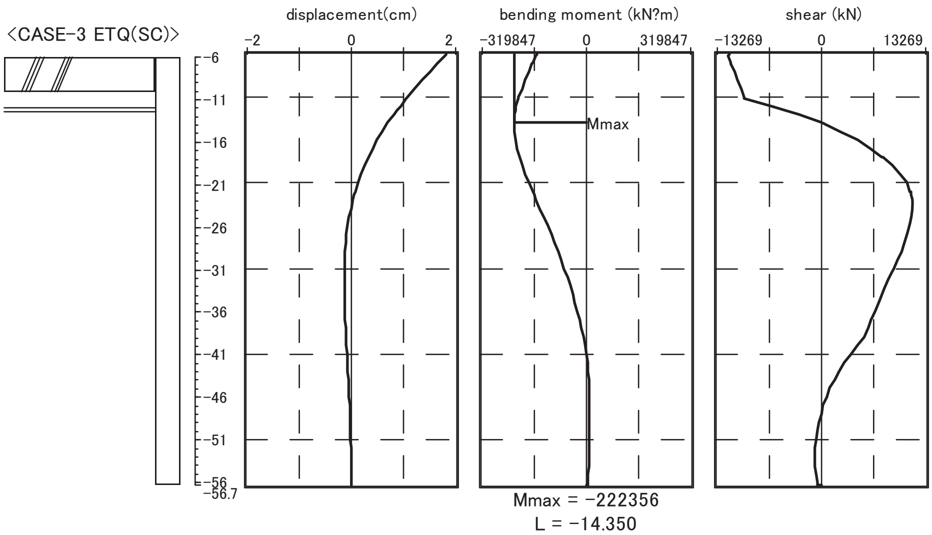

1.11 displacement / member force diagram

bridge axis direction





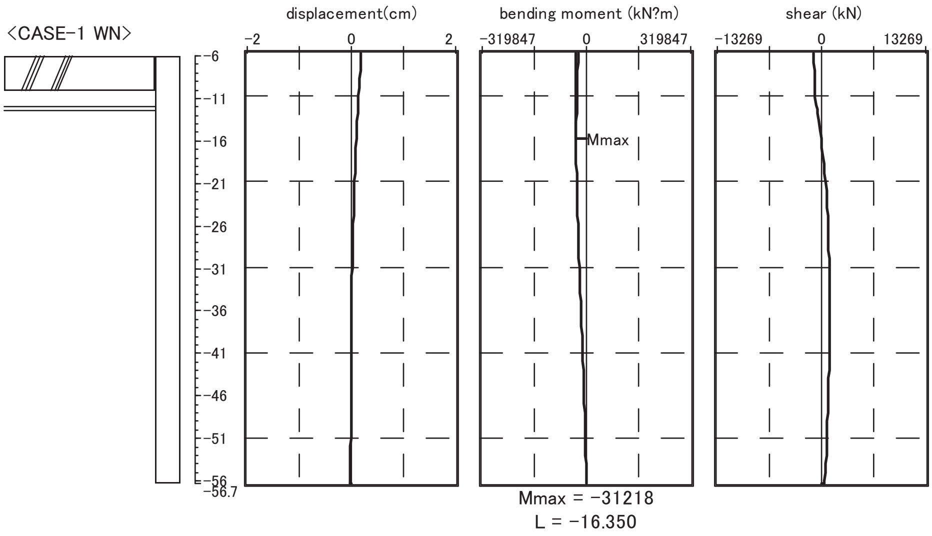
<CASE-2 OD-CL(SC)>
displacement(cm)
bending moment (kN?m)
shear (kN)
Mmax
Mmax = −59287
L = −14.350



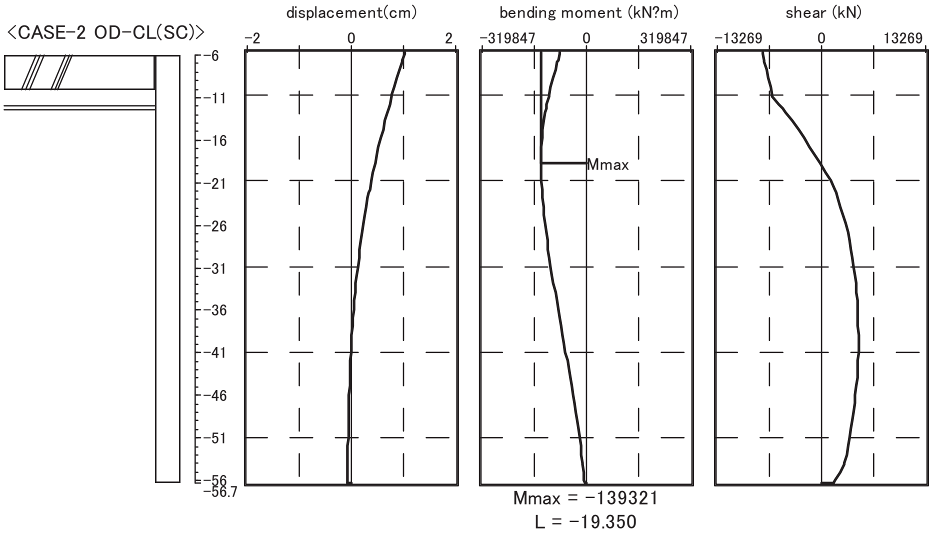
<CASE-3 ETQ(SC)>
displacement(cm)
bending moment (kN?m)
shear (kN)
Mmax
Mmax = −222356
L = −14.350

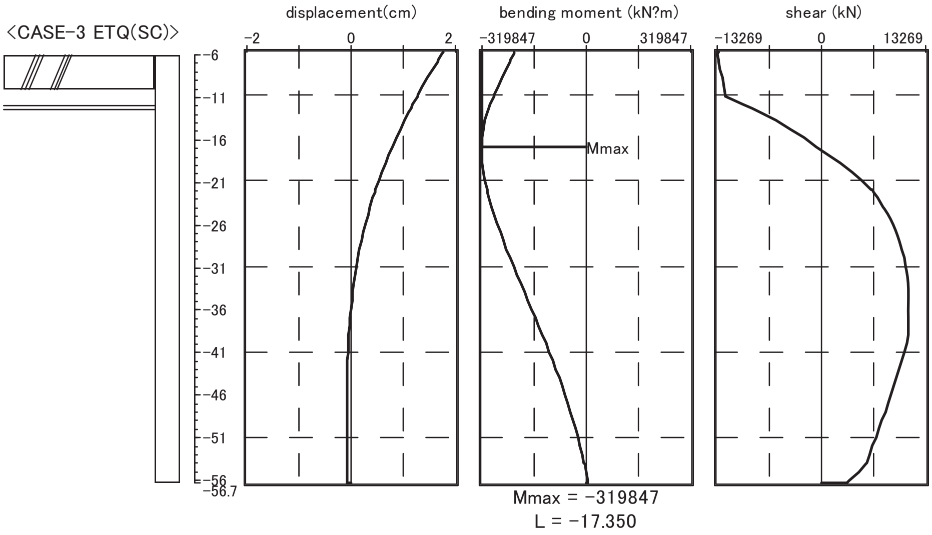
perpendicular direction

<CASE-1 WN>



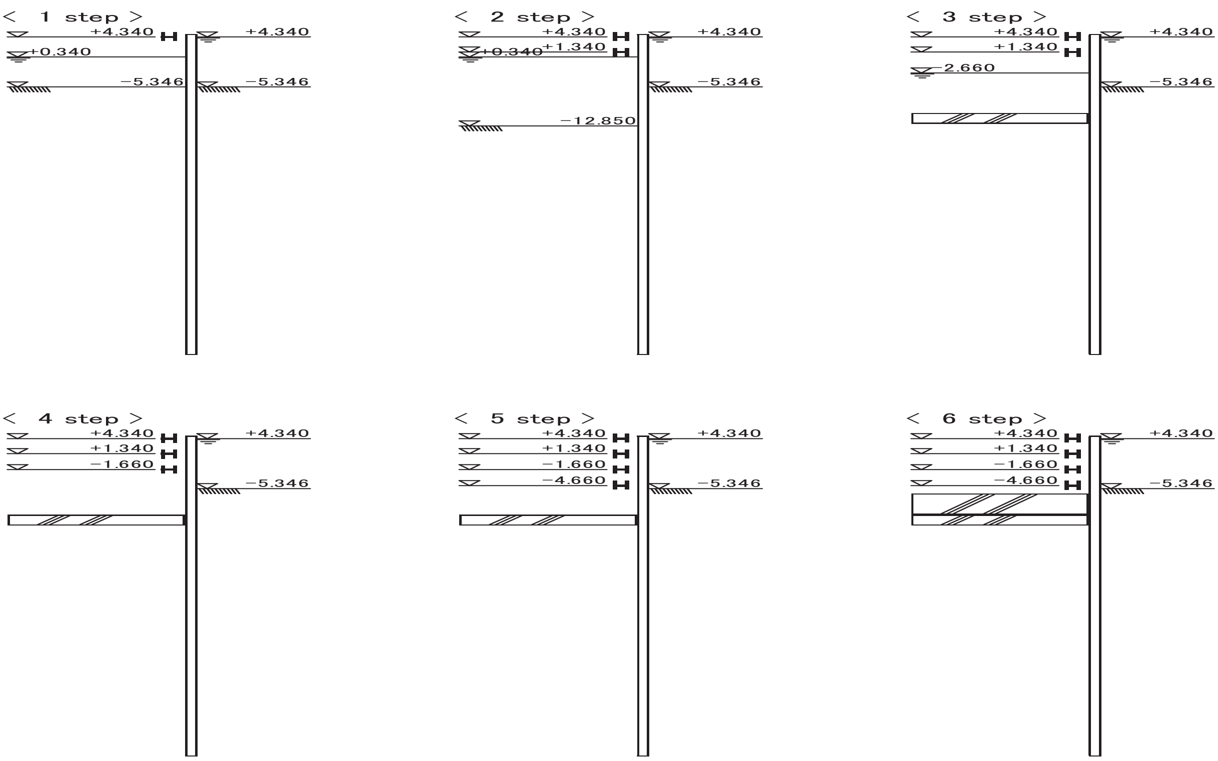
<CASE-2 OD-CL(SC)>





2 coffering calculation

2.1 construction step diagram



2.2 section properties

steel pipe pile body external diameter Phi.1200.0 (mm)
errosion allowance external side = 0.0 (mm) internal side = 0.0 (mm)

No	L (m)	bridge axis direction		perpendicular direction		material
		I(cm⁴/m)	Z(cm³/m)	I(cm⁴/m)	Z(cm³/m)	
1	10.000	633569.6	10559.5	641007.8	10683.5	SKY400
2	17.500	720452.4	12007.5	728910.6	12148.5	SKY400
3	34.000	633569.6	10559.5	641007.8	10683.5	SKY400
						Sig.= 61.500 (m)

2.3 soil condition

current ground surface elevation -5.346 (m)
riverside water table elevation +4.340 (m)
boundary condition of steel pipe sheet pile tip :free

No	soil	layer thickness (m)	average N value	unit weight Gam.(kN/m³)		c (kN/m²)	Phi. Deg.	elastic assing (*)
				Gam.	Gam.'			
1	cohesv	2.070	1.0	17.5	7.5	10.0	0.0	0
2	sandy	4.000	3.0	17.5	8.5	0.0	28.0	0
3	sandy	7.000	13.0	17.0	8.0	0.0	33.0	0
4	cohesv	4.000	9.0	17.5	7.5	54.0	0.0	0
5	cohesv	17.000	7.0	17.5	7.5	42.0	0.0	0
6	cohesv	15.000	18.0	18.0	8.0	108.0	0.0	0
7	sandy	2.244	50.0	19.0	10.0	0.0	35.0	0

(*)0:if subgrade reaction> upper limit of subgrade reaction plastic area, 1: always elastic area

horizontal modulus of subgrade reaction kH (kN/m³)

No	bridge axis direction		perpendicular direction		step
	KH1	KH2	KH1	KH2	
1	865	865	865	865	0

No	bridge axis direction		perpendicular direction		step
	KH1	KH2	KH1	KH2	
2	1153	1153	1153	1153	0
3	4998	4998	4998	4998	0
4	6055	6055	6055	6055	0
5	4710	4710	4710	4710	0
6	12110	12110	12110	12110	0
7	33639	33639	33639	33639	0

2.4 timbering, construction step

(1) timbering

row	installation level(m)	step No		support point condition (tensile)	H shaped steel		
		set	remove		arc part	linear part(wailing)	linear part(strut)
1	+4.340	1	0	invld	H-350*350*12*19	H-350*350*12*19	H-350*350*12*19
2	+1.340	2	0	invld	2H-350*350*12*19	2H-350*350*12*19	2H-350*350*12*19
3	-1.660	4	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15
4	-4.660	5	0	invld	H-300*300*10*15	H-300*300*10*15	H-300*300*10*15

(2)H shaped steel

1)linear

**wailing

row	H (cm)	B (cm)	A (cm²)	Aw (cm²)	Iy (cm⁴)	Zy (cm³)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

2) arc

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

(3) strut spacing/brace span

row	perpendicular direction	
	strut spacing L1(m)	brace span L2(m)
1	4.000	1.300
2	4.000	1.300
3	4.000	1.300
4	4.000	1.300

(4)construction step

step	excavation area(m)	inside water level(m)
1	-5.346	+0.340
2	-12.850	+0.340
3	-12.850	-2.660
4	-12.850	-12.850

step	excavation area(m)	inside water level(m)
5	-12.850	-12.850
6	-12.850	-12.850

footing concrete cast --- 3 step
pile capcast --- 6 step

2.5 arbitrary load

No	working elevation (m)	load type	working width (m)	load (kN,kN/m)		working step number	
				top end	bottom end	begin	end
1	+4.340	distributed	9.686	0.270	0.068	1	6

note: positive load is applied from back side, negative load is applied from excavation area side

2.6 support point spring

(1) spring constant of timbering

arc part

$$K = \frac{E*A1}{r^2} \quad (kN/m/m)$$

linear part

$$K = \frac{E*A2}{\frac{L1}{2}} * \frac{1}{L2} \quad (kN/m/m)$$

Here, E : Young's modulus of timbering = 2.00 * 10^8(kN/m^2)
A1 : sectional area of wailing(m^2)
A2 : sectional area of strut (m^2)
r : timbering radius in arc part (m)
L1 : strut length (m)
L2 : strut spacing (m)

1)bridge axis direction

linear part

row	A2 (cm^2)	L1 (m)	L2 (m)	K (kN/m/m)
1	171.90	5.785	4.000	2.9714E+005
2	343.80	5.785	4.000	5.9429E+005
3	118.40	5.835	4.000	2.0291E+005
4	118.40	5.835	4.000	2.0291E+005

arc part

row	A1 (cm^2)	r (m)	K (kN/m/m)
1	171.90	2.893	4.1091E+005
2	343.80	2.893	8.2183E+005
3	118.40	2.918	2.7820E+005
4	118.40	2.918	2.7820E+005

(2)footing concrete spring constant

$$K = \frac{Alp.*(Ec*Ac)}{\frac{B}{2}} \quad (kN/m/m)$$

where, Alp. : reduction coefficient of spring = 0.050
Ec : Young's modulus of concrete at bottom = 2.35 * 10^7(kN/m^2)
Ac : sectional area per unit width of footing concrete = 2.000 (m^2/m)
B : footing concrete width (m)
bridge axis direction B = 6.135
perpendicular direction B = 17.717

1)bridge axis direction
K = 7.6609E+005 (kN/m/m)

2)perpendicular direction
K = 2.6527E+005 (kN/m/m)

(4) using value

1)support point spring constant (kN/m/m)

	support point condition(tensile)	bridge axis direction	perpendicular direction
timbering 1row	invld	2.9715E+005	4.1091E+005
timbering 2row	invld	5.9429E+005	8.2183E+005
timbering 3row	invld	2.0291E+005	2.7820E+005
timbering 4row	invld	2.0291E+005	2.7820E+005
footing concrete	invld	7.6609E+005	2.6527E+005

2.7 side pressure

(1) active side pressure

sand soil

$$Pa = Ka(Gam.*h - pw1 + q) - 2c * \sqrt{Ka} + pw1$$

where, Pa : active side pressure (kN/m^2)
Ka : active earth pressure coefficient $Ka = \tan^2(45Deg.- Phi. / 2)$
q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
Gam. : unit weight of wet soil (kN/m^3)
pw1 : backsides water pressure at depth h (kN/m^2)
h : depth from ground surface (m)
Phi. : internal friction angle of soil (Deg.)
c : cohesion of soil (kN/m^2)

------

h<=H

$$Pa = Ka1(Gam.*h + q)$$

h>H

$$Pa = Ka1(Gam.*H + q) + Ka2*Gam.(h - H)$$

where, Ka1,Ka2 : active earth pressure coefficient for cohesive soil

cohesive soil N value	Ka1		Ka2
	presumption equation	minimum	
8 <= N	0.5 - 0.010H	0.3	0.5
4 <= N < 8	0.6 - 0.010H	0.4	0.6
2 <= N < 4	0.7 - 0.025H	0.5	0.7
N < 2	0.8 - 0.025H	0.6	0.8

H : excavation depth

(2)passive side pressure

sand soil

$$Pp = Kp(Gam.*h - pw2 + q) + 2c* \sqrt{Kp} + pw2$$

$$Pp = Kp(Gam.*h + q) + 2c*\sqrt{Kp}$$

where, Pp : passive side pressure (kN/m^2)
Kp : passive earth pressure coefficient

$$Kp = \frac{\cos^2 Phi}{\left(1 - \sqrt{\sin(Phi - Del.)*\frac{sinPhi}{cosDel.}} \right)^2}$$

pw2 : water pressure on excavation side at depth h (kN/m^2)
Del. : friction angle between steel pipe sheet pile and soil (Deg.) (Del. = -Phi./3)
q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
(after concrete is casted to footing, includes weight of footing concrete and paving sand)

(3)at rest side pressure
use less value of either Po or Po'

1)before excavation
sand soil
Po = Ko(Gam.*h - pw1 + q) + pw1

cohesive soil
Po = ko(Gam.*h + q)

where, Po : side pressure at rest before excavation (kN/m^2)
Ko : at rest side pressure coefficient
Ko = 1 - sinPhi.(sand soil)
cohesive soil

N value of cohesive soil	Ko
8 <= N	0.5
4 <= N < 8	0.6
2 <= N < 4	0.7
N < 2	0.8

q : surcharge load (kN/m^2) (including weight of water upper than ground surface)

2)after excavation
sand soil

$$Po' = Ko(Gam.*h' - pw2 + q) + Ko*\frac{f*h'}{B} + pw2$$

cohesive soil

$$Po' = Ko(Gam.*h' + q) + Ko*\frac{f*h'}{B}$$

where, Po' : side pressure at rest after excavation (kN/m^2)
h' : depth from excavation areah (m)
q : surcharge load (kN/m^2) (including weight of water upper than ground surface)
(after concrete is casted to footing, includes weight of footing concrete and paving sand)
B : range of friction influence (m)
(let B=5.0m, if excavation width is less than 10m, then let excavation width 1/2)
f : friction force between steel pipe sheet pile and ground (kN/m^2)
sand soil : 1 * N(<=50)
cohesive soil : 0.5 * c or 5 * N(<=100)
where, if N<=2 weak layer, then friction force is not considered

steel pipe sheet pile length L = 61.500 (m)
design water tableelevation +4.340 (m)
design ground elevation -5.346 (m)

(4)sum up
1) 1 step
excavation area elevation = -5.346 (m)
landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
3	-5.346 -7.416	2.070	77.49 106.47	76.86 113.09	45.49 74.47	32.00 32.00	31.37 38.62
4	-7.416 -11.416	4.000	123.17 174.00	134.06 283.23	85.80 143.79	37.37 30.21	48.26 139.44
5	-11.416 -18.416	7.000	170.98 255.43	340.27 649.99	140.07 245.89	30.91 9.54	200.20 404.10
6	-18.416 -19.146	0.730	161.04 167.42	390.09 402.86	157.83 167.42	3.21 0.00	232.26 235.43
7	-19.146 -22.009	2.863	167.42 192.48	402.86 452.96	167.42 192.48	0.00 0.00	235.43 260.49
8	-22.009 -22.416	0.407	192.48 196.04	452.96 460.09	192.48 196.04	0.00 0.00	260.49 264.05
9	-22.416 -39.416	17.000	235.25 413.75	436.09 733.58	235.25 413.75	0.00 0.00	200.84 319.83
10	-39.416 -54.416	15.000	344.79 479.79	865.58 1135.58	344.79 479.79	0.00 0.00	520.79 655.79
11	-54.416 -56.660	2.244	688.38 716.29	2434.56 2569.35	746.20 777.25	0.00 0.00	1688.36 1792.10

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00
3	-5.346 -7.416	2.070	77.49 106.47	76.86 113.09	45.49 74.47	32.00 32.00	31.37 38.62
4	-7.416 -11.416	4.000	123.17 174.00	134.06 283.23	85.80 142.99	37.37 31.01	48.26 140.24
5	-11.416 -18.416	7.000	170.98 255.43	340.27 649.99	139.38 239.98	31.60 15.45	200.89 410.01
6	-18.416 -19.146	0.730	161.04 167.42	390.09 402.86	151.34 159.69	9.70 7.73	238.75 243.16
7	-19.146 -22.009	2.863	167.42 192.48	402.86 452.96	159.69 192.48	7.73 0.00	243.16 260.49

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
8	-22.009 -22.416	0.407	192.48 196.04	452.96 460.09	192.48 196.04	0.00 0.00	260.49 264.05
9	-22.416 -39.416	17.000	235.25 413.75	436.09 733.58	235.25 413.75	0.00 0.00	200.84 319.83
10	-39.416 -54.416	15.000	344.79 479.79	865.58 1135.58	344.79 479.79	0.00 0.00	520.79 655.79
11	-54.416 -56.660	2.244	688.38 716.29	2434.56 2569.35	746.20 777.25	0.00 0.00	1688.36 1792.10

2) 2 step
excavation area elevation = -12.850 (m)
landside water table elevation = +0.340 (m)

before footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	56.86 77.56	56.86 77.56	2.46 3.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	77.56 117.56	77.56 117.56	45.61 56.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	117.56 131.90	117.56 131.90	53.42 56.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	131.90 378.17	131.90 216.04	56.38 39.38	0.00 162.12
7	-18.416 -22.416	4.000	143.97 178.97	334.52 404.52	125.06 177.66	18.92 1.31	209.47 226.86
8	-22.416 -23.631	1.215	218.18 230.94	380.52 401.79	213.19 230.94	4.99 0.00	167.33 170.85
9	-23.631 -27.787	4.155	230.94 274.57	401.79 474.51	230.94 291.64	0.00 0.00	170.85 182.87
10	-27.787 -29.807	2.021	274.57 295.79	474.51 509.87	291.64 312.86	0.00 0.00	182.87 197.01
11	-29.807 -36.581	6.773	295.79 366.91	509.87 628.40	312.86 383.98	0.00 0.00	197.01 244.42
12	-36.581 -39.416	2.835	366.91 396.68	628.40 678.02	383.98 413.75	0.00 0.00	244.42 264.27
13	-39.416 -54.416	15.000	327.72 462.72	810.02 1080.02	344.79 479.79	0.00 0.00	465.23 600.23
14	-54.416 -56.660	2.244	688.38 716.29	2125.47 2260.26	746.20 777.25	0.00 0.00	1379.27 1483.01

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 +0.340	4.000	0.00 40.00	0.00 0.00	0.00 0.00	0.00 40.00	0.00 0.00
2	+0.340 -5.346	5.686	40.00 96.86	0.00 56.86	0.00 56.86	40.00 40.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	56.86 77.56	56.86 77.56	2.46 3.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	77.56 117.56	77.56 117.56	45.61 56.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	117.56 131.90	117.56 131.90	53.42 56.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	131.90 378.17	131.90 211.89	56.38 43.53	0.00 166.27
7	-18.416 -22.416	4.000	143.97 178.97	334.52 404.52	120.50 166.30	23.48 12.68	214.03 238.23
8	-22.416 -23.631	1.215	218.18 230.94	380.52 401.79	199.56 215.38	18.63 15.56	180.97 186.41
9	-23.631 -27.787	4.155	230.94 274.57	401.79 474.51	215.38 269.48	15.56 5.09	186.41 205.03
10	-27.787 -29.807	2.021	274.57 295.79	474.51 509.87	269.48 295.79	5.09 0.00	205.03 214.08
11	-29.807 -36.581	6.773	295.79 366.91	509.87 628.40	295.79 383.98	0.00 0.00	214.08 244.42
12	-36.581 -39.416	2.835	366.91 396.68	628.40 678.02	383.98 413.75	0.00 0.00	244.42 264.27
13	-39.416 -54.416	15.000	327.72 462.72	810.02 1080.02	344.79 479.79	0.00 0.00	465.23 600.23
14	-54.416 -56.660	2.244	688.38 716.29	2125.47 2260.26	746.20 777.25	0.00 0.00	1379.27 1483.01

3) 3 step
excavation area elevation   = -12.850 (m)
landside water table elevation =   -2.660 (m)

after footing concrete cast,   before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -2.660	7.000	0.00 70.00	0.00 0.00	0.00 0.00	0.00 70.00	0.00 0.00
2	-2.660 -5.346	2.686	70.00 96.86	0.00 26.86	0.00 26.86	70.00 70.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	26.86 47.56	26.86 47.56	32.46 33.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	47.56 87.56	47.56 87.56	75.61 86.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	87.56 101.90	87.56 101.90	83.42 86.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	253.56 499.82	116.02 200.16	72.26 55.27	137.54 299.66
7	-18.416 -22.416	4.000	143.97 178.97	335.52 405.52	125.56 178.16	18.42 0.81	209.97 227.36
8	-22.416 -23.485	1.069	218.18 229.41	381.52 400.23	213.79 229.41	4.39 0.00	167.73 170.82
9	-23.485 -27.641	4.155	229.41 273.04	400.23 472.95	229.41 290.11	0.00 0.00	170.82 182.84
10	-27.641 -29.569	1.929	273.04 293.29	472.95 506.70	290.11 310.36	0.00 0.00	182.84 196.34
11	-29.569 -36.343	6.773	293.29 364.41	506.70 625.24	310.36 381.48	0.00 0.00	196.34 243.76
12	-36.343 -39.416	3.073	364.41 396.68	625.24 679.02	381.48 413.75	0.00 0.00	243.76 265.27
13	-39.416 -54.416	15.000	327.72 462.72	811.02 1081.02	344.79 479.79	0.00 0.00	466.23 601.23
14	-54.416 -56.660	2.244	688.38 716.29	2131.04 2265.82	746.20 777.25	0.00 0.00	1384.84 1488.57

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -2.660	7.000	0.00 70.00	0.00 0.00	0.00 0.00	0.00 70.00	0.00 0.00
2	-2.660 -5.346	2.686	70.00 96.86	0.00 26.86	0.00 26.86	70.00 70.00	0.00 0.00
3	-5.346 -7.416	2.070	59.32 81.50	26.86 47.56	26.86 47.56	32.46 33.94	0.00 0.00
4	-7.416 -11.416	4.000	123.17 174.00	47.56 87.56	47.56 87.56	75.61 86.44	0.00 0.00
5	-11.416 -12.850	1.434	170.98 188.28	87.56 101.90	87.56 101.90	83.42 86.38	0.00 0.00
6	-12.850 -18.416	5.566	188.28 255.43	253.56 499.82	116.02 196.01	72.26 59.42	137.54 303.81
7	-18.416 -22.416	4.000	143.97 178.97	335.52 405.52	121.00 166.80	22.98 12.18	214.53 238.73
8	-22.416 -23.485	1.069	218.18 229.41	381.52 400.23	200.16 214.08	18.03 15.33	181.37 186.16
9	-23.485 -27.641	4.155	229.41 273.04	400.23 472.95	214.08 268.18	15.33 4.86	186.16 204.77
10	-27.641 -29.569	1.929	273.04 293.29	472.95 506.70	268.18 293.29	4.86 0.00	204.77 213.41
11	-29.569 -36.343	6.773	293.29 364.41	506.70 625.24	293.29 381.48	0.00 0.00	213.41 243.76
12	-36.343 -39.416	3.073	364.41 396.68	625.24 679.02	381.48 413.75	0.00 0.00	243.76 265.27
13	-39.416 -54.416	15.000	327.72 462.72	811.02 1081.02	344.79 479.79	0.00 0.00	466.23 601.23
14	-54.416 -56.660	2.244	688.38 716.29	2131.04 2265.82	746.20 777.25	0.00 0.00	1384.84 1488.57

4) 4 step
excavation area elevation = -12.850 (m)
landside water table elevation = -12.850 (m)

after footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 98.26	174.16 157.17	137.54 299.66
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	74.61 127.21	69.37 51.76	159.02 176.41
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	152.65 385.70	65.53 0.00	126.97 173.12
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	385.70 400.98	0.00 0.00	173.12 176.14
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	334.15 355.68	0.00 0.00	374.97 375.21
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	355.68 390.50	0.00 0.00	375.21 410.04
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	390.50 418.95	0.00 0.00	410.04 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m^2)	passive side pressure (kN/m^2)	at rest side pressure (kN/m^2)	effective side pressure (kN/m^2)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 94.11	174.16 161.32	137.54 303.81
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	70.05 115.85	73.93 63.13	163.58 187.78
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	139.02 346.74	79.17 38.96	140.61 212.08
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	346.74 360.36	38.96 36.33	212.08 216.77
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	300.30 317.71	27.43 20.90	408.83 413.18
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	317.71 373.44	20.90 0.00	413.18 427.11
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	373.44 418.95	0.00 0.00	427.11 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

5) 5 step
excavation area elevation = -12.850 (m)
landside water table elevation = -12.850 (m)

after footing concrete cast, before pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 98.26	174.16 157.17	137.54 299.66
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	74.61 127.21	69.37 51.76	159.02 176.41
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	152.65 385.70	65.53 0.00	126.97 173.12
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	385.70 400.98	0.00 0.00	173.12 176.14
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	334.15 355.68	0.00 0.00	374.97 375.21
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	355.68 390.50	0.00 0.00	375.21 410.04
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	390.50 418.95	0.00 0.00	410.04 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 94.11	174.16 161.32	137.54 303.81
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	70.05 115.85	73.93 63.13	163.58 187.78
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	139.02 346.74	79.17 38.96	140.61 212.08
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	346.74 360.36	38.96 36.33	212.08 216.77
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	300.30 317.71	27.43 20.90	408.83 413.18
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	317.71 373.44	20.90 0.00	413.18 427.11
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	373.44 418.95	0.00 0.00	427.11 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

6) 6 step
excavation area elevation = -12.850 (m)
landside water table elevation = -12.850 (m)

after footing concrete cast, after pile cap cast
bridge axis direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 98.26	174.16 157.17	137.54 299.66
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	74.61 127.21	69.37 51.76	159.02 176.41
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	152.65 385.70	65.53 0.00	126.97 173.12
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	385.70 400.98	0.00 0.00	173.12 176.14
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	334.15 355.68	0.00 0.00	374.97 375.21
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	355.68 390.50	0.00 0.00	375.21 410.04
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	390.50 418.95	0.00 0.00	410.04 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

perpendicular direction

No	elevation (m)	layer thick (m)	active side pressure (kN/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						active	passive
1	+4.340 -5.346	9.686	0.00 96.86	0.00 0.00	0.00 0.00	0.00 96.86	0.00 0.00
2	-5.346 -7.416	2.070	59.32 81.50	0.00 0.00	0.00 0.00	59.32 81.50	0.00 0.00
3	-7.416 -11.416	4.000	123.17 174.00	0.00 0.00	0.00 0.00	123.17 174.00	0.00 0.00
4	-11.416 -12.850	1.434	170.98 188.28	0.00 0.00	0.00 0.00	170.98 188.28	0.00 0.00
5	-12.850 -18.416	5.566	188.28 255.43	151.66 397.92	14.12 94.11	174.16 161.32	137.54 303.81
6	-18.416 -22.416	4.000	143.97 178.97	233.62 303.62	70.05 115.85	73.93 63.13	163.58 187.78
7	-22.416 -38.370	15.954	218.18 385.70	279.62 558.82	139.02 346.74	79.17 38.96	140.61 212.08
8	-38.370 -39.416	1.046	385.70 396.68	558.82 577.12	346.74 360.36	38.96 36.33	212.08 216.77
9	-39.416 -40.625	1.209	327.72 338.61	709.12 730.89	300.30 317.71	27.43 20.90	408.83 413.18
10	-40.625 -44.495	3.870	338.61 373.44	730.89 800.54	317.71 373.44	20.90 0.00	413.18 427.11
11	-44.495 -47.656	3.161	373.44 401.88	800.54 857.44	373.44 418.95	0.00 0.00	427.11 438.49
12	-47.656 -54.416	6.760	401.88 462.72	857.44 979.12	418.95 479.79	0.00 0.00	438.49 499.33
13	-54.416 -56.660	2.244	688.38 716.29	1564.18 1698.97	746.20 777.25	0.00 0.00	817.98 921.72

2.8 side pressure detail output

(1)construction step [1]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -5.346	5.686	----	----	----	----
3	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
4	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
5	sandy	-11.416 -18.416	7.000	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -19.146	0.730	17.5	54.0	0.00	9.0
7	cohesv	-19.146 -22.009	2.863	17.5	54.0	0.00	9.0
8	cohesv	-22.009 -22.416	0.407	17.5	54.0	0.00	9.0
9	cohesv	-22.416 -39.416	17.000	17.5	42.0	0.00	7.0
10	cohesv	-39.416 -54.416	15.000	18.0	108.0	0.00	18.0
11	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00
2	----	+0.340 -5.346	5.686	0.00 0.00	-------- --------	40.00 96.86	------- -------	------- -------	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	0.000 36.225	-------- --------	0.8000 0.8000	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	0.000 0.000	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
5	sandy	-11.416 -18.416	7.000	203.09 322.09	0.000 0.000	157.56 227.56	0.2948 0.2948	------- -------	13.42 27.87	170.98 255.43
6	cohesv	-18.416 -19.146	0.730	322.09 334.85	225.225 237.994	-------- --------	0.5000 0.5000	0.5000 0.5000	161.04 167.43	161.04 167.43
7	cohesv	-19.146 -22.009	2.863	334.85 384.96	237.994 288.095	-------- --------	0.5000 0.5000	0.5000 0.5000	167.43 192.48	167.43 192.48
8	cohesv	-22.009 -22.416	0.407	384.96 392.09	288.095 295.225	-------- --------	0.5000 0.5000	0.5000 0.5000	192.48 196.04	192.48 196.04
9	cohesv	-22.416 -39.416	17.000	392.09 689.58	295.225 592.725	-------- --------	0.6000 0.6000	0.6000 0.6000	235.25 413.75	235.25 413.75
10	cohesv	-39.416 -54.416	15.000	689.58 959.58	592.725 862.725	-------- --------	0.5000 0.5000	0.5000 0.5000	344.79 479.79	344.79 479.79
11	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \qquad \text{(sand soil)}$$

$$Pa = Pa1 + pw1 \qquad \text{(sand soil)}$$

$$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\} \qquad \text{(cohesive soil)}$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	----	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	56.86 93.09	-------- --------	1.0000 1.0000	76.86 113.09	76.86 113.09
4	sandy	-7.416 -11.416	4.000	93.09 163.09	77.56 117.56	3.6391 3.6391	56.50 165.67	134.06 283.23
5	sandy	-11.416 -18.416	7.000	163.09 282.09	117.56 187.56	4.8921 4.8921	222.71 462.43	340.27 649.99
6	cohesv	-18.416 -19.146	0.730	282.09 294.85	-------- --------	1.0000 1.0000	390.09 402.85	390.09 402.85
7	cohesv	-19.146 -22.009	2.863	294.85 344.96	-------- --------	1.0000 1.0000	402.85 452.96	402.85 452.96

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
8	cohesv	-22.009 -22.416	0.407	344.96 352.09	-------- --------	1.0000 1.0000	452.96 460.09	452.96 460.09
9	cohesv	-22.416 -39.416	17.000	352.09 649.58	-------- --------	1.0000 1.0000	436.09 733.58	436.09 733.58
10	cohesv	-39.416 -54.416	15.000	649.58 919.58	-------- --------	1.0000 1.0000	865.58 1135.58	865.58 1135.58
11	sandy	-54.416 -56.660	2.244	919.58 962.22	587.56 610.00	5.5628 5.5628	1847.00 1959.35	2434.56 2569.35

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	40.00 96.86	0.0000 0.0000	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
5	sandy	-11.416 -18.416	7.000	203.09 322.09	157.56 227.56	0.4554 0.4554	20.73 43.04	178.29 270.60
6	cohesv	-18.416 -19.146	0.730	322.09 334.85	-------- --------	0.5000 0.5000	161.04 167.43	161.04 167.43
7	cohesv	-19.146 -22.009	2.863	334.85 384.96	-------- --------	0.5000 0.5000	167.43 192.48	167.43 192.48
8	cohesv	-22.009 -22.416	0.407	384.96 392.09	-------- --------	0.5000 0.5000	192.48 196.04	192.48 196.04
9	cohesv	-22.416 -39.416	17.000	392.09 689.58	-------- --------	0.6000 0.6000	235.25 413.75	235.25 413.75
10	cohesv	-39.416 -54.416	15.000	689.58 959.58	-------- --------	0.5000 0.5000	344.79 479.79	344.79 479.79

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
11	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (sand soil)

$Po = Po1 + pw1$ (sand soil)

$Po = Po1 = Ko * \left\{ Sum.(Gam.*h) + q \right\}$ (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	56.86 93.09	-------- --------	0.00	0.00 0.00	0.8000 0.8000	45.49 74.47	45.49 74.47
4	sandy	-7.416 -11.416	4.000	93.09 163.09	77.56 117.56	3.00	0.00 12.00	0.5305 0.5305	8.24 26.23	85.80 143.79
5	sandy	-11.416 -18.416	7.000	163.09 282.09	117.56 187.56	13.00	12.00 103.00	0.4554 0.4554	22.51 58.33	140.07 245.89
6	cohesv	-18.416 -19.146	0.730	282.09 294.85	-------- --------	27.00	103.00 122.70	0.5000 0.5000	157.83 167.43	157.83 167.43
7	cohesv	-19.146 -22.009	2.863	294.85 344.96	-------- --------	27.00	122.70 200.00	0.5000 0.5000	167.43 205.08	167.43 205.08
8	cohesv	-22.009 -22.416	0.407	344.96 352.09	-------- --------	27.00	200.00 211.00	0.5000 0.5000	205.08 210.43	205.08 210.43
9	cohesv	-22.416 -39.416	17.000	352.09 649.58	-------- --------	21.00	211.00 568.00	0.6000 0.6000	252.52 500.85	252.52 500.85
10	cohesv	-39.416 -54.416	15.000	649.58 919.58	-------- --------	54.00	568.00 1378.00	0.5000 0.5000	417.38 684.40	417.38 684.40

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
11	sandy	-54.416 -56.660	2.244	919.58 962.22	587.56 610.00	50.00	1378.00 1490.20	0.4264 0.4264	333.14 357.35	920.70 967.35

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	56.86 93.09	-------- --------	0.00	0.00 0.00	0.8000 0.8000	45.49 74.47	45.49 74.47
4	sandy	-7.416 -11.416	4.000	93.09 163.09	77.56 117.56	3.00	0.00 12.00	0.5305 0.5305	8.24 25.43	85.80 142.99
5	sandy	-11.416 -18.416	7.000	163.09 282.09	117.56 187.56	13.00	12.00 103.00	0.4554 0.4554	21.82 52.42	139.38 239.98
6	cohesv	-18.416 -19.146	0.730	282.09 294.85	-------- --------	27.00	103.00 122.70	0.5000 0.5000	151.34 159.70	151.34 159.70
7	cohesv	-19.146 -22.009	2.863	294.85 344.96	-------- --------	27.00	122.70 200.00	0.5000 0.5000	159.70 192.48	159.70 192.48
8	cohesv	-22.009 -22.416	0.407	344.96 352.09	-------- --------	27.00	200.00 211.00	0.5000 0.5000	192.48 197.14	192.48 197.14
9	cohesv	-22.416 -39.416	17.000	352.09 649.58	-------- --------	21.00	211.00 568.00	0.6000 0.6000	236.57 457.91	236.57 457.91
10	cohesv	-39.416 -54.416	15.000	649.58 919.58	-------- --------	54.00	568.00 1378.00	0.5000 0.5000	381.59 597.59	381.59 597.59

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
11	sandy	-54.416 -56.660	2.244	919.58 962.22	587.56 610.00	50.00	1378.00 1490.20	0.4264 0.4264	259.11 277.29	846.67 887.29

friction force B7027influence range B = 5.000 (m)

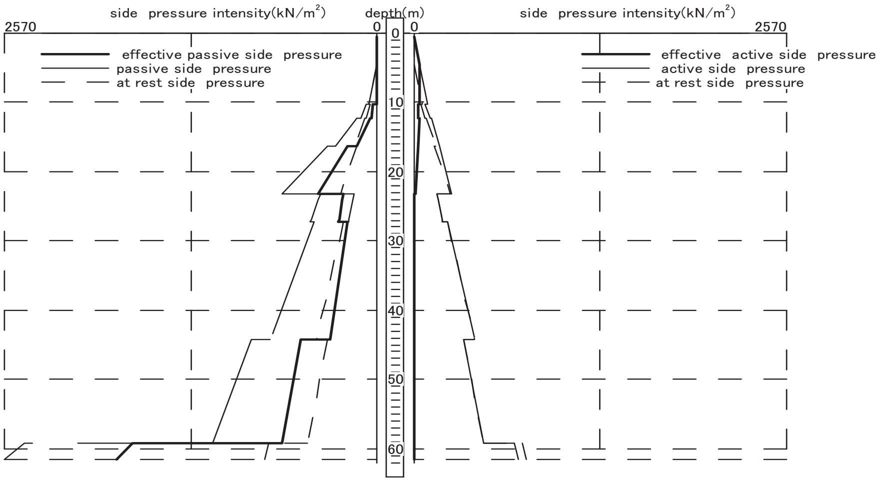
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

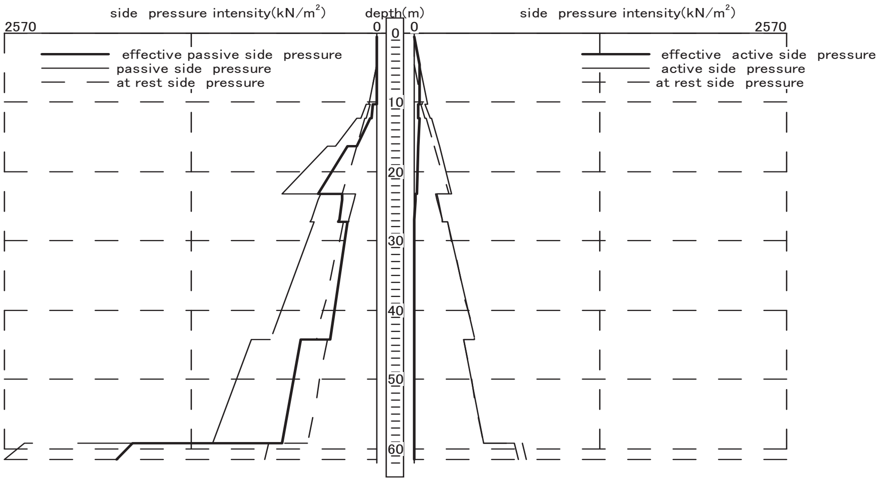
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(2)construction step [2]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 +0.340	4.000	----	----	----	----
2	-------	+0.340 -5.346	5.686	----	----	----	----
3	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
4	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
5	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
6	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
7	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
8	cohesv	-22.416 -23.631	1.215	17.5	42.0	0.00	7.0
9	cohesv	-23.631 -27.787	4.155	17.5	42.0	0.00	7.0
10	cohesv	-27.787 -29.807	2.021	17.5	42.0	0.00	7.0
11	cohesv	-29.807 -36.581	6.773	17.5	42.0	0.00	7.0
12	cohesv	-36.581 -39.416	2.835	17.5	42.0	0.00	7.0
13	cohesv	-39.416 -54.416	15.000	18.0	108.0	0.00	18.0
14	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 +0.340	4.000	0.00 0.00	-------- --------	0.00 40.00	------- -------	------- -------	0.00 0.00	0.00 40.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
2	----	+0.340 -5.346	5.686	0.00 0.00	-------- --------	40.00 96.86	------- -------	------- -------	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50
4	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
5	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
6	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
8	cohesv	-22.416 -23.631	1.215	392.09 413.35	164.622 185.888	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 230.94	218.18 230.94
9	cohesv	-23.631 -27.787	4.155	413.35 486.07	185.888 258.609	-------- --------	0.5250 0.5250	0.6000 0.6000	230.94 274.57	230.94 274.57
10	cohesv	-27.787 -29.807	2.021	486.07 521.43	258.609 293.969	-------- --------	0.5250 0.5250	0.6000 0.6000	274.57 295.79	274.57 295.79
11	cohesv	-29.807 -36.581	6.773	521.43 639.97	293.969 412.503	-------- --------	0.5250 0.5250	0.6000 0.6000	295.79 366.91	295.79 366.91
12	cohesv	-36.581 -39.416	2.835	639.97 689.58	412.503 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	366.91 396.68	366.91 396.68
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	462.122 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 462.72	327.72 462.72
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$Pa1 = Ka1*\{ Sum.((Gam.*h)) + q - pw1 \} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1*\{ Sum.(Gam.*H) + q \} + Ka2*\{ Sum.(Gam.(h - H)) \}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
2	----	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	56.86 77.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	77.56 117.56	0.0000 0.0000	0.00 0.00	77.56 117.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	117.56 131.90	0.0000 0.0000	0.00 0.00	117.56 131.90
6	sandy	-12.850 -18.416	5.566	131.90 226.52	131.90 187.56	4.8921 4.8921	0.00 190.61	131.90 378.17
7	cohesv	-18.416 -22.416	4.000	226.52 296.52	-------- --------	1.0000 1.0000	334.52 404.52	334.52 404.52
8	cohesv	-22.416 -23.631	1.215	296.52 317.79	-------- --------	1.0000 1.0000	380.52 401.79	380.52 401.79
9	cohesv	-23.631 -27.787	4.155	317.79 390.51	-------- --------	1.0000 1.0000	401.79 474.51	401.79 474.51
10	cohesv	-27.787 -29.807	2.021	390.51 425.87	-------- --------	1.0000 1.0000	474.51 509.87	474.51 509.87
11	cohesv	-29.807 -36.581	6.773	425.87 544.40	-------- --------	1.0000 1.0000	509.87 628.40	509.87 628.40
12	cohesv	-36.581 -39.416	2.835	544.40 594.02	-------- --------	1.0000 1.0000	628.40 678.02	628.40 678.02
13	cohesv	-39.416 -54.416	15.000	594.02 864.02	-------- --------	1.0000 1.0000	810.02 1080.02	810.02 1080.02
14	sandy	-54.416 -56.660	2.244	864.02 906.66	587.56 610.00	5.5628 5.5628	1537.91 1650.26	2125.47 2260.26

$Pp1 = Kp * \{ Sum.((Gam.*h)) + q - pw2 \} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp*\{ Sum.((Gam.*h)) + q \} + 2*c*\sqrt{kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 40.00	0.0000 0.0000	0.00 0.00	0.00 40.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
2	-------	+0.340 -5.346	5.686	0.00 0.00	40.00 96.86	0.0000 0.0000	0.00 0.00	40.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
5	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20
6	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
8	cohesv	-22.416 -23.631	1.215	392.09 413.35	-------- --------	0.6000 0.6000	235.25 248.01	235.25 248.01
9	cohesv	-23.631 -27.787	4.155	413.35 486.07	-------- --------	0.6000 0.6000	248.01 291.64	248.01 291.64
10	cohesv	-27.787 -29.807	2.021	486.07 521.43	-------- --------	0.6000 0.6000	291.64 312.86	291.64 312.86
11	cohesv	-29.807 -36.581	6.773	521.43 639.97	-------- --------	0.6000 0.6000	312.86 383.98	312.86 383.98
12	cohesv	-36.581 -39.416	2.835	639.97 689.58	-------- --------	0.6000 0.6000	383.98 413.75	383.98 413.75
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	-------- --------	0.5000 0.5000	344.79 479.79	344.79 479.79
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	56.86 77.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	77.56 117.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	77.56 117.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	117.56 131.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	117.56 131.90
6	sandy	-12.850 -18.416	5.566	131.90 226.52	131.90 187.56	13.00	0.00 72.36	0.4554 0.4554	0.00 28.48	131.90 216.04
7	cohesv	-18.416 -22.416	4.000	226.52 296.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	125.06 177.66	125.06 177.66
8	cohesv	-22.416 -23.631	1.215	296.52 317.79	-------- --------	21.00	180.36 205.88	0.6000 0.6000	213.19 230.94	213.19 230.94
9	cohesv	-23.631 -27.787	4.155	317.79 390.51	-------- --------	21.00	205.88 293.14	0.6000 0.6000	230.94 291.64	230.94 291.64
10	cohesv	-27.787 -29.807	2.021	390.51 425.87	-------- --------	21.00	293.14 335.57	0.6000 0.6000	291.64 321.16	291.64 321.16
11	cohesv	-29.807 -36.581	6.773	425.87 544.40	-------- --------	21.00	335.57 477.81	0.6000 0.6000	321.16 420.10	321.16 420.10
12	cohesv	-36.581 -39.416	2.835	544.40 594.02	-------- --------	21.00	477.81 537.36	0.6000 0.6000	420.10 461.52	420.10 461.52
13	cohesv	-39.416 -54.416	15.000	594.02 864.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	384.60 651.63	384.60 651.63
14	sandy	-54.416 -56.660	2.244	864.02 906.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	305.19 329.40	892.75 939.40

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 +0.340	4.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	+0.340 -5.346	5.686	0.00 0.00	0.00 56.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 56.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	56.86 77.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	77.56 117.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	77.56 117.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	117.56 131.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	117.56 131.90
6	sandy	-12.850 -18.416	5.566	131.90 226.52	131.90 187.56	13.00	0.00 72.36	0.4554 0.4554	0.00 24.33	131.90 211.89
7	cohesv	-18.416 -22.416	4.000	226.52 296.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	120.50 166.30	120.50 166.30
8	cohesv	-22.416 -23.631	1.215	296.52 317.79	-------- --------	21.00	180.36 205.88	0.6000 0.6000	199.56 215.38	199.56 215.38
9	cohesv	-23.631 -27.787	4.155	317.79 390.51	-------- --------	21.00	205.88 293.14	0.6000 0.6000	215.38 269.48	215.38 269.48
10	cohesv	-27.787 -29.807	2.021	390.51 425.87	-------- --------	21.00	293.14 335.57	0.6000 0.6000	269.48 295.79	269.48 295.79
11	cohesv	-29.807 -36.581	6.773	425.87 544.40	-------- --------	21.00	335.57 477.81	0.6000 0.6000	295.79 383.98	295.79 383.98
12	cohesv	-36.581 -39.416	2.835	544.40 594.02	-------- --------	21.00	477.81 537.36	0.6000 0.6000	383.98 420.90	383.98 420.90
13	cohesv	-39.416 -54.416	15.000	594.02 864.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	350.75 566.75	350.75 566.75
14	sandy	-54.416 -56.660	2.244	864.02 906.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	232.80 250.98	820.36 860.98

friction force B7027influence range B = 5.000 (m)

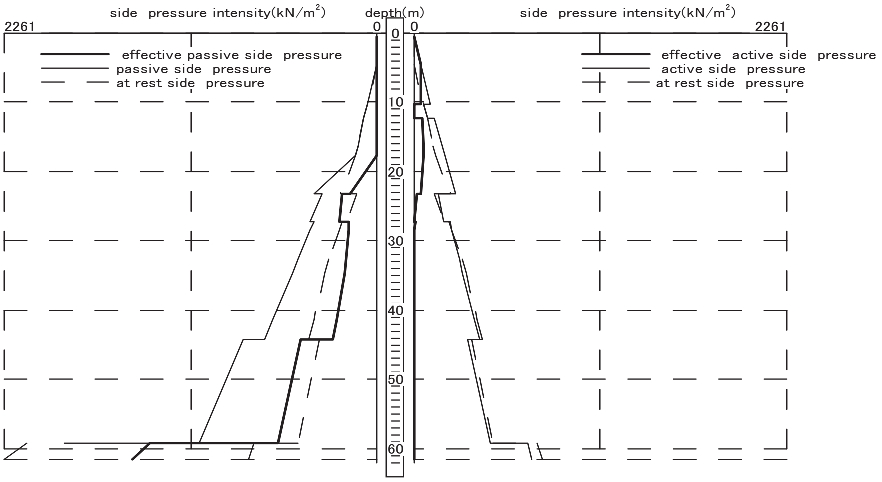
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

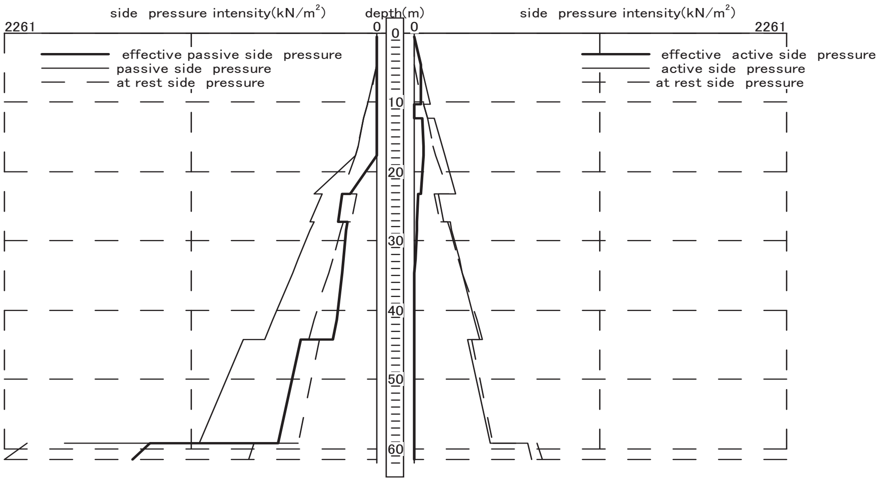
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(3)construction step [3]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -2.660	7.000	----	----	----	----
2	-------	-2.660 -5.346	2.686	----	----	----	----
3	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
4	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
5	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
6	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
7	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
8	cohesv	-22.416 -23.485	1.069	17.5	42.0	0.00	7.0
9	cohesv	-23.485 -27.641	4.155	17.5	42.0	0.00	7.0
10	cohesv	-27.641 -29.569	1.929	17.5	42.0	0.00	7.0
11	cohesv	-29.569 -36.343	6.773	17.5	42.0	0.00	7.0
12	cohesv	-36.343 -39.416	3.073	17.5	42.0	0.00	7.0
13	cohesv	-39.416 -54.416	15.000	18.0	108.0	0.00	18.0
14	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -2.660	7.000	0.00 0.00	-------- --------	0.00 70.00	------- -------	------- -------	0.00 0.00	0.00 70.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
2	----	-2.660 -5.346	2.686	0.00 0.00	-------- --------	70.00 96.86	------- -------	------- -------	0.00 0.00	70.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50
4	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
5	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
6	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
8	cohesv	-22.416 -23.485	1.069	392.09 410.79	164.622 183.332	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 229.41	218.18 229.41
9	cohesv	-23.485 -27.641	4.155	410.79 483.52	183.332 256.053	-------- --------	0.5250 0.5250	0.6000 0.6000	229.41 273.04	229.41 273.04
10	cohesv	-27.641 -29.569	1.929	483.52 517.27	256.053 289.803	-------- --------	0.5250 0.5250	0.6000 0.6000	273.04 293.29	273.04 293.29
11	cohesv	-29.569 -36.343	6.773	517.27 635.80	289.803 408.336	-------- --------	0.5250 0.5250	0.6000 0.6000	293.29 364.41	293.29 364.41
12	cohesv	-36.343 -39.416	3.073	635.80 689.58	408.336 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	364.41 396.68	364.41 396.68
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	462.122 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 462.72	327.72 462.72
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 -2.660	7.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
2	----	-2.660 -5.346	2.686	0.00 0.00	0.00 26.86	0.0000 0.0000	0.00 0.00	0.00 26.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	26.86 47.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	47.56 87.56	0.0000 0.0000	0.00 0.00	47.56 87.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	87.56 101.90	0.0000 0.0000	0.00 0.00	87.56 101.90
6	sandy	-12.850 -18.416	5.566	132.90 227.52	101.90 157.56	4.8921 4.8921	151.66 342.26	253.56 499.82
7	cohesv	-18.416 -22.416	4.000	227.52 297.52	-------- --------	1.0000 1.0000	335.52 405.52	335.52 405.52
8	cohesv	-22.416 -23.485	1.069	297.52 316.23	-------- --------	1.0000 1.0000	381.52 400.23	381.52 400.23
9	cohesv	-23.485 -27.641	4.155	316.23 388.95	-------- --------	1.0000 1.0000	400.23 472.95	400.23 472.95
10	cohesv	-27.641 -29.569	1.929	388.95 422.70	-------- --------	1.0000 1.0000	472.95 506.70	472.95 506.70
11	cohesv	-29.569 -36.343	6.773	422.70 541.24	-------- --------	1.0000 1.0000	506.70 625.24	506.70 625.24
12	cohesv	-36.343 -39.416	3.073	541.24 595.02	-------- --------	1.0000 1.0000	625.24 679.02	625.24 679.02
13	cohesv	-39.416 -54.416	15.000	595.02 865.02	-------- --------	1.0000 1.0000	811.02 1081.02	811.02 1081.02
14	sandy	-54.416 -56.660	2.244	865.02 907.66	587.56 610.00	5.5628 5.5628	1543.48 1655.82	2131.04 2265.82

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp * \left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 -2.660	7.000	0.00 0.00	0.00 70.00	0.0000 0.0000	0.00 0.00	0.00 70.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
2	-------	-2.660 -5.346	2.686	0.00 0.00	70.00 96.86	0.0000 0.0000	0.00 0.00	70.00 96.86
3	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
4	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
5	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20
6	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
7	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
8	cohesv	-22.416 -23.485	1.069	392.09 410.79	-------- --------	0.6000 0.6000	235.25 246.48	235.25 246.48
9	cohesv	-23.485 -27.641	4.155	410.79 483.52	-------- --------	0.6000 0.6000	246.48 290.11	246.48 290.11
10	cohesv	-27.641 -29.569	1.929	483.52 517.27	-------- --------	0.6000 0.6000	290.11 310.36	290.11 310.36
11	cohesv	-29.569 -36.343	6.773	517.27 635.80	-------- --------	0.6000 0.6000	310.36 381.48	310.36 381.48
12	cohesv	-36.343 -39.416	3.073	635.80 689.58	-------- --------	0.6000 0.6000	381.48 413.75	381.48 413.75
13	cohesv	-39.416 -54.416	15.000	689.58 959.58	-------- --------	0.5000 0.5000	344.79 479.79	344.79 479.79
14	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -2.660	7.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	-2.660 -5.346	2.686	0.00 0.00	0.00 26.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 26.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	26.86 47.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	47.56 87.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	47.56 87.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	87.56 101.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	87.56 101.90
6	sandy	-12.850 -18.416	5.566	132.90 227.52	101.90 157.56	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	116.02 200.16
7	cohesv	-18.416 -22.416	4.000	227.52 297.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	125.56 178.16	125.56 178.16
8	cohesv	-22.416 -23.485	1.069	297.52 316.23	-------- --------	21.00	180.36 202.81	0.6000 0.6000	213.79 229.41	213.79 229.41
9	cohesv	-23.485 -27.641	4.155	316.23 388.95	-------- --------	21.00	202.81 290.07	0.6000 0.6000	229.41 290.11	229.41 290.11
10	cohesv	-27.641 -29.569	1.929	388.95 422.70	-------- --------	21.00	290.07 330.57	0.6000 0.6000	290.11 318.28	290.11 318.28
11	cohesv	-29.569 -36.343	6.773	422.70 541.24	-------- --------	21.00	330.57 472.81	0.6000 0.6000	318.28 417.22	318.28 417.22
12	cohesv	-36.343 -39.416	3.073	541.24 595.02	-------- --------	21.00	472.81 537.36	0.6000 0.6000	417.22 462.12	417.22 462.12
13	cohesv	-39.416 -54.416	15.000	595.02 865.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	385.10 652.13	385.10 652.13
14	sandy	-54.416 -56.660	2.244	865.02 907.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	305.62 329.82	893.18 939.82

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
1	-------	+4.340 -2.660	7.000	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	-------	-2.660 -5.346	2.686	0.00 0.00	0.00 26.86	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 26.86
3	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	26.86 47.56
4	sandy	-7.416 -11.416	4.000	0.00 0.00	47.56 87.56	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	47.56 87.56
5	sandy	-11.416 -12.850	1.434	0.00 0.00	87.56 101.90	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	87.56 101.90
6	sandy	-12.850 -18.416	5.566	132.90 227.52	101.90 157.56	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	116.02 196.01
7	cohesv	-18.416 -22.416	4.000	227.52 297.52	-------- --------	27.00	72.36 180.36	0.5000 0.5000	121.00 166.80	121.00 166.80
8	cohesv	-22.416 -23.485	1.069	297.52 316.23	-------- --------	21.00	180.36 202.81	0.6000 0.6000	200.16 214.08	200.16 214.08
9	cohesv	-23.485 -27.641	4.155	316.23 388.95	-------- --------	21.00	202.81 290.07	0.6000 0.6000	214.08 268.18	214.08 268.18
10	cohesv	-27.641 -29.569	1.929	388.95 422.70	-------- --------	21.00	290.07 330.57	0.6000 0.6000	268.18 293.29	268.18 293.29
11	cohesv	-29.569 -36.343	6.773	422.70 541.24	-------- --------	21.00	330.57 472.81	0.6000 0.6000	293.29 381.48	293.29 381.48
12	cohesv	-36.343 -39.416	3.073	541.24 595.02	-------- --------	21.00	472.81 537.36	0.6000 0.6000	381.48 421.50	381.48 421.50
13	cohesv	-39.416 -54.416	15.000	595.02 865.02	-------- --------	54.00	537.36 1347.36	0.5000 0.5000	351.25 567.25	351.25 567.25
14	sandy	-54.416 -56.660	2.244	865.02 907.66	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	233.23 251.41	820.79 861.41

friction force B7027influence range B = 5.000 (m)

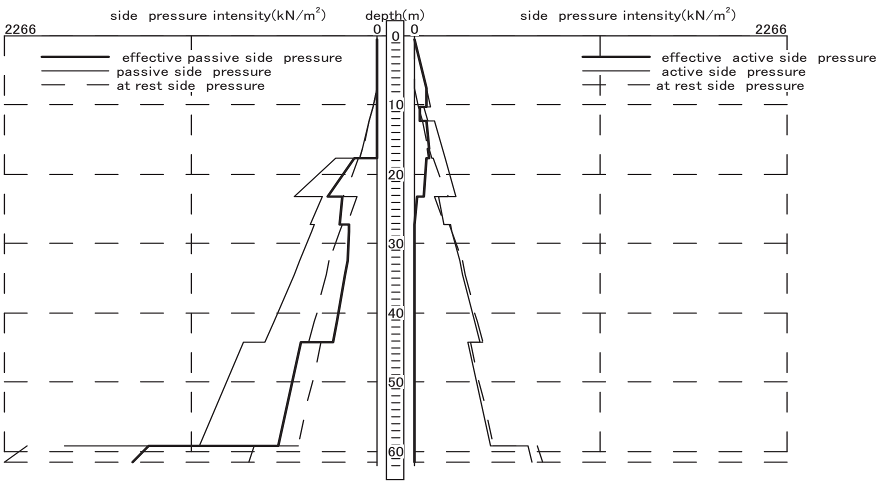
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

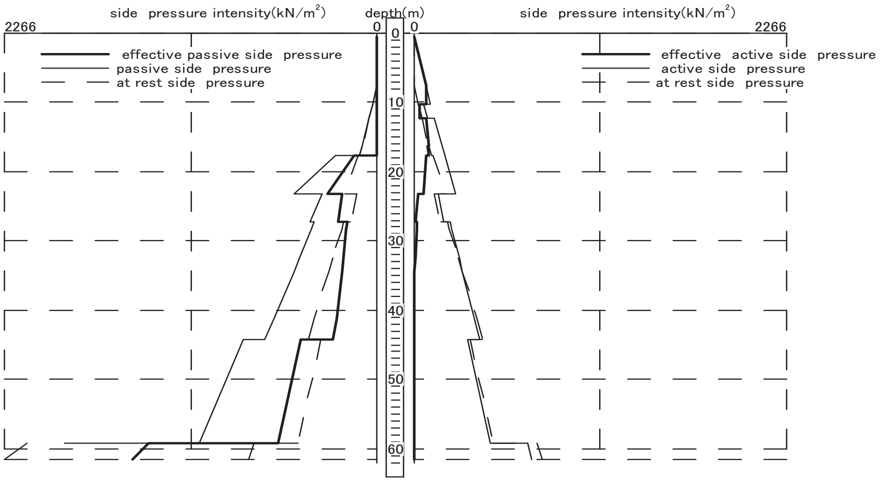
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(4)construction step [4]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.346	9.686	----	----	----	----
2	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
3	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
4	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
5	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
7	cohesv	-22.416 -38.370	15.954	17.5	42.0	0.00	7.0
8	cohesv	-38.370 -39.416	1.046	17.5	42.0	0.00	7.0
9	cohesv	-39.416 -40.625	1.209	18.0	108.0	0.00	18.0
10	cohesv	-40.625 -44.495	3.870	18.0	108.0	0.00	18.0
11	cohesv	-44.495 -47.656	3.161	18.0	108.0	0.00	18.0
12	cohesv	-47.656 -54.416	6.760	18.0	108.0	0.00	18.0
13	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	-------- --------	0.00 96.86	------- -------	------- -------	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
3	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
4	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
5	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	164.622 443.816	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 385.70	218.18 385.70
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	443.816 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	385.70 396.68	385.70 396.68
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	462.122 483.888	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 338.61	327.72 338.61
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	483.888 553.545	-------- --------	0.4250 0.4250	0.5000 0.5000	338.61 373.44	338.61 373.44
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	553.545 610.441	-------- --------	0.4250 0.4250	0.5000 0.5000	373.44 401.88	373.44 401.88
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	610.441 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	401.88 462.72	401.88 462.72
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$Pa1 = Ka1 * \{ Sum.((Gam.*h)) + q - pw1 \} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1 * \{ Sum.(Gam.*H) + q \} + Ka2 * \{ Sum.(Gam.(h - H)) \}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	4.8921 4.8921	151.66 342.26	151.66 397.92
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	1.0000 1.0000	233.62 303.62	233.62 303.62
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	1.0000 1.0000	279.62 558.82	279.62 558.82
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	1.0000 1.0000	558.82 577.12	558.82 577.12
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	1.0000 1.0000	709.12 730.89	709.12 730.89
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	1.0000 1.0000	730.89 800.54	730.89 800.54
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	1.0000 1.0000	800.54 857.44	800.54 857.44
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	1.0000 1.0000	857.44 979.12	857.44 979.12
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	5.5628 5.5628	976.62 1088.97	1564.18 1698.97

$Pp1 = Kp * \{ Sum.((Gam.*h)) + q - pw2 \} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp * \{ Sum.((Gam.*h)) + q \} + 2*c*\sqrt{Kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 96.86	0.0000 0.0000	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
3	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
4	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
5	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	-------- --------	0.6000 0.6000	235.25 402.77	235.25 402.77
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	-------- --------	0.6000 0.6000	402.77 413.75	402.77 413.75
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	-------- --------	0.5000 0.5000	344.79 355.68	344.79 355.68
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	-------- --------	0.5000 0.5000	355.68 390.50	355.68 390.50
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	-------- --------	0.5000 0.5000	390.50 418.95	390.50 418.95
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	-------- --------	0.5000 0.5000	418.95 479.79	418.95 479.79
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	14.12 98.26
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	74.61 127.21	74.61 127.21
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	152.65 385.70	152.65 385.70
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	385.70 400.98	385.70 400.98
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	334.15 355.68	334.15 355.68
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	355.68 424.57	355.68 424.57
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	424.57 480.84	424.57 480.84
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	480.84 601.18	480.84 601.18
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	262.16 286.37	849.72 896.37

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	14.12 94.11
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	70.05 115.85	70.05 115.85
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	139.02 346.74	139.02 346.74
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	346.74 360.36	346.74 360.36
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	300.30 317.71	300.30 317.71
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	317.71 373.43	317.71 373.43
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	373.43 418.95	373.43 418.95
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	418.95 516.30	418.95 516.30
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	189.77 207.95	777.33 817.95

friction force B7027influence range B = 5.000 (m)

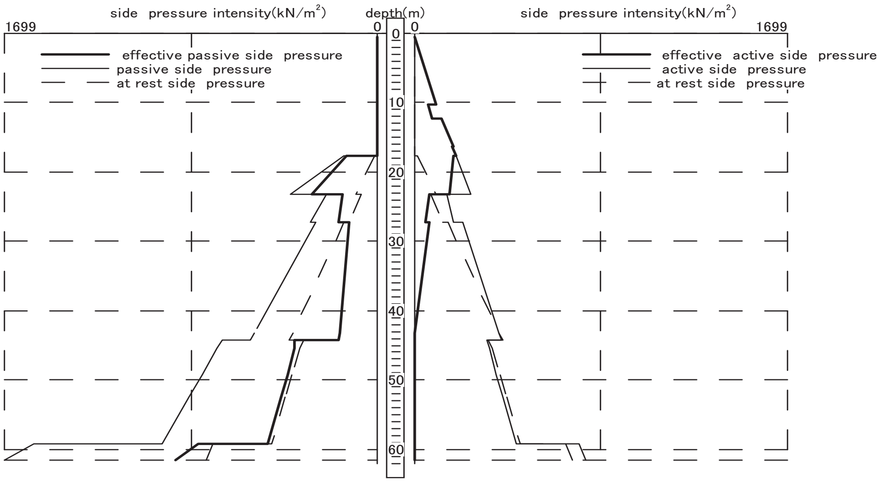
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

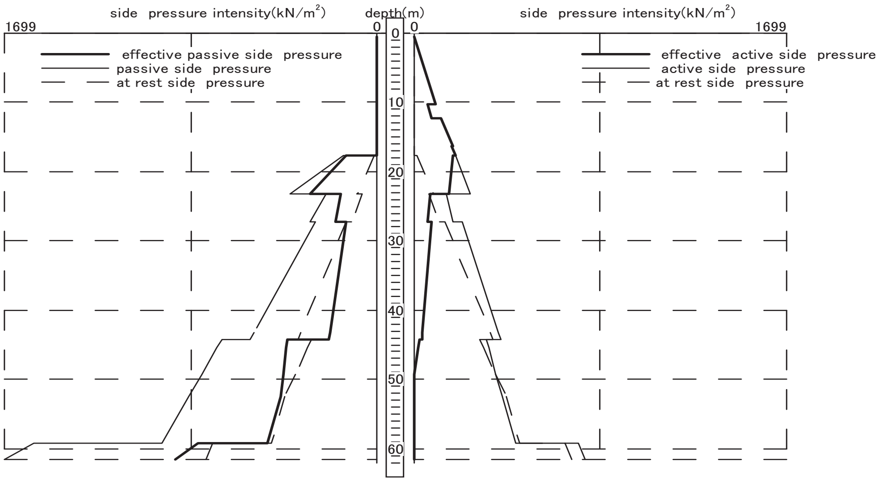
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(5)construction step [5]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.346	9.686	----	----	----	----
2	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
3	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
4	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
5	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
7	cohesv	-22.416 -38.370	15.954	17.5	42.0	0.00	7.0
8	cohesv	-38.370 -39.416	1.046	17.5	42.0	0.00	7.0
9	cohesv	-39.416 -40.625	1.209	18.0	108.0	0.00	18.0
10	cohesv	-40.625 -44.495	3.870	18.0	108.0	0.00	18.0
11	cohesv	-44.495 -47.656	3.161	18.0	108.0	0.00	18.0
12	cohesv	-47.656 -54.416	6.760	18.0	108.0	0.00	18.0
13	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	-------- --------	0.00 96.86	------- -------	------- -------	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	Gam.*(h-H) (kN/m^2)	pw1 (kN/m^2)	Ka1	Ka2	Pa1 (kN/m^2)	Pa (kN/m^2)
3	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
4	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
5	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	164.622 443.816	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 385.70	218.18 385.70
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	443.816 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	385.70 396.68	385.70 396.68
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	462.122 483.888	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 338.61	327.72 338.61
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	483.888 553.545	-------- --------	0.4250 0.4250	0.5000 0.5000	338.61 373.44	338.61 373.44
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	553.545 610.441	-------- --------	0.4250 0.4250	0.5000 0.5000	373.44 401.88	373.44 401.88
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	610.441 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	401.88 462.72	401.88 462.72
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1} \qquad (\text{ sand soil })$$
$$Pa = Pa1 + pw1 \qquad (\text{ sand soil })$$
$$Pa = Pa1 = Ka1*\left\{ Sum.(Gam.*H) + q \right\} + Ka2*\left\{ Sum.\left(Gam.(h - H)\right) \right\} \quad (\text{ cohesive soil })$$

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	4.8921 4.8921	151.66 342.26	151.66 397.92
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	1.0000 1.0000	233.62 303.62	233.62 303.62
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	1.0000 1.0000	279.62 558.82	279.62 558.82
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	1.0000 1.0000	558.82 577.12	558.82 577.12
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	1.0000 1.0000	709.12 730.89	709.12 730.89
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	1.0000 1.0000	730.89 800.54	730.89 800.54
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	1.0000 1.0000	800.54 857.44	800.54 857.44
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	1.0000 1.0000	857.44 979.12	857.44 979.12
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	5.5628 5.5628	976.62 1088.97	1564.18 1698.97

$$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp} \qquad (\text{ sand soil })$$
$$Pp = Pp1 + pw2 \qquad (\text{ sand soil })$$
$$Pp = Pp1 - Kp*\left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{kp} \qquad (\text{cohesive soil })$$

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 96.86	0.0000 0.0000	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
3	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
4	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
5	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	-------- --------	0.6000 0.6000	235.25 402.77	235.25 402.77
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	-------- --------	0.6000 0.6000	402.77 413.75	402.77 413.75
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	-------- --------	0.5000 0.5000	344.79 355.68	344.79 355.68
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	-------- --------	0.5000 0.5000	355.68 390.50	355.68 390.50
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	-------- --------	0.5000 0.5000	390.50 418.95	390.50 418.95
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	-------- --------	0.5000 0.5000	418.95 479.79	418.95 479.79
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	14.12 98.26
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	74.61 127.21	74.61 127.21
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	152.65 385.70	152.65 385.70
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	385.70 400.98	385.70 400.98
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	334.15 355.68	334.15 355.68
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	355.68 424.57	355.68 424.57
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	424.57 480.84	424.57 480.84
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	480.84 601.18	480.84 601.18
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	262.16 286.37	849.72 896.37

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	14.12 94.11
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	70.05 115.85	70.05 115.85
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	139.02 346.74	139.02 346.74
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	346.74 360.36	346.74 360.36
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	300.30 317.71	300.30 317.71
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	317.71 373.43	317.71 373.43
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	373.43 418.95	373.43 418.95
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	418.95 516.30	418.95 516.30
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	189.77 207.95	777.33 817.95

friction force B7027influence range B = 5.000 (m)

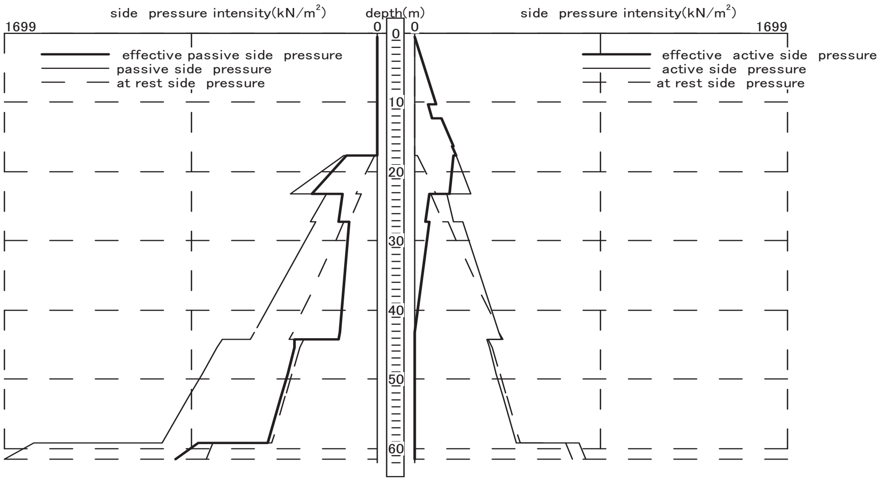
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

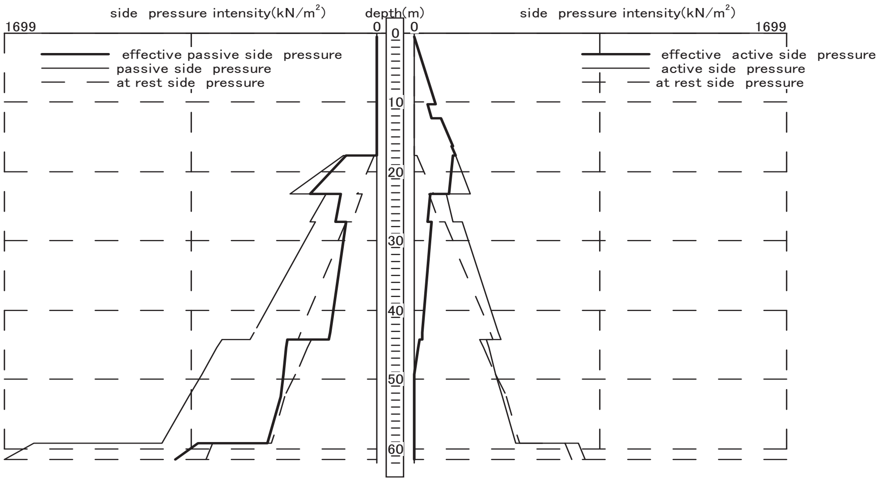
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



(6)construction step [6]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.346	9.686	----	----	----	----
2	cohesv	-5.346 -7.416	2.070	17.5	10.0	0.00	1.0
3	sandy	-7.416 -11.416	4.000	17.5	0.0	28.00	3.0
4	sandy	-11.416 -12.850	1.434	17.0	0.0	33.00	13.0
5	sandy	-12.850 -18.416	5.566	17.0	0.0	33.00	13.0
6	cohesv	-18.416 -22.416	4.000	17.5	54.0	0.00	9.0
7	cohesv	-22.416 -38.370	15.954	17.5	42.0	0.00	7.0
8	cohesv	-38.370 -39.416	1.046	17.5	42.0	0.00	7.0
9	cohesv	-39.416 -40.625	1.209	18.0	108.0	0.00	18.0
10	cohesv	-40.625 -44.495	3.870	18.0	108.0	0.00	18.0
11	cohesv	-44.495 -47.656	3.161	18.0	108.0	0.00	18.0
12	cohesv	-47.656 -54.416	6.760	18.0	108.0	0.00	18.0
13	sandy	-54.416 -56.660	2.244	19.0	0.0	35.00	50.0

1) active side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	-------- --------	0.00 96.86	------- -------	------- -------	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	-------- --------	0.6124 0.6124	0.8000 0.8000	59.32 81.50	59.32 81.50

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
3	sandy	-7.416 -11.416	4.000	133.09 203.09	-------- --------	117.56 157.56	0.3610 0.3610	------- -------	5.61 16.44	123.17 174.00
4	sandy	-11.416 -12.850	1.434	203.09 227.46	-------- --------	157.56 171.90	0.2948 0.2948	------- -------	13.42 16.38	170.98 188.28
5	sandy	-12.850 -18.416	5.566	227.46 322.09	0.000 0.000	171.90 227.56	0.2948 0.2948	------- -------	16.38 27.87	188.28 255.43
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	94.622 164.622	-------- --------	0.4250 0.4250	0.5000 0.5000	143.97 178.97	143.97 178.97
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	164.622 443.816	-------- --------	0.5250 0.5250	0.6000 0.6000	218.18 385.70	218.18 385.70
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	443.816 462.122	-------- --------	0.5250 0.5250	0.6000 0.6000	385.70 396.68	385.70 396.68
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	462.122 483.888	-------- --------	0.4250 0.4250	0.5000 0.5000	327.72 338.61	327.72 338.61
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	483.888 553.545	-------- --------	0.4250 0.4250	0.5000 0.5000	338.61 373.44	338.61 373.44
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	553.545 610.441	-------- --------	0.4250 0.4250	0.5000 0.5000	373.44 401.88	373.44 401.88
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	610.441 732.122	-------- --------	0.4250 0.4250	0.5000 0.5000	401.88 462.72	401.88 462.72
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	0.000 0.000	587.56 610.00	0.2710 0.2710	------- -------	100.82 106.29	688.38 716.29

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (sand soil)

$Pa = Pa1 + pw1$ (sand soil)

$Pa = Pa1 = Ka1 * \left\{ Sum.(Gam.*H) + q \right\} + Ka2 * \left\{ Sum.\left(Gam.(h - H)\right) \right\}$ (cohesive soil)

2)passive side pressure

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
1	----	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	4.8921 4.8921	151.66 342.26	151.66 397.92
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	1.0000 1.0000	233.62 303.62	233.62 303.62
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	1.0000 1.0000	279.62 558.82	279.62 558.82
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	1.0000 1.0000	558.82 577.12	558.82 577.12
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	1.0000 1.0000	709.12 730.89	709.12 730.89
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	1.0000 1.0000	730.89 800.54	730.89 800.54
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	1.0000 1.0000	800.54 857.44	800.54 857.44
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	1.0000 1.0000	857.44 979.12	857.44 979.12
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	5.5628 5.5628	976.62 1088.97	1564.18 1698.97

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (sand soil)

$Pp = Pp1 + pw2$ (sand soil)

$Pp = Pp1 - Kp * \left\{ Sum.\left((Gam.*h)\right) + q \right\} + 2*c*\sqrt{Kp}$ (cohesive soil)

3)at rest side pressure (before excavation)

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 96.86	0.0000 0.0000	0.00 0.00	0.00 96.86
2	cohesv	-5.346 -7.416	2.070	96.86 133.09	-------- --------	0.8000 0.8000	77.49 106.47	77.49 106.47
3	sandy	-7.416 -11.416	4.000	133.09 203.09	117.56 157.56	0.5305 0.5305	8.24 24.15	125.80 181.71
4	sandy	-11.416 -12.850	1.434	203.09 227.46	157.56 171.90	0.4554 0.4554	20.73 25.30	178.29 197.20

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
5	sandy	-12.850 -18.416	5.566	227.46 322.09	171.90 227.56	0.4554 0.4554	25.30 43.04	197.20 270.60
6	cohesv	-18.416 -22.416	4.000	322.09 392.09	-------- --------	0.5000 0.5000	161.04 196.04	161.04 196.04
7	cohesv	-22.416 -38.370	15.954	392.09 671.28	-------- --------	0.6000 0.6000	235.25 402.77	235.25 402.77
8	cohesv	-38.370 -39.416	1.046	671.28 689.58	-------- --------	0.6000 0.6000	402.77 413.75	402.77 413.75
9	cohesv	-39.416 -40.625	1.209	689.58 711.35	-------- --------	0.5000 0.5000	344.79 355.68	344.79 355.68
10	cohesv	-40.625 -44.495	3.870	711.35 781.01	-------- --------	0.5000 0.5000	355.68 390.50	355.68 390.50
11	cohesv	-44.495 -47.656	3.161	781.01 837.90	-------- --------	0.5000 0.5000	390.50 418.95	390.50 418.95
12	cohesv	-47.656 -54.416	6.760	837.90 959.58	-------- --------	0.5000 0.5000	418.95 479.79	418.95 479.79
13	sandy	-54.416 -56.660	2.244	959.58 1002.22	587.56 610.00	0.4264 0.4264	158.64 167.25	746.20 777.25

Po1 = Ko * { Sum.(Gam.*h) + q - pw1 } (sand soil)

Po = Po1 + pw1 (sand soil)

Po = Po1 = Ko * { Sum.(Gam.*h) + q } (cohesive soil)

4)at rest side pressure (after excavation)

bridge axis direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 42.60	14.12 98.26
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	74.61 127.21	74.61 127.21
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	152.65 385.70	152.65 385.70
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	385.70 400.98	385.70 400.98
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	334.15 355.68	334.15 355.68
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	355.68 424.57	355.68 424.57
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	424.57 480.84	424.57 480.84
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	480.84 601.18	480.84 601.18
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	262.16 286.37	849.72 896.37

friction force B7027influence range B = 3.068 (m)

Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

perpendicular direction

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m^2)	pw2 (kN/m^2)	f (kN/m^2)	f*h (kN.m)	ko	Po1' (kN/m^2)	Po' (kN/m^2)
1	-------	+4.340 -5.346	9.686	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	cohesv	-5.346 -7.416	2.070	0.00 0.00	-------- --------	0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-7.416 -11.416	4.000	0.00 0.00	0.00 0.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	f (kN/m²)	f*h (kN.m)	ko	Po1' (kN/m²)	Po' (kN/m²)
4	sandy	-11.416 -12.850	1.434	0.00 0.00	0.00 0.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
5	sandy	-12.850 -18.416	5.566	31.00 125.62	0.00 55.66	13.00	0.00 72.36	0.4554 0.4554	14.12 38.45	14.12 94.11
6	cohesv	-18.416 -22.416	4.000	125.62 195.62	-------- --------	27.00	72.36 180.36	0.5000 0.5000	70.05 115.85	70.05 115.85
7	cohesv	-22.416 -38.370	15.954	195.62 474.82	-------- --------	21.00	180.36 515.39	0.6000 0.6000	139.02 346.74	139.02 346.74
8	cohesv	-38.370 -39.416	1.046	474.82 493.12	-------- --------	21.00	515.39 537.36	0.6000 0.6000	346.74 360.36	346.74 360.36
9	cohesv	-39.416 -40.625	1.209	493.12 514.89	-------- --------	54.00	537.36 602.66	0.5000 0.5000	300.30 317.71	300.30 317.71
10	cohesv	-40.625 -44.495	3.870	514.89 584.54	-------- --------	54.00	602.66 811.63	0.5000 0.5000	317.71 373.43	317.71 373.43
11	cohesv	-44.495 -47.656	3.161	584.54 641.44	-------- --------	54.00	811.63 982.31	0.5000 0.5000	373.43 418.95	373.43 418.95
12	cohesv	-47.656 -54.416	6.760	641.44 763.12	-------- --------	54.00	982.31 1347.36	0.5000 0.5000	418.95 516.30	418.95 516.30
13	sandy	-54.416 -56.660	2.244	763.12 805.76	587.56 610.00	50.00	1347.36 1459.56	0.4264 0.4264	189.77 207.95	777.33 817.95

friction force B7027influence range B = 5.000 (m)

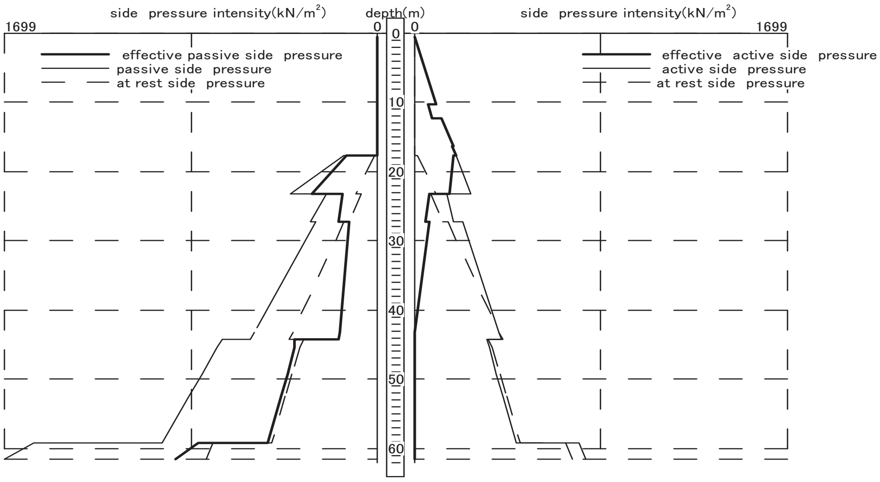
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

Po' = Po1'= Ko * { Sum.(Gam.*h) + q }+ Ko * { Sum.(f*h)—B } (cohesive soil)

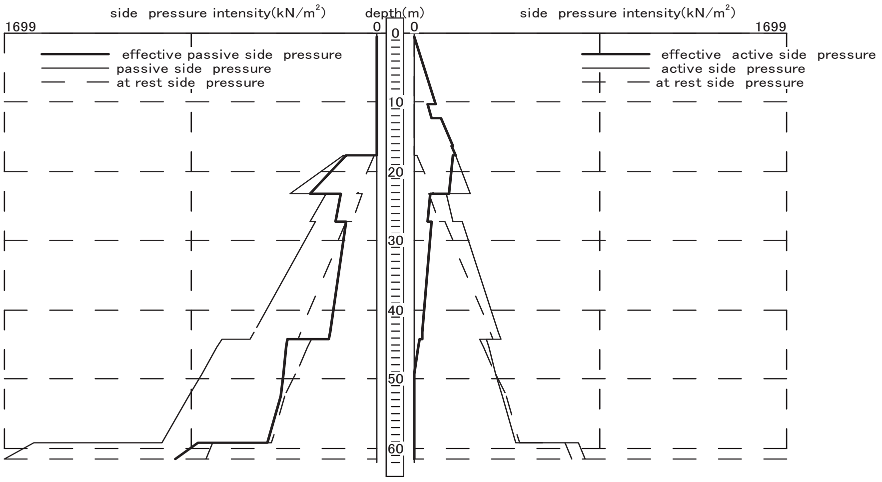
bridge axis direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



perpendicular direction

effective passive side pressure intensity dist effective active side pressure intensity distribution diagram



2.9 calculation result table

1)bridge axis direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	2.662	4.939	5.379	5.387
	accrue location	Lm	m	-4.660	-8.160	-7.160	-7.160
displace coffer displace part	max bending moment	Mmax	kN.m	932.0	1225.0	1657.0	1689.0
		Sig.	N/mm²	88.31	102.05	138.00	140.69
		Lm	m	-3.160	-6.350	-6.350	-5.346
	SKY400	M	kN.m	932.0	1168.0	1632.0	1684.0
		Sig.max	N/mm²	88.31	110.57	154.57	159.45
		Lm	m	-3.160	-5.160	-5.160	-5.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	706.0	1292.0	1657.0	1679.0
		Sig.	N/mm²	58.76	107.57	138.00	139.86
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY400	M	kN.m	706.0	1292.0	1657.0	1679.0
		Sig.max	N/mm²	58.76	107.57	138.00	139.86
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	209.4	0.0	0.0	0.0
		2nd row	kN/m	------	358.2	468.4	466.2
		3rd row	kN/m	------	------	------	26.1
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	93.4	921.3

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	5.387	5.382
	accrue location	Lm	m	-7.160	-7.160
displace coffer displace part	max bending moment	Mmax	kN.m	1689.0	1685.0
		Sig.	N/mm^2	140.69	140.32
		Lm	m	-5.346	-5.346
	SKY400	M	kN.m	1684.0	1680.0
		Sig.max	N/mm^2	159.45	159.06
		Lm	m	-5.160	-5.160
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm^2	------	------
		Lm	m	------	------
displace celler displace part	max bending moment	Mmax	kN.m	1679.0	1673.0
		Sig.	N/mm^2	139.86	139.32
		Lm	m	-6.350	-6.350
	SKY400	M	kN.m	1679.0	1673.0
		Sig.max	N/mm^2	139.86	139.32
		Lm	m	-6.350	-6.350
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm^2	------	------
		Lm	m	------	------
(SKY400)		Sig.a	N/mm^2	210.00	210.00
(SKY490)		Sig.a	N/mm^2	------	------

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	466.2	467.2
		3rd row	kN/m	26.1	23.1
		4th row	kN/m	0.0	0.0
		5th row	kN/m	------	------
		6th row	kN/m	------	------
		7th row	kN/m	------	------
		8th row	kN/m	------	------
		9th row	kN/m	------	------
		10th row	kN/m	------	------
	footing concrete reaction		kN/m	921.3	917.3

note)Lm shows elevation

2)perpendicular direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	2.667	4.955	5.405	5.547
	accrue location	Lm	m	-4.660	-8.160	-7.160	-7.416
displace coffer displace part	max bending moment	Mmax	kN.m	935.0	1227.0	1670.0	1713.0
		Sig.	N/mm²	87.52	101.02	137.43	141.02
		Lm	m	-3.160	-6.350	-6.350	-6.160
	SKY400	M	kN.m	935.0	1169.0	1643.0	1688.0
		Sig.max	N/mm²	87.52	109.44	153.77	157.96
		Lm	m	-3.160	-5.160	-5.160	-5.160
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
displace celler displace part	max bending moment	Mmax	kN.m	709.0	1294.0	1670.0	1711.0
		Sig.	N/mm²	58.37	106.51	137.43	140.80
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY400	M	kN.m	709.0	1294.0	1670.0	1711.0
		Sig.max	N/mm²	58.37	106.51	137.43	140.80
		Lm	m	-6.350	-8.160	-6.350	-6.350
	SKY490	M	kN.m	--------	--------	--------	--------
		Sig.max	N/mm²	------	------	------	------
		Lm	m	------	------	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------	------	------

support point reaction force	timbering reaction	1st row	kN/m	209.7	0.0	0.0	0.0
		2nd row	kN/m	------	358.5	470.0	440.7
		3rd row	kN/m	------	------	------	74.6
		4th row	kN/m	------	------	------	------
		5th row	kN/m	------	------	------	------
		6th row	kN/m	------	------	------	------
		7th row	kN/m	------	------	------	------
		8th row	kN/m	------	------	------	------
		9th row	kN/m	------	------	------	------
		10th row	kN/m	------	------	------	------
	footing concrete reaction		kN/m	0.0	0.0	84.2	854.6

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	5.547	5.542
	accrue location	Lm	m	-7.416	-7.416
displace coffer displace part	max bending moment	Mmax	kN.m	1713.0	1707.0
		Sig.	N/mm²	141.02	140.52
		Lm	m	-6.160	-6.160
	SKY400	M	kN.m	1688.0	1684.0
		Sig.max	N/mm²	157.96	157.60
		Lm	m	-5.160	-5.160
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm²	------	------
		Lm	m	------	------
displace celler displace part	max bending moment	Mmax	kN.m	1711.0	1704.0
		Sig.	N/mm²	140.80	140.27
		Lm	m	-6.350	-6.350
	SKY400	M	kN.m	1711.0	1704.0
		Sig.max	N/mm²	140.80	140.27
		Lm	m	-6.350	-6.350
	SKY490	M	kN.m	--------	--------
		Sig.max	N/mm²	------	------
		Lm	m	------	------
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	------	------

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	440.7	442.0
		3rd row	kN/m	74.6	71.1
		4th row	kN/m	0.0	0.0
		5th row	kN/m	------	------
		6th row	kN/m	------	------
		7th row	kN/m	------	------
		8th row	kN/m	------	------
		9th row	kN/m	------	------
		10th row	kN/m	------	------
	footing concrete reaction		kN/m	854.6	852.1

note)Lm shows elevation

2.10 detail output

(1)bridge axis direction 1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.164	4.696	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.070	4.696	0.0	0.0	0.00	0.0	0.0	
209.4										
	+4.340	0.3	0.070	4.696	0.0	209.4	0.00	0.0	0.0	
	+3.840	5.3	0.305	4.676	104.4	208.0	9.89	0.0	0.0	
	+2.840	15.2	0.766	4.512	308.1	197.7	29.18	0.0	0.0	
	+1.840	25.2	1.202	4.193	496.6	177.5	47.03	0.0	0.0	
	+1.340	30.2	1.407	3.980	582.0	163.7	55.12	0.0	0.0	
	+0.840	35.2	1.600	3.735	659.8	147.3	62.49	0.0	0.0	
	+0.340	40.2	1.780	3.461	728.9	128.5	69.03	0.0	0.0	
	-0.160	40.2	1.945	3.161	788.1	108.4	74.63	0.0	0.0	
	-1.160	40.2	2.229	2.502	876.4	68.2	82.99	0.0	0.0	
	-1.660	40.1	2.345	2.150	905.5	48.1	85.75	0.0	0.0	
	-2.160	40.1	2.444	1.788	924.5	28.1	87.55	0.0	0.0	
	-3.160	40.1	2.586	1.053	932.5	-12.1	88.31	0.0	0.0	
	-4.160	40.1	2.655	0.327	900.4	-52.2	85.27	0.0	0.0	
	-4.660	40.1	2.662	-0.022	869.3	-72.2	82.32	0.0	0.0	
	-5.160	40.1	2.653	-0.358	828.2	-92.3	78.43	0.0	0.0	
	-5.160	40.1	2.653	-0.358	828.2	-92.3	68.97	0.0	0.0	
	-5.346	32.0	2.645	-0.463	810.3	-99.7	67.48	22.9	31.4	
	-6.160	32.0	2.589	-0.898	726.1	-107.3	60.47	22.4	34.2	
	-6.350	32.0	2.571	-0.992	705.5	-109.1	58.76	22.2	34.9	
	-7.160	32.0	2.476	-1.363	613.8	-117.4	51.12	21.4	37.7	
	-7.416	37.4	2.439	-1.470	583.4	-120.1	48.59	28.1	48.3	
	-8.160	36.0	2.319	-1.747	491.5	-127.0	40.93	26.7	65.2	
	-9.160	34.2	2.129	-2.043	359.8	-136.5	29.97	24.5	88.0	
	-10.160	32.5	1.914	-2.244	218.4	-146.5	18.19	22.1	110.8	
	-10.350	32.1	1.871	-2.271	190.4	-148.5	15.85	21.6	115.1	
	-11.160	30.7	1.684	-2.344	66.6	-157.3	5.54	19.4	133.6	
	-11.350	30.3	1.639	-2.351	36.5	-159.5	3.04	18.9	137.9	
	-11.416	30.9	1.624	-2.352	25.9	-160.2	2.16	81.1	200.2	
	-12.160	28.6	1.449	-2.337	-80.0	-125.2	6.66	72.4	221.9	
	-13.160	25.6	1.219	-2.243	-184.7	-85.7	15.39	60.9	251.0	
	-14.160	22.5	1.002	-2.089	-254.1	-54.3	21.16	50.1	280.1	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-14.350	22.0	0.963	-2.055	-264.0	-49.2	21.98	48.1	285.7	
	-15.160	19.5	0.803	-1.897	-295.9	-30.3	24.64	40.1	309.3	
	-16.160	16.4	0.624	-1.683	-316.9	-12.7	26.39	31.2	338.4	
	-17.160	13.4	0.466	-1.460	-323.1	-0.5	26.91	23.3	367.5	
	-18.160	10.3	0.332	-1.237	-319.3	7.5	26.59	16.6	396.6	
	-18.416	3.2	0.301	-1.180	-317.2	9.0	26.41	18.2	232.3	
	-19.146	0.0	0.220	-1.022	-306.7	19.3	25.55	13.3	235.4	
	-19.160	0.0	0.219	-1.019	-306.5	19.5	25.52	13.3	235.6	
	-20.160	0.0	0.127	-0.814	-281.3	29.9	23.43	7.7	244.3	
	-21.160	0.0	0.055	-0.630	-248.3	35.3	20.68	3.3	253.1	
	-22.009	0.0	0.008	-0.493	-217.5	36.9	18.12	0.5	260.5	
	-22.160	0.0	0.000	-0.470	-211.9	36.9	17.65	0.0	261.8	
	-22.416	0.0	-0.011	-0.434	-202.5	36.8	16.86	0.0	200.8	
	-22.660	0.0	-0.021	-0.400	-193.5	36.7	16.12	0.0	202.5	
	-22.660	0.0	-0.021	-0.400	-193.5	36.7	18.33	0.0	202.5	
	-23.160	0.0	-0.039	-0.327	-175.3	35.9	16.61	0.0	206.0	
	-24.160	0.0	-0.066	-0.203	-140.6	33.4	13.31	0.0	213.0	
	-25.160	0.0	-0.081	-0.105	-108.8	29.9	10.31	0.0	220.0	
	-26.160	0.0	-0.087	-0.030	-80.9	25.9	7.66	0.0	227.0	
	-27.160	0.0	-0.088	0.024	-57.0	21.8	5.40	0.0	234.0	
	-28.160	0.0	-0.083	0.061	-37.2	17.8	3.53	0.0	241.0	
	-29.160	0.0	-0.076	0.084	-21.4	14.0	2.02	0.0	248.0	
	-30.160	0.0	-0.067	0.096	-9.1	10.6	0.86	0.0	255.0	
	-31.160	0.0	-0.057	0.099	0.1	7.7	0.01	0.0	262.0	
	-32.160	0.0	-0.047	0.096	6.5	5.3	0.62	0.0	269.0	
	-33.160	0.0	-0.038	0.089	10.8	3.3	1.02	0.0	276.0	
	-34.160	0.0	-0.029	0.080	13.2	1.7	1.25	0.0	283.0	
	-35.160	0.0	-0.022	0.069	14.3	0.5	1.36	0.0	290.0	
	-36.160	0.0	-0.016	0.057	14.4	-0.4	1.36	0.0	297.0	
	-37.160	0.0	-0.010	0.046	13.7	-1.0	1.29	0.0	304.0	
	-38.160	0.0	-0.006	0.036	12.5	-1.4	1.18	0.0	311.0	
	-39.160	0.0	-0.003	0.027	11.0	-1.6	1.04	0.0	318.0	
	-39.416	0.0	-0.003	0.025	10.5	-1.6	1.00	0.0	520.8	
	-40.160	0.0	-0.001	0.019	9.3	-1.8	0.88	0.0	527.5	
	-41.160	0.0	0.001	0.012	7.5	-1.8	0.71	0.1	536.5	
	-42.160	0.0	0.002	0.007	5.7	-1.7	0.54	0.2	545.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-43.160	0.0	0.002	0.003	4.1	-1.5	0.39	0.2	554.5	
	-44.160	0.0	0.002	0.000	2.8	-1.2	0.26	0.3	563.5	
	-45.160	0.0	0.002	-0.001	1.7	-0.9	0.16	0.3	572.5	
	-46.160	0.0	0.002	-0.002	0.9	-0.7	0.09	0.2	581.5	
	-47.160	0.0	0.002	-0.003	0.3	-0.5	0.03	0.2	590.5	
	-48.160	0.0	0.001	-0.003	-0.1	-0.3	0.01	0.2	599.5	
	-49.160	0.0	0.001	-0.003	-0.3	-0.2	0.03	0.1	608.5	
	-50.160	0.0	0.001	-0.003	-0.4	-0.1	0.04	0.1	617.5	
	-51.160	0.0	0.001	-0.002	-0.4	0.0	0.04	0.1	626.5	
	-52.160	0.0	0.000	-0.002	-0.4	0.1	0.04	0.0	635.5	
	-53.160	0.0	0.000	-0.002	-0.3	0.1	0.03	0.0	644.5	
	-54.160	0.0	0.000	-0.001	-0.2	0.1	0.02	0.0	653.5	
	-54.416	0.0	0.000	-0.001	-0.2	0.1	0.02	0.0	1688.4	
	-55.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1722.8	
	-56.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1769.0	
	-56.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1792.1	

(2)bridge axis direction　 2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.648	6.038	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.346	6.038	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.346	6.038	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.044	6.038	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.560	6.040	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.164	6.052	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.467	6.066	-46.1	-45.7	4.37	0.0	0.0	
358.2										
	+1.340	30.2	1.467	6.066	-46.1	312.5	4.37	0.0	0.0	
	+0.840	35.2	1.770	6.054	106.1	296.2	10.05	0.0	0.0	
	+0.340	40.2	2.071	5.983	249.6	277.3	23.64	0.0	0.0	
	-0.160	40.2	2.368	5.858	383.3	257.2	36.29	0.0	0.0	
	-1.160	40.2	2.935	5.459	620.4	217.1	58.75	0.0	0.0	
	-1.660	40.1	3.202	5.194	723.9	197.0	68.55	0.0	0.0	
	-2.160	40.1	3.454	4.889	817.4	176.9	77.41	0.0	0.0	
	-3.160	40.1	3.908	4.180	974.2	136.8	92.26	0.0	0.0	
	-4.160	40.1	4.286	3.362	1090.9	96.7	103.31	0.0	0.0	
	-4.660	40.1	4.443	2.923	1134.3	76.6	107.42	0.0	0.0	
	-5.160	40.1	4.578	2.469	1167.6	56.6	110.57	0.0	0.0	
	-5.160	40.1	4.578	2.469	1167.6	56.6	97.24	0.0	0.0	
	-5.346	2.5	4.623	2.317	1177.4	49.1	98.06	0.0	0.0	
	-6.160	3.0	4.784	1.641	1216.5	46.9	101.32	0.0	0.0	
	-6.350	3.2	4.814	1.480	1225.4	46.3	102.05	0.0	0.0	
	-7.160	3.8	4.905	0.781	1261.8	43.5	105.09	0.0	0.0	
	-7.416	45.6	4.922	0.556	1272.8	42.5	106.00	0.0	0.0	
	-8.160	47.6	4.939	-0.108	1291.7	7.8	107.57	0.0	0.0	
	-9.160	50.3	4.884	-1.001	1275.2	-41.1	106.20	0.0	0.0	
	-10.160	53.0	4.740	-1.866	1208.5	-92.8	100.65	0.0	0.0	
	-10.350	53.5	4.703	-2.024	1189.9	-102.9	99.10	0.0	0.0	
	-11.160	55.7	4.513	-2.666	1088.7	-147.2	90.67	0.0	0.0	
	-11.350	56.3	4.461	-2.808	1059.7	-157.8	88.26	0.0	0.0	
	-11.416	53.4	4.442	-2.856	1049.2	-161.6	87.38	0.0	0.0	
	-12.160	55.0	4.210	-3.364	914.1	-201.9	76.13	0.0	0.0	
	-12.850	56.4	3.964	-3.767	761.6	-240.3	63.43	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-12.850	56.4	3.964	-3.767	761.6	-240.3	63.43	0.0	0.0	*
	-13.160	55.4	3.844	-3.922	684.6	-256.2	57.01	9.0	9.0	*
	-14.160	52.4	3.431	-4.304	410.5	-286.5	34.19	38.2	38.2	*
	-14.350	51.8	3.349	-4.355	355.8	-288.7	29.63	43.7	43.7	*
	-15.160	49.3	2.990	-4.489	122.2	-284.7	10.18	67.3	67.3	*
	-16.160	46.3	2.540	-4.478	-148.1	-250.6	12.33	96.4	96.4	*
	-16.755	44.5	2.276	-4.387	-287.1	-215.1	23.91	113.7	113.7	*
	-16.755	44.5	2.276	-4.387	-287.1	-215.1	23.91	113.8	113.7	
	-17.160	43.2	2.100	-4.295	-368.8	-188.6	30.72	105.0	125.5	
	-18.160	40.2	1.686	-3.980	-529.5	-135.8	44.10	84.2	154.7	
	-18.416	18.9	1.585	-3.883	-562.9	-125.0	46.88	96.0	209.5	
	-19.160	15.6	1.307	-3.572	-635.9	-72.8	52.96	79.2	212.7	
	-20.160	11.2	0.973	-3.112	-679.7	-17.5	56.61	58.9	217.1	
	-21.160	6.8	0.685	-2.640	-675.6	23.4	56.27	41.5	221.4	
	-22.160	2.4	0.444	-2.182	-636.7	52.8	53.02	26.9	225.7	
	-22.416	5.0	0.390	-2.071	-622.4	58.8	51.83	18.4	167.3	
	-22.660	4.0	0.341	-1.966	-607.6	61.9	50.60	16.0	168.0	
	-22.660	4.0	0.341	-1.966	-607.6	61.9	57.54	16.0	168.0	
	-23.160	1.9	0.248	-1.733	-575.3	67.3	54.48	11.7	169.5	
	-23.631	0.0	0.172	-1.525	-542.6	71.5	51.38	8.1	170.8	
	-24.160	0.0	0.097	-1.307	-503.8	74.8	47.71	4.6	172.4	
	-25.160	0.0	-0.015	-0.939	-427.7	76.6	40.50	0.0	175.3	
	-26.160	0.0	-0.093	-0.631	-352.1	73.9	33.35	0.0	178.2	
	-27.160	0.0	-0.143	-0.382	-280.8	68.3	26.60	0.0	181.1	
	-27.787	0.0	-0.163	-0.254	-239.5	63.7	22.68	0.0	182.9	
	-28.160	0.0	-0.171	-0.186	-216.2	60.8	20.48	0.0	185.5	
	-29.160	0.0	-0.182	-0.039	-159.6	52.4	15.11	0.0	192.5	
	-29.807	0.0	-0.182	0.034	-127.5	46.8	12.07	0.0	197.0	
	-30.160	0.0	-0.180	0.068	-111.5	43.8	10.56	0.0	199.5	
	-31.160	0.0	-0.170	0.139	-71.8	35.6	6.80	0.0	206.5	
	-32.160	0.0	-0.153	0.183	-40.1	27.9	3.80	0.0	213.5	
	-33.160	0.0	-0.134	0.205	-15.7	21.2	1.48	0.0	220.5	
	-34.160	0.0	-0.113	0.210	2.5	15.3	0.24	0.0	227.5	
	-35.160	0.0	-0.092	0.202	15.3	10.5	1.45	0.0	234.5	
	-36.160	0.0	-0.073	0.186	23.8	6.6	2.26	0.0	241.5	
	-36.581	0.0	-0.065	0.178	26.3	5.3	2.49	0.0	244.4	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-37.160	0.0	-0.055	0.165	28.9	3.6	2.74	0.0	248.5	
	-38.160	0.0	-0.040	0.142	31.3	1.4	2.97	0.0	255.5	
	-39.160	0.0	-0.027	0.116	31.9	-0.2	3.02	0.0	262.5	
	-39.416	0.0	-0.024	0.110	31.8	-0.5	3.01	0.0	465.2	
	-40.160	0.0	-0.017	0.092	30.8	-2.3	2.91	0.0	471.9	
	-41.160	0.0	-0.009	0.068	27.6	-3.8	2.62	0.0	480.9	
	-42.160	0.0	-0.003	0.048	23.5	-4.4	2.22	0.0	489.9	
	-43.160	0.0	0.001	0.032	19.0	-4.5	1.80	0.1	498.9	
	-44.160	0.0	0.004	0.018	14.6	-4.2	1.38	0.4	507.9	
	-45.160	0.0	0.005	0.008	10.6	-3.7	1.01	0.6	516.9	
	-46.160	0.0	0.005	0.001	7.3	-3.0	0.69	0.7	525.9	
	-47.160	0.0	0.005	-0.003	4.6	-2.4	0.43	0.6	534.9	
	-48.160	0.0	0.005	-0.006	2.5	-1.7	0.24	0.6	543.9	
	-49.160	0.0	0.004	-0.007	1.1	-1.2	0.10	0.5	552.9	
	-50.160	0.0	0.003	-0.008	0.1	-0.7	0.01	0.4	561.9	
	-51.160	0.0	0.003	-0.008	-0.4	-0.4	0.04	0.3	570.9	
	-52.160	0.0	0.002	-0.007	-0.7	-0.1	0.06	0.2	579.9	
	-53.160	0.0	0.001	-0.007	-0.6	0.1	0.06	0.1	588.9	
	-54.160	0.0	0.001	-0.006	-0.5	0.2	0.05	0.1	597.9	
	-54.416	0.0	0.000	-0.006	-0.4	0.2	0.04	0.1	1379.3	
	-55.160	0.0	0.000	-0.006	-0.2	0.3	0.02	0.0	1413.7	
	-56.160	0.0	-0.001	-0.006	0.0	0.1	0.00	0.0	1459.9	
	-56.660	0.0	-0.001	-0.006	0.0	0.0	0.00	0.0	1483.0	

*showing plastic

(3)bridge axis direction   3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.121	7.442	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.749	7.442	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.749	7.442	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.377	7.442	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.368	7.443	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.112	7.455	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.469	-46.1	-45.7	4.37	0.0	0.0	
468.4										
	+1.340	30.2	1.485	7.469	-46.1	422.6	4.37	0.0	0.0	
	+0.840	35.2	1.859	7.446	161.2	406.3	15.27	0.0	0.0	
	-0.160	45.2	2.592	7.163	548.2	366.1	51.92	0.0	0.0	
	-1.160	55.2	3.282	6.593	890.1	315.9	84.29	0.0	0.0	
	-1.660	60.1	3.602	6.211	1041.0	287.1	98.58	0.0	0.0	
	-2.160	65.1	3.902	5.773	1176.8	255.8	111.44	0.0	0.0	
	-2.660	70.1	4.179	5.285	1296.3	222.0	122.77	0.0	0.0	
	-3.160	70.1	4.430	4.752	1398.6	186.9	132.45	0.0	0.0	
	-4.160	70.1	4.847	3.584	1550.4	116.8	146.83	0.0	0.0	
	-4.660	70.1	5.011	2.962	1600.1	81.8	151.53	0.0	0.0	
	-5.160	70.1	5.143	2.324	1632.2	46.7	154.57	0.0	0.0	
	-5.160	70.1	5.143	2.324	1632.2	46.7	135.93	0.0	0.0	
	-5.346	32.5	5.185	2.112	1639.7	33.7	136.55	0.0	0.0	
	-6.160	33.0	5.319	1.180	1656.3	7.0	137.94	0.0	0.0	
	-6.350	33.2	5.339	0.962	1657.0	0.8	138.00	0.0	0.0	
	-7.160	33.8	5.379	0.032	1646.7	-26.4	137.14	0.0	0.0	
	-7.416	75.6	5.376	-0.260	1638.8	-35.0	136.48	0.0	0.0	
	-8.160	77.6	5.326	-1.095	1591.7	-92.0	132.56	0.0	0.0	
	-9.160	80.3	5.162	-2.159	1460.4	-171.0	121.62	0.0	0.0	
	-10.160	83.0	4.898	-3.104	1248.8	-252.7	104.00	0.0	0.0	
	-10.350	83.5	4.838	-3.265	1199.3	-268.5	99.88	0.0	0.0	
	-11.160	85.7	4.547	-3.873	969.5	-337.1	80.74	0.0	0.0	
	-11.350	86.3	4.473	-3.995	911.9	-353.4	75.94	0.0	0.0	
93.4										
	-11.350	86.3	4.473	-3.995	911.9	-260.0	75.94	0.0	0.0	
	-11.416	83.4	4.446	-4.035	891.6	-265.7	74.25	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-12.160	85.0	4.131	-4.430	651.1	-328.3	54.23	0.0	0.0	
	-12.850	86.4	3.816	-4.684	403.4	-387.4	33.60	0.0	0.0	
	-12.850	72.3	3.816	-4.684	403.4	-387.4	33.60	137.5	137.5	*
	-13.160	71.3	3.669	-4.758	286.6	-365.6	23.87	146.6	146.6	*
	-13.852	69.2	3.336	-4.838	53.2	-305.8	4.43	166.7	166.7	*
	-13.852	69.2	3.336	-4.838	53.2	-305.8	4.43	166.7	166.7	
	-14.160	68.3	3.187	-4.839	-36.3	-276.8	3.02	159.3	175.7	
	-14.350	67.7	3.095	-4.831	-87.3	-259.9	7.27	154.7	181.2	
	-15.160	65.2	2.708	-4.728	-271.1	-196.3	22.58	135.3	204.8	
	-16.160	62.2	2.246	-4.479	-435.7	-136.3	36.29	112.3	234.0	
	-17.160	59.1	1.815	-4.135	-550.1	-95.6	45.81	90.7	263.1	
	-18.160	56.0	1.422	-3.723	-632.7	-72.4	52.69	71.0	292.2	
	-18.416	18.4	1.328	-3.609	-650.8	-69.1	54.20	80.4	210.0	
	-19.160	15.1	1.072	-3.263	-686.2	-27.6	57.15	64.9	213.2	
	-20.160	10.7	0.770	-2.782	-691.4	14.9	57.58	46.6	217.6	
	-21.160	6.3	0.515	-2.311	-660.5	45.1	55.01	31.2	221.9	
	-22.160	1.9	0.306	-1.871	-604.5	65.6	50.34	18.5	226.2	
	-22.416	4.4	0.260	-1.765	-587.2	69.6	48.90	12.2	167.7	
	-22.660	3.4	0.218	-1.667	-570.0	71.4	47.47	10.3	168.4	
	-22.660	3.4	0.218	-1.667	-570.0	71.4	53.98	10.3	168.4	
	-23.160	1.3	0.140	-1.450	-533.5	74.4	50.52	6.6	169.9	
	-23.485	0.0	0.095	-1.316	-509.0	76.0	48.21	4.5	170.8	
	-24.160	0.0	0.015	-1.059	-457.0	77.7	43.28	0.7	172.8	
	-25.160	0.0	-0.074	-0.728	-379.7	76.2	35.96	0.0	175.7	
	-26.160	0.0	-0.133	-0.458	-305.8	71.2	28.96	0.0	178.6	
	-27.160	0.0	-0.167	-0.244	-238.0	64.1	22.54	0.0	181.5	
	-27.641	0.0	-0.177	-0.160	-208.2	60.2	19.71	0.0	182.8	
	-28.160	0.0	-0.183	-0.081	-178.0	55.8	16.86	0.0	186.5	
	-29.160	0.0	-0.185	0.039	-126.6	47.1	11.99	0.0	193.5	
	-29.569	0.0	-0.182	0.077	-108.1	43.5	10.24	0.0	196.3	
	-30.160	0.0	-0.176	0.122	-83.9	38.5	7.94	0.0	200.5	
	-31.160	0.0	-0.161	0.174	-49.4	30.5	4.68	0.0	207.5	
	-32.160	0.0	-0.143	0.202	-22.5	23.4	2.13	0.0	214.5	
	-33.160	0.0	-0.122	0.211	-2.3	17.1	0.22	0.0	221.5	
	-34.160	0.0	-0.101	0.207	12.1	11.9	1.15	0.0	228.5	
	-35.160	0.0	-0.081	0.193	21.8	7.6	2.06	0.0	235.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	0.0	-0.062	0.173	27.7	4.3	2.62	0.0	242.5	
	-36.343	0.0	-0.059	0.169	28.4	3.7	2.69	0.0	243.8	
	-37.160	0.0	-0.046	0.150	30.6	1.7	2.90	0.0	249.5	
	-38.160	0.0	-0.032	0.126	31.3	-0.1	2.97	0.0	256.5	
	-39.160	0.0	-0.021	0.101	30.6	-1.4	2.89	0.0	263.5	
	-39.416	0.0	-0.019	0.095	30.2	-1.6	2.86	0.0	466.2	
	-40.160	0.0	-0.012	0.078	28.4	-3.0	2.69	0.0	472.9	
	-41.160	0.0	-0.005	0.057	24.9	-4.0	2.36	0.0	481.9	
	-42.160	0.0	-0.001	0.039	20.6	-4.4	1.95	0.0	490.9	
	-43.160	0.0	0.002	0.024	16.3	-4.3	1.54	0.3	499.9	
	-44.160	0.0	0.004	0.013	12.2	-3.8	1.16	0.5	508.9	
	-45.160	0.0	0.005	0.005	8.7	-3.3	0.82	0.6	517.9	
	-46.160	0.0	0.005	-0.001	5.7	-2.6	0.54	0.6	526.9	
	-47.160	0.0	0.005	-0.005	3.4	-2.0	0.32	0.6	535.9	
	-48.160	0.0	0.004	-0.006	1.7	-1.4	0.16	0.5	544.9	
	-49.160	0.0	0.004	-0.007	0.5	-1.0	0.05	0.4	553.9	
	-50.160	0.0	0.003	-0.007	-0.3	-0.5	0.02	0.4	562.9	
	-51.160	0.0	0.002	-0.007	-0.6	-0.2	0.06	0.3	571.9	
	-52.160	0.0	0.002	-0.006	-0.8	0.0	0.07	0.2	580.9	
	-53.160	0.0	0.001	-0.006	-0.7	0.1	0.06	0.1	589.9	
	-54.160	0.0	0.000	-0.005	-0.5	0.2	0.05	0.0	598.9	
	-54.416	0.0	0.000	-0.005	-0.4	0.2	0.04	0.1	1384.8	
	-55.160	0.0	0.000	-0.005	-0.2	0.3	0.02	0.0	1419.2	
	-56.160	0.0	-0.001	-0.005	0.0	0.1	0.00	0.0	1465.5	
	-56.660	0.0	-0.001	-0.005	0.0	0.0	0.00	0.0	1488.6	

*showing plastic

bending moment at support of footing concrete is reduced value

(4)bridge axis direction   4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.136	7.483	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.387	7.483	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.361	7.485	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.110	7.496	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.511	-46.1	-45.7	4.37	0.0	0.0	
466.2										
	+1.340	30.2	1.485	7.511	-46.1	420.5	4.37	0.0	0.0	
	+0.840	35.2	1.860	7.488	160.1	404.2	15.17	0.0	0.0	
	-0.160	45.2	2.598	7.207	545.0	364.0	51.62	0.0	0.0	
	-1.160	55.2	3.292	6.639	884.8	313.8	83.79	0.0	0.0	
	-1.660	60.1	3.615	6.260	1034.6	285.0	97.97	0.0	0.0	
26.1										
	-1.660	60.1	3.615	6.260	1034.6	311.1	97.97	0.0	0.0	
	-2.160	65.1	3.917	5.822	1182.4	279.8	111.97	0.0	0.0	
	-3.160	75.1	4.449	4.788	1427.9	209.6	135.23	0.0	0.0	
	-4.160	85.1	4.869	3.588	1598.3	129.5	151.37	0.0	0.0	
	-4.660	90.1	5.033	2.946	1652.3	85.8	156.47	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	159.45	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	140.22	0.0	0.0	
	-5.346	59.3	5.204	2.070	1689.4	21.6	140.69	0.0	0.0	
	-6.160	68.0	5.334	1.114	1686.3	-30.2	140.44	0.0	0.0	
	-6.350	70.1	5.353	0.892	1679.4	-43.3	139.86	0.0	0.0	
	-7.160	78.8	5.387	-0.037	1620.3	-103.6	134.94	0.0	0.0	
	-7.416	123.2	5.383	-0.323	1591.2	-124.1	132.51	0.0	0.0	
	-8.160	132.6	5.329	-1.115	1463.8	-219.3	121.91	0.0	0.0	
	-9.160	145.3	5.169	-2.039	1176.1	-358.3	97.95	0.0	0.0	
	-10.160	158.0	4.929	-2.713	743.1	-509.9	61.88	0.0	0.0	
	-10.350	160.4	4.877	-2.805	643.3	-540.2	53.58	0.0	0.0	
	-11.160	170.7	4.639	-3.034	303.1	-674.3	25.24	0.0	0.0	
	-11.350	173.2	4.581	-3.045	251.1	-707.0	20.91	0.0	0.0	
921.3										
	-11.350	173.2	4.581	-3.045	251.1	214.3	20.91	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-11.416	171.0	4.561	-3.046	235.5	202.8	19.61	0.0	0.0	
	-12.160	180.0	4.333	-3.095	145.6	72.3	12.13	0.0	0.0	
	-12.850	188.3	4.117	-3.166	143.7	-54.8	11.96	0.0	0.0	
	-12.850	174.2	4.117	-3.166	143.7	-54.8	11.96	137.5	137.5	*
	-13.160	173.2	4.018	-3.195	125.1	-64.6	10.42	146.6	146.6	*
	-14.160	170.2	3.695	-3.257	52.5	-75.1	4.37	175.7	175.7	*
	-14.350	169.6	3.633	-3.263	38.4	-73.5	3.20	181.2	181.2	*
	-14.350	169.6	3.633	-3.263	38.4	-73.5	3.20	181.6	181.2	
	-15.160	167.1	3.368	-3.268	-18.4	-68.1	1.53	168.3	204.8	
	-16.160	164.1	3.043	-3.232	-88.1	-73.5	7.34	152.1	234.0	
	-17.160	161.0	2.724	-3.143	-169.8	-92.0	14.14	136.1	263.1	
	-18.160	157.9	2.416	-2.990	-276.3	-123.1	23.01	120.8	292.2	
	-18.416	69.4	2.341	-2.938	-309.1	-133.0	25.74	141.7	159.0	
	-19.160	66.1	2.128	-2.756	-388.9	-82.8	32.39	128.9	162.3	
	-20.160	61.7	1.867	-2.465	-442.2	-25.8	36.83	113.1	166.6	
	-21.160	57.3	1.636	-2.154	-444.0	20.6	36.98	99.1	171.0	
	-22.160	52.9	1.436	-1.858	-403.9	58.3	33.64	86.9	175.3	
	-22.416	65.5	1.389	-1.788	-387.9	66.8	32.30	65.4	127.0	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	30.95	63.4	127.7	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	35.19	63.4	127.7	
	-23.160	62.5	1.264	-1.583	-338.5	65.7	32.05	59.5	129.1	
	-24.160	58.4	1.118	-1.342	-274.8	61.2	26.02	52.7	132.0	
	-25.160	54.3	0.994	-1.148	-216.7	54.6	20.53	46.8	134.9	
	-26.160	50.2	0.887	-0.998	-166.1	46.6	15.73	41.8	137.8	
	-27.160	46.0	0.793	-0.884	-123.8	38.0	11.72	37.4	140.7	
	-28.160	41.9	0.709	-0.800	-90.1	29.4	8.53	33.4	143.6	
	-29.160	37.8	0.632	-0.739	-65.0	21.0	6.15	29.8	146.5	
	-30.160	33.7	0.561	-0.695	-47.8	13.3	4.53	26.4	149.4	
	-31.160	29.6	0.493	-0.662	-38.0	6.5	3.60	23.2	152.3	
	-32.160	25.5	0.428	-0.634	-34.6	0.6	3.28	20.2	155.2	
	-33.160	21.4	0.366	-0.606	-36.5	-4.2	3.46	17.2	158.0	
	-34.160	17.3	0.307	-0.575	-42.5	-7.7	4.03	14.5	160.9	
	-35.160	13.2	0.251	-0.538	-51.4	-9.8	4.87	11.8	163.8	
	-36.160	9.1	0.200	-0.493	-61.6	-10.3	5.83	9.4	166.7	
	-37.160	5.0	0.153	-0.441	-71.4	-9.1	6.76	7.2	169.6	
	-38.160	0.9	0.112	-0.381	-79.0	-5.8	7.48	5.3	172.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-38.370	0.0	0.104	-0.368	-80.1	-4.8	7.59	4.9	173.1	
	-39.160	0.0	0.077	-0.317	-82.5	-1.4	7.81	3.6	175.4	
	-39.416	0.0	0.069	-0.301	-82.8	-0.6	7.84	8.3	375.0	
	-40.160	0.0	0.048	-0.252	-81.1	4.7	7.68	5.9	375.1	
	-40.625	0.0	0.037	-0.223	-78.3	7.1	7.42	4.5	375.2	
	-41.160	0.0	0.026	-0.191	-73.9	9.2	7.00	3.2	380.0	
	-42.160	0.0	0.010	-0.136	-63.5	11.3	6.02	1.2	389.0	
	-43.160	0.0	-0.001	-0.091	-51.9	11.8	4.91	0.0	398.0	
	-44.160	0.0	-0.008	-0.054	-40.3	11.2	3.82	0.0	407.0	
	-44.495	0.0	-0.010	-0.044	-36.7	10.8	3.47	0.0	410.0	
	-45.160	0.0	-0.012	-0.027	-29.8	9.9	2.82	0.0	416.0	
	-46.160	0.0	-0.014	-0.007	-20.7	8.2	1.96	0.0	425.0	
	-47.160	0.0	-0.014	0.006	-13.4	6.5	1.26	0.0	434.0	
	-47.656	0.0	-0.014	0.011	-10.3	5.7	0.98	0.0	438.5	
	-48.160	0.0	-0.013	0.014	-7.7	4.9	0.73	0.0	443.0	
	-49.160	0.0	-0.011	0.019	-3.6	3.4	0.34	0.0	452.0	
	-50.160	0.0	-0.009	0.020	-0.8	2.1	0.08	0.0	461.0	
	-51.160	0.0	-0.007	0.020	0.8	1.1	0.07	0.0	470.0	
	-52.160	0.0	-0.005	0.020	1.5	0.4	0.14	0.0	479.0	
	-53.160	0.0	-0.003	0.018	1.5	-0.2	0.15	0.0	488.0	
	-54.160	0.0	-0.002	0.017	1.2	-0.5	0.12	0.0	497.0	
	-54.416	0.0	-0.001	0.017	1.1	-0.5	0.10	0.0	818.0	
	-55.160	0.0	0.000	0.016	0.6	-0.6	0.06	0.0	852.4	
	-56.160	0.0	0.002	0.016	0.1	-0.4	0.01	0.6	898.6	
	-56.660	0.0	0.003	0.016	0.0	0.0	0.00	0.8	921.7	

*showing plastic
bending moment at support of footing concrete is reduced value

(5)bridge axis direction   5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.136	7.483	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.762	7.483	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.387	7.483	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.361	7.485	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.110	7.496	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.511	-46.1	-45.7	4.37	0.0	0.0	
466.2										
	+1.340	30.2	1.485	7.511	-46.1	420.5	4.37	0.0	0.0	
	+0.840	35.2	1.860	7.488	160.1	404.2	15.17	0.0	0.0	
	-0.160	45.2	2.598	7.207	545.0	364.0	51.62	0.0	0.0	
	-1.160	55.2	3.292	6.639	884.8	313.8	83.79	0.0	0.0	
	-1.660	60.1	3.615	6.260	1034.6	285.0	97.97	0.0	0.0	
26.1										
	-1.660	60.1	3.615	6.260	1034.6	311.1	97.97	0.0	0.0	
	-2.160	65.1	3.917	5.822	1182.4	279.8	111.97	0.0	0.0	
	-3.160	75.1	4.449	4.788	1427.9	209.6	135.23	0.0	0.0	
	-4.160	85.1	4.869	3.588	1598.3	129.5	151.37	0.0	0.0	
	-4.660	90.1	5.033	2.946	1652.3	85.8	156.47	0.0	0.0	
0.0										
	-4.660	90.1	5.033	2.946	1652.3	85.8	156.47	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	159.45	0.0	0.0	
	-5.160	95.1	5.164	2.287	1683.7	39.5	140.22	0.0	0.0	
	-5.346	59.3	5.204	2.070	1689.4	21.6	140.69	0.0	0.0	
	-6.160	68.0	5.334	1.114	1686.3	-30.2	140.44	0.0	0.0	
	-6.350	70.1	5.353	0.892	1679.4	-43.3	139.86	0.0	0.0	
	-7.160	78.8	5.387	-0.037	1620.3	-103.6	134.94	0.0	0.0	
	-7.416	123.2	5.383	-0.323	1591.2	-124.1	132.51	0.0	0.0	
	-8.160	132.6	5.329	-1.115	1463.8	-219.3	121.91	0.0	0.0	
	-9.160	145.3	5.169	-2.039	1176.1	-358.3	97.95	0.0	0.0	
	-10.160	158.0	4.929	-2.713	743.1	-509.9	61.88	0.0	0.0	
	-10.350	160.4	4.877	-2.805	643.3	-540.2	53.58	0.0	0.0	
	-11.160	170.7	4.639	-3.034	303.1	-674.3	25.24	0.0	0.0	
	-11.350	173.2	4.581	-3.045	251.1	-707.0	20.91	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
921.3										
	-11.350	173.2	4.581	-3.045	251.1	214.3	20.91	0.0	0.0	
	-11.416	171.0	4.561	-3.046	235.5	202.8	19.61	0.0	0.0	
	-12.160	180.0	4.333	-3.095	145.6	72.3	12.13	0.0	0.0	
	-12.850	188.3	4.117	-3.166	143.7	-54.8	11.96	0.0	0.0	
	-12.850	174.2	4.117	-3.166	143.7	-54.8	11.96	137.5	137.5	*
	-13.160	173.2	4.018	-3.195	125.1	-64.6	10.42	146.6	146.6	*
	-14.160	170.2	3.695	-3.257	52.5	-75.1	4.37	175.7	175.7	*
	-14.350	169.6	3.633	-3.263	38.4	-73.5	3.20	181.2	181.2	*
	-14.361	169.5	3.629	-3.263	37.6	-73.4	3.13	181.6	181.6	*
	-14.361	169.5	3.629	-3.263	37.6	-73.4	3.13	181.4	181.6	
	-15.160	167.1	3.368	-3.268	-18.4	-68.1	1.53	168.3	204.8	
	-16.160	164.1	3.043	-3.232	-88.1	-73.5	7.34	152.1	234.0	
	-17.160	161.0	2.724	-3.143	-169.8	-92.0	14.14	136.1	263.1	
	-18.160	157.9	2.416	-2.990	-276.3	-123.1	23.01	120.8	292.2	
	-18.416	69.4	2.341	-2.938	-309.1	-133.0	25.74	141.7	159.0	
	-19.160	66.1	2.128	-2.756	-388.9	-82.8	32.39	128.9	162.3	
	-20.160	61.7	1.867	-2.465	-442.2	-25.8	36.83	113.1	166.6	
	-21.160	57.3	1.636	-2.154	-444.0	20.6	36.98	99.1	171.0	
	-22.160	52.9	1.436	-1.858	-403.9	58.3	33.64	86.9	175.3	
	-22.416	65.5	1.389	-1.788	-387.9	66.8	32.30	65.4	127.0	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	30.95	63.4	127.7	
	-22.660	64.5	1.346	-1.723	-371.6	66.7	35.19	63.4	127.7	
	-23.160	62.5	1.264	-1.583	-338.5	65.7	32.05	59.5	129.1	
	-24.160	58.4	1.118	-1.342	-274.8	61.2	26.02	52.7	132.0	
	-25.160	54.3	0.994	-1.148	-216.7	54.6	20.53	46.8	134.9	
	-26.160	50.2	0.887	-0.998	-166.1	46.6	15.73	41.8	137.8	
	-27.160	46.0	0.793	-0.884	-123.8	38.0	11.72	37.4	140.7	
	-28.160	41.9	0.709	-0.800	-90.1	29.4	8.53	33.4	143.6	
	-29.160	37.8	0.632	-0.739	-65.0	21.0	6.15	29.8	146.5	
	-30.160	33.7	0.561	-0.695	-47.8	13.3	4.53	26.4	149.4	
	-31.160	29.6	0.493	-0.662	-38.0	6.5	3.60	23.2	152.3	
	-32.160	25.5	0.428	-0.634	-34.6	0.6	3.28	20.2	155.2	
	-33.160	21.4	0.366	-0.606	-36.5	-4.2	3.46	17.2	158.0	
	-34.160	17.3	0.307	-0.575	-42.5	-7.7	4.03	14.5	160.9	
	-35.160	13.2	0.251	-0.538	-51.4	-9.8	4.87	11.8	163.8	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	9.1	0.200	-0.493	-61.6	-10.3	5.83	9.4	166.7	
	-37.160	5.0	0.153	-0.441	-71.4	-9.1	6.76	7.2	169.6	
	-38.160	0.9	0.112	-0.381	-79.0	-5.8	7.48	5.3	172.5	
	-38.370	0.0	0.104	-0.368	-80.1	-4.8	7.59	4.9	173.1	
	-39.160	0.0	0.077	-0.317	-82.5	-1.4	7.81	3.6	175.4	
	-39.416	0.0	0.069	-0.301	-82.8	-0.6	7.84	8.3	375.0	
	-40.160	0.0	0.048	-0.252	-81.1	4.7	7.68	5.9	375.1	
	-40.625	0.0	0.037	-0.223	-78.3	7.1	7.42	4.5	375.2	
	-41.160	0.0	0.026	-0.191	-73.9	9.2	7.00	3.2	380.0	
	-42.160	0.0	0.010	-0.136	-63.5	11.3	6.02	1.2	389.0	
	-43.160	0.0	-0.001	-0.091	-51.9	11.8	4.91	0.0	398.0	
	-44.160	0.0	-0.008	-0.054	-40.3	11.2	3.82	0.0	407.0	
	-44.495	0.0	-0.010	-0.044	-36.7	10.8	3.47	0.0	410.0	
	-45.160	0.0	-0.012	-0.027	-29.8	9.9	2.82	0.0	416.0	
	-46.160	0.0	-0.014	-0.007	-20.7	8.2	1.96	0.0	425.0	
	-47.160	0.0	-0.014	0.006	-13.4	6.5	1.26	0.0	434.0	
	-47.656	0.0	-0.014	0.011	-10.3	5.7	0.98	0.0	438.5	
	-48.160	0.0	-0.013	0.014	-7.7	4.9	0.73	0.0	443.0	
	-49.160	0.0	-0.011	0.019	-3.6	3.4	0.34	0.0	452.0	
	-50.160	0.0	-0.009	0.020	-0.8	2.1	0.08	0.0	461.0	
	-51.160	0.0	-0.007	0.020	0.8	1.1	0.07	0.0	470.0	
	-52.160	0.0	-0.005	0.020	1.5	0.4	0.14	0.0	479.0	
	-53.160	0.0	-0.003	0.018	1.5	-0.2	0.15	0.0	488.0	
	-54.160	0.0	-0.002	0.017	1.2	-0.5	0.12	0.0	497.0	
	-54.416	0.0	-0.001	0.017	1.1	-0.5	0.10	0.0	818.0	
	-55.160	0.0	0.000	0.016	0.6	-0.6	0.06	0.0	852.4	
	-56.160	0.0	0.002	0.016	0.1	-0.4	0.01	0.6	898.6	
	-56.660	0.0	0.003	0.016	0.0	0.0	0.00	0.8	921.7	

*showing plastic

bending moment at support of footing concrete is reduced value

(6)bridge axis direction　 6 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.134	7.479	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.760	7.479	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.760	7.479	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.386	7.479	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.362	7.480	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.110	7.492	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.485	7.506	-46.1	-45.7	4.37	0.0	0.0	
467.2										
	+1.340	30.2	1.485	7.506	-46.1	421.5	4.37	0.0	0.0	
	+0.840	35.2	1.860	7.483	160.7	405.2	15.21	0.0	0.0	
	-0.160	45.2	2.597	7.202	546.6	365.0	51.76	0.0	0.0	
	-1.160	55.2	3.291	6.633	887.3	314.8	84.03	0.0	0.0	
	-1.660	60.1	3.613	6.252	1037.6	286.0	98.26	0.0	0.0	
23.1										
	-1.660	60.1	3.613	6.252	1037.6	309.1	98.26	0.0	0.0	
	-2.160	65.1	3.915	5.813	1184.4	277.7	112.17	0.0	0.0	
	-3.160	75.1	4.447	4.778	1427.9	207.6	135.23	0.0	0.0	
	-4.160	85.1	4.866	3.579	1596.3	127.5	151.17	0.0	0.0	
	-4.660	90.1	5.029	2.938	1649.2	83.7	156.18	0.0	0.0	
0.0										
	-4.660	90.1	5.029	2.938	1649.2	83.7	156.18	0.0	0.0	
	-5.160	95.1	5.159	2.281	1679.6	37.4	159.06	0.0	0.0	
	-5.160	95.1	5.159	2.281	1679.6	37.4	139.88	0.0	0.0	
	-5.346	59.3	5.199	2.064	1684.9	19.6	140.32	0.0	0.0	
	-6.160	68.0	5.329	1.111	1680.2	-32.3	139.93	0.0	0.0	
	-6.350	535355.2	5.348	0.890	1672.9	-45.4	139.32	0.0	0.0	
	-7.160	538803.6	5.382	-0.038	1648.0	-17.5	137.25	0.0	0.0	
	-7.416	538385.7	5.377	-0.330	1625.9	-155.7	135.41	0.0	0.0	
	-8.160	533007.3	5.323	-1.129	1458.5	-308.1	121.46	0.0	0.0	
	-9.160	517087.3	5.163	-2.025	1146.0	-327.5	95.44	0.0	0.0	
	-10.160	493088.9	4.925	-2.682	745.5	-442.5	62.09	0.0	0.0	
	-10.350	160.4	4.874	-2.774	652.2	-537.9	54.32	0.0	0.0	
	-11.160	170.7	4.638	-3.008	313.2	-672.0	26.08	0.0	0.0	
	-11.350	173.2	4.580	-3.021	261.3	-704.7	21.76	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
917.3										
	-11.350	173.2	4.580	-3.021	261.3	212.6	21.76	0.0	0.0	
	-11.416	171.0	4.560	-3.023	245.7	201.2	20.46	0.0	0.0	
	-12.160	180.0	4.334	-3.077	155.4	70.6	12.94	0.0	0.0	
	-12.850	188.3	4.119	-3.152	152.4	-56.4	12.69	0.0	0.0	
	-12.850	174.2	4.119	-3.152	152.4	-56.4	12.69	137.5	137.5	*
	-13.160	173.2	4.021	-3.183	133.3	-66.2	11.10	146.6	146.6	*
	-14.160	170.2	3.699	-3.250	59.1	-76.8	4.92	175.7	175.7	*
	-14.350	169.6	3.637	-3.257	44.6	-75.1	3.72	181.2	181.2	*
	-14.362	169.5	3.633	-3.257	43.8	-75.0	3.65	181.6	181.6	*
	-14.362	169.5	3.633	-3.257	43.8	-75.0	3.65	181.6	181.6	
	-15.160	167.1	3.372	-3.265	-13.4	-69.6	1.12	168.6	204.8	
	-16.160	164.1	3.047	-3.232	-84.5	-74.8	7.04	152.3	234.0	
	-17.160	161.0	2.728	-3.145	-167.4	-93.0	13.94	136.3	263.1	
	-18.160	157.9	2.420	-2.994	-274.8	-123.9	22.89	121.0	292.2	
	-18.416	69.4	2.344	-2.942	-307.8	-133.8	25.63	141.9	159.0	
	-19.160	66.1	2.132	-2.761	-388.2	-83.4	32.33	129.1	162.3	
	-20.160	61.7	1.870	-2.469	-442.1	-26.3	36.81	113.2	166.6	
	-21.160	57.3	1.639	-2.159	-444.3	20.3	37.00	99.2	171.0	
	-22.160	52.9	1.438	-1.862	-404.4	58.2	33.68	87.1	175.3	
	-22.416	65.5	1.391	-1.792	-388.4	66.7	32.35	65.5	127.0	
	-22.660	64.5	1.348	-1.728	-372.2	66.6	30.99	63.5	127.7	
	-22.660	64.5	1.348	-1.728	-372.2	66.6	35.24	63.5	127.7	
	-23.160	62.5	1.265	-1.587	-339.1	65.6	32.11	59.6	129.1	
	-24.160	58.4	1.119	-1.345	-275.5	61.2	26.09	52.7	132.0	
	-25.160	54.3	0.995	-1.151	-217.4	54.6	20.59	46.8	134.9	
	-26.160	50.2	0.887	-1.000	-166.8	46.6	15.79	41.8	137.8	
	-27.160	46.0	0.793	-0.886	-124.4	38.1	11.78	37.4	140.7	
	-28.160	41.9	0.709	-0.801	-90.7	29.4	8.58	33.4	143.6	
	-29.160	37.8	0.632	-0.740	-65.4	21.1	6.20	29.8	146.5	
	-30.160	33.7	0.561	-0.696	-48.2	13.4	4.57	26.4	149.4	
	-31.160	29.6	0.493	-0.662	-38.3	6.5	3.63	23.2	152.3	
	-32.160	25.5	0.428	-0.634	-34.8	0.6	3.30	20.2	155.2	
	-33.160	21.4	0.366	-0.606	-36.7	-4.1	3.47	17.2	158.0	
	-34.160	17.3	0.307	-0.575	-42.7	-7.6	4.04	14.5	160.9	
	-35.160	13.2	0.251	-0.538	-51.5	-9.7	4.88	11.8	163.8	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-36.160	9.1	0.200	-0.493	-61.6	-10.3	5.84	9.4	166.7	
	-37.160	5.0	0.153	-0.441	-71.4	-9.0	6.77	7.2	169.6	
	-38.160	0.9	0.112	-0.381	-79.0	-5.7	7.48	5.3	172.5	
	-38.370	0.0	0.104	-0.368	-80.1	-4.8	7.59	4.9	173.1	
	-39.160	0.0	0.077	-0.317	-82.5	-1.4	7.81	3.6	175.4	
	-39.416	0.0	0.069	-0.300	-82.7	-0.5	7.84	8.3	375.0	
	-40.160	0.0	0.048	-0.252	-81.1	4.7	7.68	5.9	375.1	
	-40.625	0.0	0.037	-0.223	-78.3	7.1	7.41	4.5	375.2	
	-41.160	0.0	0.026	-0.191	-73.9	9.2	7.00	3.2	380.0	
	-42.160	0.0	0.010	-0.136	-63.5	11.3	6.01	1.2	389.0	
	-43.160	0.0	-0.001	-0.091	-51.8	11.8	4.91	0.0	398.0	
	-44.160	0.0	-0.008	-0.054	-40.3	11.2	3.82	0.0	407.0	
	-44.495	0.0	-0.010	-0.044	-36.6	10.8	3.47	0.0	410.0	
	-45.160	0.0	-0.012	-0.027	-29.8	9.9	2.82	0.0	416.0	
	-46.160	0.0	-0.014	-0.007	-20.7	8.2	1.96	0.0	425.0	
	-47.160	0.0	-0.014	0.006	-13.3	6.5	1.26	0.0	434.0	
	-47.656	0.0	-0.014	0.011	-10.3	5.7	0.98	0.0	438.5	
	-48.160	0.0	-0.013	0.014	-7.7	4.9	0.73	0.0	443.0	
	-49.160	0.0	-0.011	0.019	-3.6	3.4	0.34	0.0	452.0	
	-50.160	0.0	-0.009	0.020	-0.8	2.1	0.08	0.0	461.0	
	-51.160	0.0	-0.007	0.020	0.8	1.1	0.07	0.0	470.0	
	-52.160	0.0	-0.005	0.020	1.5	0.4	0.14	0.0	479.0	
	-53.160	0.0	-0.003	0.018	1.6	-0.2	0.15	0.0	488.0	
	-54.160	0.0	-0.002	0.017	1.2	-0.5	0.12	0.0	497.0	
	-54.416	0.0	-0.001	0.017	1.1	-0.5	0.10	0.0	818.0	
	-55.160	0.0	0.000	0.016	0.6	-0.6	0.06	0.0	852.4	
	-56.160	0.0	0.002	0.016	0.1	-0.4	0.01	0.6	898.6	
	-56.660	0.0	0.003	0.016	0.0	0.0	0.00	0.8	921.7	

*showing plastic
bending moment at support of footing concrete is reduced value

(7)perpendicular direction   1 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.184	4.706	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.051	4.706	0.0	0.0	0.00	0.0	0.0	
209.7										
	+4.340	0.3	0.051	4.706	0.0	209.7	0.00	0.0	0.0	
	+3.840	5.3	0.286	4.685	104.6	208.3	9.79	0.0	0.0	
	+2.840	15.2	0.748	4.524	308.6	198.1	28.89	0.0	0.0	
	+1.840	25.2	1.186	4.208	497.4	177.8	46.56	0.0	0.0	
	+1.340	30.2	1.391	3.997	583.0	164.0	54.57	0.0	0.0	
	+0.840	35.2	1.585	3.754	661.0	147.6	61.87	0.0	0.0	
	+0.340	40.2	1.766	3.482	730.2	128.8	68.35	0.0	0.0	
	-0.160	40.2	1.933	3.186	789.6	108.7	73.91	0.0	0.0	
	-1.160	40.2	2.219	2.533	878.2	68.5	82.20	0.0	0.0	
	-1.660	40.1	2.337	2.184	907.5	48.5	84.94	0.0	0.0	
	-2.160	40.1	2.437	1.826	926.7	28.4	86.74	0.0	0.0	
	-3.160	40.1	2.584	1.097	935.0	-11.7	87.52	0.0	0.0	
	-4.160	40.1	2.657	0.378	903.2	-51.8	84.55	0.0	0.0	
	-4.660	40.1	2.667	0.031	872.3	-71.9	81.65	0.0	0.0	
	-5.160	40.1	2.660	-0.301	831.4	-91.9	77.82	0.0	0.0	
	-5.160	40.1	2.660	-0.301	831.4	-91.9	68.43	0.0	0.0	
	-5.346	32.0	2.654	-0.406	813.6	-99.4	66.97	23.0	31.4	
	-6.160	32.0	2.603	-0.837	729.6	-106.9	60.06	22.5	34.2	
	-6.350	32.0	2.586	-0.931	709.2	-108.7	58.37	22.4	34.9	
	-7.160	32.0	2.495	-1.300	617.9	-116.8	50.86	21.6	37.7	
	-7.416	37.4	2.461	-1.406	587.6	-119.5	48.37	28.4	48.3	
	-8.160	36.2	2.346	-1.683	496.2	-126.2	40.85	27.1	65.4	
	-9.160	34.6	2.162	-1.979	365.3	-135.6	30.07	24.9	88.4	
	-10.160	33.0	1.953	-2.182	224.8	-145.7	18.50	22.5	111.4	
	-10.350	32.7	1.911	-2.209	196.9	-147.7	16.21	22.0	115.7	
	-11.160	31.4	1.729	-2.285	73.7	-156.6	6.07	19.9	134.4	
	-11.350	31.1	1.685	-2.292	43.7	-158.8	3.60	19.4	138.7	
	-11.416	31.6	1.670	-2.294	33.2	-159.6	2.74	83.5	200.9	
	-12.160	29.9	1.500	-2.283	-71.8	-123.5	5.91	74.9	223.1	
	-13.160	27.6	1.275	-2.196	-174.3	-83.0	14.35	63.7	253.0	
	-14.160	25.3	1.062	-2.052	-240.6	-51.1	19.81	53.1	282.9	
	-14.350	24.8	1.023	-2.020	-249.8	-45.9	20.56	51.2	288.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-15.160	23.0	0.866	-1.873	-279.1	-27.1	22.97	43.3	312.7	
	-16.160	20.7	0.688	-1.674	-297.1	-10.1	24.46	34.4	342.6	
	-17.160	18.3	0.531	-1.468	-301.3	0.8	24.81	26.5	372.5	
	-18.160	16.0	0.395	-1.263	-297.3	6.6	24.47	19.7	402.4	
	-18.416	9.7	0.363	-1.210	-295.5	7.4	24.32	22.0	238.8	
	-19.146	7.7	0.280	-1.064	-287.1	15.2	23.63	17.0	243.2	
	-19.160	7.7	0.278	-1.062	-286.9	15.4	23.61	16.9	243.3	
	-20.160	5.0	0.182	-0.871	-267.5	22.9	22.02	11.0	249.3	
	-21.160	2.3	0.104	-0.696	-242.0	27.8	19.92	6.3	255.4	
	-22.009	0.0	0.050	-0.562	-217.1	30.7	17.87	3.1	260.5	
	-22.160	0.0	0.042	-0.540	-212.5	31.1	17.49	2.5	261.8	
	-22.416	0.0	0.029	-0.503	-204.4	31.7	16.83	1.4	200.8	
	-22.660	0.0	0.017	-0.470	-196.7	31.9	16.19	0.8	202.5	
	-22.660	0.0	0.017	-0.470	-196.7	31.9	18.41	0.8	202.5	
	-23.160	0.0	-0.005	-0.396	-180.6	32.1	16.91	0.0	206.0	
	-24.160	0.0	-0.038	-0.268	-148.9	31.0	13.94	0.0	213.0	
	-25.160	0.0	-0.059	-0.163	-119.0	28.7	11.14	0.0	220.0	
	-26.160	0.0	-0.071	-0.081	-91.8	25.6	8.59	0.0	227.0	
	-27.160	0.0	-0.076	-0.019	-67.9	22.1	6.35	0.0	234.0	
	-28.160	0.0	-0.076	0.025	-47.6	18.5	4.45	0.0	241.0	
	-29.160	0.0	-0.071	0.056	-30.8	15.1	2.88	0.0	248.0	
	-30.160	0.0	-0.065	0.074	-17.4	11.8	1.62	0.0	255.0	
	-31.160	0.0	-0.057	0.084	-7.0	9.0	0.65	0.0	262.0	
	-32.160	0.0	-0.048	0.086	0.7	6.5	0.07	0.0	269.0	
	-33.160	0.0	-0.040	0.083	6.1	4.4	0.57	0.0	276.0	
	-34.160	0.0	-0.032	0.077	9.7	2.7	0.91	0.0	283.0	
	-35.160	0.0	-0.025	0.068	11.7	1.4	1.10	0.0	290.0	
	-36.160	0.0	-0.018	0.059	12.6	0.4	1.18	0.0	297.0	
	-37.160	0.0	-0.013	0.049	12.6	-0.3	1.18	0.0	304.0	
	-38.160	0.0	-0.008	0.039	12.0	-0.8	1.12	0.0	311.0	
	-39.160	0.0	-0.005	0.030	11.0	-1.1	1.03	0.0	318.0	
	-39.416	0.0	-0.004	0.028	10.7	-1.2	1.00	0.0	520.8	
	-40.160	0.0	-0.002	0.022	9.7	-1.5	0.90	0.0	527.5	
	-41.160	0.0	0.000	0.015	8.1	-1.7	0.76	0.0	536.5	
	-42.160	0.0	0.001	0.010	6.4	-1.6	0.60	0.1	545.5	
	-43.160	0.0	0.002	0.005	4.9	-1.5	0.45	0.2	554.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-44.160	0.0	0.002	0.002	3.5	-1.3	0.32	0.2	563.5	
	-45.160	0.0	0.002	0.000	2.3	-1.0	0.22	0.2	572.5	
	-46.160	0.0	0.002	-0.002	1.4	-0.8	0.13	0.2	581.5	
	-47.160	0.0	0.002	-0.002	0.7	-0.6	0.07	0.2	590.5	
	-48.160	0.0	0.001	-0.003	0.2	-0.4	0.02	0.2	599.5	
	-49.160	0.0	0.001	-0.003	-0.1	-0.2	0.01	0.1	608.5	
	-50.160	0.0	0.001	-0.003	-0.3	-0.1	0.03	0.1	617.5	
	-51.160	0.0	0.001	-0.002	-0.4	0.0	0.03	0.1	626.5	
	-52.160	0.0	0.000	-0.002	-0.3	0.0	0.03	0.1	635.5	
	-53.160	0.0	0.000	-0.002	-0.3	0.1	0.03	0.0	644.5	
	-54.160	0.0	0.000	-0.002	-0.2	0.1	0.02	0.0	653.5	
	-54.416	0.0	0.000	-0.002	-0.2	0.1	0.02	0.0	1688.4	
	-55.160	0.0	0.000	-0.001	-0.1	0.1	0.01	0.0	1722.8	
	-56.160	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1769.0	
	-56.660	0.0	0.000	-0.001	0.0	0.0	0.00	0.0	1792.1	

(8)perpendicular direction   2 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-0.690	6.065	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.387	6.065	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.387	6.065	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.083	6.065	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.523	6.066	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.130	6.078	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.434	6.092	-46.1	-45.7	4.32	0.0	0.0	
358.5										
	+1.340	30.2	1.434	6.092	-46.1	312.8	4.32	0.0	0.0	
	+0.840	35.2	1.739	6.080	106.3	296.4	9.95	0.0	0.0	
	+0.340	40.2	2.041	6.010	249.9	277.6	23.39	0.0	0.0	
	-0.160	40.2	2.339	5.886	383.6	257.5	35.91	0.0	0.0	
	-1.160	40.2	2.910	5.492	621.0	217.3	58.13	0.0	0.0	
	-1.660	40.1	3.178	5.229	724.6	197.2	67.83	0.0	0.0	
	-2.160	40.1	3.432	4.928	818.2	177.2	76.59	0.0	0.0	
	-3.160	40.1	3.891	4.226	975.3	137.0	91.29	0.0	0.0	
	-4.160	40.1	4.273	3.417	1092.3	96.9	102.24	0.0	0.0	
	-4.660	40.1	4.433	2.982	1135.7	76.9	106.31	0.0	0.0	
	-5.160	40.1	4.571	2.532	1169.2	56.8	109.44	0.0	0.0	
	-5.160	40.1	4.571	2.532	1169.2	56.8	96.24	0.0	0.0	
	-5.346	2.5	4.617	2.382	1179.0	49.4	97.05	0.0	0.0	
	-6.160	3.0	4.784	1.713	1218.4	47.2	100.29	0.0	0.0	
	-6.350	3.2	4.815	1.554	1227.3	46.6	101.02	0.0	0.0	
	-7.160	3.8	4.913	0.861	1263.9	43.8	104.04	0.0	0.0	
	-7.416	45.6	4.932	0.639	1275.0	42.8	104.95	0.0	0.0	
	-8.160	47.6	4.955	-0.018	1294.0	8.1	106.51	0.0	0.0	
	-9.160	50.3	4.909	-0.903	1277.8	-40.9	105.18	0.0	0.0	
	-10.160	53.0	4.776	-1.760	1211.3	-92.6	99.71	0.0	0.0	
	-10.350	53.5	4.741	-1.916	1192.7	-102.7	98.18	0.0	0.0	
	-11.160	55.7	4.559	-2.553	1091.8	-147.0	89.87	0.0	0.0	
	-11.350	56.3	4.509	-2.693	1062.8	-157.6	87.49	0.0	0.0	
	-11.416	53.4	4.492	-2.741	1052.3	-161.3	86.62	0.0	0.0	
	-12.160	55.0	4.268	-3.245	917.4	-201.6	75.51	0.0	0.0	
	-12.850	56.4	4.030	-3.644	765.0	-240.0	62.97	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-12.850	56.4	4.030	-3.644	765.0	-240.0	62.97	0.0	0.0	*
	-13.160	55.7	3.915	-3.799	688.1	-256.0	56.64	9.3	9.3	*
	-14.160	53.4	3.515	-4.178	414.3	-286.3	34.10	39.1	39.1	*
	-14.350	52.9	3.435	-4.229	359.7	-288.4	29.60	44.8	44.8	*
	-15.160	51.0	3.086	-4.364	126.2	-284.4	10.39	69.0	69.0	*
	-16.160	48.7	2.648	-4.356	-143.8	-250.4	11.84	98.9	98.9	*
	-16.810	47.2	2.368	-4.257	-294.5	-211.0	24.24	118.3	118.3	*
	-16.810	47.2	2.368	-4.257	-294.5	-211.0	24.24	118.4	118.3	
	-17.160	46.4	2.220	-4.178	-364.1	-187.2	29.97	111.0	128.8	
	-18.160	44.1	1.817	-3.871	-522.2	-131.8	42.98	90.8	158.6	
	-18.416	23.5	1.719	-3.776	-554.4	-120.4	45.64	104.1	214.0	
	-19.160	21.5	1.449	-3.474	-623.0	-65.8	51.28	87.8	218.5	
	-20.160	18.8	1.124	-3.031	-658.6	-8.2	54.21	68.0	224.6	
	-21.160	16.1	0.843	-2.582	-644.7	33.7	53.07	51.1	230.6	
	-22.160	13.4	0.607	-2.155	-595.6	62.6	49.02	36.7	236.7	
	-22.416	18.6	0.553	-2.051	-578.8	68.3	47.64	26.0	181.0	
	-22.660	18.0	0.504	-1.956	-561.9	69.9	46.26	23.7	182.1	
	-22.660	18.0	0.504	-1.956	-561.9	69.9	52.60	23.7	182.1	
	-23.160	16.8	0.412	-1.744	-526.4	72.0	49.27	19.4	184.3	
	-23.631	15.6	0.334	-1.556	-492.3	72.6	46.08	15.7	186.4	
	-24.160	14.2	0.257	-1.361	-454.0	72.1	42.50	12.1	188.8	
	-25.160	11.7	0.137	-1.035	-383.6	68.2	35.91	6.5	193.3	
	-26.160	9.2	0.048	-0.762	-318.3	62.0	29.80	2.3	197.7	
	-27.160	6.7	-0.016	-0.536	-259.9	54.8	24.32	0.0	202.2	
	-27.787	5.1	-0.046	-0.418	-227.0	50.1	21.25	0.0	205.0	
	-28.160	4.2	-0.061	-0.354	-208.8	47.5	19.54	0.0	206.7	
	-29.160	1.6	-0.089	-0.209	-164.6	41.0	15.41	0.0	211.2	
	-29.807	0.0	-0.099	-0.132	-139.2	37.6	13.03	0.0	214.1	
	-30.160	0.0	-0.104	-0.096	-126.3	35.9	11.82	0.0	215.7	
	-31.160	0.0	-0.109	-0.011	-92.8	30.9	8.69	0.0	220.1	
	-32.160	0.0	-0.106	0.050	-64.5	25.8	6.04	0.0	224.6	
	-33.160	0.0	-0.099	0.091	-41.1	20.9	3.85	0.0	229.1	
	-34.160	0.0	-0.089	0.116	-22.5	16.5	2.10	0.0	233.6	
	-35.160	0.0	-0.077	0.127	-7.9	12.6	0.74	0.0	238.1	
	-36.160	0.0	-0.064	0.129	3.0	9.3	0.28	0.0	242.5	
	-36.581	0.0	-0.058	0.127	6.6	8.1	0.62	0.0	244.4	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-37.160	0.0	-0.051	0.123	10.9	6.6	1.02	0.0	248.5	
	-38.160	0.0	-0.039	0.113	16.4	4.5	1.53	0.0	255.5	
	-39.160	0.0	-0.029	0.098	20.0	2.9	1.88	0.0	262.5	
	-39.416	0.0	-0.026	0.094	20.7	2.6	1.94	0.0	465.2	
	-40.160	0.0	-0.020	0.082	21.9	0.5	2.05	0.0	471.9	
	-41.160	0.0	-0.012	0.065	21.4	-1.4	2.00	0.0	480.9	
	-42.160	0.0	-0.007	0.049	19.4	-2.5	1.82	0.0	489.9	
	-43.160	0.0	-0.002	0.035	16.6	-3.0	1.55	0.0	498.9	
	-44.160	0.0	0.001	0.023	13.5	-3.1	1.27	0.1	507.9	
	-45.160	0.0	0.002	0.014	10.5	-2.9	0.98	0.3	516.9	
	-46.160	0.0	0.003	0.007	7.7	-2.6	0.73	0.4	525.9	
	-47.160	0.0	0.004	0.002	5.4	-2.1	0.51	0.5	534.9	
	-48.160	0.0	0.004	-0.002	3.5	-1.7	0.33	0.5	543.9	
	-49.160	0.0	0.003	-0.004	2.1	-1.2	0.19	0.4	552.9	
	-50.160	0.0	0.003	-0.005	1.0	-0.8	0.10	0.4	561.9	
	-51.160	0.0	0.002	-0.006	0.3	-0.5	0.03	0.3	570.9	
	-52.160	0.0	0.002	-0.006	0.0	-0.3	0.00	0.2	579.9	
	-53.160	0.0	0.001	-0.006	-0.2	-0.1	0.02	0.1	588.9	
	-54.160	0.0	0.001	-0.006	-0.2	0.0	0.02	0.1	597.9	
	-54.416	0.0	0.001	-0.005	-0.2	0.1	0.02	0.2	1379.3	
	-55.160	0.0	0.000	-0.005	-0.2	0.1	0.01	0.0	1413.7	
	-56.160	0.0	0.000	-0.005	0.0	0.1	0.00	0.0	1459.9	
	-56.660	0.0	-0.001	-0.005	0.0	0.0	0.00	0.0	1483.0	

*showing plastic

(9)perpendicular direction   3 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.178	7.498	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.803	7.498	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.803	7.498	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.428	7.498	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.322	7.500	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.072	7.511	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.448	7.525	-46.1	-45.7	4.32	0.0	0.0	
470.0										
	+1.340	30.2	1.448	7.525	-46.1	424.3	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.502	162.0	407.9	15.17	0.0	0.0	
	-0.160	45.2	2.563	7.222	550.7	367.7	51.55	0.0	0.0	
	-1.160	55.2	3.259	6.655	894.2	317.6	83.70	0.0	0.0	
	-1.660	60.1	3.582	6.276	1045.8	288.7	97.89	0.0	0.0	
	-2.160	65.1	3.886	5.841	1182.5	257.4	110.68	0.0	0.0	
	-2.660	70.1	4.166	5.356	1302.8	223.6	121.95	0.0	0.0	
	-3.160	70.1	4.420	4.827	1405.9	188.5	131.59	0.0	0.0	
	-4.160	70.1	4.846	3.666	1559.4	118.4	145.96	0.0	0.0	
	-4.660	70.1	5.014	3.048	1609.8	83.4	150.68	0.0	0.0	
	-5.160	70.1	5.151	2.413	1642.8	48.4	153.77	0.0	0.0	
	-5.160	70.1	5.151	2.413	1642.8	48.4	135.22	0.0	0.0	
	-5.346	32.5	5.193	2.203	1650.5	35.3	135.86	0.0	0.0	
	-6.160	33.0	5.335	1.275	1668.5	8.7	137.34	0.0	0.0	
	-6.350	33.2	5.357	1.057	1669.5	2.4	137.43	0.0	0.0	
	-7.160	33.8	5.405	0.131	1660.5	-24.7	136.68	0.0	0.0	
	-7.416	75.6	5.405	-0.160	1653.1	-33.4	136.07	0.0	0.0	
	-8.160	77.6	5.362	-0.993	1607.1	-90.4	132.29	0.0	0.0	
	-9.160	80.3	5.209	-2.056	1477.5	-169.4	121.62	0.0	0.0	
	-10.160	83.0	4.955	-3.002	1267.5	-251.1	104.33	0.0	0.0	
	-10.350	83.5	4.896	-3.164	1218.3	-266.9	100.28	0.0	0.0	
	-11.160	85.7	4.614	-3.776	988.3	-335.4	81.35	0.0	0.0	
	-11.350	86.3	4.541	-3.898	930.2	-351.8	76.57	0.0	0.0	
84.2										
	-11.350	86.3	4.541	-3.898	930.2	-267.6	76.57	0.0	0.0	
	-11.416	83.4	4.515	-3.939	909.7	-273.3	74.88	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-12.160	85.0	4.207	-4.338	665.5	-336.0	54.78	0.0	0.0	
	-12.850	86.4	3.898	-4.595	412.6	-395.1	33.96	0.0	0.0	
	-12.850	72.3	3.898	-4.595	412.6	-395.1	33.96	137.5	137.5	*
	-13.160	71.5	3.754	-4.670	293.4	-373.3	24.15	146.8	146.8	*
	-13.940	69.7	3.386	-4.753	27.6	-304.8	2.27	170.1	170.1	*
	-13.940	69.7	3.386	-4.753	27.6	-304.8	2.27	169.2	170.1	
	-14.160	69.2	3.281	-4.753	-37.0	-283.4	3.05	164.0	176.7	
	-14.350	68.8	3.191	-4.744	-89.2	-265.8	7.34	159.5	182.3	
	-15.160	66.9	2.810	-4.640	-276.6	-199.4	22.77	140.4	206.5	
	-16.160	64.6	2.358	-4.390	-442.7	-136.1	36.44	117.8	236.4	
	-17.160	62.3	1.935	-4.045	-555.4	-92.4	45.71	96.7	266.3	
	-18.160	60.0	1.551	-3.636	-633.5	-66.7	52.15	77.5	296.2	
	-18.416	23.0	1.459	-3.523	-650.0	-62.7	53.51	88.4	214.5	
	-19.160	21.0	1.210	-3.182	-679.8	-19.0	55.96	73.2	219.0	
	-20.160	18.3	0.915	-2.715	-675.3	25.5	55.59	55.4	225.1	
	-21.160	15.6	0.666	-2.264	-633.5	56.2	52.15	40.3	231.1	
	-22.160	12.9	0.461	-1.852	-566.7	75.9	46.65	27.9	237.2	
	-22.416	18.0	0.415	-1.754	-546.8	79.4	45.01	19.5	181.4	
	-22.660	17.4	0.373	-1.664	-527.4	79.6	43.41	17.6	182.5	
	-22.660	17.4	0.373	-1.664	-527.4	79.6	49.36	17.6	182.5	
	-23.160	16.2	0.295	-1.466	-487.6	79.1	45.65	13.9	184.7	
	-23.485	15.3	0.249	-1.346	-462.1	78.1	43.25	11.7	186.2	
	-24.160	13.6	0.166	-1.116	-410.4	74.9	38.41	7.8	189.2	
	-25.160	11.1	0.069	-0.824	-338.8	68.0	31.71	3.3	193.7	
	-26.160	8.6	-0.001	-0.586	-274.9	59.6	25.73	0.0	198.1	
	-27.160	6.1	-0.049	-0.393	-219.6	51.1	20.55	0.0	202.6	
	-27.641	4.9	-0.066	-0.315	-196.0	47.1	18.35	0.0	204.8	
	-28.160	3.6	-0.081	-0.241	-172.6	43.1	16.15	0.0	207.1	
	-29.160	1.0	-0.098	-0.122	-132.9	36.6	12.44	0.0	211.6	
	-29.569	0.0	-0.103	-0.082	-118.3	34.4	11.08	0.0	213.4	
	-30.160	0.0	-0.106	-0.032	-98.9	31.5	9.25	0.0	216.1	
	-31.160	0.0	-0.106	0.033	-69.8	26.5	6.54	0.0	220.5	
	-32.160	0.0	-0.100	0.078	-45.8	21.7	4.29	0.0	225.0	
	-33.160	0.0	-0.091	0.106	-26.4	17.2	2.47	0.0	229.5	
	-34.160	0.0	-0.079	0.121	-11.3	13.1	1.06	0.0	234.0	
	-35.160	0.0	-0.067	0.125	0.1	9.7	0.01	0.0	238.5	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	0.0	-0.054	0.121	8.3	6.9	0.78	0.0	242.9	
	-36.343	0.0	-0.052	0.120	9.5	6.4	0.89	0.0	243.8	
	-37.160	0.0	-0.043	0.112	14.0	4.6	1.31	0.0	249.5	
	-38.160	0.0	-0.032	0.100	17.6	2.8	1.65	0.0	256.5	
	-39.160	0.0	-0.023	0.085	19.7	1.5	1.85	0.0	263.5	
	-39.416	0.0	-0.021	0.081	20.1	1.3	1.88	0.0	466.2	
	-40.160	0.0	-0.015	0.070	20.4	-0.4	1.91	0.0	472.9	
	-41.160	0.0	-0.009	0.054	19.3	-1.8	1.80	0.0	481.9	
	-42.160	0.0	-0.004	0.040	17.0	-2.6	1.59	0.0	490.9	
	-43.160	0.0	-0.001	0.028	14.3	-2.9	1.34	0.0	499.9	
	-44.160	0.0	0.001	0.018	11.4	-2.8	1.07	0.2	508.9	
	-45.160	0.0	0.003	0.010	8.6	-2.6	0.81	0.3	517.9	
	-46.160	0.0	0.003	0.004	6.2	-2.2	0.58	0.4	526.9	
	-47.160	0.0	0.004	0.000	4.2	-1.8	0.39	0.4	535.9	
	-48.160	0.0	0.003	-0.003	2.6	-1.4	0.24	0.4	544.9	
	-49.160	0.0	0.003	-0.004	1.4	-1.0	0.13	0.4	553.9	
	-50.160	0.0	0.003	-0.005	0.6	-0.7	0.06	0.3	562.9	
	-51.160	0.0	0.002	-0.005	0.1	-0.4	0.01	0.2	571.9	
	-52.160	0.0	0.002	-0.005	-0.2	-0.2	0.02	0.2	580.9	
	-53.160	0.0	0.001	-0.005	-0.3	0.0	0.03	0.1	589.9	
	-54.160	0.0	0.001	-0.005	-0.3	0.1	0.02	0.1	598.9	
	-54.416	0.0	0.000	-0.005	-0.2	0.1	0.02	0.1	1384.8	
	-55.160	0.0	0.000	-0.005	-0.2	0.1	0.01	0.0	1419.2	
	-56.160	0.0	0.000	-0.005	0.0	0.1	0.00	0.0	1465.5	
	-56.660	0.0	-0.001	-0.005	0.0	0.0	0.00	0.0	1488.6	

*showing plastic

bending moment at support of footing concrete is reduced value

(10)perpendicular direction 4 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.205	7.565	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.448	7.565	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.308	7.567	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.065	7.578	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.444	7.592	-46.1	-45.7	4.32	0.0	0.0	
440.7										
	+1.340	30.2	1.444	7.592	-46.1	395.0	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.572	147.4	378.7	13.80	0.0	0.0	
	-0.160	45.2	2.571	7.314	506.8	338.5	47.44	0.0	0.0	
	-1.160	55.2	3.278	6.793	821.0	288.3	76.85	0.0	0.0	
	-1.660	60.1	3.609	6.446	958.1	259.5	89.68	0.0	0.0	
74.6										
	-1.660	60.1	3.609	6.446	958.1	334.0	89.68	0.0	0.0	
	-2.160	65.1	3.922	6.041	1117.4	302.7	104.59	0.0	0.0	
	-3.160	75.1	4.478	5.060	1385.9	232.6	129.72	0.0	0.0	
	-4.160	85.1	4.928	3.898	1579.3	152.5	147.82	0.0	0.0	
	-4.660	90.1	5.107	3.269	1644.7	108.7	153.95	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	157.96	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	138.91	0.0	0.0	
	-5.346	59.3	5.301	2.402	1697.5	44.6	139.73	0.0	0.0	
	-6.160	68.0	5.457	1.448	1713.2	-7.3	141.02	0.0	0.0	
	-6.350	70.1	5.483	1.225	1710.6	-20.4	140.80	0.0	0.0	
	-7.160	78.8	5.544	0.283	1670.1	-80.7	137.47	0.0	0.0	
	-7.416	123.2	5.547	-0.008	1646.8	-101.2	135.56	0.0	0.0	
	-8.160	132.6	5.516	-0.823	1536.6	-196.3	126.49	0.0	0.0	
	-9.160	145.3	5.384	-1.794	1271.8	-335.3	104.69	0.0	0.0	
	-10.160	158.0	5.165	-2.535	861.8	-487.0	70.93	0.0	0.0	
	-10.350	160.4	5.116	-2.641	766.4	-517.2	63.08	0.0	0.0	
	-11.160	170.7	4.888	-2.941	433.8	-651.4	35.71	0.0	0.0	
	-11.350	173.2	4.832	-2.971	380.4	-684.0	31.31	0.0	0.0	
854.6										
	-11.350	173.2	4.832	-2.971	380.4	170.6	31.31	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-11.416	171.0	4.812	-2.978	364.0	159.1	29.96	0.0	0.0	
	-12.160	180.0	4.586	-3.091	255.6	28.6	21.04	0.0	0.0	
	-12.850	188.3	4.369	-3.206	224.1	-98.5	18.44	0.0	0.0	
	-12.850	174.2	4.369	-3.206	224.1	-98.5	18.44	137.5	137.5	*
	-13.160	173.4	4.269	-3.251	191.9	-108.3	15.80	146.8	146.8	*
	-14.160	171.1	3.939	-3.343	75.7	-118.9	6.23	176.7	176.7	*
	-14.350	170.7	3.875	-3.351	53.2	-117.2	4.38	182.3	182.3	*
	-14.593	170.1	3.794	-3.358	25.2	-113.4	2.07	189.6	189.6	*
	-14.593	170.1	3.794	-3.358	25.2	-113.4	2.07	189.6	189.6	
	-15.160	168.8	3.603	-3.356	-36.5	-104.7	3.00	180.1	206.5	
	-16.160	166.5	3.270	-3.295	-138.0	-100.7	11.36	163.4	236.4	
	-17.160	164.2	2.946	-3.166	-242.6	-110.8	19.97	147.3	266.3	
	-18.160	161.9	2.639	-2.959	-364.0	-134.3	29.97	131.9	296.2	
	-18.416	73.9	2.565	-2.892	-399.5	-142.4	32.88	155.3	163.6	
	-19.160	71.9	2.358	-2.665	-483.9	-85.9	39.83	142.8	168.1	
	-20.160	69.2	2.108	-2.311	-536.5	-21.4	44.16	127.7	174.1	
	-21.160	66.5	1.896	-1.942	-530.5	31.8	43.67	114.8	180.2	
	-22.160	63.8	1.719	-1.594	-476.0	75.9	39.18	104.1	186.2	
	-22.416	79.2	1.680	-1.512	-455.3	86.0	37.48	79.1	140.6	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	35.75	77.4	141.7	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	40.65	77.4	141.7	
	-23.160	77.3	1.576	-1.277	-391.6	84.7	36.66	74.2	143.9	
	-24.160	74.8	1.462	-1.004	-308.9	80.2	28.92	68.9	148.4	
	-25.160	72.3	1.373	-0.793	-232.1	73.3	21.72	64.7	152.9	
	-26.160	69.7	1.302	-0.640	-162.7	65.3	15.23	61.3	157.4	
	-27.160	67.2	1.243	-0.537	-101.7	56.7	9.52	58.6	161.9	
	-28.160	64.7	1.193	-0.479	-49.4	48.1	4.62	56.2	166.3	
	-29.160	62.2	1.146	-0.458	-5.5	39.7	0.52	54.0	170.8	
	-30.160	59.7	1.100	-0.468	30.1	31.7	2.82	51.8	175.3	
	-31.160	57.1	1.052	-0.503	57.9	24.0	5.42	49.5	179.8	
	-32.160	54.6	0.999	-0.557	78.1	16.4	7.31	47.0	184.3	
	-33.160	52.1	0.940	-0.623	90.7	8.7	8.49	44.3	188.7	
	-34.160	49.6	0.874	-0.696	95.4	0.6	8.93	41.2	193.2	
	-35.160	47.1	0.801	-0.770	91.8	-8.2	8.59	37.7	197.7	
	-36.160	44.5	0.720	-0.837	78.7	-18.1	7.36	33.9	202.2	
	-37.160	42.0	0.634	-0.890	55.0	-29.5	5.15	29.8	206.7	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-38.160	39.5	0.543	-0.919	19.1	-42.5	1.79	25.6	211.1	
	-38.370	39.0	0.524	-0.922	9.9	-45.5	0.92	24.7	212.1	
	-39.160	37.0	0.451	-0.916	-30.7	-57.4	2.87	21.2	215.6	
	-39.416	27.4	0.428	-0.908	-45.9	-61.5	4.30	51.8	408.8	
	-40.160	23.4	0.361	-0.870	-85.3	-44.8	7.98	43.8	411.5	
	-40.625	20.9	0.322	-0.835	-104.0	-35.9	9.74	39.0	413.2	
	-41.160	18.0	0.278	-0.788	-120.7	-26.9	11.30	33.7	415.1	
	-42.160	12.6	0.204	-0.685	-140.4	-13.1	13.15	24.8	418.7	
	-43.160	7.2	0.142	-0.572	-147.9	-2.2	13.84	17.1	422.3	
	-44.160	1.8	0.090	-0.457	-145.3	7.2	13.60	10.9	425.9	
	-44.495	0.0	0.075	-0.420	-142.3	10.3	13.32	9.1	427.1	
	-45.160	0.0	0.050	-0.348	-133.7	15.3	12.52	6.0	429.5	
	-46.160	0.0	0.020	-0.250	-116.0	19.4	10.86	2.4	433.1	
	-47.160	0.0	-0.001	-0.168	-95.8	20.5	8.97	0.0	436.7	
	-47.656	0.0	-0.008	-0.132	-85.7	20.3	8.02	0.0	438.5	
	-48.160	0.0	-0.014	-0.101	-75.6	19.6	7.08	0.0	443.0	
	-49.160	0.0	-0.021	-0.049	-57.1	17.4	5.34	0.0	452.0	
	-50.160	0.0	-0.024	-0.011	-41.1	14.6	3.84	0.0	461.0	
	-51.160	0.0	-0.024	0.016	-27.9	11.7	2.61	0.0	470.0	
	-52.160	0.0	-0.021	0.033	-17.7	8.9	1.65	0.0	479.0	
	-53.160	0.0	-0.017	0.044	-10.0	6.5	0.93	0.0	488.0	
	-54.160	0.0	-0.013	0.049	-4.4	4.7	0.41	0.0	497.0	
	-54.416	0.0	-0.011	0.050	-3.2	4.3	0.30	0.0	818.0	
	-55.160	0.0	-0.008	0.051	-1.0	1.9	0.09	0.0	852.4	
	-56.160	0.0	-0.003	0.052	0.0	0.2	0.00	0.0	898.6	
	-56.660	0.0	0.000	0.052	0.0	0.0	0.00	0.0	921.7	

*showing plastic

bending moment at support of footing concrete is reduced value

(11)perpendicular direction   5 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.205	7.565	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.827	7.565	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.448	7.565	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.308	7.567	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.065	7.578	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.444	7.592	-46.1	-45.7	4.32	0.0	0.0	
440.7										
	+1.340	30.2	1.444	7.592	-46.1	395.0	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.572	147.4	378.7	13.80	0.0	0.0	
	-0.160	45.2	2.571	7.314	506.8	338.5	47.44	0.0	0.0	
	-1.160	55.2	3.278	6.793	821.0	288.3	76.85	0.0	0.0	
	-1.660	60.1	3.609	6.446	958.1	259.5	89.68	0.0	0.0	
74.6										
	-1.660	60.1	3.609	6.446	958.1	334.0	89.68	0.0	0.0	
	-2.160	65.1	3.922	6.041	1117.4	302.7	104.59	0.0	0.0	
	-3.160	75.1	4.478	5.060	1385.9	232.6	129.72	0.0	0.0	
	-4.160	85.1	4.928	3.898	1579.3	152.5	147.82	0.0	0.0	
	-4.660	90.1	5.107	3.269	1644.7	108.7	153.95	0.0	0.0	
0.0										
	-4.660	90.1	5.107	3.269	1644.7	108.7	153.95	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	157.96	0.0	0.0	
	-5.160	95.1	5.254	2.618	1687.6	62.4	138.91	0.0	0.0	
	-5.346	59.3	5.301	2.402	1697.5	44.6	139.73	0.0	0.0	
	-6.160	68.0	5.457	1.448	1713.2	-7.3	141.02	0.0	0.0	
	-6.350	70.1	5.483	1.225	1710.6	-20.4	140.80	0.0	0.0	
	-7.160	78.8	5.544	0.283	1670.1	-80.7	137.47	0.0	0.0	
	-7.416	123.2	5.547	-0.008	1646.8	-101.2	135.56	0.0	0.0	
	-8.160	132.6	5.516	-0.823	1536.6	-196.3	126.49	0.0	0.0	
	-9.160	145.3	5.384	-1.794	1271.8	-335.3	104.69	0.0	0.0	
	-10.160	158.0	5.165	-2.535	861.8	-487.0	70.93	0.0	0.0	
	-10.350	160.4	5.116	-2.641	766.4	-517.2	63.08	0.0	0.0	
	-11.160	170.7	4.888	-2.941	433.8	-651.4	35.71	0.0	0.0	
	-11.350	173.2	4.832	-2.971	380.4	-684.0	31.31	0.0	0.0	

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
854.6										
	-11.350	173.2	4.832	-2.971	380.4	170.6	31.31	0.0	0.0	
	-11.416	171.0	4.812	-2.978	364.0	159.1	29.96	0.0	0.0	
	-12.160	180.0	4.586	-3.091	255.6	28.6	21.04	0.0	0.0	
	-12.850	188.3	4.369	-3.206	224.1	-98.5	18.44	0.0	0.0	
	-12.850	174.2	4.369	-3.206	224.1	-98.5	18.44	137.5	137.5	*
	-13.160	173.4	4.269	-3.251	191.9	-108.3	15.80	146.8	146.8	*
	-14.160	171.1	3.939	-3.343	75.7	-118.9	6.23	176.7	176.7	*
	-14.350	170.7	3.875	-3.351	53.2	-117.2	4.38	182.3	182.3	*
	-14.596	170.1	3.793	-3.358	24.9	-113.4	2.05	189.7	189.7	*
	-14.596	170.1	3.793	-3.358	24.9	-113.4	2.05	189.6	189.7	
	-15.160	168.8	3.603	-3.356	-36.5	-104.7	3.00	180.1	206.5	
	-16.160	166.5	3.270	-3.295	-138.0	-100.7	11.36	163.4	236.4	
	-17.160	164.2	2.946	-3.166	-242.6	-110.8	19.97	147.3	266.3	
	-18.160	161.9	2.639	-2.959	-364.0	-134.3	29.97	131.9	296.2	
	-18.416	73.9	2.565	-2.892	-399.5	-142.4	32.88	155.3	163.6	
	-19.160	71.9	2.358	-2.665	-483.9	-85.9	39.83	142.8	168.1	
	-20.160	69.2	2.108	-2.311	-536.5	-21.4	44.16	127.7	174.1	
	-21.160	66.5	1.896	-1.942	-530.5	31.8	43.67	114.8	180.2	
	-22.160	63.8	1.719	-1.594	-476.0	75.9	39.18	104.1	186.2	
	-22.416	79.2	1.680	-1.512	-455.3	86.0	37.48	79.1	140.6	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	35.75	77.4	141.7	
	-22.660	78.6	1.644	-1.438	-434.3	85.8	40.65	77.4	141.7	
	-23.160	77.3	1.576	-1.277	-391.6	84.7	36.66	74.2	143.9	
	-24.160	74.8	1.462	-1.004	-308.9	80.2	28.92	68.9	148.4	
	-25.160	72.3	1.373	-0.793	-232.1	73.3	21.72	64.7	152.9	
	-26.160	69.7	1.302	-0.640	-162.7	65.3	15.23	61.3	157.4	
	-27.160	67.2	1.243	-0.537	-101.7	56.7	9.52	58.6	161.9	
	-28.160	64.7	1.193	-0.479	-49.4	48.1	4.62	56.2	166.3	
	-29.160	62.2	1.146	-0.458	-5.5	39.7	0.52	54.0	170.8	
	-30.160	59.7	1.100	-0.468	30.1	31.7	2.82	51.8	175.3	
	-31.160	57.1	1.052	-0.503	57.9	24.0	5.42	49.5	179.8	
	-32.160	54.6	0.999	-0.557	78.1	16.4	7.31	47.0	184.3	
	-33.160	52.1	0.940	-0.623	90.7	8.7	8.49	44.3	188.7	
	-34.160	49.6	0.874	-0.696	95.4	0.6	8.93	41.2	193.2	
	-35.160	47.1	0.801	-0.770	91.8	-8.2	8.59	37.7	197.7	

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support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-36.160	44.5	0.720	-0.837	78.7	-18.1	7.36	33.9	202.2	
	-37.160	42.0	0.634	-0.890	55.0	-29.5	5.15	29.8	206.7	
	-38.160	39.5	0.543	-0.919	19.1	-42.5	1.79	25.6	211.1	
	-38.370	39.0	0.524	-0.922	9.9	-45.5	0.92	24.7	212.1	
	-39.160	37.0	0.451	-0.916	-30.7	-57.4	2.87	21.2	215.6	
	-39.416	27.4	0.428	-0.908	-45.9	-61.5	4.30	51.8	408.8	
	-40.160	23.4	0.361	-0.870	-85.3	-44.8	7.98	43.8	411.5	
	-40.625	20.9	0.322	-0.835	-104.0	-35.9	9.74	39.0	413.2	
	-41.160	18.0	0.278	-0.788	-120.7	-26.9	11.30	33.7	415.1	
	-42.160	12.6	0.204	-0.685	-140.4	-13.1	13.15	24.8	418.7	
	-43.160	7.2	0.142	-0.572	-147.9	-2.2	13.84	17.1	422.3	
	-44.160	1.8	0.090	-0.457	-145.3	7.2	13.60	10.9	425.9	
	-44.495	0.0	0.075	-0.420	-142.3	10.3	13.32	9.1	427.1	
	-45.160	0.0	0.050	-0.348	-133.7	15.3	12.52	6.0	429.5	
	-46.160	0.0	0.020	-0.250	-116.0	19.4	10.86	2.4	433.1	
	-47.160	0.0	-0.001	-0.168	-95.8	20.5	8.97	0.0	436.7	
	-47.656	0.0	-0.008	-0.132	-85.7	20.3	8.02	0.0	438.5	
	-48.160	0.0	-0.014	-0.101	-75.6	19.6	7.08	0.0	443.0	
	-49.160	0.0	-0.021	-0.049	-57.1	17.4	5.34	0.0	452.0	
	-50.160	0.0	-0.024	-0.011	-41.1	14.6	3.84	0.0	461.0	
	-51.160	0.0	-0.024	0.016	-27.9	11.7	2.61	0.0	470.0	
	-52.160	0.0	-0.021	0.033	-17.7	8.9	1.65	0.0	479.0	
	-53.160	0.0	-0.017	0.044	-10.0	6.5	0.93	0.0	488.0	
	-54.160	0.0	-0.013	0.049	-4.4	4.7	0.41	0.0	497.0	
	-54.416	0.0	-0.011	0.050	-3.2	4.3	0.30	0.0	818.0	
	-55.160	0.0	-0.008	0.051	-1.0	1.9	0.09	0.0	852.4	
	-56.160	0.0	-0.003	0.052	0.0	0.2	0.00	0.0	898.6	
	-56.660	0.0	0.000	0.052	0.0	0.0	0.00	0.0	921.7	

*showing plastic

bending moment at support of footing concrete is reduced value

(12)perpendicular direction　6 step

support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	+4.840	0.0	-1.204	7.562	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-0.826	7.562	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-0.826	7.562	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.448	7.562	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.309	7.564	-5.9	-11.6	0.55	0.0	0.0	
	+1.840	25.2	1.066	7.575	-26.8	-31.9	2.51	0.0	0.0	
	+1.340	30.2	1.445	7.589	-46.1	-45.7	4.32	0.0	0.0	
442.0										
	+1.340	30.2	1.445	7.589	-46.1	396.3	4.32	0.0	0.0	
	+0.840	35.2	1.824	7.569	148.0	379.9	13.86	0.0	0.0	
	-0.160	45.2	2.570	7.310	508.7	339.7	47.62	0.0	0.0	
	-1.160	55.2	3.277	6.787	824.2	289.6	77.15	0.0	0.0	
	-1.660	60.1	3.608	6.438	961.9	260.8	90.04	0.0	0.0	
71.1										
	-1.660	60.1	3.608	6.438	961.9	331.9	90.04	0.0	0.0	
	-2.160	65.1	3.920	6.032	1120.1	300.5	104.84	0.0	0.0	
	-3.160	75.1	4.476	5.050	1386.4	230.4	129.77	0.0	0.0	
	-4.160	85.1	4.924	3.888	1577.6	150.3	147.67	0.0	0.0	
	-4.660	90.1	5.103	3.260	1641.9	106.5	153.69	0.0	0.0	
0.0										
	-4.660	90.1	5.103	3.260	1641.9	106.5	153.69	0.0	0.0	
	-5.160	95.1	5.250	2.611	1683.7	60.2	157.60	0.0	0.0	
	-5.160	95.1	5.250	2.611	1683.7	60.2	138.60	0.0	0.0	
	-5.346	59.3	5.296	2.395	1693.3	42.4	139.38	0.0	0.0	
	-6.160	68.0	5.452	1.444	1707.2	-9.5	140.52	0.0	0.0	
	-6.350	548356.3	5.478	1.221	1704.1	-22.6	140.27	0.0	0.0	
	-7.160	554458.2	5.539	0.281	1699.1	7.7	139.86	0.0	0.0	
	-7.416	554854.4	5.542	-0.016	1683.2	-133.3	138.55	0.0	0.0	
	-8.160	551736.9	5.510	-0.839	1531.4	-289.9	126.06	0.0	0.0	
	-9.160	538509.7	5.377	-1.782	1239.7	-306.3	102.05	0.0	0.0	
	-10.160	516641.3	5.161	-2.503	864.7	-412.6	71.17	0.0	0.0	
	-10.350	160.4	5.112	-2.610	776.3	-516.2	63.90	0.0	0.0	
	-11.160	170.7	4.886	-2.915	444.1	-650.4	36.56	0.0	0.0	
	-11.350	173.2	4.831	-2.947	390.7	-683.1	32.16	0.0	0.0	

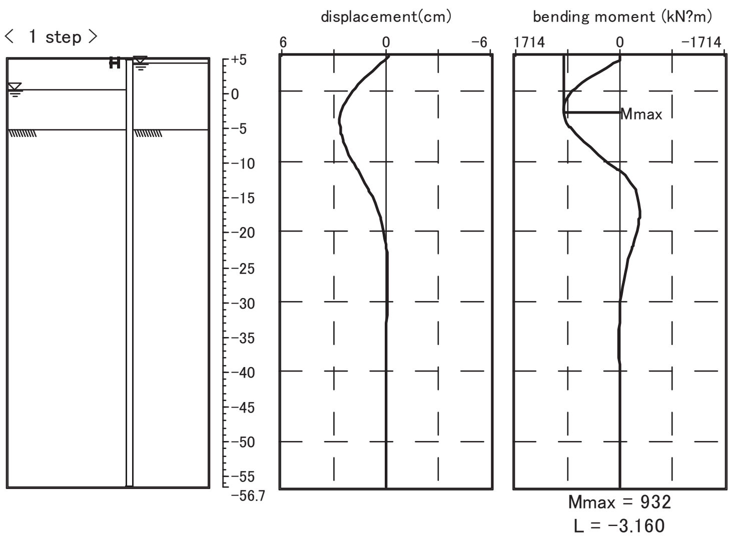
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
852.1										
	-11.350	173.2	4.831	-2.947	390.7	169.0	32.16	0.0	0.0	
	-11.416	171.0	4.811	-2.955	374.3	157.6	30.81	0.0	0.0	
	-12.160	180.0	4.587	-3.073	265.2	27.0	21.83	0.0	0.0	
	-12.850	188.3	4.371	-3.192	232.6	-100.0	19.15	0.0	0.0	
	-12.850	174.2	4.371	-3.192	232.6	-100.0	19.15	137.5	137.5	*
	-13.160	173.4	4.271	-3.238	200.0	-109.8	16.47	146.8	146.8	*
	-14.160	171.1	3.942	-3.336	82.2	-120.4	6.77	176.7	176.7	*
	-14.350	170.7	3.878	-3.345	59.5	-118.8	4.90	182.3	182.3	*
	-14.596	170.1	3.796	-3.353	30.7	-114.9	2.53	189.7	189.7	*
	-14.596	170.1	3.796	-3.353	30.7	-114.9	2.53	189.7	189.7	
	-15.160	168.8	3.607	-3.352	-31.4	-106.2	2.59	180.3	206.5	
	-16.160	166.5	3.274	-3.295	-134.3	-101.9	11.05	163.6	236.4	
	-17.160	164.2	2.950	-3.167	-240.0	-111.8	19.76	147.4	266.3	
	-18.160	161.9	2.643	-2.962	-362.5	-135.2	29.84	132.1	296.2	
	-18.416	73.9	2.568	-2.895	-398.1	-143.2	32.77	155.5	163.6	
	-19.160	71.9	2.361	-2.669	-483.1	-86.5	39.76	142.9	168.1	
	-20.160	69.2	2.111	-2.315	-536.3	-21.9	44.14	127.8	174.1	
	-21.160	66.5	1.898	-1.946	-530.6	31.4	43.68	114.9	180.2	
	-22.160	63.8	1.721	-1.598	-476.4	75.7	39.21	104.2	186.2	
	-22.416	79.2	1.681	-1.517	-455.7	85.8	37.51	79.2	140.6	
	-22.660	78.6	1.645	-1.442	-434.8	85.7	35.79	77.5	141.7	
	-22.660	78.6	1.645	-1.442	-434.8	85.7	40.70	77.5	141.7	
	-23.160	77.3	1.577	-1.281	-392.2	84.6	36.71	74.3	143.9	
	-24.160	74.8	1.463	-1.007	-309.6	80.1	28.98	68.9	148.4	
	-25.160	72.3	1.374	-0.796	-232.7	73.3	21.78	64.7	152.9	
	-26.160	69.7	1.302	-0.642	-163.3	65.3	15.29	61.3	157.4	
	-27.160	67.2	1.244	-0.539	-102.3	56.7	9.58	58.6	161.9	
	-28.160	64.7	1.193	-0.481	-49.9	48.1	4.67	56.2	166.3	
	-29.160	62.2	1.146	-0.459	-6.0	39.8	0.56	54.0	170.8	
	-30.160	59.7	1.100	-0.469	29.7	31.8	2.78	51.8	175.3	
	-31.160	57.1	1.052	-0.504	57.6	24.0	5.39	49.5	179.8	
	-32.160	54.6	0.999	-0.557	77.9	16.5	7.29	47.0	184.3	
	-33.160	52.1	0.940	-0.623	90.5	8.8	8.47	44.3	188.7	
	-34.160	49.6	0.874	-0.696	95.3	0.7	8.92	41.2	193.2	
	-35.160	47.1	0.801	-0.770	91.7	-8.2	8.58	37.7	197.7	

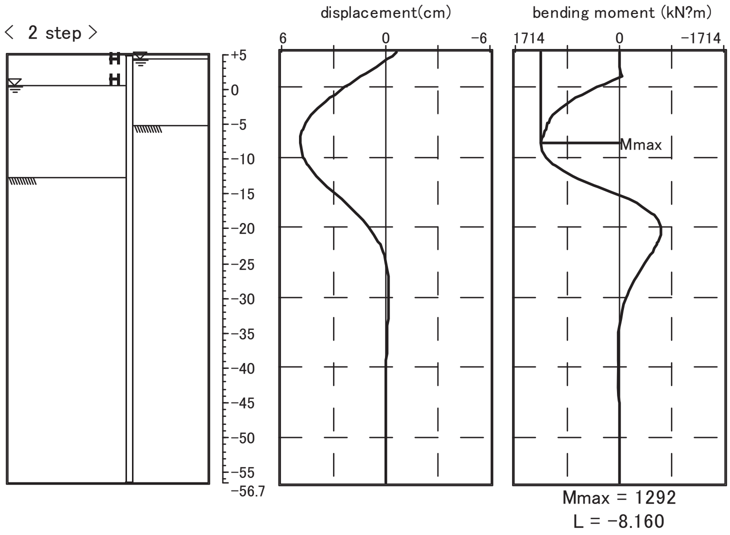
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-36.160	44.5	0.720	-0.837	78.6	-18.1	7.36	33.9	202.2	
	-37.160	42.0	0.634	-0.890	55.0	-29.5	5.14	29.8	206.7	
	-38.160	39.5	0.543	-0.919	19.1	-42.5	1.79	25.6	211.1	
	-38.370	39.0	0.524	-0.922	9.9	-45.5	0.92	24.7	212.1	
	-39.160	37.0	0.451	-0.916	-30.7	-57.3	2.87	21.2	215.6	
	-39.416	27.4	0.428	-0.908	-45.9	-61.4	4.30	51.8	408.8	
	-40.160	23.4	0.361	-0.869	-85.2	-44.8	7.98	43.8	411.5	
	-40.625	20.9	0.322	-0.835	-104.0	-35.9	9.73	39.0	413.2	
	-41.160	18.0	0.278	-0.788	-120.7	-26.9	11.30	33.7	415.1	
	-42.160	12.6	0.204	-0.685	-140.4	-13.1	13.14	24.8	418.7	
	-43.160	7.2	0.142	-0.572	-147.8	-2.2	13.84	17.1	422.3	
	-44.160	1.8	0.090	-0.457	-145.2	7.2	13.59	10.9	425.9	
	-44.495	0.0	0.075	-0.420	-142.3	10.3	13.32	9.1	427.1	
	-45.160	0.0	0.050	-0.348	-133.7	15.3	12.51	6.0	429.5	
	-46.160	0.0	0.020	-0.250	-116.0	19.4	10.86	2.4	433.1	
	-47.160	0.0	-0.001	-0.168	-95.8	20.5	8.97	0.0	436.7	
	-47.656	0.0	-0.008	-0.132	-85.7	20.3	8.02	0.0	438.5	
	-48.160	0.0	-0.014	-0.101	-75.6	19.6	7.08	0.0	443.0	
	-49.160	0.0	-0.021	-0.049	-57.1	17.4	5.34	0.0	452.0	
	-50.160	0.0	-0.024	-0.011	-41.0	14.6	3.84	0.0	461.0	
	-51.160	0.0	-0.024	0.016	-27.9	11.7	2.61	0.0	470.0	
	-52.160	0.0	-0.021	0.033	-17.7	8.9	1.65	0.0	479.0	
	-53.160	0.0	-0.017	0.044	-10.0	6.5	0.93	0.0	488.0	
	-54.160	0.0	-0.013	0.049	-4.4	4.7	0.41	0.0	497.0	
	-54.416	0.0	-0.011	0.050	-3.2	4.3	0.30	0.0	818.0	
	-55.160	0.0	-0.008	0.051	-1.0	1.9	0.09	0.0	852.4	
	-56.160	0.0	-0.003	0.052	0.0	0.2	0.00	0.0	898.6	
	-56.660	0.0	0.000	0.052	0.0	0.0	0.00	0.0	921.7	

*showing plastic
bending moment at support of footing concrete is reduced value

2.11 displacement / member force diagram

bridge axis direction

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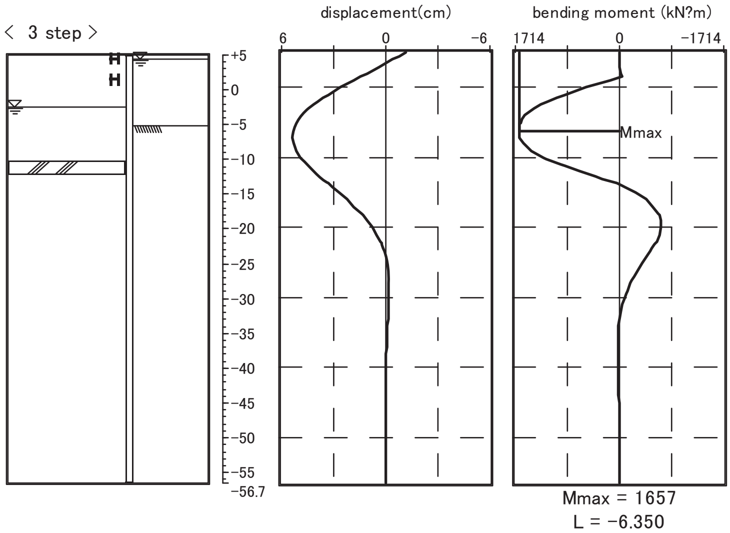
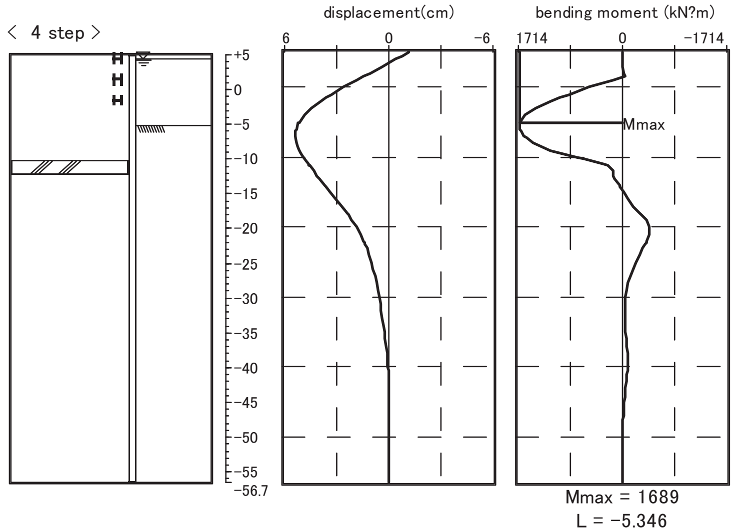
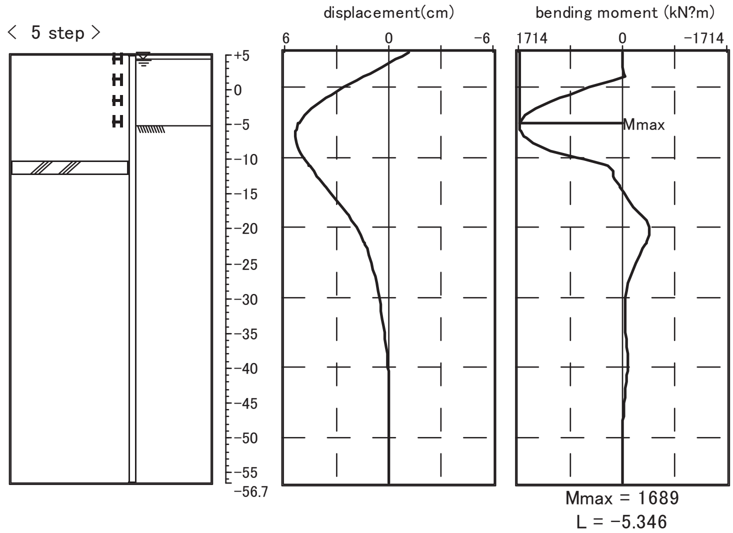
displacement(cm)
bending moment (kN?m)
6
0
−6
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
H
H
Mmax
Mmax = 1292
L = −8.160

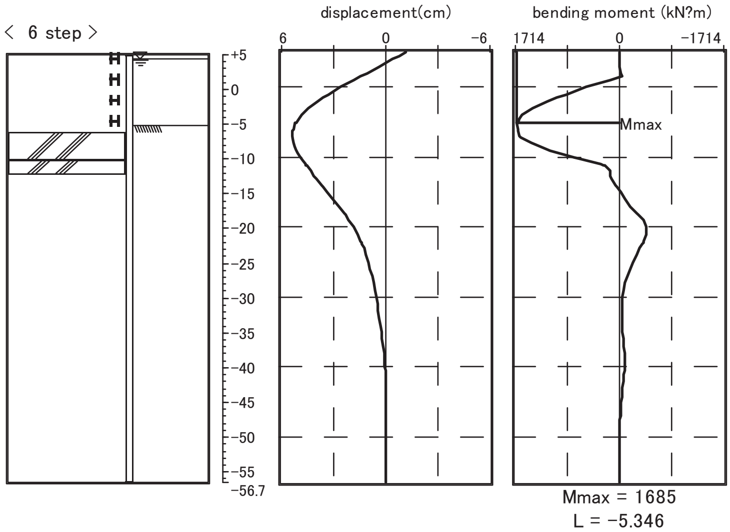

< 3 step >
displacement(cm)
bending moment (kN?m)
6
0
−6
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
H
H
Mmax
Mmax = 1657
L = −6.350



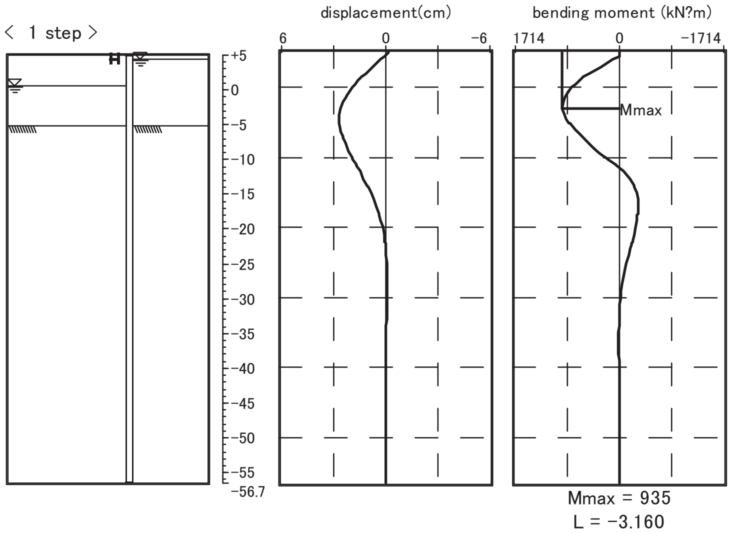
< 4 step >
displacement(cm)
6
0
−6
bending moment (kN?m)
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
Mmax
Mmax = 1689
L = −5.346

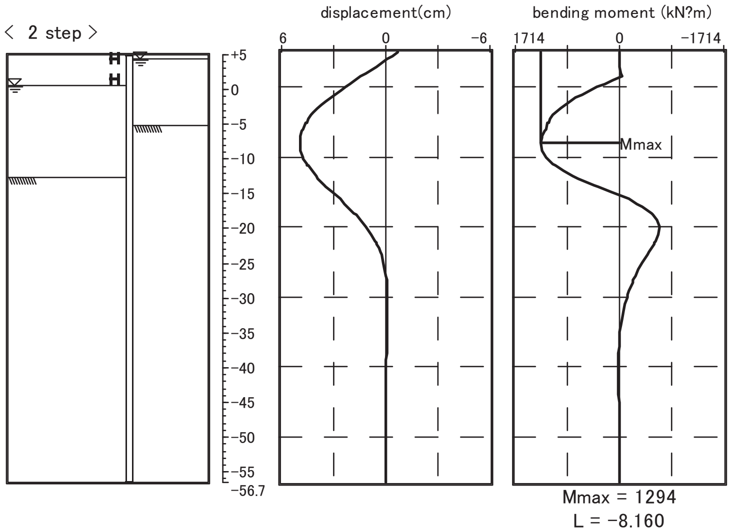


< 5 step >
displacement(cm)
6
0
−6
bending moment (kN?m)
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
Mmax
Mmax = 1689
L = −5.346

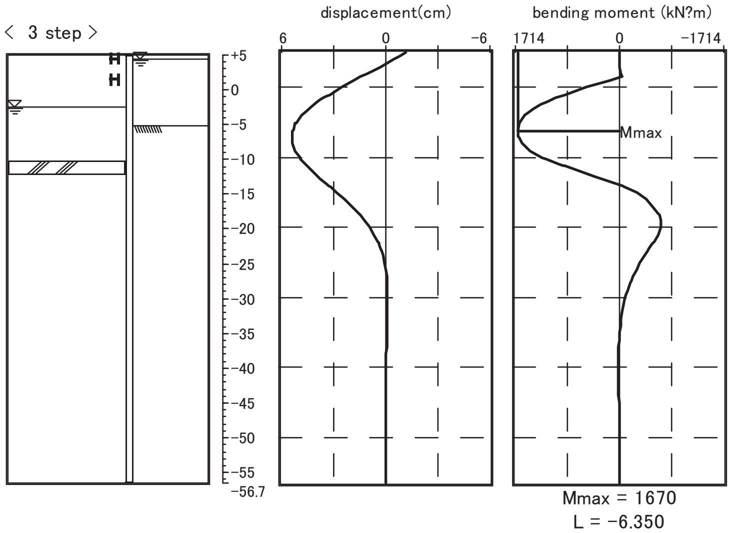


perpendicular direction

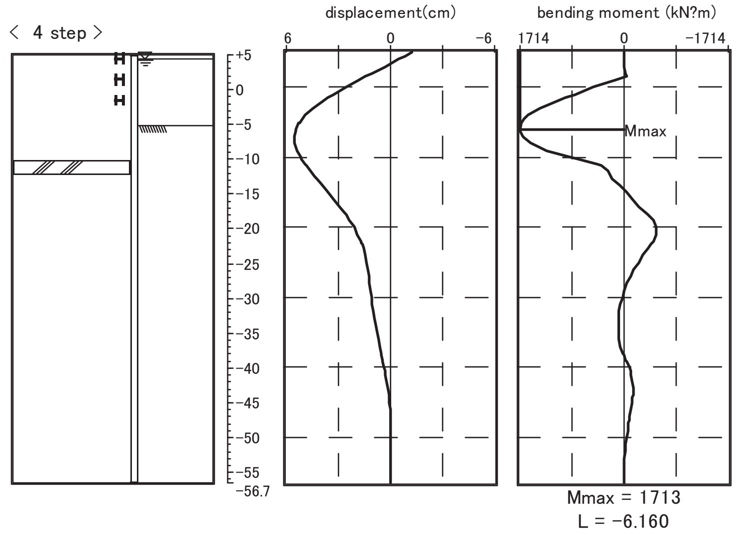




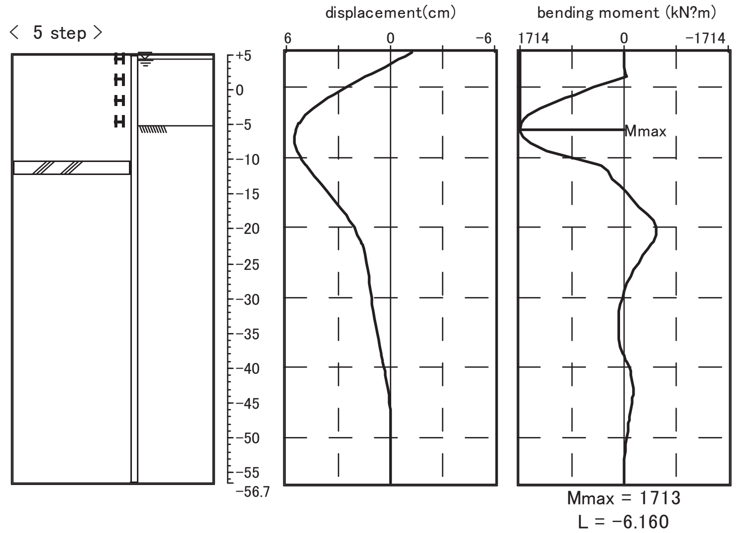
< 2 step >
displacement(cm)
bending moment (kN?m)
6
0
−6
1714
0
−1714
Mmax
Mmax = 1294
L = −8.160



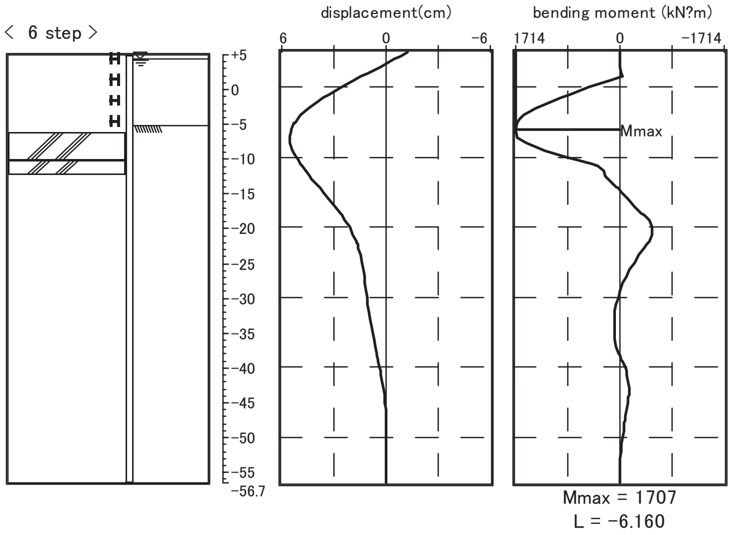
< 3 step >
displacement(cm)
bending moment (kN?m)
6
0
−6
1714
0
−1714
Mmax
Mmax = 1670
L = −6.350



< 4 step >
displacement(cm)
6
0
−6
bending moment (kN?m)
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
Mmax
Mmax = 1713
L = −6.160



< 5 step >
displacement(cm)
6
0
−6
bending moment (kN?m)
1714
0
−1714
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−55
−56.7
Mmax
Mmax = 1713
L = −6.160



2.12 check timbering

(1) section performance

1)bridge axis direction (linear)

**wailing

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

**strut

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

2)perpendicular direction (arc)

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
1	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
2	35.0	35.0	171.90	37.44	39800	2280	15.20	8.89
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55
4	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

(2) maximum timbering reaction Rmax (kN/m)

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
1	H-350*350*12*19	209.37	H-350*350*12*19	209.71
2	2H-350*350*12*19	234.18	2H-350*350*12*19	234.99

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
3	H-300*300*10*15	26.12	H-300*300*10*15	74.56
4	H-300*300*10*15	0.00	H-300*300*10*15	0.00

note)double timbering is 1/2 value

(3)arc part

1)check of ring buckling

about buckling of arc wailing, following equation to calculate allowable timbering reaction in considertaion of ring buckling safety is checked

$$Ra = \frac{2*E*Iy}{r^3} >= R1max$$

where, Ra : allowable timbering reaction (N/mm)

E : Young's modulus of wailing = 2.00 * 10^5(N/mm^2)

Iy : moment of inertia of wailing(mm^4)

r : radius of circular timbering (mm)

R1max : maximum timbering reaction (N/mm) ------ perpendicular direction(arc part)

row	section	r (cm)	Iy (cm^4)	Ra (kN/m)	R1max (kN/m)	judge
1	H-350*350*12*19	289.25	39800	6578.22	209.71	OK
2	2H-350*350*12*19	289.25	39800	6578.22	234.99	OK
3	H-300*300*10*15	291.75	20200	3253.60	74.56	OK
4	H-300*300*10*15	291.75	20200	3253.60	0.00	OK

2)wailing stress check

arc wailing may be calculated as an axial compression member under uniformly distributed pressure
Acutually, irregular shape of timbering and precision to cast steel pipe sheet pile (actual observation, radius in oval part about 1 to 2%), because imbalanced pressure induced moment is observed,
for safety, following procedure is taken to consider influence of ovalization in principle
stress working at wailing is given by the following equation.

$$Sig.s = \frac{N}{A} + \frac{M1 + M2}{Z} <= Sig.sa$$

where, Sig.s : stress of wailing(N/mm^2)

Sig.sa : allowable stress of wailing (N/mm^2)

A : sectional area of wailing (mm^2)

Z : section coefficient of wailing (mm^3)

N : axial force (N) = R1max * r

R1max : maximum timbering reaction (N/mm)

r : radius of wailing (mm)

M1 : bending moment in consideration of ovalization (N.mm) = R1max * r^2* Del.

Del. : ovalization rate, 2% wailing radius is supposed to be standard.

M2 : support point bending moment in linear part (N.mm) = (R2max.L1^2) / 12

R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)

L1 : effective span in linear part of wailing (mm)

row	section	A (cm^2)	Z (cm^3)	R1max (kN/m)	R2max (kN/m)	r (cm)
1	H-350*350*12*19	171.90	2280	209.71	209.37	289.25
2	2H-350*350*12*19	171.90	2280	234.99	234.18	289.25
3	H-300*300*10*15	118.40	1350	74.56	26.12	291.75
4	H-300*300*10*15	118.40	1350	0.00	0.00	291.75

row	L1 (m)	N (kN)	M1 (kN.m)	M2 (kN.m)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	judge
1	2.700	606.6	35.1	127.2	106.46	210.00	OK
2	2.700	679.7	39.3	142.3	119.18	210.00	OK
3	2.700	217.5	12.7	15.9	39.53	210.00	OK
4	2.700	0.0	0.0	0.0	0.00	210.00	OK

(4)linear part

1)check of wailing

wailing in linear part is a member which receives both axial compressive force and bending moment together are supposed to be checked using the following equation

besides, as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy * \left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0 \quad --- \quad check1$$

$$Sig.c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} <= Sig.cal \quad --- \quad check2$$

where, Sig.c : compressive stress by axial force acting on check section (N/mm^2)

Sig.bcy : bending compressive stress by bending moment about strong axis (N/mm^2)

Sig.caz : about weak axis allowable axial direction compressive stress (N/mm^2)

$$\frac{L5}{rz} <= 18 : Sig.caz = 210.0$$

$$18 < \frac{L5}{rz} <= 92 : Sig.caz = 1.5*\left\{ 140.0 - 0.82\left(\frac{L5}{rz} - 18\right) \right\}$$

$$92 < \frac{L5}{rz} \quad : Sig.caz = \frac{1.5*1,200,000}{6700 + \left(\frac{L5}{rz}\right)^2}$$

L5 : about weak axis effective buckling length (mm)

rz : about weak axis section second radius (mm)

Sig.bagy : without considering local tbuckling, allowable bending compressive stress about strong axis (N/mm^2)

$$\frac{L2}{b} <= 4.5 \quad : Sig.bagy = 210.0$$

$$4.5 < \frac{L2}{b} <= 30 \quad : Sig.bagy = 1.5*\left\{ 140.0 - 2.4\left(\frac{L2}{b} - 4.5 \right) \right\}$$

L2 : distance between fixed flange (mm)

b : compressive flange width (mm)

Sig.cal : allowable stress for local buckling of protrusion under compressive force (N/mm^2)

(= 210.0 (N/mm^2))

Sig.eay : Euler buckling stress about strong axis(N/mm^2) = $\frac{1,200,000}{\left(\frac{L4}{ry}\right)^2}$

L4 : effective buckling length about strong axis (mm)

ry : section second radius about strong axis (mm)

a)stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0$$

N = R1max*r + Del.N

$$M = \frac{R2max*L1^2}{8}$$

$$sc = \frac{N}{A}, \qquad sbcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \qquad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, R1max : maximum timbering reaction (N/mm) perpendicular direction(arc part)

R2max : maximum timbering reaction (N/mm) bridge axis direction(linear part)

N : axial force (N)

L : maximum strut spacing (mm)

L' : brace setting length (mm)

L1 : effective buckling length (mm) = L - L'

L2 : distance between fixed flange (mm)

L4 : effective buckling length about strong axis (mm)

L5 : effective buckling length about weak axis (mm)

row	section	A (cm^2)	Z (cm^3)	r (cm)	L (m)	L' (m)	L1 (m)	L2 (m)	L4 (m)	L5 (m)
1	H-350*350*12*19	171.90	2280	289.25	4.000	1.300	2.700	2.700	2.700	2.700
2	2H-350*350*12*19	171.90	2280	289.25	4.000	1.300	2.700	2.700	2.700	2.700
3	H-300*300*10*15	118.40	1350	291.75	4.000	1.300	2.700	2.700	2.700	2.700
4	H-300*300*10*15	118.40	1350	291.75	4.000	1.300	2.700	2.700	2.700	2.700

row	L5/rz	Sig.caz (N/mm²)	L2/b	Sig.bagy (N/mm²)	L4/ry (m)	Sig.eay (N/mm²)
1	30.37	194.78	7.71	198.43	17.76	3803.13
2	30.37	194.78	7.71	198.43	17.76	3803.13
3	35.76	188.15	9.00	193.80	20.61	2824.86
4	35.76	188.15	9.00	193.80	20.61	2824.86

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	209.71	209.37	756.59	190.79	44.01	83.68
2	234.99	234.18	829.72	213.39	48.27	93.59
3	74.56	26.12	367.52	23.80	31.04	17.63
4	0.00	0.00	150.00	0.00	12.67	0.00

row	Alp.	Beta	Alp.+Beta	judgement
1	0.226	0.427	0.653	OK
2	0.248	0.478	0.726	OK
3	0.165	0.092	0.257	OK
4	0.067	0.000	0.067	OK

b)stability check2

$$\text{Sig..c} + \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}} \le \text{Sig.cal}$$

$$\text{Gam.} = \frac{\text{Sig.bcy}}{1 - \dfrac{\text{Sig.c}}{\text{Sig.eay}}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	44.01	83.68	3803.13	84.66	128.67	210.00	OK
2	48.27	93.59	3803.13	94.80	143.06	210.00	OK
3	31.04	17.63	2824.86	17.82	48.87	210.00	OK
4	12.67	0.00	2824.86	0.00	12.67	210.00	OK

c) check of shear stress

$$\text{Smax} = \frac{\text{R2max*L1}}{2}$$

$$\text{Tau.s} = \frac{\text{Smax}}{\text{Aw}} \le \text{Tau.sa}$$

where, Smax : maximum shear force (N)
Aw : web sectional area (mm²)
Tau.s : accrue shear stress (N/mm²)
Tau.sa : allowable shear stress (N/mm²)

row	R2max (kN/m)	L1 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	209.37	2.700	282.65	37.44	75.49	120.00	OK
2	234.18	2.700	316.14	37.44	84.44	120.00	OK
3	26.12	2.700	35.26	27.00	13.06	120.00	OK
4	0.00	2.700	0.00	27.00	0.00	120.00	OK

2) check of strut

strut is a member which receives both axial compression force and bending moment with wailing likewise check. vertical load working at strut is sume of strut dead weight+surcharge load (w = 5.0 kN/m) as axial force, it is supposed to add temperature stress(Del.N = 150 kN)

a) stability check1

$$\frac{Sig.c}{Sig.caz} + \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)} <= 1.0$$

$$N = R2max*L1 + Del.N$$

$$M = \frac{w*L3^2}{8}$$

$$Sig.c = \frac{N}{A}, \quad Sig.bcy = \frac{M}{Z}$$

$$Alp. = \frac{Sig.c}{Sig.caz}, \quad Beta = \frac{Sig.bcy}{Sig.bagy*\left(1 - \frac{Sig.c}{Sig.eay}\right)}$$

where, L1 : axial force sharing width of strut (mm)
L2 : distance between fixed flange (mm)
L3 : strut bending span (mm)
L4 : effective buckling length about strong axis (mm)
L5 : effective buckling length about weak axis (mm)

row	section	A (cm2)	Z (cm3)	L1 (m)	L2 (m)	L3 (m)	L4 (m)	L5 (m)
1	H-350*350*12*19	171.90	2280	4.000	2.835	5.435	5.435	2.835
2	2H-350*350*12*19	171.90	2280	4.000	2.835	5.435	5.435	2.835
3	H-300*300*10*15	118.40	1350	4.000	2.935	5.535	5.535	2.935
4	H-300*300*10*15	118.40	1350	4.000	2.935	5.535	5.535	2.935

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	31.89	192.92	8.10	197.04	35.76	938.58
2	31.89	192.92	8.10	197.04	35.76	938.58

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
3	38.87	184.32	9.78	190.98	42.25	672.18
4	38.87	184.32	9.78	190.98	42.25	672.18

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	209.71	209.37	987.48	18.46	57.45	8.10
2	234.99	234.18	1086.71	18.46	63.22	8.10
3	74.56	26.12	254.46	19.15	21.49	14.18
4	0.00	0.00	150.00	19.15	12.67	14.18

row	Alp.	Beta	Alp.+Beta	judgement
1	0.298	0.044	0.342	OK
2	0.328	0.044	0.372	OK
3	0.117	0.077	0.193	OK
4	0.069	0.076	0.144	OK

b)stability check2

$$Sig..c + \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}} <= Sig.cal$$

$$Gam. = \frac{Sig.bcy}{1 - \frac{Sig.c}{Sig.eay}}$$

row	Sig.c (N/mm2)	Sig.bcy (N/mm2)	Sig.eay (N/mm2)	Gam. (N/mm2)	Sig.c+Gam. (N/mm2)	Sig.cal (N/mm2)	judgement
1	57.45	8.10	938.58	8.63	66.07	210.00	OK
2	63.22	8.10	938.58	8.68	71.90	210.00	OK
3	21.49	14.18	672.18	14.65	36.14	210.00	OK
4	12.67	14.18	672.18	14.46	27.12	210.00	OK

c) check of shear stress

$$Smax = \frac{5.0*L3}{2}$$

$$Tau.s = \frac{Smax}{Aw} <= Tau.sa$$

row	L3 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	5.435	13.59	37.44	3.63	120.00	OK
2	5.435	13.59	37.44	3.63	120.00	OK
3	5.535	13.84	27.00	5.13	120.00	OK
4	5.535	13.84	27.00	5.13	120.00	OK

3)check of brace beam

brace beam is a member which receives only axial compression force from wailing and use the following equation are supposed to be checked

$$Sig.c = \frac{N}{A} <= Sig.caz$$

$$N = \frac{(L1 + L2)*R2max}{2*cosTheta}$$

where, L : brace length (mm)

L1 : brace setting length (mm)

L2 : strut spacing - 2 * brace span (mm)

Theta : brace setting angle (Deg.)

row	section	A (cm2)	Theta (Deg.)	L (m)	L1 (m)	L2 (m)
1	H-350*350*12*19	171.90	45.0	1.838	1.300	1.400
2	2H-350*350*12*19	171.90	45.0	1.838	1.300	1.400
3	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400
4	H-300*300*10*15	118.40	45.0	1.838	1.300	1.400

row	L/rz	R2max (kN/m)	N (kN)	Sig.c (N/mm2)	Sig.caz (N/mm2)	judgement
1	20.68	209.37	399.73	23.25	206.70	OK
2	20.68	234.18	447.09	26.01	206.70	OK
3	24.35	26.12	49.86	4.21	202.19	OK
4	24.35	0.00	0.00	0.00	202.19	OK

2.13 check of embedment length

current ground surface elevation -5.346 (m)
riverside water table elevation +4.340 (m)
steel pipe sheet pile length 61.500 (m)

(1)final excavation time (5 step)
observing strut elevation = -4.660 (m)
coffered landside excavation area elevation = -12.850 (m)
coffered landside water table elevation = -12.850 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	-4.660 -5.346	0.686	------- -------	0.00 0.00	90.00 96.86
2	-5.346 -7.416	2.070	------- -------	0.00 0.00	96.86 117.56
3	-7.416 -11.416	4.000	------- -------	5.61 17.88	117.56 157.56
4	-11.416 -12.850	1.434	------- -------	14.60 17.98	157.56 171.90
5	-12.850 -18.416	5.566	0.00 151.04	17.98 31.11	171.90 89.10
6	-18.416 -18.746	0.330	152.53 155.00	0.00 0.00	89.10 84.19
7	-18.746 -22.416	3.670	155.00 182.53	0.00 27.53	84.19 29.59
8	-22.416 -24.405	1.989	158.53 173.45	51.52 66.44	29.59 0.00

active earth pressure /water pressure Pa = 2440.5 (kN/m)
ya = 8.932 (m)
Ma = 21797 (kN.m/m)
passive earth pressure Pp = 1420.7 (kN/m)
yp = 15.343 (m)
Mp = 21797 (kN.m/m)
balanced depth Z = 11.555 (m) (elevation = -24.405 (m))
embedment length D = 13.866 (m) (elevation = -26.716 (m))

required sheet pile length L = 31.556 (m)

(2)before installation of the lower strut (4 step)
observing strut elevation = -1.660 (m)
coffered landside excavation area elevation = -12.850 (m)
coffered landside water table elevation = -12.850 (m)

layer No	elevation (m)	layer thickness (m)	passive side pressure (kN/m2)	active side pressure (kN/m2)	water pressure (kN/m2)
1	-1.660 -5.346	3.686	------- -------	0.00 0.00	60.00 96.86
2	-5.346 -7.416	2.070	------- -------	0.00 0.00	96.86 117.56
3	-7.416 -11.416	4.000	------- -------	5.61 17.88	117.56 157.56
4	-11.416 -12.850	1.434	------- -------	14.60 17.98	157.56 171.90
5	-12.850 -18.416	5.566	0.00 151.04	17.98 31.11	171.90 109.52
6	-18.416 -18.746	0.330	152.53 155.00	0.00 0.00	109.52 105.82
7	-18.746 -22.416	3.670	155.00 182.53	0.00 27.53	105.82 64.69
8	-22.416 -28.188	5.772	158.53 201.82	51.52 94.82	64.69 0.00

active earth pressure /water pressure Pa = 3295.6 (kN/m)
ya = 13.224 (m)
Ma = 43580 (kN.m/m)
passive earth pressure Pp = 2130.5 (kN/m)
yp = 20.456 (m)
Mp = 43580 (kN.m/m)
balanced depth Z = 15.338 (m) (elevation = -28.188 (m))
embedment length D = 18.406 (m) (elevation = -31.256 (m))
required sheet pile length L = 36.096 (m)

3 composite stress calculation

3.1 maximum stress table

(1)bridge axis direction

1) material :SKY400

Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Wind+Temp	-10.350	30.27	53.58	83.85	189.00
2	Ord+Collision(scour)	-10.350	43.42	53.58	96.99	210.00
3	Earthquake(scour)	-10.350	81.65	53.58	135.23	210.00

(2)perpendicular direction

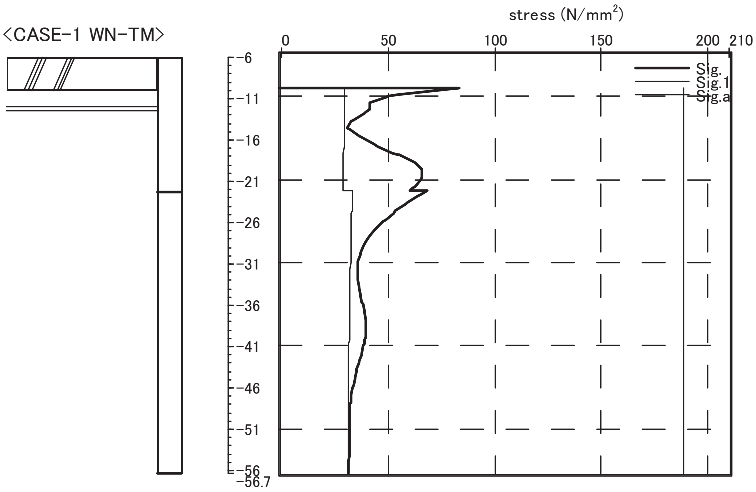
1) material :SKY400

Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Wind	-10.350	34.51	63.08	97.60	175.00
2	Ord+Collision(scour)	-10.350	52.02	63.08	115.10	210.00
3	Earthquake(scour)	-10.350	84.46	63.08	147.54	210.00

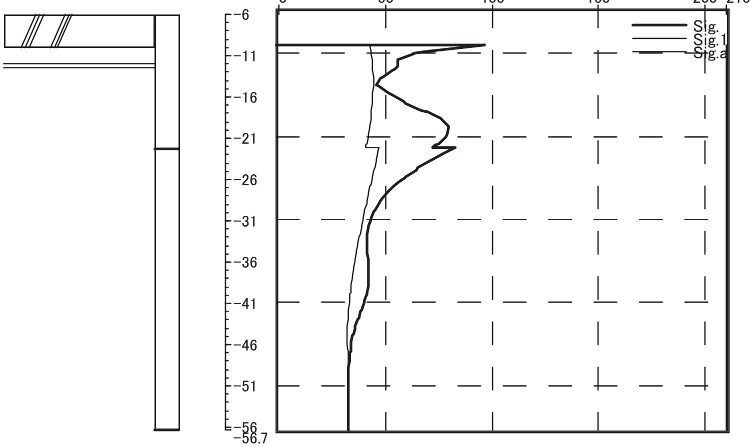
occurence location shows elevation
Sig.1 : stress after completion by design external force
Sig.2 : resultant stress(5 step)
Sig.max: composite stress
Sig.a : allowabe stress of steel pipe sheet pile

3.2 stress distribution diagram

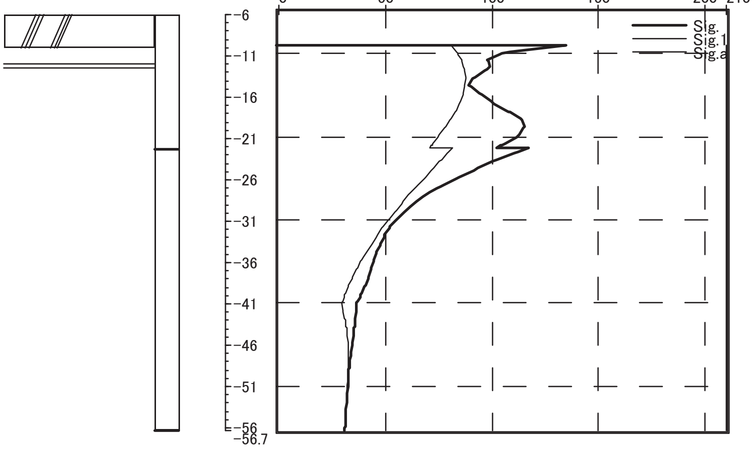
(1)bridge axis direction



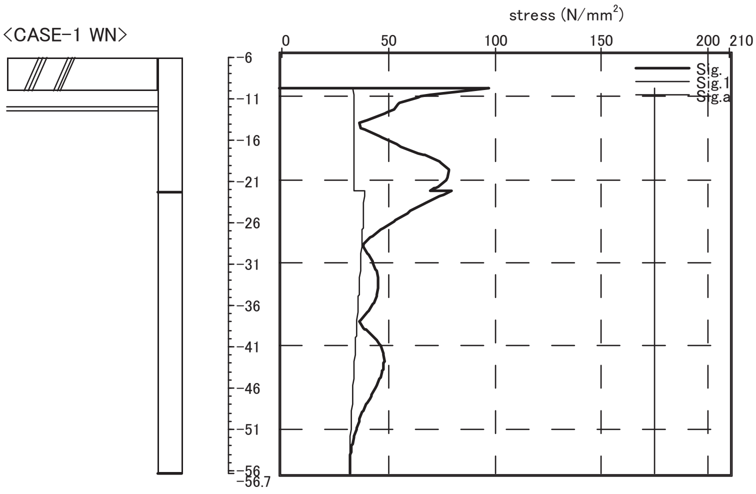
<CASE-2 OD-CL(SC)>

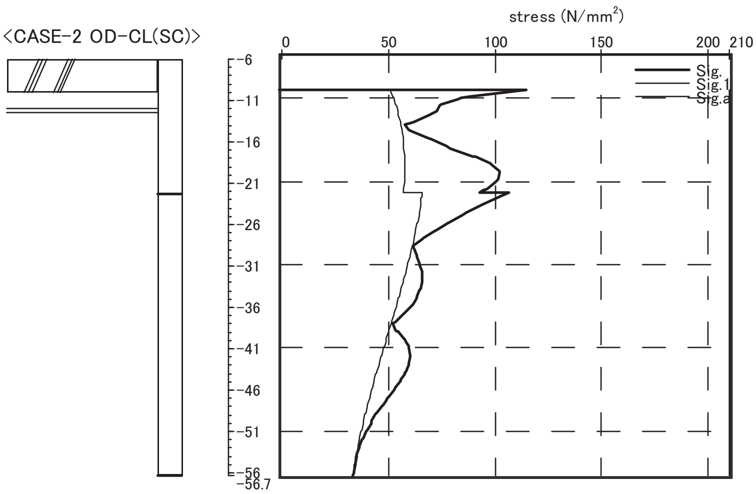


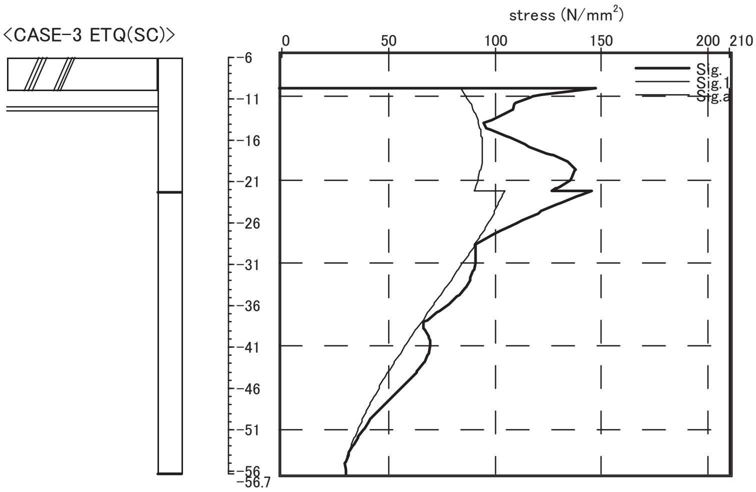
<CASE-3 ETQ(SC)>



(2)perpendicular direction







3.3 detail output

(1)bridge axis direction

1)Wind+Temp

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	30.27	53.58	83.85	**
-11.160	30.32	25.24	55.56	
-11.350	30.32	20.91	51.24	
-11.416	30.33	19.61	49.94	
-12.160	30.35	12.13	42.48	
-12.350	30.36	12.08	42.44	
-12.850	30.37	11.96	42.33	
-13.160	30.37	10.42	40.79	
-13.350	30.38	9.27	39.64	
-14.160	30.37	4.37	34.75	
-14.350	30.37	3.20	33.57	
-14.361	30.37	3.13	33.50	
-15.160	30.35	1.53	31.88	
-15.350	30.35	2.64	32.98	
-16.160	30.32	7.34	37.66	
-16.350	30.31	8.63	38.94	
-17.160	30.27	14.14	44.41	
-17.350	30.26	15.83	46.09	
-18.160	30.21	23.01	53.22	
-18.350	30.20	25.04	55.23	
-18.416	30.19	25.74	55.93	
-19.160	30.14	32.39	62.53	
-19.350	30.13	33.23	63.36	
-20.160	30.07	36.83	66.89	
-20.350	30.05	36.86	66.91	
-21.160	29.99	36.98	66.96	
-21.350	29.97	36.34	66.31	
-22.160	29.90	33.64	63.54	
-22.350	29.88	32.65	62.53	
-22.416	29.88	32.30	62.18	
-22.660	29.85	30.95	60.80	
-22.660	34.24	35.19	69.43	
-23.160	34.19	32.05	66.24	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-23.350	34.17	30.91	65.07	
-24.160	34.08	26.02	60.10	
-24.350	34.06	24.98	59.04	
-25.160	33.98	20.53	54.50	
-25.350	33.96	19.62	53.57	
-26.160	33.87	15.73	49.60	
-26.350	33.85	14.97	48.82	
-27.160	33.77	11.72	45.49	
-27.350	33.75	11.12	44.87	
-28.160	33.67	8.53	42.20	
-28.350	33.65	8.08	41.73	
-29.160	33.57	6.15	39.72	
-29.350	33.55	5.84	39.40	
-30.160	33.48	4.53	38.01	
-30.350	33.46	4.35	37.81	
-31.160	33.38	3.60	36.98	
-31.350	33.37	3.54	36.91	
-32.160	33.30	3.28	36.57	
-32.350	33.28	3.31	36.59	
-33.160	33.21	3.46	36.67	
-33.350	33.20	3.56	36.76	
-34.160	33.13	4.03	37.16	
-34.350	33.12	4.19	37.31	
-35.160	33.06	4.87	37.93	
-35.350	33.04	5.05	38.09	
-36.160	32.99	5.83	38.82	
-36.350	32.97	6.01	38.98	
-37.160	32.92	6.76	39.68	
-37.350	32.91	6.90	39.81	
-38.160	32.86	7.48	40.34	
-38.350	32.84	7.58	40.42	
-38.370	32.84	7.59	40.43	
-39.160	32.80	7.81	40.61	
-39.350	32.78	7.83	40.62	
-39.416	32.78	7.84	40.62	
-40.160	32.74	7.68	40.42	
-40.350	32.73	7.57	40.30	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-40.625	32.72	7.42	40.13	
-41.160	32.69	7.00	39.70	
-41.350	32.68	6.82	39.50	
-42.160	32.65	6.02	38.67	
-42.350	32.65	5.81	38.45	
-43.160	32.62	4.91	37.53	
-43.350	32.61	4.71	37.32	
-44.160	32.62	3.82	36.44	
-44.350	32.62	3.62	36.24	
-44.495	32.62	3.47	36.09	
-45.160	32.63	2.82	35.45	
-45.350	32.64	2.66	35.29	
-46.160	32.65	1.96	34.61	
-46.350	32.65	1.83	34.48	
-47.160	32.66	1.26	33.92	
-47.350	32.66	1.16	33.82	
-47.656	32.66	0.98	33.64	
-48.160	32.67	0.73	33.39	
-48.350	32.67	0.65	33.32	
-49.160	32.67	0.34	33.01	
-49.350	32.67	0.29	32.96	
-50.160	32.67	0.08	32.75	
-50.350	32.67	0.08	32.75	
-51.160	32.67	0.07	32.74	
-51.350	32.67	0.08	32.75	
-52.160	32.67	0.14	32.81	
-52.350	32.67	0.14	32.81	
-53.160	32.66	0.15	32.81	
-53.350	32.66	0.14	32.80	
-54.160	32.66	0.12	32.77	
-54.350	32.66	0.11	32.76	
-54.416	32.66	0.10	32.76	
-55.160	32.65	0.06	32.71	
-55.350	32.65	0.05	32.70	
-56.160	32.65	0.01	32.66	
-56.350	32.65	0.01	32.65	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	32.65	0.00	32.65	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

2)Ord+Collision(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	43.42	53.58	96.99	**
-11.160	44.02	25.24	69.26	
-11.350	44.16	20.91	65.07	
-11.416	44.20	19.61	63.81	
-12.160	44.64	12.13	56.77	
-12.350	44.76	12.08	56.84	
-12.850	44.97	11.96	56.93	
-13.160	45.07	10.42	55.48	
-13.350	45.13	9.27	54.40	
-14.160	45.27	4.37	49.64	
-14.350	45.30	3.20	48.50	
-14.361	45.30	3.13	48.43	
-15.160	45.30	1.53	46.83	
-15.350	45.30	2.64	47.93	
-16.160	45.17	7.34	52.51	
-16.350	45.15	8.63	53.78	
-17.160	44.92	14.14	59.06	
-17.350	44.86	15.83	60.69	
-18.160	44.54	23.01	67.55	
-18.350	44.47	25.04	69.50	
-18.416	44.44	25.74	70.18	
-19.160	44.07	32.39	76.45	
-19.350	43.97	33.23	77.20	
-20.160	43.50	36.83	80.33	
-20.350	43.39	36.86	80.24	
-21.160	42.86	36.98	79.83	
-21.350	42.73	36.34	79.08	
-22.160	42.15	33.64	75.79	
-22.350	42.02	32.65	74.67	
-22.416	41.97	32.30	74.27	
-22.660	41.79	30.95	72.74	
-22.660	48.02	35.19	83.21	
-23.160	47.59	32.05	79.64	
-23.350	47.42	30.91	78.33	
-24.160	46.70	26.02	72.73	
-24.350	46.54	24.98	71.51	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	45.81	20.53	66.34	
-25.350	45.64	19.62	65.25	
-26.160	44.91	15.73	60.64	
-26.350	44.74	14.97	59.71	
-27.160	44.01	11.72	55.74	
-27.350	43.84	11.12	54.96	
-28.160	43.13	8.53	51.66	
-28.350	42.96	8.08	51.04	
-29.160	42.26	6.15	48.41	
-29.350	42.10	5.84	47.94	
-30.160	41.41	4.53	45.94	
-30.350	41.25	4.35	45.61	
-31.160	40.59	3.60	44.19	
-31.350	40.44	3.54	43.98	
-32.160	39.80	3.28	43.08	
-32.350	39.65	3.31	42.96	
-33.160	39.04	3.46	42.50	
-33.350	38.90	3.56	42.46	
-34.160	38.31	4.03	42.34	
-34.350	38.17	4.19	42.36	
-35.160	37.62	4.87	42.48	
-35.350	37.48	5.05	42.53	
-36.160	36.95	5.83	42.78	
-36.350	36.83	6.01	42.84	
-37.160	36.32	6.76	43.09	
-37.350	36.20	6.90	43.10	
-38.160	35.72	7.48	43.21	
-38.350	35.61	7.58	43.19	
-38.370	35.60	7.59	43.19	
-39.160	35.16	7.81	42.97	
-39.350	35.05	7.83	42.88	
-39.416	35.01	7.84	42.85	
-40.160	34.63	7.68	42.31	
-40.350	34.54	7.57	42.11	
-40.625	34.41	7.42	41.83	
-41.160	34.18	7.00	41.18	
-41.350	34.09	6.82	40.91	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	33.79	6.02	39.81	
-42.350	33.72	5.81	39.53	
-43.160	33.47	4.91	38.38	
-43.350	33.41	4.71	38.11	
-44.160	33.20	3.82	37.02	
-44.350	33.15	3.62	36.77	
-44.495	33.14	3.47	36.61	
-45.160	33.11	2.82	35.93	
-45.350	33.10	2.66	35.76	
-46.160	33.23	1.96	35.19	
-46.350	33.26	1.83	35.09	
-47.160	33.35	1.26	34.62	
-47.350	33.38	1.16	34.53	
-47.656	33.40	0.98	34.38	
-48.160	33.44	0.73	34.17	
-48.350	33.46	0.65	34.11	
-49.160	33.50	0.34	33.84	
-49.350	33.51	0.29	33.80	
-50.160	33.53	0.08	33.61	
-50.350	33.54	0.08	33.62	
-51.160	33.54	0.07	33.61	
-51.350	33.54	0.08	33.63	
-52.160	33.53	0.14	33.67	
-52.350	33.53	0.14	33.67	
-53.160	33.51	0.15	33.66	
-53.350	33.51	0.14	33.65	
-54.160	33.49	0.12	33.60	
-54.350	33.48	0.11	33.59	
-54.416	33.48	0.10	33.58	
-55.160	33.45	0.06	33.51	
-55.350	33.45	0.05	33.50	
-56.160	33.42	0.01	33.43	
-56.350	33.42	0.01	33.42	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	33.41	0.00	33.41	

*   :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

3)Earthquake(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	81.65	53.58	135.23	**
-11.160	83.93	25.24	109.17	
-11.350	84.46	20.91	105.38	
-11.416	84.65	19.61	104.26	
-12.160	86.32	12.13	98.45	
-12.350	86.75	12.08	98.83	
-12.850	87.51	11.96	99.47	
-13.160	87.83	10.42	98.25	
-13.350	88.03	9.27	97.30	
-14.160	88.36	4.37	92.74	
-14.350	88.44	3.20	91.64	
-14.361	88.43	3.13	91.56	
-15.160	88.16	1.53	89.69	
-15.350	88.09	2.64	90.73	
-16.160	87.29	7.34	94.63	
-16.350	87.11	8.63	95.74	
-17.160	85.88	14.14	100.02	
-17.350	85.59	15.83	101.41	
-18.160	84.00	23.01	107.01	
-18.350	83.63	25.04	108.66	
-18.416	83.49	25.74	109.22	
-19.160	81.73	32.39	114.12	
-19.350	81.29	33.23	114.52	
-20.160	79.12	36.83	115.95	
-20.350	78.62	36.86	115.47	
-21.160	76.25	36.98	113.23	
-21.350	75.70	36.34	112.04	
-22.160	73.20	33.64	106.84	
-22.350	72.61	32.65	105.26	
-22.416	72.41	32.30	104.71	
-22.660	71.63	30.95	102.58	
-22.660	82.51	35.19	117.70	
-23.160	80.67	32.05	112.72	
-23.350	79.97	30.91	110.88	
-24.160	76.97	26.02	102.99	
-24.350	76.26	24.98	101.24	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	73.27	20.53	93.79	
-25.350	72.56	19.62	92.18	
-26.160	69.61	15.73	85.34	
-26.350	68.91	14.97	83.88	
-27.160	66.02	11.72	77.74	
-27.350	65.34	11.12	76.46	
-28.160	62.54	8.53	71.07	
-28.350	61.88	8.08	69.96	
-29.160	59.17	6.15	65.33	
-29.350	58.54	5.84	64.38	
-30.160	55.95	4.53	60.48	
-30.350	55.34	4.35	59.69	
-31.160	52.87	3.60	56.47	
-31.350	52.29	3.54	55.83	
-32.160	49.95	3.28	53.23	
-32.350	49.40	3.31	52.71	
-33.160	47.19	3.46	50.65	
-33.350	46.68	3.56	50.24	
-34.160	44.60	4.03	48.62	
-34.350	44.11	4.19	48.30	
-35.160	42.16	4.87	47.03	
-35.350	41.70	5.05	46.75	
-36.160	39.88	5.83	45.71	
-36.350	39.45	6.01	45.46	
-37.160	37.75	6.76	44.51	
-37.350	37.35	6.90	44.25	
-38.160	35.76	7.48	43.24	
-38.350	35.39	7.58	42.97	
-38.370	35.35	7.59	42.94	
-39.160	33.91	7.81	41.72	
-39.350	33.56	7.83	41.39	
-39.416	33.44	7.84	41.28	
-40.160	32.24	7.68	39.92	
-40.350	31.94	7.57	39.51	
-40.625	31.57	7.42	38.99	
-41.160	30.85	7.00	37.86	
-41.350	30.60	6.82	37.42	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	31.23	6.02	37.24	
-42.350	31.37	5.81	37.18	
-43.160	32.05	4.91	36.96	
-43.350	32.21	4.71	36.91	
-44.160	32.71	3.82	36.53	
-44.350	32.83	3.62	36.45	
-44.495	32.89	3.47	36.37	
-45.160	33.18	2.82	36.01	
-45.350	33.27	2.66	35.93	
-46.160	33.49	1.96	35.46	
-46.350	33.55	1.83	35.38	
-47.160	33.66	1.26	34.92	
-47.350	33.69	1.16	34.84	
-47.656	33.69	0.98	34.67	
-48.160	33.71	0.73	34.43	
-48.350	33.71	0.65	34.37	
-49.160	33.66	0.34	33.99	
-49.350	33.64	0.29	33.93	
-50.160	33.53	0.08	33.61	
-50.350	33.50	0.08	33.58	
-51.160	33.34	0.07	33.41	
-51.350	33.30	0.08	33.38	
-52.160	33.10	0.14	33.24	
-52.350	33.06	0.14	33.20	
-53.160	32.85	0.15	32.99	
-53.350	32.80	0.14	32.94	
-54.160	32.58	0.12	32.69	
-54.350	32.52	0.11	32.63	
-54.416	32.51	0.10	32.61	
-55.160	32.31	0.06	32.37	
-55.350	32.26	0.05	32.32	
-56.160	32.09	0.01	32.10	
-56.350	32.06	0.01	32.06	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	32.01	0.00	32.01	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

(2)perpendicular direction

1)Wind

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	34.51	63.08	97.60	**
-11.160	34.65	35.71	70.36	
-11.350	34.68	31.31	66.00	
-11.416	34.70	29.96	64.66	
-12.160	34.81	21.04	55.84	
-12.350	34.83	20.32	55.16	
-12.850	34.90	18.44	53.34	
-13.160	34.93	15.80	50.73	
-13.350	34.95	13.98	48.93	
-14.160	35.01	6.23	41.24	
-14.350	35.03	4.38	39.41	
-14.596	35.04	2.05	37.09	
-15.160	35.07	3.00	38.07	
-15.350	35.08	4.59	39.67	
-16.160	35.10	11.36	46.46	
-16.350	35.10	12.99	48.10	
-17.160	35.10	19.97	55.07	
-17.350	35.10	21.87	56.96	
-18.160	35.07	29.97	65.04	
-18.350	35.07	32.13	67.20	
-18.416	35.07	32.88	67.95	
-19.160	35.03	39.83	74.86	
-19.350	35.02	40.65	75.67	
-20.160	34.95	44.16	79.11	
-20.350	34.94	44.07	79.01	
-21.160	34.86	43.67	78.52	
-21.350	34.84	42.81	77.65	
-22.160	34.74	39.18	73.92	
-22.350	34.72	37.92	72.63	
-22.416	34.71	37.48	72.18	
-22.660	34.68	35.75	70.43	
-22.660	39.82	40.65	80.47	
-23.160	39.74	36.66	76.40	
-23.350	39.71	35.19	74.89	
-24.160	39.57	28.92	68.48	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-24.350	39.53	27.55	67.08	
-25.160	39.38	21.72	61.10	
-25.350	39.35	20.49	59.84	
-26.160	39.19	15.23	54.42	
-26.350	39.15	14.15	53.29	
-27.160	38.98	9.52	48.50	
-27.350	38.94	8.59	47.53	
-28.160	38.76	4.62	43.39	
-28.350	38.72	3.84	42.57	
-29.160	38.54	0.52	39.06	
-29.350	38.50	0.96	39.45	
-30.160	38.31	2.82	41.13	
-30.350	38.27	3.31	41.58	
-31.160	38.07	5.42	43.50	
-31.350	38.03	5.78	43.81	
-32.160	37.83	7.31	45.14	
-32.350	37.79	7.54	45.32	
-33.160	37.59	8.49	46.08	
-33.350	37.54	8.57	46.12	
-34.160	37.34	8.93	46.27	
-34.350	37.29	8.87	46.16	
-35.160	37.09	8.59	45.68	
-35.350	37.04	8.36	45.40	
-36.160	36.84	7.36	44.20	
-36.350	36.79	6.94	43.73	
-37.160	36.59	5.15	41.73	
-37.350	36.54	4.51	41.05	
-38.160	36.33	1.79	38.12	
-38.350	36.29	1.00	37.29	
-38.370	36.28	0.92	37.20	
-39.160	36.08	2.87	38.96	
-39.350	36.04	3.93	39.97	
-39.416	36.02	4.30	40.32	
-40.160	35.83	7.98	43.81	
-40.350	35.79	8.70	44.48	
-40.625	35.72	9.74	45.45	
-41.160	35.59	11.30	46.89	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-41.350	35.54	11.65	47.19	
-42.160	35.34	13.15	48.49	
-42.350	35.30	13.28	48.57	
-43.160	35.10	13.84	48.95	
-43.350	35.06	13.80	48.86	
-44.160	34.87	13.60	48.47	
-44.350	34.83	13.44	48.27	
-44.495	34.80	13.32	48.12	
-45.160	34.65	12.52	47.16	
-45.350	34.61	12.20	46.81	
-46.160	34.43	10.86	45.29	
-46.350	34.39	10.50	44.89	
-47.160	34.22	8.97	43.19	
-47.350	34.18	8.61	42.79	
-47.656	34.12	8.02	42.14	
-48.160	34.02	7.08	41.10	
-48.350	33.98	6.75	40.73	
-49.160	33.83	5.34	39.17	
-49.350	33.79	5.06	38.85	
-50.160	33.64	3.84	37.48	
-50.350	33.61	3.61	37.22	
-51.160	33.47	2.61	36.08	
-51.350	33.43	2.43	35.87	
-52.160	33.30	1.65	34.96	
-52.350	33.27	1.52	34.79	
-53.160	33.15	0.93	34.08	
-53.350	33.12	0.83	33.95	
-54.160	33.00	0.41	33.41	
-54.350	32.98	0.33	33.31	
-54.416	32.97	0.30	33.27	
-55.160	32.88	0.09	32.97	
-55.350	32.85	0.07	32.93	
-56.160	32.78	0.00	32.78	
-56.350	32.76	0.00	32.76	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	32.73	0.00	32.73	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

2)Ord+Collision(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	52.02	63.08	115.10	**
-11.160	53.13	35.71	88.84	
-11.350	53.39	31.31	84.70	
-11.416	53.48	29.96	83.44	
-12.160	54.41	21.04	75.44	
-12.350	54.64	20.32	74.97	
-12.850	55.19	18.44	73.64	
-13.160	55.51	15.80	71.31	
-13.350	55.70	13.98	69.68	
-14.160	56.40	6.23	62.63	
-14.350	56.57	4.38	60.95	
-14.596	56.74	2.05	58.79	
-15.160	57.14	3.00	60.14	
-15.350	57.27	4.59	61.86	
-16.160	57.70	11.36	69.06	
-16.350	57.80	12.99	70.80	
-17.160	58.12	19.97	78.08	
-17.350	58.19	21.87	80.06	
-18.160	58.39	29.97	88.35	
-18.350	58.43	32.13	90.56	
-18.416	58.45	32.88	91.33	
-19.160	58.52	39.83	98.35	
-19.350	58.54	40.65	99.19	
-20.160	58.50	44.16	102.66	
-20.350	58.49	44.07	102.56	
-21.160	58.35	43.67	102.01	
-21.350	58.31	42.81	101.13	
-22.160	58.07	39.18	97.25	
-22.350	58.01	37.92	95.93	
-22.416	57.99	37.48	95.46	
-22.660	57.90	35.75	93.65	
-22.660	66.68	40.65	107.34	
-23.160	66.44	36.66	103.10	
-23.350	66.35	35.19	101.54	
-24.160	65.90	28.92	94.81	
-24.350	65.79	27.55	93.34	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	65.27	21.72	86.99	
-25.350	65.15	20.49	85.63	
-26.160	64.56	15.23	79.79	
-26.350	64.42	14.15	78.57	
-27.160	63.79	9.52	73.31	
-27.350	63.64	8.59	72.23	
-28.160	62.95	4.62	67.57	
-28.350	62.79	3.84	66.63	
-29.160	62.05	0.52	62.57	
-29.350	61.88	0.96	62.84	
-30.160	61.11	2.82	63.93	
-30.350	60.93	3.31	64.24	
-31.160	60.13	5.42	65.55	
-31.350	59.94	5.78	65.72	
-32.160	59.10	7.31	66.42	
-32.350	58.91	7.54	66.44	
-33.160	58.05	8.49	66.54	
-33.350	57.85	8.57	66.42	
-34.160	56.97	8.93	65.90	
-34.350	56.76	8.87	65.63	
-35.160	55.86	8.59	64.45	
-35.350	55.65	8.36	64.01	
-36.160	54.74	7.36	62.11	
-36.350	54.53	6.94	61.47	
-37.160	53.61	5.15	58.75	
-37.350	53.39	4.51	57.90	
-38.160	52.46	1.79	54.25	
-38.350	52.24	1.00	53.25	
-38.370	52.22	0.92	53.14	
-39.160	51.31	2.87	54.18	
-39.350	51.09	3.93	55.02	
-39.416	51.01	4.30	55.31	
-40.160	50.15	7.98	58.13	
-40.350	49.93	8.70	58.62	
-40.625	49.61	9.74	59.34	
-41.160	48.99	11.30	60.29	
-41.350	48.76	11.65	60.42	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	47.83	13.15	60.97	
-42.350	47.61	13.28	60.89	
-43.160	46.68	13.84	60.52	
-43.350	46.46	13.80	60.26	
-44.160	45.55	13.60	59.14	
-44.350	45.33	13.44	58.77	
-44.495	45.17	13.32	58.49	
-45.160	44.43	12.52	56.95	
-45.350	44.22	12.20	56.42	
-46.160	43.35	10.86	54.21	
-46.350	43.14	10.50	53.64	
-47.160	42.29	8.97	51.26	
-47.350	42.09	8.61	50.69	
-47.656	41.78	8.02	49.80	
-48.160	41.26	7.08	48.34	
-48.350	41.07	6.75	47.82	
-49.160	40.27	5.34	45.61	
-49.350	40.09	5.06	45.14	
-50.160	39.32	3.84	43.16	
-50.350	39.14	3.61	42.75	
-51.160	38.41	2.61	41.03	
-51.350	38.24	2.43	40.67	
-52.160	37.55	1.65	39.21	
-52.350	37.39	1.52	38.91	
-53.160	36.74	0.93	37.67	
-53.350	36.58	0.83	37.42	
-54.160	35.97	0.41	36.38	
-54.350	35.83	0.33	36.16	
-54.416	35.78	0.30	36.09	
-55.160	35.29	0.09	35.38	
-55.350	35.17	0.07	35.24	
-56.160	34.76	0.00	34.76	
-56.350	34.66	0.00	34.66	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	34.54	0.00	34.54	

* :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

3)Earthquake(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-10.350	84.46	63.08	147.54	**
-11.160	86.59	35.71	122.30	
-11.350	87.09	31.31	118.41	
-11.416	87.27	29.96	117.23	
-12.160	89.03	21.04	110.07	
-12.350	89.48	20.32	109.81	
-12.850	90.49	18.44	108.94	
-13.160	91.05	15.80	106.85	
-13.350	91.39	13.98	105.37	
-14.160	92.56	6.23	98.79	
-14.350	92.84	4.38	97.22	
-14.596	93.09	2.05	95.14	
-15.160	93.68	3.00	96.68	
-15.350	93.87	4.59	98.46	
-16.160	94.40	11.36	105.76	
-16.350	94.52	12.99	107.52	
-17.160	94.76	19.97	114.73	
-17.350	94.82	21.87	116.69	
-18.160	94.80	29.97	124.76	
-18.350	94.79	32.13	126.92	
-18.416	94.78	32.88	127.66	
-19.160	94.51	39.83	134.34	
-19.350	94.44	40.65	135.10	
-20.160	93.90	44.16	138.06	
-20.350	93.77	44.07	137.84	
-21.160	92.99	43.67	136.65	
-21.350	92.80	42.81	135.62	
-22.160	91.81	39.18	130.99	
-22.350	91.57	37.92	129.49	
-22.416	91.48	37.48	128.96	
-22.660	91.14	35.75	126.89	
-22.660	105.18	40.65	145.83	
-23.160	104.33	36.66	140.99	
-23.350	104.01	35.19	139.19	
-24.160	102.50	28.92	131.42	
-24.350	102.15	27.55	129.70	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.160	100.51	21.72	122.23	
-25.350	100.13	20.49	120.62	
-26.160	98.38	15.23	113.61	
-26.350	97.96	14.15	112.11	
-27.160	96.11	9.52	105.63	
-27.350	95.68	8.59	104.27	
-28.160	93.74	4.62	98.36	
-28.350	93.28	3.84	97.12	
-29.160	91.27	0.52	91.79	
-29.350	90.80	0.96	91.75	
-30.160	88.72	2.82	91.54	
-30.350	88.24	3.31	91.55	
-31.160	86.12	5.42	91.54	
-31.350	85.62	5.78	91.40	
-32.160	83.46	7.31	90.77	
-32.350	82.95	7.54	90.49	
-33.160	80.77	8.49	89.26	
-33.350	80.25	8.57	88.83	
-34.160	78.05	8.93	86.98	
-34.350	77.53	8.87	86.40	
-35.160	75.31	8.59	83.90	
-35.350	74.79	8.36	83.14	
-36.160	72.56	7.36	79.93	
-36.350	72.04	6.94	78.98	
-37.160	69.81	5.15	74.96	
-37.350	69.29	4.51	73.80	
-38.160	67.07	1.79	68.86	
-38.350	66.55	1.00	67.56	
-38.370	66.50	0.92	67.42	
-39.160	64.34	2.87	67.22	
-39.350	63.82	3.93	67.75	
-39.416	63.64	4.30	67.94	
-40.160	61.64	7.98	69.62	
-40.350	61.13	8.70	69.83	
-40.625	60.40	9.74	70.14	
-41.160	58.99	11.30	70.29	
-41.350	58.49	11.65	70.14	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	56.41	13.15	69.55	
-42.350	55.92	13.28	69.20	
-43.160	53.90	13.84	67.74	
-43.350	53.42	13.80	67.22	
-44.160	51.47	13.60	65.06	
-44.350	51.01	13.44	64.45	
-44.495	50.67	13.32	63.99	
-45.160	49.12	12.52	61.64	
-45.350	48.68	12.20	60.88	
-46.160	46.87	10.86	57.73	
-46.350	46.44	10.50	56.94	
-47.160	44.70	8.97	53.67	
-47.350	44.30	8.61	52.90	
-47.656	43.67	8.02	51.69	
-48.160	42.64	7.08	49.72	
-48.350	42.25	6.75	49.00	
-49.160	40.67	5.34	46.01	
-49.350	40.30	5.06	45.35	
-50.160	38.80	3.84	42.64	
-50.350	38.44	3.61	42.05	
-51.160	37.02	2.61	39.64	
-51.350	36.69	2.43	39.12	
-52.160	35.35	1.65	37.00	
-52.350	35.03	1.52	36.55	
-53.160	33.77	0.93	34.71	
-53.350	33.48	0.83	34.31	
-54.160	32.29	0.41	32.70	
-54.350	32.02	0.33	32.35	
-54.416	31.92	0.30	32.23	
-55.160	30.97	0.09	31.06	
-55.350	30.73	0.07	30.80	
-56.160	31.11	0.00	31.12	
-56.350	31.20	0.00	31.21	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-56.660	31.47	0.00	31.47	

*   :location unable to weld in site
** :SKY400 maximum stress accrue location
*** :SKY490 maximum stress accrue location

4 member calculation

4.1 calculation of pile cap

4.1.1 design condition

(1) calculation method : cantilever
(2) concrete design standard strength : Sig.ck = 24 (N/mm²)
(3) rebar in use : SD345(underwater member)
(4) shape dimension
pile cap thickness h = 4.000 (m)
center spacing of steel pipe sheet piles a = 1.4478 (m) (bridge axis direction)
1.4310 (m) (perpendicular direction)
(5) dead weight of pile cap and surcharge load
1)bridge axis direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m²)
1	WN-TM	-6.350	4.990	58.00
2	OD-CL(SC)	-6.350	3.180	58.00
3	ETQ(SC)	-6.350	0.290	58.00

2)perpendicular direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m²)
1	WN	-6.350	4.990	58.00
2	OD-CL(SC)	-6.350	3.180	58.00
3	ETQ(SC)	-6.350	0.290	58.00

note: backfilling soil height , water table height is shown in elevation(crest of pile cap elevation = -6.350m)

4.1.2 external working force

pile cap is designed for external working force at bottom of pile cap

besides, in estimating vertical load, dead weight of pile cap upto celler part internal periphery and surcharge load are considered

(1) area of pile cap(let internal periphery sheet pile)

oval: $A1 = B^2 = PI /4 + B * (L-B)$

$= 6.135^2 * Pai/4 + 6.135*(17.717 - 6.135) = 100.620\ (m^2)$

(2)area of backfilling soil

$A2 = A1 - Ap = 63.550\ (m^2)$

where, Ap:leg column cross sectional area = 37.07 (m^2)

(3)working force at leg column bottom

1)bridge axis direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	WN-TM	46500.0	300.0	5600.0	1200.0	6800.0
2	OD-CL(SC)	46500.0	3800.0	39300.0	15200.0	54500.0
3	ETQ(SC)	41300.0	11700.0	153600.0	46800.0	200400.0

2)perpendicular direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	WN	46500.0	1000.0	24800.0	4000.0	28800.0
2	OD-CL(SC)	46500.0	7500.0	80600.0	30000.0	110600.0
3	ETQ(SC)	41300.0	13100.0	219800.0	52400.0	272200.0

(4) pile cap, backfilling soil

V1 = A1*{ h1*Gam.c + h2*(Gam.c - Gam.w) }

V2 = A2*{ h1'*Gam.t + h2'*(Gam.sat - Gam.w) }

V3 = Ap*hw*Gam.w

where, V1 : weight of pile cap (kN)

V2 : weight of backfilling soil (kN)

V3 : buoyancy working at column (kN)

h1 : pile cap thickness upper than water table(m)

h2 : pile cap thickness lower than water table(m)

h1' : backfilling soil thickness upper than water table(m)

h2' : backfilling soil thickness lower than water table(m)

Gam.c : pile cap concrete unit weight = 24.5 (kN/m^3)

Gam.w : unit weight of water =10.00 (kN/m^3)

Gam.t : unit weight of backfilling soil(wet) = 17.5 (kN/m^3)

Gam.sat: unit weight of backfilling soil(saturated) = 17.5 (kN/m^3)

hw : water table (m)(height from crest of pile cap)

h' : backfilling soil thickness (m)

H1 : pile cap and filling concrete inertia force (kN)

y : pile cap inertia force working gravity location height (m)

1)bridge axis direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	WN-TM	11.340	0.000	5835.98	0.00	4203.74	1632.24
2	OD-CL(SC)	9.530	0.000	5835.98	0.00	3532.77	2303.21
3	ETQ(SC)	6.640	0.000	5835.98	0.00	2461.45	3374.53

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	WN-TM	0.00	0.000	0.00
2	OD-CL(SC)	0.00	0.000	0.00
3	ETQ(SC)	168.28	3.920	659.65

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	WN	11.340	0.000	5835.98	0.00	4203.74	1632.24
2	OD-CL(SC)	9.530	0.000	5835.98	0.00	3532.77	2303.21
3	ETQ(SC)	6.640	0.000	5835.98	0.00	2461.45	3374.53

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	WN	0.00	0.000	0.00
2	OD-CL(SC)	0.00	0.000	0.00
3	ETQ(SC)	168.28	3.920	659.65

(5)external force sum up

Vo = V + V1 + V2 - V3 + V4

Ho = H + H1

Mo = M + H*y + H1*y = SumM + H1*y

where, V4: other load (kN)

1)bridge axis direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	WN-TM	0.0	48132.2	300.0	6800.0
2	OD-CL(SC)	0.0	48803.2	3800.0	54500.0
3	ETQ(SC)	0.0	44674.5	11868.3	201059.7

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	WN	0.0	48132.2	1000.0	28800.0
2	OD-CL(SC)	0.0	48803.2	7500.0	110600.0
3	ETQ(SC)	0.0	44674.5	13268.3	272859.7

(6) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

	number ni (num)	sectional area Aoi (m^2/num)	IBi (m^2)	
			bridge axis direction	perpendicular direction
periphery sheet pile(1)	32	0.05199	322.82	1255.78
separation wall sheet pile(2)	4	0.04464	10.76	0.00
intermediate driven pile (3)	--	------	----------	----------

1)bridge axis direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	WN-TM	1433	1283	1.35
2	OD-CL(SC)	1979	775	1.50
3	ETQ(SC)	3481	-960	1.50

2)perpendicular direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	WN	1575	1141	1.25
2	OD-CL(SC)	2210	544	1.50
3	ETQ(SC)	3316	-794	1.50

4.1.3 calculation of member force

(1)section of leg column bottom external edge

pile cap shape : oval

pile cap dimension : external width By = 8.5351 (m) (bridge axis direction)

Bx = 20.1175 (m) (perpendicular direction)

periphery steel pipe pile body diameter Do = 1.2000 (m)

leg column shape : oval

leg column dimension : 3.000 (m) (bridge axis direction)

13.000 (m) (perpendicular direction)

(2) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

where, Ri : vertical reaction of i-th steel pipe sheet pile and intermediate driven single pile (kN/number)
Vo : vertical load working at bottom of pile cap (kN)
Mo : moment working at bottom of pile cap (kN.m)
n1 : number of periphery steel pipe sheet pile = 32 (number)
n2 : number of separation wall steel pipe sheet pile = 4 (number)
n3 : number of intermediate driven single pile = 0 (number)
Ao1 : pure cross sectional area of periphery steel pipe sheet pile = 0.05199 (m^2/number)
Ao2 : pure cross sectional area of separation wall steel pipe sheet pile = 0.04464 (m^2/number)
Ao3 : pure cross sectional area of intermediate driven single pile = 0.00000 (m^2/number)
IBi : sum of squared distance from centroid of steel pipe sheet to neutral axis of horizontal section of celler (m^2)

		bridge axis direction	perpendicular direction
periphery steel pipe sheet pile	IB1	322.82	1255.78
separation wall steel pipe sheet pile	IB2	10.76	0.00
intermediate driven single pile	IB3	0.00	0.00

1)bridge axis direction

1. check location

X1 = 3.6675 (m)
X2 = -3.6675 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Wind+Temp	48132.2	6800.0	1.35
2	Ord+Collision(scour)	48803.2	54500.0	1.50
3	Earthquake(scour)	44674.5	201059.7	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	3.6675	-3.6675
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Wind+Temp	1433.5	1283.2
2	Ord+Collision(scour)	1979.2	775.3
3	Earthquake(scour)	3481.4	-959.9

4.separation wall steel pipe sheet pile reaction

coordinated system of center of figure		
pile No	number	Xi (m)
1	1	2.2005

abbreviation	[1] WN-TM		[2] OD-CL(SC)		[3] ETQ(SC)	
pile No	R1	R2	R1	R2	R1	R2
1	1205.0	1127.6	1492.6	872.4	2226.5	-61.5

2)perpendicular direction

1. check location

Y1 = 9.4587 (m)
Y2 = -9.4587 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Wind	48132.2	28800.0	1.25
2	Ord+Collision(scour)	48803.2	110600.0	1.50
3	Earthquake(scour)	44674.5	272859.7	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	9.4587	-9.4587
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Wind	1575.3	1141.4
2	Ord+Collision(scour)	2210.3	544.2
3	Earthquake(scour)	3316.0	-794.4

(3)section of leg column bottom external edge

calculate cantilever with leg column bottom external edge as fixed end

$$MA = \frac{Rmax}{Do'} * \left(L + \frac{Do}{2}\right) + \Sigma \left(Ri * \frac{Li}{ai}\right) - \frac{w * L^2}{2} \quad (kN.m/m)$$

$$MA' = \frac{Rmin}{Do'} * \left(L + \frac{Do}{2}\right) + \Sigma \left(Ri * \frac{Li}{ai}\right) - \frac{w * L^2}{2} \quad (kN.m/m)$$

where,

MA,MA': bending moment per unit width of external edge of leg column bottom (kN.m/m)
Rmaxi : maximum vertical reaction induced in single steel pipe sheet pile (kN/number)
Rmini : minimum vertical reaction induced in single steel pipe sheet pile(kN/number)
Ri : influence range of design cantilever at maximum or minimum vertical reaction of steel pipe sheet pile
vertical reaction of separation wall steel pipe sheet pile, intermediate driven single pile (kN/number)
L : distance from external edge of body bottom to celler of internal celler periphery = 1.5675 (m)(bridge axis direction)
= 2.6587 (m)(perpendicular direction)
Li : distance from external edge of body bottom to center of separation wall steel pipe sheet pile,
intermediate driven single pile within influence range(m)
w : dead weight of pile cap and surcharge load (kN/m^2)
Do : external diameter = 1.2000 (m) (periphery steel pipe sheet pile)
: = 1.2000 (m) (separation wall steel pipe sheet pile)
: = --- (m) (intermediate driven single pile)
Do' :center spacing of periphery steel pipe sheet piles = 1.4478 (m) (bridge axis direction)
= 1.4310 (m) (perpendicular direction)
d : effective height of pile cap = 3.6360 (m) (bridge axis direction)
= 3.6916 (m) (perpendicular direction)
ai : Do + d

		bridge axis direction	perpendicular direction
separation wall steel pipe sheet pile	ai	4.8360	4.8916

(4)periphery steel pipe sheet pile front section

$$QB = \frac{Rmax}{Do'} \quad (kN/m)$$

$$QB1 = \frac{Rmax}{Do' + \frac{Ri}{ai} - w\left(L - \frac{h}{2}\right)} \quad (kN/m)$$

where, QB : shear force per unit width in periphery steel pipe sheet pile front (kN/m)
QB1: shear force at location where is 1/2 of thickness of pile cap apart from external edge of body bottom (kN/m)
h : pile cap thickness = 4.0000 (m)

(5)member force sum up table

1)bridge axis direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
1	Wind+Temp	2249	2013	990	990
2	Ord+Collision(scour)	3108	1216	1367	1367
3	Earthquake(scour)	5463	-1517	2405	2405

2)perpendicular direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
1	Wind	3382	2394	1101	1063
2	Ord+Collision(scour)	4828	1034	1545	1506
3	Earthquake(scour)	7346	-2014	2317	2279

4.1.4 stress calculation

(1)bridge axis direction

b = 100.0 (cm) h = 400.0 (cm)

rebar in use

lower tensile (As = 98.718 (cm^2))
1 row cover 290 (mm) D38 @ 228
2 row cover 440 (mm) D38 @ 234

upper tensile (As = 45.569 (cm^2))
1 row cover 150 (mm) D29 @ 278
2 row cover 300 (mm) D29 @ 286

			unit	WN-TM	OD-CL(SC)	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	2249.0	3108.0	5463.0
	required rebar amount	Asr	cm^2	30.820	30.660	54.814
	neutral axis	x	cm	90.0	90.0	90.0
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.50 70.11	2.07 96.88	3.64 170.30
	tensile resultant force required rebar amount	T As	kN cm^2	999.7 46.283	1381.4 46.046	2428.2 80.939
top side ten sile	bending moment	MA'	kN.m	2013.0	1216.0	-1517.0
	required rebar amount	Asr	cm^2	0.000	0.000	14.153
	neutral axis	x	cm	12.0	12.0	65.4
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	1.31 95.73
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	674.3 22.478
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	10.80 216.00	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	990.0 0.27 1.29	1367.0 0.38 1.45	2405.0 0.66 1.45
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	990.0 0.27 1.29	1367.0 0.38 1.45	2405.0 0.66 1.45
shear force to share by concrete		SC a	kN	4690.0	5287.0	5287.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.172	0.172	0.172
	allowable tensile stress	Sig.sa	N/mm^2	160.00	200.00	200.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height Ce = 0.668 : effective height d = 363.60 (cm)

2) correction coefficient about tensile rebar percentage Cpt = 0.972 : tensile rebar percentage pt = 0.272 (%)

3) for shear span ratio increment coefficient Cdc = 6.400 : shear span a = 1.568 (m)

(2)perpendicular direction

b = 100.0 (cm) h = 400.0 (cm)

rebar in use

lower tensile (As = 111.349 (cm^2))

1 row cover 236 (mm) D38 @ 198

2 row cover 386 (mm) D38 @ 212

upper tensile (As = 48.113 (cm^2))

1 row cover 121 (mm) D29 @ 198

2 row cover 271 (mm) D29 @ 410

			unit	WN	OD-CL(SC)	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	3382.0	4828.0	7346.0
	required rebar amount	Asr	cm^2	49.916	47.428	73.229
	neutral axis	x	cm	95.6	95.6	95.6
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.10 92.40	2.99 131.91	4.55 200.69
	tensile resultant force required rebar amount	T As	kN cm^2	1503.2 75.162	2146.0 71.533	3265.0 108.834
top side ten sile	bending moment	MA'	kN.m	2394.0	1034.0	-2014.0
	required rebar amount	Asr	cm^2	0.000	0.000	18.471
	neutral axis	x	cm	10.0	10.0	67.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	1.66 117.85
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	895.2 29.839
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	10.00 200.00	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1101.0 0.30 1.02	1545.0 0.42 1.25	2317.0 0.63 1.25
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1063.0 0.29 1.02	1506.0 0.41 1.25	2279.0 0.62 1.25
shear force to share by concrete		SC a	kN	3779.0	4601.0	4601.0
rebar	shear force to share	Sh'	kN	0.0	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0	100.0
	reduction coefficient	Cds	----	0.288	0.288	0.288
	allowable tensile stress	Sig.sa	N/mm^2	160.00	200.00	200.00
	amount of rebar in use	Aw	cm^2	3.871	3.871	3.871
	required rebar amount	Awreq	cm^2	0.000	0.000	0.000

increment of allowable shear stress Tau.a1' = Tau.a1 * Ce * Cpt * Cdc

1) correction coefficient about effective height Ce = 0.665 : effective height d = 369.16 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.002 : tensile rebar percentage pt = 0.302 (%)
3) for shear span ratio increment coefficient Cdc = 5.343 : shear span a = 2.659 (m)

(3) required thickness of pile cap

$$h >= 1.94 * \sqrt[3]{\frac{kp*Lambda^4}{E}} = 1.374 \text{ (m)}$$

where, h : required thickness of pile cap(m)

kp : equivalent modulus of subgrade reaction (kN/m^3)

$$kp = \frac{Kv1*n1 + Kv2*n2 + Kv3*n3}{A}$$

Kv : axial direction spring constant of steel pipe sheet pile or intermediate driven single pile (kN/m)

$$Kv = a * \frac{Ap*Ep}{L}$$

Ap : pure cross sectional area of steel pipe sheet pile or intermediate driven single pile (m^2)
Ep : Young's modulus of steel pipe sheet pile or 1 center pick single pile (kN/m^2)
L : pile length (m)
a : correction coefficient
a = 0.014*(L/D) + 0.72
Kv1(periphery steel pipe sheet pile) = 2.8296E+005
Kv2(separation wall steel pipe sheet pile) = 2.4294E+005
Kv3(intermediate driven single pile) = 0.0000E+000

n1 : number of periphery steel pipe sheet pile = 32
n2 : number of separation wall steel pipe sheet pile = 4
n3 : number of intermediate driven single pile = 0
A : area of pile cap (m^2) = 127.2
E : Young's modulus of pile cap (kN/m^2) = $2.50 * 10^7$
Lambda : protrusion length of pile cap (m) = 3.26

(4) minimum rebar amount check

		Mu(kN.m)	Mc(kN.m)	1.7M(kN.m)	As(mm^2/m)	judge
bridge axis direction	lower tensile	12091	5103	9288	9872	OK
	upper tensile	5874	5103	2579	4557	OK
perpendicular direction	lower tensile	13810	5103	12489	11135	OK
	upper tensile	6288	5103	3424	4811	OK

Note: 1)Mu>=Mc, 2)1.7M<=Mc, 3)As>=500(mm^2/m)
if either 1) or 2) and 3) are satisfied, it is OK
Note: 1.7M is the value against maximum moment in all cases.

4.2 calculation of pile cap / sheet pile joint part

4.2.1 design condition

(1) steel material in use :SS400,SM400
(2) rebar in use :SD345(underwater member)
(3) concrete design standard strength :Sig.ck = 24 (N/mm^2)
(4) material of steel pipe sheet pile :SKY400
(5) diameter of steel material main body :D = 1200.0 (mm)
(6) section coefficient of steel pipe pile body :Z = 15184.5 (cm^3)
(7) joint method :rebar stud welding method

4.2.2 external working force

pile cap / sheet pile joint part is designed for external working force at bottom of pile cap
besides, in estimating vertical load, dead weight of pile cap upto celler part internal periphery and surcharge load are considered

(1) area of pile cap(let internal periphery sheet pile)

oval: $A1 = B^2 = PI /4 + B * (L-B)$

$= 6.135^2 * Pai/4 + 6.135*(17.717- 6.135) = 100.620\ (m^2)$

(2)area of backfilling soil

$A2 = A1 - Ap = 63.550\ (m^2)$

where, Ap:leg column cross sectional area = 37.07 (m^2)

(3)working force at leg column bottom

1)bridge axis direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	WN-TM	46500.0	300.0	5600.0	1200.0	6800.0
2	OD-CL(SC)	46500.0	3800.0	39300.0	15200.0	54500.0
3	ETQ(SC)	41300.0	11700.0	153600.0	46800.0	200400.0

2)perpendicular direction y = 4.00 (m)

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
1	WN	46500.0	1000.0	24800.0	4000.0	28800.0
2	OD-CL(SC)	46500.0	7500.0	80600.0	30000.0	110600.0

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
3	ETQ(SC)	41300.0	13100.0	219800.0	52400.0	272200.0

(4) pile cap, backfilling soil

V1 = A1*{ h1*Gam.c + h2*(Gam.c - Gam.w) }
V2 = A2*{ h1'*Gam.t + h2'*(Gam.sat - Gam.w) }
V3 = Ap*hw*Gam.w

where, V1 : weight of pile cap (kN)
V2 : weight of backfilling soil (kN)
V3 : buoyancy working at column (kN)
h1 : pile cap thickness upper than water table(m)
h2 : pile cap thickness lower than water table(m)
h1' : backfilling soil thickness upper than water table(m)
h2' : backfilling soil thickness lower than water table(m)
Gam.c : pile cap concrete unit weight = 24.5 (kN/m^3)
Gam.w : unit weight of water =10.00 (kN/m^3)
Gam.t : unit weight of backfilling soil(wet) = 17.5 (kN/m^3)
Gam.sat: unit weight of backfilling soil(saturated) = 17.5 (kN/m^3)
hw : water table (m)(height from crest of pile cap)
h' : backfilling soil thickness (m)
H1 : pile cap and filling concrete inertia force (kN)
y : pile cap inertia force working gravity location height (m)

1)bridge axis direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	WN-TM	11.340	0.000	5835.98	0.00	4203.74	1632.24
2	OD-CL(SC)	9.530	0.000	5835.98	0.00	3532.77	2303.21
3	ETQ(SC)	6.640	0.000	5835.98	0.00	2461.45	3374.53

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	WN-TM	0.00	0.000	0.00
2	OD-CL(SC)	0.00	0.000	0.00

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
3	ETQ(SC)	168.28	3.920	659.65

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	WN	11.340	0.000	5835.98	0.00	4203.74	1632.24
2	OD-CL(SC)	9.530	0.000	5835.98	0.00	3532.77	2303.21
3	ETQ(SC)	6.640	0.000	5835.98	0.00	2461.45	3374.53

2.horizontal force

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
1	WN	0.00	0.000	0.00
2	OD-CL(SC)	0.00	0.000	0.00
3	ETQ(SC)	168.28	3.920	659.65

(5)external force sum up

Vo = V + V1 + V2 - V3 + V4

Ho = H + H1

Mo = M + H*y + H1*y = SumM + H1*y

where, V4: other load (kN)

1)bridge axis direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	WN-TM	0.0	48132.2	300.0	6800.0
2	OD-CL(SC)	0.0	48803.2	3800.0	54500.0
3	ETQ(SC)	0.0	44674.5	11868.3	201059.7

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	WN	0.0	48132.2	1000.0	28800.0

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
2	OD-CL(SC)	0.0	48803.2	7500.0	110600.0
3	ETQ(SC)	0.0	44674.5	13268.3	272859.7

(6) reaction

$$Ri = \frac{Vo*Aoi}{\Sigma(ni*Aoi)} + \frac{Mo*Aoi}{\Sigma(IBi*Aoi)}*Xi$$

$$Hi = \frac{Ho}{n1}$$

	number ni (num)	sectional area Aoi (m^2/num)	IBi (m^2)	
			bridge axis direction	perpendicular direction
periphery sheet pile(1)	32	0.05199	322.82	1255.78
separation wall sheet pile(2)	4	0.04464	10.76	0.00
intermediate driven pile (3)	--	------	----------	----------

1)bridge axis direction

No	abbreviation	vertical reaction(kN/num)	horizontal react (kN/num)	increment coefficient
1	WN-TM	1433	9	1.35
2	OD-CL(SC)	1979	119	1.50
3	ETQ(SC)	3481	371	1.50

2)perpendicular direction

No	abbreviation	vertical reaction(kN/num)	horizontal react (kN/num)	increment coefficient
1	WN	1575	31	1.25
2	OD-CL(SC)	2210	234	1.50
3	ETQ(SC)	3316	415	1.50

4.2.3 reaction

(1)bridge axis direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Wind+Temp	1433	9	1.35
2	Ord+Collision(scour)	1979	119	1.50
3	Earthquake(scour)	3481	371	1.50

(2)perpendicular direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Wind	1575	31	1.25
2	Ord+Collision(scour)	2210	234	1.50
3	Earthquake(scour)	3316	415	1.50

4.2.4 rebar stud welding method

(1) design bending moment

Me = Rp*e

MFix = Sig.sa * Zo

where, Me : moment by eccentricity of reaction(kN.m)

MFix : constraining moment (kN.m)

Rp : vertical reaction per single steel pipe sheet pile(kN)

e : eccentricity (m) = 0.6000

Sig.sa: allowable stress of steel pipe sheet pile (kN/m^2) = 140.00 (N/mm^2)

Zo : section coefficient of steel pipe pile body (m^3) = 15184.5 (cm^3)

select bigger of either Me or MFix

(2) moment rebar design

1) tensile stress by moment

$$T1 = \frac{M}{h}$$

$$Sig.s1 = \frac{T1}{nb*Ab}$$

where, T1 : tensile force working at moment rebar row (N)

M : design moment (N.mm)

h : center spacing of moment rebar row (mm) = 2800.00

Sig.s1: moment rebar tensile stress (N/mm^2)

nb : number of moment rebar (number/ row) = 16

Ab : cross sectional area of single moment rebar (mm^2) = 387.1 (D22)

2)tensile stress by horizontal force

$$T2 = \frac{Ho}{n1}$$

$$Sig.s2 = \frac{T2}{2*nb*Ab}$$

where, T2 : horizontal tensile force working at moment rebar row (N)

Ho : horizontal force working at bottom of pile cap(N)

n1 : number of periphery steel pipe sheet pile

Sig.s2: moment rebar tensile stress (N/mm^2)

3)composite

Sig.s = Sig.s1 + Sig.s2 <= Sig.sa

where, Sig.sa: moment rebar allowable tensile stress (N/mm^2)

4)required number of rebar

$$nba >= \frac{2*T1 + T2}{2*Sig.sa*Ab}$$

where, nba: required number of moment rebar (rebar/ row)

(3) shear rebar design

1) shear stress

$$Tau_s = \frac{Rp}{ns*As} \le Tau.sa$$

where, Tau.s : shear rebar shear stress (N/mm^2)

Rp : vertical reaction per single steel pipe sheet pile (N)

ns : number of shear rebar = 64

As : cross sectional area of single shear rebar (mm^2) = 387.1 (D22)

Tau.sa: shear rebar allowable shear stress (N/mm^2)

2)required number of rebar

$$nsa \ge \frac{Rp}{Tau.sa*As}$$

where, nsa: required number of shear rebar (number)

bridge axis direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	WN-TM	1433.0	860	2870	2870	1025.0	9.0
2	OD-CL(SC)	1979.0	1187	3189	3189	1138.8	119.0
3	ETQ(SC)	3481.0	2089	3189	3189	1138.8	371.0

No	Sig.s1 (N/mm^2)	Sig.s2 (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	nb nba (rebar/row)	Tau.s (N/mm^2)	Tau.sa (N/mm^2)	ns nsa (rebar)
1	165.49	0.73	166.21	216.00	16 >= 13	57.84	129.60	64 >= 29
2	183.87	9.61	193.48	300.00	16 >= 11	79.88	180.00	64 >= 29
3	183.87	29.95	213.82	300.00	16 >= 12	140.51	180.00	64 >= 50

perpendicular direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	WN	1575.0	945	2657	2657	949.0	31.0
2	OD-CL(SC)	2210.0	1326	3189	3189	1138.8	234.0
3	ETQ(SC)	3316.0	1990	3189	3189	1138.8	415.0

No	Sig.s1 (N/mm^2)	Sig.s2 (N/mm^2)	Sig.s (N/mm^2)	Sig.sa (N/mm^2)	nb nba (rebar/row)	Tau.s (N/mm^2)	Tau.sa (N/mm^2)	ns nsa (rebar)
1	153.23	2.50	155.73	200.00	16 >= 13	63.57	120.00	64 >= 34
2	183.87	18.89	202.76	300.00	16 >= 11	89.20	180.00	64 >= 32
3	183.87	33.50	217.38	300.00	16 >= 12	133.85	180.00	64 >= 48

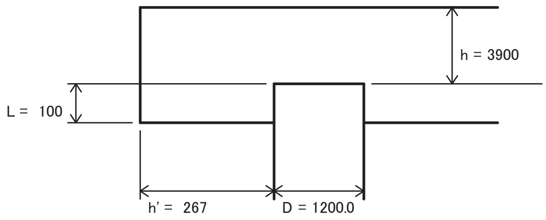
4.3 calculation of pile head joint part

4.3.1 design condition

(1) design condition

1) joint method : method B
2) concrete design standard strength :Sig.ck = 24 (N/mm^2)
3) rebar in use :SD345(underwater member)

(2) shape dimension



(3) pile head working force

1)bridge axis direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Wind+Temp	1.35	1205	1128	7	7
2	Ord+Collision(scour)	1.50	1460	905	83	47
3	Earthquake(scour)	1.50	2223	-58	284	195

2)perpendicular direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Wind	1.25	1166	1166	24	28
2	Ord+Collision(scour)	1.50	1183	1183	165	98
3	Earthquake(scour)	1.50	1082	1082	318	265

4.3.2 pile head joint part stress calculation

(1) pile cap concrete vertical bearing stress

$$Sig.cv = \frac{PNmax}{Pai*D^2/4} <= Sig.ca$$

where, PNmax : axial direction maximum compressive force (N)
D : pile external diameter (mm) = 120.00 (cm)
Sig.ca : concrete allowable bearing stress (N/mm^2)

(2) punching shear stress at pile cap concrete

$$Tau_v = \frac{PNmax}{Pai*(D + h)*h} <= Tau_a$$

where, h : effective thickness of pile cap to resist vertical punching shear force (mm) = 390.0 (cm)
Tau.a: concrete allowable punching shear stress (N/mm^2)

1)bridge axis direction

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
1	Wind+Temp	1205	1.07	9.72	0.019	0.900
2	Ord+Collision(scour)	1460	1.29	10.80	0.023	0.900
3	Earthquake(scour)	2223	1.97	10.80	0.036	0.900

2)perpendicular direction

No	load name	PNmax (kN)	Sig.cv (N/mm^2)	Sig.ca (N/mm^2)	Tau.v (N/mm^2)	Tau.a (N/mm^2)
1	Wind	1166	1.03	9.00	0.019	0.900
2	Ord+Collision(scour)	1183	1.05	10.80	0.019	0.900
3	Earthquake(scour)	1082	0.96	10.80	0.017	0.900

(3) horizontal bearing stress at pile cap concrete

$$Sig.ch = \frac{PHmax}{D*I} <= Sig.ca$$

where, PHmax : axial orthogonal direction force (N)
I : pile embedment length (mm) = 10.0 (cm)
Sig.ca : concrete allowable bearing stress (N/mm²)

1)bridge axis direction

No	load name	PHmax (kN)	Sig.ch (N/mm²)	Sig.ca (N/mm²)
1	Wind+Temp	7	0.058	9.720
2	Ord+Collision(scour)	83	0.692	10.800
3	Earthquake(scour)	284	2.367	10.800

2)perpendicular direction

No	load name	PHmax (kN)	Sig.ch (N/mm²)	Sig.ca (N/mm²)
1	Wind	24	0.200	9.000
2	Ord+Collision(scour)	165	1.375	10.800
3	Earthquake(scour)	318	2.650	10.800

4.3.3 pile head reinforcing rebar calculation

(1)calculation of imaginary rebar concrete section

sec	dia(cm)	cover(cm)	rebar	amount of used rebar(cm²)
1row	160.00	26.0	D22 - 12 (@283)	46.452

1)bridge axis direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm²)	neutral axis (cm)	Sig.c (N/mm²)	Sig.ca (N/mm²)	Sig.s (N/mm²)	Sig.sa (N/mm²)
1	WN-TM	7.0	1205.0	0.000	2826.14	0.60	10.80	-8.52	216.00
		7.0	1128.0	0.000	2650.65	0.56	10.80	-7.96	216.00
2	OD-CL(SC)	47.0	1460.0	0.000	575.55	0.82	12.00	-9.38	300.00
		47.0	905.0	0.000	387.17	0.55	12.00	-5.38	300.00
3	ETQ(SC)	195.0	2223.0	0.000	261.86	1.54	12.00	-11.27	300.00
		195.0	-58.0	15.563	28.22	1.90	12.00	106.54	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

2)perpendicular direction

No	load name abbreviation	M (kN.m)	N (kN)	required rebar amount (cm²)	neutral axis (cm)	Sig.c (N/mm²)	Sig.ca (N/mm²)	Sig.s (N/mm²)	Sig.sa (N/mm²)
1	WN	28.0	1166.0	0.000	744.31	0.63	10.00	-7.72	200.00
		28.0	1166.0	0.000	744.31	0.63	10.00	-7.72	200.00
2	OD-CL(SC)	98.0	1183.0	0.000	272.57	0.80	12.00	-6.14	300.00
		98.0	1183.0	0.000	272.57	0.80	12.00	-6.14	300.00
3	ETQ(SC)	265.0	1082.0	0.000	143.75	1.17	12.00	-1.19	300.00
		265.0	1082.0	0.000	143.75	1.17	12.00	-1.19	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

(2) pile head reinforcing rebar anchor length

$$Lo = \frac{Sig.sa}{4*Tau.oa} Phi = 687 \text{ (mm)}$$

Lo : rebaranchor length (mm)
Sig.sa : rebar allowable tensile stress = 200.00 (N/mm^2)
Tau.oa : allowable rebar bond stress = 1.600 (N/mm^2)
Phi. : pile head reinforcing rebar diameter = 22 (mm)

embedment length L >= Lo + 10 * Phi. = 908 (mm)

assure L from center of rebar in bottom of pile cap

(3) welding length of pile head supplemental rebar welding part by shear stress

$$Tau_s = \frac{Sig.sa*Ast}{1.4*Lambda*Ls} <= Tau.sa$$

$$Ls = \frac{Sig.s*Ast}{1.4*Lambda*Tau_{sa}}$$

where, Tau.sa: allowable shear stress of fillet welding = 72.00 (N/mm^2)
Sig.sa: rebar allowable tensile stress(to estimate anchor length) = 200.00 (N/mm^2)
Ast : sectional area of sigle pile head supplemental rebar = 3.871 (cm^2)
Lambda : fleg length of fillet welding (cm)
Ls : fillet welding length

welding leg length Lambda (cm)	0.6	0.7	0.8	0.9
welding length Ls (cm)	12.8	11.0	9.6	8.5

5 foundation spring calculation

subgrade reaction constant value used in calculation of natural period
It is calculated by the analysis model used in horizontal capacity method. But the upper limit of the subgrade reaction is not considered.

(1)Layer data

	type sand	thick(m) Layer	Nvalue	usual time	in quakes	calculation natural period	
				Alp.*Eo (kN/m^2)	Alp.*Eo (kN/m^2)	dyna.het.coef ED(kN/m)	dyna.pois.rate NyuD
1	clay	1.066	1.0	3600	7200	34286	0.50
2	sandy	4.000	3.0	4800	9600	45643	0.50
3	sandy	7.000	13.0	20800	41600	117855	0.50
4	clay	4.000	9.0	25200	50400	148348	0.50
5	clay	17.000	7.0	19600	39200	125458	0.50
6	clay	15.000	18.0	50400	100800	242205	0.50
7	sandy	2.244	50.0	140000	280000	323331	0.50

(2)modulus of subgrade reaction
1) foundation bottom spring

	vertical direction kv(kN/m^3)	horizontal direction shear ks(kN/m^3)
periphery sheet pile	381049	114315
separation wall sheet pile	381049	114315
intermediate driven pile	----------	----------

2) foundation front , side spring

usual time/ earthquake time kHo = Alp.*Eo/0.3

estimate natural period kHo = ED/0.3

foundation front horizontal direction kh = Alp.k*kHo*(Be/0.3)$^{(-3/4)}$(kN/m^3)

foundation front vertical direction kSVB = 0.3*Alp.k*kHo*(Be/0.3)$^{(-3/4)}$(kN/m^3)

foundation side horizontal direction kSHD = 0.6*Alp.k*kHo*(De/0.3)$^{(-3/4)}$(kN/m^3)

foundation side vertical direction kSVD = 0.3*Alp.k*kHo*(De/0.3)$^{(-3/4)}$(kN/m^3)

where Alp.k : modulus of subgrade reaction correction coefficient (= 1.50)

Alp. : modulus of elasticity in ground (kN/m^2)

Eo : dynamic modulus of elasticity in ground (kN/m^2)

ED : dynamic modulus of elasticity in ground (kN/m^2)

Nu.D: dynamic Poisson's ratio

Be : equivalent loading width in orthogonal direction to external force, foundation width (m)

De : equivalent loading width in external force direction, foundation width (m)

both Be,De are values which 0.2*D is deducted in case of circular and oval shape (D:circular diameter (m))

usual time

1.bridge axis direction(Be = 18.41045, De = 6.82805)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-6.510 - -7.416	821	246	1036	518
2	-7.416 - -10.350	1095	328	1382	691
3	-10.350 - -11.416	1095	328	1382	691
4	-11.416 - -18.416	4743	1423	5988	2994
5	-18.416 - -22.416	5747	1724	7255	3628
6	-22.416 - -39.416	4470	1341	5643	2821
7	-39.416 - -50.525	11493	3448	14510	7255
8	-50.525 - -54.416	11493	6896	14510	14510
9	-54.416 - -56.660	31926	19155	40306	40306

2.perpendicular direction(Be = 6.82805, De = 18.41045)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-6.510 - -7.416	1727	518	493	246
2	-7.416 - -10.350	2303	691	657	328
3	-10.350 - -11.416	2303	691	657	328
4	-11.416 - -18.416	9980	2994	2846	1423
5	-18.416 - -22.416	12092	3628	3448	1724
6	-22.416 - -39.416	9405	2821	2682	1341
7	-39.416 - -50.525	24183	7255	6896	3448
8	-50.525 - -54.416	24183	14510	6896	6896
9	-54.416 - -56.660	67176	40306	19155	19155

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -50.525(m) evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

earthquake time

1.bridge axis direction(Be = 18.41045, De = 6.82805)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-6.510 - -7.416	547	164	690	345
2	-7.416 - -10.350	729	219	920	460
3	-10.350 - -11.416	729	219	920	460
4	-11.416 - -18.416	9486	2846	11977	5988
5	-18.416 - -22.416	11493	3448	14510	7255
6	-22.416 - -39.416	8939	2682	11286	5643
7	-39.416 - -50.525	22987	6896	29020	14510
8	-50.525 - -54.416	22987	13792	29020	29020
9	-54.416 - -56.660	63851	38311	80612	80612

2.perpendicular direction(Be = 6.82805, De = 18.41045)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-6.510 - -7.416	1150	345	328	164
2	-7.416 - -10.350	1534	460	437	219
3	-10.350 - -11.416	1534	460	437	219
4	-11.416 - -18.416	19961	5988	5692	2846
5	-18.416 - -22.416	24183	7255	6896	3448
6	-22.416 - -39.416	18809	5643	5364	2682
7	-39.416 - -50.525	48367	14510	13792	6896
8	-50.525 - -54.416	48367	29020	13792	13792
9	-54.416 - -56.660	134353	80612	38311	38311

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -50.525(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

to estimate natural period

1.bridge axis direction(Be = 18.41045, De = 6.82805)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-6.510 - -7.416	7819	2346	9871	4935
2	-7.416 - -10.350	10408	3123	13141	6570
3	-10.350 - -11.416	10408	3123	13141	6570
4	-11.416 - -18.416	26876	8063	33930	16965
5	-18.416 - -22.416	33829	10149	42709	21355
6	-22.416 - -39.416	28610	8583	36119	18060
7	-39.416 - -50.525	55233	16570	69730	34865
8	-50.525 - -54.416	55233	33140	69730	69730
9	-54.416 - -56.660	73733	44240	93087	93087

2.perpendicular direction(Be = 6.82805, De = 18.41045)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-6.510 - -7.416	16451	4935	4691	2346
2	-7.416 - -10.350	21901	6570	6245	3123
3	-10.350 - -11.416	21901	6570	6245	3123
4	-11.416 - -18.416	56550	16965	16125	8063
5	-18.416 - -22.416	71182	21355	20298	10149
6	-22.416 - -39.416	60199	18060	17166	8583
7	-39.416 - -50.525	116217	34865	33140	16570
8	-50.525 - -54.416	116217	69730	33140	33140
9	-54.416 - -56.660	155144	93087	44240	44240

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -50.525(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

(3)joint pipe external diameter ,shear resistance of joint

joint pipe external diameter

periphery   :linear part   = 0.1652 (m)
periphery   :curve part   = 0.1652 (m)
separation wall:Y direction   = 0.1652 (m)
separation wall:X direction   = 0.1652 (m)

shear resistance of joint

shear rigidity Gj   = 1200000 (kN/m²)
shear capacity qju   =   200 (kN/m)

(4) ground spring constant to estimate natural period

general equation

$$\begin{bmatrix} H \\ M \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del. \\ Theta \end{bmatrix}$$

hence

$$\begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} = \begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}$$

$$\begin{bmatrix} Ass & Asr \\ Ars & Arr \end{bmatrix} = \begin{bmatrix} Ho & O \\ O & Mo \end{bmatrix} \begin{bmatrix} Del.oH & Del.oM \\ Theta.oH & Theta.oM \end{bmatrix}^{-1}$$

where Ho : unit horizontal force to apply at crest of foundation (kN)
Mo : unit moment to apply at crest of foundation (kN.m)
Del.oH : horizontal displacement at crest of foundation by Ho(m)
$Theta_{oH}$: rotational angle at crest of foundation by Ho (rad)
Del.oM : horizontal displacement at crest of foundation by Mo(m)
$Theta_{oM}$: rotational angle at crest of foundation by Mo (rad)
Ass : ground spring constant (kN/m)
Asr : ground spring constant (kN/rad)
Ars : ground spring constant (kN.m/m)
Arr : ground spring constant (kN.m/rad)

usual time

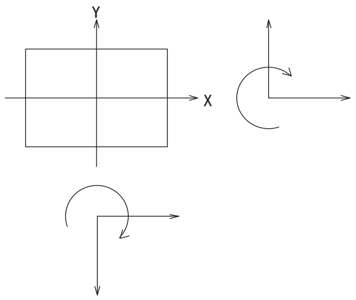
item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.1910E-001	7.3347E-002
ThetaoH	mrad	6.2105E-003	2.5474E-003
Del.oM	mm	6.2105E-002	2.5474E-002
ThetaoM	mrad	6.0095E-003	2.0751E-003
Ass	kN/m	1.8210E+006	2.3767E+006
Asr	kN/rad	-1.8819E+007	-2.9176E+007
Ars	kN.m/m	-1.8819E+007	-2.9176E+007
Arr	kN.m/rad	3.6089E+008	8.4006E+008

earthquake time

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	8.8855E-002	5.1636E-002
ThetaoH	mrad	5.2849E-003	1.9850E-003
Del.oM	mm	5.2849E-002	1.9850E-002
ThetaoM	mrad	5.5894E-003	1.8271E-003
Ass	kN/m	2.5717E+006	3.3256E+006
Asr	kN/rad	-2.4315E+007	-3.6132E+007
Ars	kN.m/m	-2.4315E+007	-3.6132E+007
Arr	kN.m/rad	4.0882E+008	9.3989E+008

to estimate natural period

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	3.1983E-002	1.8900E-002
ThetaoH	mrad	2.4668E-003	9.2887E-004
Del.oM	mm	2.4668E-002	9.2887E-003
ThetaoM	mrad	3.3932E-003	1.1074E-003
Ass	kN/m	7.1176E+006	9.0018E+006
Asr	kN/rad	-5.1745E+007	-7.5506E+007
Ars	kN.m/m	-5.1745E+007	-7.5506E+007
Arr	kN.m/rad	6.7089E+008	1.5364E+009



Y direction: bridge axis direction
X direction:perpendicular direction

CHAPTER 4. RC PIER SUBSTRUCTURE DESIGN

4.1 SUMMARY OF RC PIER COLUMN DESIGN

1) Design Section

A verification of the sections of pier column will be made at the bottom section against bending moment and shear force in each bridge axis and axis perpendicular direction as shown in the figure below.

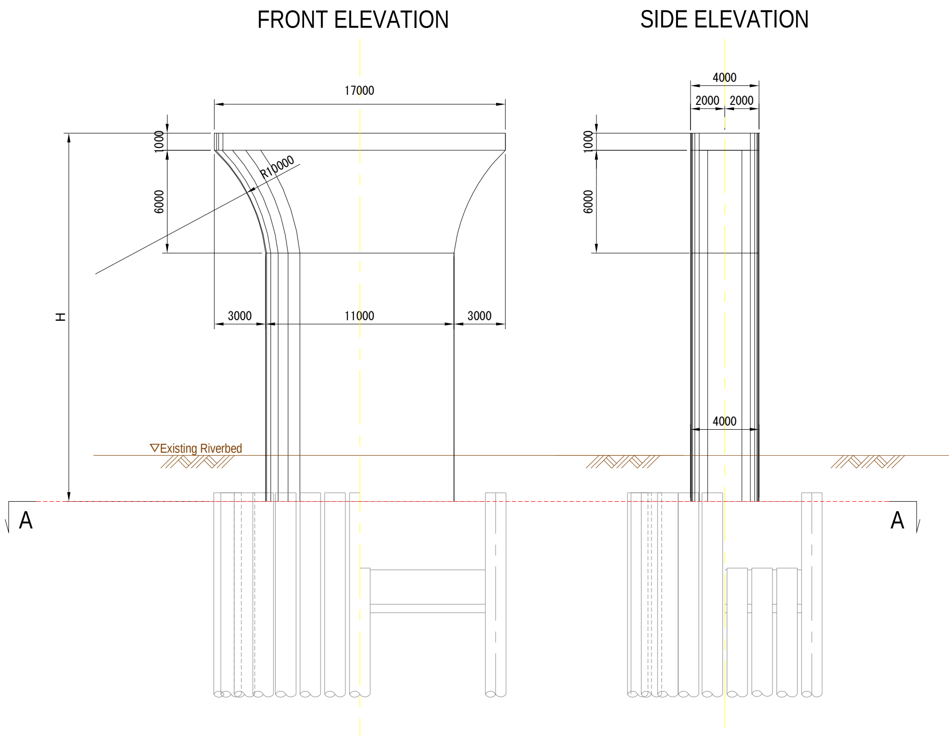


Figure Design Section of Pier Column

2) Design Condition

- Applied reinforcement bar:

  SD345 for shear reinforcement and main reinforcement (underwater member)
- Concrete design strength: 30 N/mm^2

3) Sectional Forces at the Bottom of the Pier Column

Sectional forces at the bottom of the pier column during earthquake condition as critical load for the design are summarized in the table below. The force due to the hydrodynamic pressure during earthquake is included in the shear force, S, and bending moment, M.

Table Section Force in Earthquake Condition

Load Direction		V (kN)	S (kN)	M (kN.m)
P6	Bridge axis direction	36,000	11,000	123,700
	Bridge axis perpendicular direction	36,000	10,800	146,600
P7	Bridge axis direction	41,300	11,600	154,200
	Bridge axis perpendicular direction	41,300	13,100	223,400

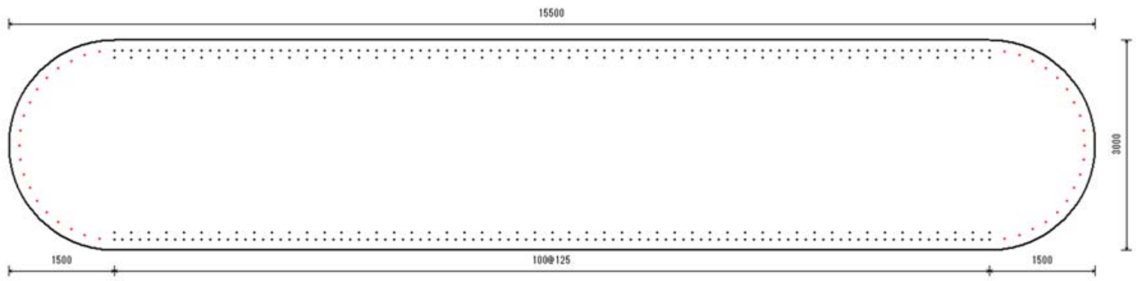
4) Rebar Arrangement

a) Main Reinforcement

- Main reinforcement is arranged as shown in the figure below, and no deduction of the rebar is made through the pier column.

P6

Cover (mm)	Straight Section		Arc Section	
	Diameter	Arrangement	Diameter	Arrangement
150	D32	100@125	D32	2 x nos.19/side
250	D32	50@250	-	-



P7

Cover (mm)	Straight Section		Arc Section	
	Diameter	Arrangement	Diameter	Arrangement
150	D38	80@125	D38	2 x nos.19/side
250	D38	40@250	-	-

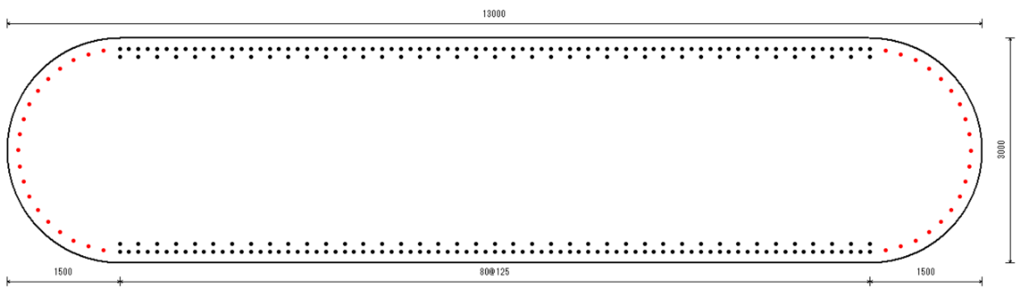


Figure Rebar Arrangement (Main Reinforcement)

Source: JICA Study Team

b) Shear Reinforcement

- Lateral tie to avoid the column from buckling due to shear force: D19 (P6) and D22 (P7), 150 mm pitch through the column
- Intermediate hoop to avoid the lateral tie from jutting outside: 15 nos.(P6) and 11 nos.(P7) for bridge axis direction and 2 nos. for bridge axis perpendicular direction per cross section, 150 mm pitch through the column

5) Verification

Pier column structure is verified by compressive stress of concrete, tensile stress of rebar, shear stress and content of shear reinforcement. The result of verification at earthquake condition which is critical condition for pier column design is summarized in the table below. Since average shear stress is over allowable stress that only concrete resists against shear force, shear reinforcement is arranged to meet the requirement.

Table Verification of Pier Column Stress at Earthquake Condition

Bridge Axis Direction

Pier No.	Compressive Stress (N/mm^2)		Tensile Stress (N/mm^2)		Shear Stress (N/mm^2)		Shear Reinforcement Content (mm^2)		Judgement
	σ_c	σ_{ca}	σ_s	σ_{sa}	τ_m	τ_{a1}, τ_{a2}	Aw	Aw_{Req}	
P6	8.3<	15.0	249.4<	300.0	0.26<	0.28,2.85	4871.0>	0.0	OK
P7	10.7<	15.0	281.3<	300.0	0.33<	0.32,2.85	5032.0>	106.3	OK

Bridge Axis Perpendicular Direction

Pier No.	Compressive Stress (N/mm^2)		Tensile Stress (N/mm^2)		Shear Stress (N/mm^2)		Shear Reinforcement Content (mm^2)		Judgement
	σ_c	σ_{ca}	σ_s	σ_{sa}	τ_m	τ_{a1}, τ_{a2}	Aw	Aw_{Req}	
P6	2.2<	15.0	13.9<	300.0	0.25<	0.19,2.85	1146.0>	95.1	OK
P7	4.9<	15.0	77.4<	300.0	0.36<	0.21,2.85	1548.4>	244.5	OK

σc: Compressive Stress of Concrete *σca: Allowable Compressive Stress of Concrete*

σs: Tensile Stress of Rebar *σsa: Allowable Tensile Stress of Rebar*

τm: Average Shear Stress *τa1: Allowable Shear Stress if only concrete resists against shear force*

τa2: Allowable Shear Stress if both concrete and shear reinforcement resist against shear force

Aw: Shear reinforcement content *Awreq: Required shear reinforcement content in τa1 <τm*

4.2 DETAIL CALCULATION SHEET OF RC PIER COLUMN OF P6

As for verification at bottom of RC Pier column, following load combinations as critical cases among various combinations are considered.

Bridge Axis Direction

Load Combination	Design Elevation	Water Level	Ground Elevation	Increase Coefficient of Allowable Stress
Ordinary Condition (D+L)	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m Low tide in spring tide EL-2.39m	Existing Ground Level EL-1.721m	1.0
Ordinary Condition(D+L)＋Effect of Temperature Change	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m Low tide in spring tide EL-2.39m	Existing Ground Level EL-1.721m	1.15
Vessel Collision	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m	Existing Ground Level EL-1.721m	1.5
Earthquake Condition with Hydrodynamic Pressure during Earthquake (Level-1)	ELE-3.45m (elevation of top of footing)	EL+0.29m	With local scouring, thus setting at same level of bottom of pier.	1.5

Bridge Axis Perpendicular Direction

Load Combination	Design Elevation	Water Level	Ground Elevation	Increase Coefficient of Allowable Stress
Ordinary Condition (D+L)	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m Low tide in spring tide EL-2.39m	Existing Ground Level EL-1.721m	1.0
Vessel Collision	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m	Existing Ground Level EL-1.721m	1.5
Earthquake Condition with Hydrodynamic Pressure during Earthquake (Level-1)	ELE-3.45m (elevation of top of footing)	EL+0.29m	With local scouring, thus setting at same level of bottom of pier.	1.5

Contents

1 Design condition

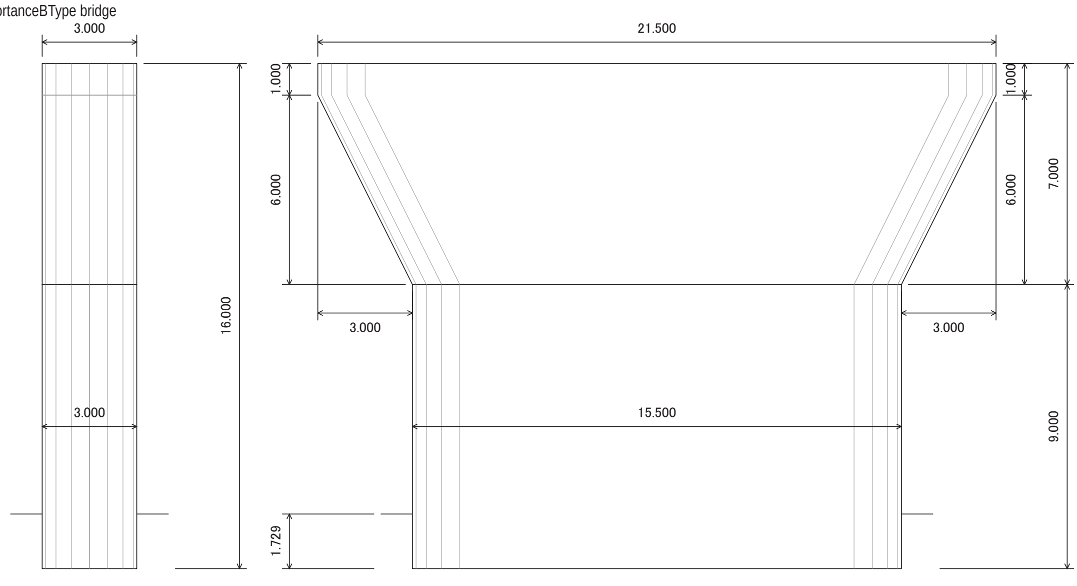
1.1 Shape dimension

Type RCOvalColumn pier (new consider)

Beam shape type Beam type(oval)

Foundation type Spread foundation

Division of importanceBType bridge



(right side is back side)

Items	Symbol	Dimension(m)
Beam height Bridge axial direction beam width Bridge axial perpendicular direction beam width (left side) Ditto (right side) Lower face bridge axial right angle drawn height Lower face bridge axial right angle drawn length (left side) Ditto (right side)	H B_L B_{TL} B_{TR} H_t B_{tL} B_{tR}	7.000 0.000 3.000 3.000 6.000 3.000 3.000
Column height(column base - beam lower face) Bridge axial direction column width Bridge axial perpendicular direction column width	H B_L B_T	9.000 3.000 15.500
Surface (from column lower edge)	h_G	1.729

1.2 Super structure reaction

1.2.1 Dead load reaction force and inertia force operated position

Super structural dead load reaction force R_D 16700.00 (kN)

bridge axial	bridge axial	right angle
operated position of super structural inertia force h_I (m)	0.000	2.627

1.2.2 Allowable stress design method

Live load reaction force and horizontal reaction force in seismic condition

bridge axial	bridge axial	right angle
super structural load reaction force R_L (kN) horizontal reaction force in seismic condition R_H (kN)	4500.00 4600.00	4500.00 4900.00

1.2.3 Ductility design method

Dead load horizontal force and eccentric moment

	bridge axial	bridge axial right angle
Dead load horizontal force H (kN) Dead load eccentric moment Me (kN.m)	0.00 0.00	0.00 0.00

Dead load horizontal force load super structural inertia force operated position.

1.3 Design horizontal seismic coefficient

Religion division : A2 Religion

Ground type : III Type ground

1.3.1 Allowable stress design method

	kh	khg
Axial direction Perpendicular direction	0.30 0.30	0.24 0.24

kh : Design horizontal seismic coefficient of level 1 earth quake vibration

khg : Design horizontal seismic coefficient in ground face of level 1 earth quake vibration

1.3.2 Ductility design method

Bridge axial direction

	Design seismic coefficient type I sharing weight				Design seismic coefficient typeII sharing weight			
	CIzkhco	khg	khcmin	Wu (kN)	CIIzkhco	khg	khcmin	Wu (kN)
Plus dir	0.3000	0.40	0.00	0.00	0.3000	0.60	0.00	0.00

Bridge axial perpendicular direction

	Design seismic coefficient type I sharing weight				Design seismic coefficient typeII sharing weight			
	CIzkhco	khg	khcmin	Wu (kN)	CIIzkhco	khg	khcmin	Wu (kN)
Plus dir	0.3000	0.40	0.00	0.00	0.3000	0.60	0.00	0.00

CIzkhco : Standard value of correction coefficient by religions x design horizontal seismic coefficient (type I)
CIIzkhco : Standard value of correction coefficient by religions x design horizontal seismic coefficient (type II)
khg : Design horizontal seismic coefficient in ground face
khcmin : Maximum value of design horizontal seismic coefficient in same vibration unit system
Wu : Super structural weight that pier supports

1.4 Unit weight

Young's modulus of reinforcement Es 2.00×10^5 (N/mm^2)
Young's modulus ratio of section design 15
Unit weight of reinforcement concrete γc 24.50(kN/m^3)
Water unit weight γw 9.80(kN/m^3)
Unit weight of sediment (backfill) γt 17.50(kN/m^3)
Water unit weight on sediment buoyancy calculation γw 9.00(kN/m^3)

1.5 Column

1.5.1 Material of use

Design standard strength of concrete σck 30.0(N/mm^2)
Young's modulus of concrete Ec 2.80×10^4 (N/mm^2)
Main reinforcement material SD345
Striped reinforcement material SD345

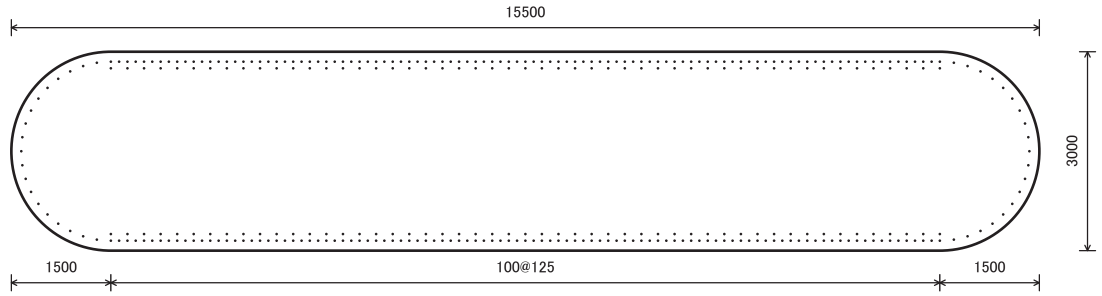
Tensile stress of column reinforcement uses basic value as the member in water.
Not consider correction coefficient cN to allowable shear stress τa1of column.

1.5.2 Rebar

(1) Base main reinforcement

Cover	Straight linear part		Circular arc	
(mm)	Diameter	Bar Arrangement	Diameter	One side Number
150	D32	1500+100@125+1500	D32	19
250	D32	1500+50@250+1500	----	----

Note : Reinforcement amount total 271616.4mm²,
*Satisfy more than [reinforcement amount of 500mm² / m (17212.4mm²)]Do.
*Satisfy no more than [reinforcement amount (44568583.5mm²) to be 6% of section area (2674115.0mm²) 」Do.



(2) Hoop reinforcement

Reinforcement diameter　D19

Striped reinforcement arranged since second step not consider as Lateral restraint bar

Striped reinforcement arranged since second step not consider as Shear supplemental bar

1) Intermediate ties

Intermediate ties arrangement

Reinforcement diameter　D19

Bridge axial direction　15 number / step

Perpendicular direction　2 number / step

Not consider Intermediate ties of perpendicular direction as Lateral restraint bar

2) Height direction arrangement

Section	Starting edge height h(m)	Height interval s(mm)	Interval multiple
1	0.000	150	1

3) Length of plastic hinged

Section	Starting edge height h(m)	Number of axial direction reinforcement ns(number)			
		Bridge axial back side	Bridge axial front side	Right angle right side	Right angle left side
1	0.000	1	1	Cal.inside	Cal.inside

1.5.3 Oval column section direction division sets and section correction coefficient

Section direction division sets　50

Section correction coefficient αβ

Section correction factor	Bridge axial	Perpendicular
α	0.20	1.00
β	0.40	1.00

1.6 Shape of earth surface

surface type :Horizontal

1.7 Allowable stress design method load case

Considering allowable stress method of column is calculated at the following load case.

1.7.1 Axial direction

(1) case : Ordinary(abbreviation : Ordinary) load condition : Ordinary (increasing coefficient of allowable stress 1.00)

low water level : 1.060m high water level : 6.630m sediment height: 1.729m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	16700.00
Live load reaction R_L	4500.00
Total	21200.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	0.000	0.00	0.00	0.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Upper load sediment on footing check

Front side(Low water level) sediment on checkDo not consider

Back side(Low water level) sediment on checkDo not consider

Front side(High water level) sediment on checkDo not consider

Back side(High water level) sediment on checkDo not consider

(2) case : Temperature Effect(abbreviation : Temperature) load condition : Dead+ Live+ Temperature (increasing coefficient of allowable stress 1.15)

low water level : 1.060m high water level : 6.630m sediment height: 1.729m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	16700.00
Live load reaction R_L	4500.00
Total	21200.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
200.00	0.000	0.00	0.00	0.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Upper load sediment on footing check

Front side(Low water level) sediment on checkDo not consider

Back side(Low water level) sediment on checkDo not consider

Front side(High water level) sediment on checkDo not consider

Back side(High water level) sediment on checkDo not consider

(3) case : Seismic Level1(abbreviation : Seismic) load condition : Lv1 E.Q (increasing coefficient of allowable stress 1.50)
low water level : 3.740m high water level : 3.740m sediment height: 0.000m (from each Lower edge of column)
1) Load
super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	16700.00
Total	16700.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
4600.00	0.000	0.00	0.00	0.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Bridge axial direction upward (plus direction)
Dynamic water pressure Bridge axial direction upward (plus direction)
Upper load sediment on footing check
Front side(Low water level) sediment on checkDo not consider
Back side(Low water level) sediment on checkDo not consider
Front side(High water level) sediment on checkDo not consider
Back side(High water level) sediment on checkDo not consider

(4) case : Vessel Collision(abbreviation : Collision) load condition : Vessel Collision (increasing coefficient of allowable stress 1.50)
low water level : 6.630m high water level : 6.630m sediment height: 0.000m (from each Lower edge of column)
1) Load
super structural reaction force (operated to beam top edge * beam center)

load name	vertical force V(kN)	horizontal force H(kN)	eccentric distance e(m)	operated height h(m)	moment M(kN.m)
RD	16700.00	0.00	0.000	0.000	0.00
RL	4500.00	0.00	0.000	0.000	0.00
total	21200.00				

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Do not consider
Load directly operated to frame body
Flowing water pressure bridge axial direction not consider

Impact load load bridge axial direction
Height from column lower edge 7.430 (m)
Load strength 3200.00 (kN)
Upper load sediment on footing check
Front side(Low water level) sediment on checkDo not consider
Back side(Low water level) sediment on checkDo not consider
Front side(High water level) sediment on checkDo not consider
Back side(High water level) sediment on checkDo not consider

1.7.2 Axial perpendicular direction

(1) case : Ordinary(abbreviation : Ordinary) load condition : Ordinary (increasing coefficient of allowable stress 1.00)

low water level : 1.060m high water level : 6.630m sediment height: 1.729m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	16700.00
Live load reaction R_L	4500.00
Total	21200.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	2.627	0.00	6800.00	6800.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Upper load sediment on footing check

Left side(Low water level) sediment on checkDo not consider

Right side(Low water level) sediment on checkDo not consider

Left side(High water level) sediment on checkDo not consider

Right side(High water level) sediment on checkDo not consider

(2) case : Seismic Level1(abbreviation : Seismic) load condition : Lv1 E.Q. (increasing coefficient of allowable stress 1.50)

low water level : 3.740m high water level : 3.740m sediment height: 0.000m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	16700.00
Total	16700.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
4900.00	2.627	12872.30	6000.00	18872.30

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition perpendicular direction rightward (plus direction)

Dynamic water pressure perpendicular direction rightward (plus direction)

Upper load sediment on footing check

Left side(Low water level) sediment on checkDo not consider

Right side(Low water level) sediment on checkDo not consider

Left side(High water level) sediment on checkDo not consider

Right side(High water level) sediment on checkDo not consider

(3) case : Vessel Collision(abbreviation : Collision) load condition : Vessel Collision (increasing coefficient of allowable stress 1.50)

low water level : 6.630m high water level : 6.630m sediment height: 1.729m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

load name	vertical force V(kN)	horizontal force H(kN)	eccentric distance e(m)	operated height h(m)	moment M(kN.m)
RD	16700.00	0.00	0.000	0.000	0.00
RL	4500.00	0.00	0.000	0.000	0.00
total 21200.00					

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Load directly operated to frame body

Flowing water pressure Bridge axial perpendicular rightward direction

Flow velocity 0.000 (m/sec)

Impact load Load to bridge axial perpendicular direction

Height from column lower edge 7.430 (m)

Load strength 6400.00 (kN)

Upper load sediment on footing check

Left side(Low water level) sediment on checkDo not consider

Right side(Low water level) sediment on checkDo not consider

Left side(High water level) sediment on checkDo not consider

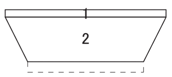
Right side(High water level) sediment on checkDo not consider

2 Column design (Allowable stress design method)

2.1 Cross section force of column base

2.1.1 Frame body own load

(1) Beam part



No.	Block name	Left height H1(m)	Right height H2(m)	Left upper width W1(m)	Left lower width B1(m)	Right upper width W2(m)	Right lower width B2(m)	Member length L(m)	Volume $V(m^3)$
1	Drawn upper face	1.000	1.000	3.000	3.000	3.000	3.000	21.500	62.56858
2	Drawn parts	6.000	6.000	3.000	3.000	3.000	3.000	21.500	321.41150

No	volume $V(m^3)$	Xg (m)	Yg (m)	Zg (m)	V*Xg (m^4)	V*Yg (m^4)	V*Zg (m^4)
1	62.56858	0.0000	6.5000	0.0000	0.0000	406.6958	0.0000
2	321.41150	0.0000	3.1680	0.0000	0.0000	1018.2345	0.0000
Σ	383.98008	------	------	------	0.0000	1424.9303	0.0000

Note : Table's center of figure (Xg,Yg,Zg) is the coordinated system that column center of beam lower edge position sets (0,0,0)

Height PH = 9.000 from column base to beam lower edge (m)

$W = \Sigma V * \gamma c = 383.98008*24.50 = 9407.51(kN)$

$Y = \Sigma(V*Yg)/\Sigma V + PH = 12.711(m)$

$Xc = \Sigma(V*Xg)/\Sigma V = 0.000(m)$

(2) Column part

No	block name	Br1 (m)	Br2 (m)	Ba1 (m)	Ba2 (m)	H (m)	volume $V(m^3)$
1	Oval Column	15.500	15.500	3.000	3.000	9.000	401.11725

No	volume $V(m^3)$	Xg (m)	Yg (m)	Zg (m)	V*Xg (m^4)	V*Yg (m^4)	V*Zg (m^4)
1	401.11725	0.0000	4.5000	0.0000	0.0000	1805.0276	0.0000
Σ	401.11725	------	------	------	0.0000	1805.0276	0.0000

Note : Table's center of figure (Xg,Yg,Zg) is the coordinated system that column center of column base (Ignore taper width) sets (0,0,0)

$W = \Sigma V * \gamma c = 401.11725*24.50 = 9827.37(kN)$

$Y = \Sigma(V*Yg)/\Sigma V = 4.500(m)$

$Xc = \Sigma(V*Xg)/\Sigma V = 0.000(m)$

(3) Weight total

$\Sigma W = \quad 19234.88 (kN)$

(4) Center of gravity position

$$Y = \frac{\Sigma W*Y}{\Sigma W} = \quad 8.516 (m)$$

$$Xc = \frac{\Sigma W*Xc}{\Sigma W} = \quad 0.000 (m)$$

2.1.2 Dynamic water pressure in seismic condition

(1) Axial direction

1) Case : Seismic Level1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 3.740(m))

$$P = \frac{9}{40} * k_h * w_0 * A_0 * h * \frac{b}{a}$$

$$= \frac{9}{40} * 0.30 * 9.80 * 44.569 * 3.740 * \frac{15.500}{3.000}$$

$$= 569.69 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 1.603 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 1.603 \text{ (m)}$$

2) Case : Seismic Level1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 3.740(m))

$$P = \frac{9}{40} * k_h * w_0 * A_0 * h * \frac{b}{a}$$

$$= \frac{9}{40} * 0.30 * 9.80 * 44.569 * 3.740 * \frac{15.500}{3.000}$$

$$= 569.69 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 1.603 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 1.603 \text{ (m)}$$

(2) Axial perpendicular direction

1) Case : Seismic Level1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 3.740(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 44.569 * 3.740 * \frac{3.000}{15.500} * \left(1 - \frac{3.000}{4 * 3.740}\right)$$

$$= 56.87 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 1.603 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 1.603 \text{ (m)}$$

2) Case : Seismic Level1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 3.740(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 44.569 * 3.740 * \frac{3.000}{15.500} * \left(1 - \frac{3.000}{4 * 3.740}\right)$$

$$= 56.87 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 1.603 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 1.603 \text{ (m)}$$

The following ;

P	: Total force of dynamic water pressure in seismic condition operated to structure (kN)
k_h	: Design horizontal seismic coefficient against level 1 earth quake vibration
w_0	: Water unit volume weight (kN/m^3)
h	: Water depth (m)
h_s	: Distance from column base to ground face (m) Note : ground face <= column base,then h_s= 0.0(m)
h_g	: The distance from ground face or column base to total force operated point of dynamic water pressure in seismic condition (m)
h_{g0}	: The distance from column base to total force operated point of dynamic water pressure in seismic condition (m)
b	: Frame body width, perpendicular direction against operated direction of dynamic water pressure in seismic condition (m)
a	: Frame body width of operated direction of dynamic water pressure in seismic condition (m)
A_0	: Section area of structure (m^2)

2.1.3 Flowing water pressure

(1) Axial perpendicular direction

1) Case : Vessel Collision(Low water level), Load plus direction (Upper load sediment height 1.729(m), water level 6.630(m))

$$P = K * v^2 * A$$

$$= 0.4 * 0.000^2 * 14.703$$

$$= 0.00 \text{ (kN)}$$

$$h_{g0} = 0.6 * h + h_s$$

$$= 0.6 * 4.901 + 1.729$$

$$= 0.000 \text{ (m)}$$

* Vertical projection area (column)

No	Height from column base (m)	Lower side column width (m)	Upper side column width (m)	Vertical projection area (m2)
1	1.729 - 6.630	3.000	3.000	14.703

2) Case : Vessel Collision(High water level), Load plus direction (Upper load sediment height 1.729(m), water level 6.630(m))

$$P = K * v^2 * A$$

$$= 0.4 * 0.000^2 * 14.703$$

$$= 0.00 \text{ (kN)}$$

$$h_{g0} = 0.6 * h + h_s$$

$$= 0.6 * 4.901 + 1.729$$

$$= 0.000 \text{ (m)}$$

* Vertical projection area (column)

No	Height from column base (m)	Lower side column width (m)	Upper side column width (m)	Vertical projection area (m2)
1	1.729 - 6.630	3.000	3.000	14.703

The following ;

- P : Total force of flowing water pressure operated to structure (kN)
- K : Resistance coefficient of pier
- v : Maximum flow velocity (m/s)
- A : Vertical projection area of pier (m^2)
- h : Floating water depth (m)
- h_s : Distance from column base to ground face (m) Note : ground face <= column base,then h_s= 0.0(m)
- h_{g0} : Distance from column base to total force operated point of flowing water pressure (m)

2.1.4 Super structural reaction force detail of every each load cases (bridge axial direction)

Bridge axial direction

Pier top edge center and eccentric distance of column center e1 = 0.000(m)

Height e2 = 0.000 from pier top edge to horizontal reaction force operated position (m)

Height from column base to pier top edge hB = 16.000(m)

load case	vertical reaction force RV(kN)	horizontal reaction force	moment (kN.m)		
			eccentric moment RM	RV * e1	RH*hB RH * e2
Collosion	21200.00	0.00	0.00	0.00	0.00 0.00

2.1.5 Super structural reaction force detail of every each load cases (perpendicular direction)

Bridge axial perpendicular direction

Pier top edge center and eccentric distance of column center e1 = 0.000(m)

Height e2 = 2.627 from pier top edge to horizontal reaction force operated position (m)

Height from column base to pier top edge hB = 16.000(m)

load case	vertical reaction force RV(kN)	horizontal reaction force	moment (kN.m)		
			eccentric moment RM	RV * e1	RH*hB RH * e2
Collision	21200.00	0.00	0.00	0.00	0.00 0.00

2.1.6 Section force of every each load cases (bridge axial direction)

Case:Ordinary

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		21200.00	0.00	16.000	0.00	0.00
Frame body		19234.88	0.00	8.516	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	40434.88	0.00	-------	----------	0.00
	High water level	40434.88	0.00	-------	----------	0.00

Case:Temperature Effect

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		21200.00	200.00	16.000	0.00	3200.00
Frame body		19234.88	0.00	8.516	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	40434.88	200.00	-------	----------	3200.00
	High water level	40434.88	200.00	-------	----------	3200.00

Case:Seismic Level1

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		16700.00	4600.00	16.000	0.00	73600.00
Frame body		19234.88	5770.47	8.516	0.00	49140.47
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Dynamic water pressure in seismic condition	Low water level	------	569.69	1.603	----------	913.14
Dynamic water pressure in seismic condition	High water level	------	569.69	1.603	----------	913.14
Total	Low water level	35934.88	10940.16	-------	----------	123653.61
	High water level	35934.88	10940.16	-------	----------	123653.61

Case:Vessel Collision

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		21200.00	0.00	16.000	0.00	0.00
Frame body		19234.88	0.00	8.516	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	3200.00	7.430	----------	23776.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	40434.88	3200.00	-------	----------	23776.00
	High water level	40434.88	3200.00	-------	----------	23776.00

2.1.7 Section force of each load cases (perpendicular direction)

Case:Ordinary

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		21200.00	0.00	16.000	6800.00	6800.00
Frame body		19234.88	0.00	8.516	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	40434.88	0.00	-------	----------	6800.00
	High water level	40434.88	0.00	-------	----------	6800.00

Case:Seismic Level1

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		16700.00	4900.00	16.000	18872.30	97272.30
Frame body		19234.88	5770.47	8.516	0.00	49140.47
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Dynamic water pressure in seismic condition	Low water level	------	56.87	1.603	----------	91.16
Dynamic water pressure in seismic condition	High water level	------	56.87	1.603	----------	91.16
Total	Low water level	35934.88	10727.34	-------	----------	146503.93
	High water level	35934.88	10727.34	-------	----------	146503.93

Case:Vessel Collision

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		21200.00	0.00	16.000	0.00	0.00
Frame body		19234.88	0.00	8.516	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	6400.00	7.430	----------	47552.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Flowing water pressure ------	Low water level					
Flowing water pressure	High water level	------	0.00	0.000	----------	0.00
Total	Low water level	40434.88	6400.00	-------	----------	47552.00
	High water level	40434.88	6400.00	-------	----------	47552.00

2.1.8 Section force list(total with column center position)

Bridge axial direction

Case	Water level	Vertical force (kN)	Horizontal force (kN)	Bending moment (kN.m)
Ordinary	Low	40434.88	0.00	0.00
Ordinary	Height	40434.88	0.00	0.00
Temperature	Low	40434.88	200.00	3200.00
Temperature	Height	40434.88	200.00	3200.00
Seismic	Low	35934.88	10940.16	123653.61
Seismic	Height	35934.88	10940.16	123653.61
Collosion	Low	40434.88	3200.00	23776.00
Collosion	Height	40434.88	3200.00	23776.00

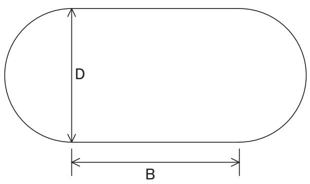
Bridge axial perpendicular direction

Case	Water level	Vertical force (kN)	Horizontal force (kN)	Bending moment (kN.m)
Ordinary	Low	40434.88	0.00	6800.00
Ordinary	Height	40434.88	0.00	6800.00
Seismic	Low	35934.88	10727.34	146503.93
Seismic	Height	35934.88	10727.34	146503.93
Collision	Low	40434.88	6400.00	47552.00
Collision	Height	40434.88	6400.00	47552.00

2.2 Consider of column base section

2.2.1 Axial direction

(1) Section shape and reinforcement arrangement



B = 12.500 (m) D = 3.000 (m)

Main reinforcement for section calculation(position is covering)

No.	Reinforcement position (mm)	Straight line part all reinforcement amount			Circle part part all reinforcement amount		
		Reinforcement diameter	Number sets	Reinforcement amount (mm2)	Reinforcement diameter	Number sets	Reinforcement amount (mm2)
1	150	D32	202	160428.4	D32	38	30179.6
2	250	D32	102	81008.4	----	----	------
					Total ΣAs1 = 241436.8	Total ΣAs2 =	30179.6
					Reinforcement amount total	ΣAs =	271616.4

Total amount of rebar As = 271616.4(mm^2)

* minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (17212.4mm^2)] OK
* maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2674115.0mm^2)] OK

(2) Section check

1)Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
Load condition	------	Ordinary			
Axial force N Bending moment M	kN kN.m	40434.88 0.00	40434.88 0.00	40434.88 3200.00	40434.88 3200.00
Compressive edge-middle axial x	mm	--------	--------	11573	11573
Compressive stress σc Tensile stress σs	N/mm^2 N/mm^2	0.83 -12.47	0.83 -12.47	0.96 -10.80	0.96 -10.80
Increasing coefficient α Allowable compressive stress σca Allowable tensile stress σsa	------ N/mm^2 N/mm^2	1.00 10.00 -200.00	1.00 10.00 -200.00	1.15 11.50 -230.00	1.15 11.50 -230.00
Crack moment Mc First yield moment My0 Ultimate bending moment Mu Minimum rebar amount as bending member Minimum rebar amount axial force member Axial force Nu 0.008A1' (axial force Na=N) 0.008A2' (axial force Nu) All reinforcement amount As >= Asmin Maximum reinforcement amount check (My0<=Mu)	kN.m kN.m kN.m ------ mm^2 kN mm^2 mm^2 ------ ------	66938.80 164461.48 182771.88 1.7M<=Mc 32027.6 35934.88 32027.6 10172.6 OK OK	66938.80 164461.48 182771.88 1.7M<=Mc 32027.6 35934.88 32027.6 10172.6 OK OK	66938.80 164461.48 182771.88 1.7M<=Mc 27850.1 35934.88 27850.1 10172.6 OK OK	66938.80 164461.48 182771.88 1.7M<=Mc 27850.1 35934.88 27850.1 10172.6 OK OK

Items	Unit	Seismic LowWL	Seismic HeightWL	Collosion LowWL	Collosion HeightWL
Load condition	------	Lv1 E.Q			
Axial force N Bending moment M	kN kN.m	35934.88 123653.61	35934.88 123653.61	40434.88 23776.00	40434.88 23776.00
Compressive edge-middle axial x	mm	948	948	2844	2844
Compressive stress σc Tensile stress σs	N/mm^2 N/mm^2	8.28 249.40	8.28 249.40	1.75 0.05	1.75 0.05
Increasing coefficient α Allowable compressive stress σca Allowable tensile stress σsa	------ N/mm^2 N/mm^2	1.50 15.00 300.00	1.50 15.00 300.00	1.50 15.00 300.00	1.50 15.00 300.00
Crack moment Mc First yield moment My0 Ultimate bending moment Mu Minimum rebar amount as bending member Minimum rebar amount axial force member Axial force Nu 0.008A1' (axial force Na=N) 0.008A2' (axial force Nu) All reinforcement amount As >= Asmin Maximum reinforcement amount check (My0<=Mu)	kN.m kN.m kN.m ------ mm^2 kN mm^2 mm^2 ------ ------	64778.02 159380.48 176921.84 Mc<=Mu 18975.5 35934.88 18975.5 10172.6 OK OK	64778.02 159380.48 176921.84 Mc<=Mu 18975.5 35934.88 18975.5 10172.6 OK OK	66938.80 164461.48 182771.88 1.7M<=Mc 21351.8 35934.88 21351.8 10172.6 OK OK	66938.80 164461.48 182771.88 1.7M<=Mc 21351.8 35934.88 21351.8 10172.6 OK OK

Asmin(0.008A') : minimum reinforcement amount of member received axial direction force

2)Consider against shear force

items	unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
condition	--------	Ordinary	Ordinary	Dead+Live+ Temperature	Dead+Live+ Temperature
b d	mm mm	15159 2780	15159 2780	15159 2780	15159 2780
S N M	kN kN kN.m	0.00 40434.88 0.00	0.00 40434.88 0.00	200.00 40434.88 3200.00	200.00 40434.88 3200.00
α pt ce cpt CN	------- % ------ ------ ------	1.00 0.322 0.733 1.022 1.000	1.00 0.322 0.733 1.022 1.000	1.15 0.322 0.733 1.022 1.000	1.15 0.322 0.733 1.022 1.000
τm $\tau a1$ $\tau a2$	N/mm^2 N/mm^2 N/mm^2	0.000 0.187 1.900	0.000 0.187 1.900	0.005 0.215 2.185	0.005 0.215 2.185

items	unit	Seismic LowWL	Seismic HeightWL	Collision LowWL	Collision HeightWL
condition	--------	Lv1 EQ	Lv1 EQ	Vessel Collision	Vessel Collision
b	mm	15159	15159	15159	15159
d	mm	2780	2780	2780	2780
S	kN	10940.16	10940.16	3200.00	3200.00
N	kN	35934.88	35934.88	40434.88	40434.88
M	kN.m	123653.61	123653.61	23776.00	23776.00
α	-------	1.50	1.50	1.50	1.50
pt	%	0.322	0.322	0.322	0.322
ce	------	0.733	0.733	0.733	0.733
cpt	------	1.022	1.022	1.022	1.022
CN	------	1.000	1.000	1.000	1.000
τm	N/mm^2	0.260	0.260	0.076	0.076
τa1	N/mm^2	0.277	0.277	0.277	0.277
τa2	N/mm^2	2.850	2.850	2.850	2.850

The following ;

S : Shear force

N : Axial force

M : Bending moment

b : Member section width

d : Effective height

α : Increasing coefficient of allowable stress

pt : Tensile main reinforcement ratio

ce : Correction coefficient of allowable shear stress about effective height d

cpt : Correction coefficient of allowable shear stress about tensile reinforcement ratio

CN : Correction coefficient by axial direction compressive force

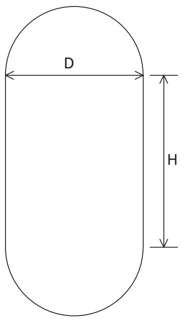
τm : Average shear stress

τa1 : Allowable shear stress when share shear force by only concrete

τa2 : Shear supplemental barAllowable shear stress when share the shear force with

2.2.2 Axial perpendicular direction

(1) Section shape and reinforcement arrangement



H = 12.500 (m) D = 3.000 (m)

Main reinforcement for section calculation(position is covering)

No.	Reinforcement position (mm)	Straight line part all reinforcement amount			Circle part part all reinforcement amount		
		Reinforcement diameter	Number sets	Reinforcement amount (mm^2)	Reinforcement diameter	Number sets	Reinforcement amount (mm^2)
1	150	D32	202	160428.4	D32	38	30179.6
2	250	D32	102	81008.4	----	----	------
					Total ΣAs1 = 241436.8	Total ΣAs2 =	30179.6
					Reinforcement amount total	ΣAs =	271616.4

Total amount of rebar As = 271616.4(mm^2)

* minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (17212.4mm^2)] OK

* maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2674115.0mm^2)] OK

(2) Section check

1)Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Seismic LowWL	Seismic HeightWL
Load condition	------	Ordinary			
Axial force N	kN	40434.88	40434.88	35934.88	35934.88
Bending moment M	kN.m	6800.00	6800.00	146503.93	146503.93
Compressive edge-middle axial x	mm	117313	117313	10799	10799
Compressive stress σc	N/mm^2	0.89	0.89	2.19	2.19
Tensile stress σs	N/mm^2	-11.60	-11.60	13.84	13.84
Increasing coefficient α	------	1.00	1.00	1.50	1.50
Allowable compressive stress σca	N/mm^2	10.00	10.00	15.00	15.00
Allowable tensile stress σsa	N/mm^2	-200.00	-200.00	300.00	300.00
Crack moment Mc	kN.m	332815.69	332815.69	322072.38	322072.38
First yield moment My0	kN.m	588644.43	588644.43	565093.47	565093.47
Ultimate bending moment Mu	kN.m	892340.37	892340.37	866148.98	866148.98
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm^2	32027.6	32027.6	18975.5	18975.5
Axial force Nu	kN	35934.88	35934.88	35934.88	35934.88
0.008A1' (axial force Na=N)	mm^2	32027.6	32027.6	18975.5	18975.5
0.008A2' (axial force Nu)	mm^2	10172.6	10172.6	10172.6	10172.6
All reinforcement amount As >= Asmin	------	OK	OK	OK	OK
Maximum reinforcement amount check (My0<=Mu)	------	OK	OK	OK	OK

Items	Unit	Collision LowWL	Collision HeightWL
Load condition	------	Vessel Collision	
Axial force N	kN	40434.88	40434.88
Bending moment M	kN.m	47552.00	47552.00
Compressive edge-middle axial x	mm	23418	23418
Compressive stress σc	N/mm^2	1.24	1.24
Tensile stress σs	N/mm^2	-6.42	-6.42
Increasing coefficient α	------	1.50	1.50
Allowable compressive stress σca	N/mm^2	15.00	15.00
Allowable tensile stress σsa	N/mm^2	-300.00	-300.00
Crack moment Mc	kN.m	332815.69	332815.69
First yield moment My0	kN.m	588644.43	588644.43
Ultimate bending moment Mu	kN.m	892340.37	892340.37
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm^2	21351.8	21351.8
Axial force Nu	kN	35934.88	35934.88
0.008A1' (axial force Na=N)	mm^2	21351.8	21351.8
0.008A2' (axial force Nu)	mm^2	10172.6	10172.6
All reinforcement amount As >= Asmin	------	OK	OK
Maximum reinforcement amount check (My0<=Mu)	------	OK	OK

Asmin(0.008A') : minimum reinforcement amount of member received axial direction force

2)Consider against shear force

items	unit	Ordinary LowWL	Ordinary HeightWL	Seismic LowWL	Seismic HeightWL
condition	--------	Ordinary	Ordinary	Lv1 EQ	Lv1 EQ
b	mm	2940	2940	2940	2940
d	mm	15042	15042	15042	15042
S	kN	0.00	0.00	10727.34	10727.34
N	kN	40434.88	40434.88	35934.88	35934.88
M	kN.m	6800.00	6800.00	146503.93	146503.93
α	-------	1.00	1.00	1.50	1.50
pt	%	0.307	0.307	0.307	0.307
ce	------	0.500	0.500	0.500	0.500
cpt	------	1.007	1.007	1.007	1.007
CN	------	1.000	1.000	1.000	1.000
τ_m	N/mm^2	0.000	0.000	0.243	0.243
τ_{a1}	N/mm^2	0.126	0.126	0.186	0.186
τ_{a2}	N/mm^2	1.900	1.900	2.850	2.850
σ_{sa}	N/mm^2	------------	------------	300.00	300.00
s	mm	------------	------------	150	150
Sca	kN	------------	------------	8239.76	8239.76
Sh'	kN	------------	------------	2487.58	2487.58
AwReq	mm^2	------------	------------	95.09	95.09
Aw	mm^2	------------	------------	1146.00	1146.00

items	unit	Collision LowWL	Collision HeightWL
condition	--------	Vessel Collision	Vessel Collision
b	mm	2940	2940
d	mm	15042	15042
S	kN	6400.00	6400.00
N	kN	40434.88	40434.88
M	kN.m	47552.00	47552.00
α	-------	1.50	1.50
pt	%	0.307	0.307
ce	------	0.500	0.500
cpt	------	1.007	1.007
CN	------	1.000	1.000
τ_m	N/mm^2	0.145	0.145
τ_{a1}	N/mm^2	0.186	0.186
τ_{a2}	N/mm^2	2.850	2.850
σ_{sa}	N/mm^2	------------	------------
s	mm	------------	------------
Sca	kN	------------	------------
Sh'	kN	------------	------------
AwReq	mm^2	------------	------------
Aw	mm^2	------------	------------

The following ;

S : Shear force

N : Axial force

M : Bending moment

b : Member section width

d : Effective height

α : Increasing coefficient of allowable stress

pt : Tensile main reinforcement ratio

ce : Correction coefficient of allowable shear stress about effective height d

cpt : Correction coefficient of allowable shear stress about tensile reinforcement ratio

CN : Correction coefficient by axial direction compressive force

τm : Average shear stress

τa1 : Allowable shear stress when share shear force by only concrete

τa2 : Shear supplemental barAllowable shear stress when share the shear force with

σsa : Allowable tensile stress of reinforcement

s : Shear supplemental bar interval of

Sca : Concrete sharing shear force

Sh' : Shear supplemental bar sharing shear force

Awreq : Necessary for τa1 < τmShear supplemental barAmount

Aw : Shear supplemental barAmount

4.3 DETAIL CALCULATION SHEET OF RC PIER COLUMN OF P7

As for verification at bottom of RC Pier column, following load combinations as critical cases among various combinations are considered.

Bridge Axis Direction

Load Combination	Design Elevation	Water Level	Ground Elevation	Increase Coefficient of Allowable Stress
Ordinary Condition (D+L)	ELE-6.35m (elevation of top of footing)	High tide in spring tide EL+3.18m Low tide in spring tide EL-2.39m	Existing Ground Level EL-5.346m	1.0
Ordinary Condition(D+L)＋Effect of Temperature Change	ELE-6.35m (elevation of top of footing)	High tide in spring tide EL+3.18m Low tide in spring tide EL-2.39m	Existing Ground Level EL-5.346m	1.15
Vessel Collision	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m	Existing Ground Level EL-1.721m	1.5
Earthquake Condition with Hydrodynamic Pressure during Earthquake (Level-1)	ELE-6.35m (elevation of top of footing)	EL+0.29m	With local scouring, thus setting at same level of bottom of pier.	1.5

Bridge Axis Perpendicular Direction

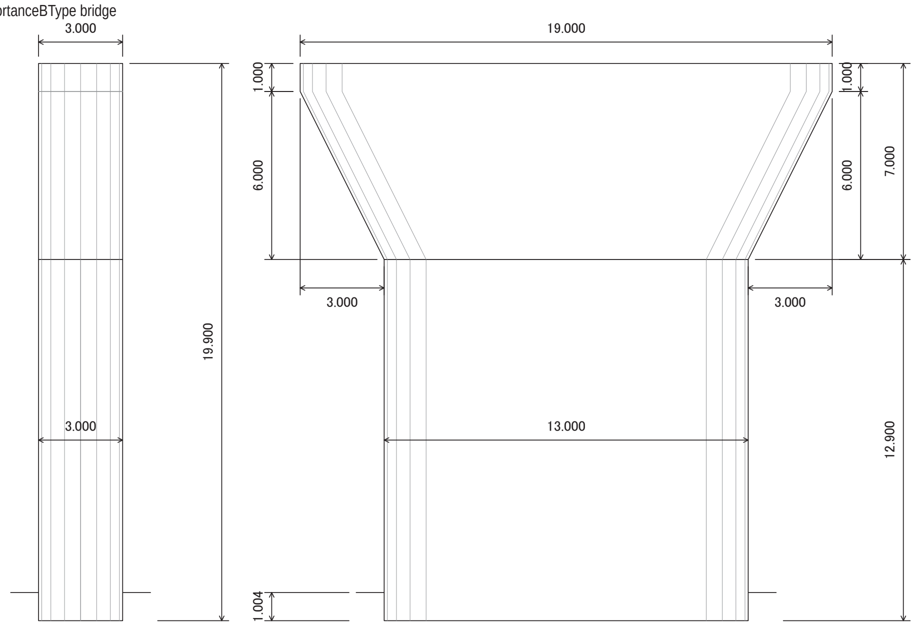
Load Combination	Design Elevation	Water Level	Ground Elevation	Increase Coefficient of Allowable Stress
Ordinary Condition (D+L)	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m Low tide in spring tide EL-2.39m	Existing Ground Level EL-1.721m	1.0
Vessel Collision	ELE-3.45m (elevation of top of footing)	High tide in spring tide EL+3.18m	Existing Ground Level EL-1.721m	1.5
Earthquake Condition with Hydrodynamic Pressure during Earthquake (Level-1)	ELE-3.45m (elevation of top of footing)	EL+0.29m	With local scouring, thus setting at same level of bottom of pier.	1.5

Contents

1 Design condition

1.1 Shape dimension

Type RCOvalColumn pier (new consider)
Beam shape type Beam type(oval)
Foundation type Spread foundation
Division of importanceBType bridge



(right side is back side)

Items	Symbol	Dimension(m)
Beam height Bridge axial direction beam width Bridge axial perpendicular direction beam width (left side) Ditto (right side) Lower face bridge axial right angle drawn height Lower face bridge axial right angle drawn length (left side) Ditto (right side)	H B_L B_{TL} B_{TR} H_t B_{tL} B_{tR}	7.000 0.000 3.000 3.000 6.000 3.000 3.000
Column height(column base - beam lower face) Bridge axial direction column width Bridge axial perpendicular direction column width	H B_L B_T	12.900 3.000 13.000
Surface (from column lower edge)	h_G	1.004

1.2 Super structure reaction

1.2.1 Dead load reaction force and inertia force operated position

Super structural dead load reaction force R_D 21400.00 (kN)

bridge axial	bridge axial	right angle
operated position of super structural inertia force h_I (m)	0.000	2.574

1.2.2 Allowable stress design method

Live load reaction force and horizontal reaction force in seismic condition

bridge axial	bridge axial	right angle
super structural load reaction force R_L (kN) horizontal reaction force in seismic condition R_H (kN)	5200.00 4400.00	5200.00 7000.00

1.2.3 Ductility design method

Dead load horizontal force and eccentric moment

	bridge axial	bridge axial right angle
Dead load horizontal force H (kN) Dead load eccentric moment Me (kN.m)	0.00 0.00	0.00 0.00

Dead load horizontal force load super structural inertia force operated position.

1.3 Design horizontal seismic coefficient

Religion division : A2 Religion

Ground type : III Type ground

1.3.1 Allowable stress design method

	kh	khg
Axial direction Perpendicular direction	0.30 0.30	0.24 0.24

kh : Design horizontal seismic coefficient of level 1 earth quake vibration

khg : Design horizontal seismic coefficient in ground face of level 1 earth quake vibration

1.3.2 Ductility design method

Bridge axial direction

	Design seismic coefficient type I sharing weight				Design seismic coefficient typeII sharing weight			
	CIzkhco	khg	khcmin	Wu (kN)	CIIzkhco	khg	khcmin	Wu (kN)
Plus dir	0.3000	0.40	0.00	0.00	0.3000	0.60	0.00	0.00

Bridge axial perpendicular direction

	Design seismic coefficient type I sharing weight				Design seismic coefficient typeII sharing weight			
	CIzkhco	khg	khcmin	Wu (kN)	CIIzkhco	khg	khcmin	Wu (kN)
Plus dir	0.3000	0.40	0.00	0.00	0.3000	0.60	0.00	0.00

CIzkhco : Standard value of correction coefficient by religions x design horizontal seismic coefficient (type I)
CIIzkhco : Standard value of correction coefficient by religions x design horizontal seismic coefficient (type II)
khg : Design horizontal seismic coefficient in ground face
khcmin : Maximum value of design horizontal seismic coefficient in same vibration unit system
Wu : Super structural weight that pier supports

1.4 Unit weight

Young's modulus of reinforcement Es 2.00x10^5(N/mm^2)
Young's modulus ratio of section design 15
Unit weight of reinforcement concrete γc 24.50(kN/m^3)
Water unit weight γw 9.80(kN/m^3)
Unit weight of sediment (backfill) γt 17.50(kN/m^3)
Water unit weight on sediment buoyancy calculation γw 9.00(kN/m^3)

1.5 Column

1.5.1 Material of use

Design standard strength of concrete σck 30.0(N/mm^2)
Young's modulus of concrete Ec 2.80x10^4(N/mm^2)
Main reinforcement material SD345
Striped reinforcement material SD345

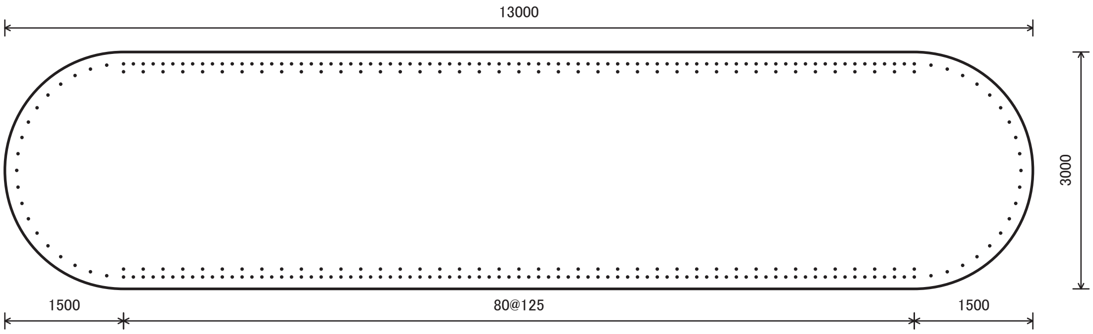
Tensile stress of column reinforcement uses basic value as the member in water.
Not consider correction coefficient cN to allowable shear stress τa1of column.

1.5.2 Rebar

(1) Base main reinforcement

Cover	Straight linear part		Circular arc	
(mm)	Diameter	Bar Arrangement	Diameter	One side Number
150 250	D38 D38	1500+80@125+1500 1500+40@250+1500	D38 ----	19 ----

Note : Reinforcement amount total 321480.0mm^2,
*Satisfy more than [reinforcement amount of 500mm^2 / m (14712.4mm^2)]Do.
*Satisfy no more than [reinforcement amount (37068583.5mm^2) to be 6% of section area (2224115.0mm^2) ｣Do.



(2) Hoop reinforcement

Reinforcement diameter　D22

Striped reinforcement arranged since second step not consider as Lateral restraint bar

Striped reinforcement arranged since second step not consider as Shear supplemental bar

1) Intermediate ties

Intermediate ties arrangement

Reinforcement diameter　D22

Bridge axial direction　11 number / step

Perpendicular direction　　2 number / step

Not consider Intermediate ties of perpendicular direction as Lateral restraint bar

2) Height direction arrangement

Section	Starting edge height h(m)	Height interval s(mm)	Interval multiple
1	0.000	150	1

3) Length of plastic hinged

Section	Starting edge height h(m)	Number of axial direction reinforcement ns(number)			
		Bridge axial back side	Bridge axial front side	Right angle right side	Right angle left side
1	0.000	1	1	Cal.inside	Cal.inside

1.5.3 Oval column section direction division sets and section correction coefficient

Section direction division sets　50

Section correction coefficient αβ

Section correction factor	Bridge axial	Perpendicular
α	0.20	1.00
β	0.40	1.00

1.6 Shape of earth surface

surface type :Horizontal

1.7 Allowable stress design method load case

Considering allowable stress method of column is calculated at the following load case.

1.7.1 Axial direction

(1) case : Ordinary(abbreviation : Ordinary) load condition : Ordinary(increasing coefficient of allowable stress 1.00)

low water level : 3.960m high water level : 9.530m sediment height: 1.004m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	21400.00
Live load reaction R_L	5200.00
Total	26600.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	0.000	0.00	0.00	0.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Upper load sediment on footing check

Front side(Low water level) sediment on checkDo not consider

Back side(Low water level) sediment on checkDo not consider

Front side(High water level) sediment on checkDo not consider

Back side(High water level) sediment on checkDo not consider

(2) case : Temperature Effect(abbreviation : Temperature) load condition : Dead+ Live + Temperature(increasing coefficient of allowable stress 1.15)

low water level : 3.960m high water level : 9.530m sediment height: 1.004m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	21400.00
Live load reaction R_L	5200.00
Total	26600.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
200.00	0.000	0.00	0.00	0.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Upper load sediment on footing check

Front side(Low water level) sediment on checkDo not consider

Back side(Low water level) sediment on checkDo not consider

Front side(High water level) sediment on checkDo not consider

Back side(High water level) sediment on checkDo not consider

(3) case : Seismic Level1(abbreviation : Seismic) load condition : Lv1E.Q.(increasing coefficient of allowable stress 1.50)
low water level : 6.640m high water level : 6.640m sediment height: 0.000m (from each Lower edge of column)
1) Load
super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	21400.00
Total	21400.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
4400.00	0.000	0.00	0.00	0.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Bridge axial direction upward (plus direction)
Dynamic water pressure Bridge axial direction upward (plus direction)
Upper load sediment on footing check
Front side(Low water level) sediment on checkDo not consider
Back side(Low water level) sediment on checkDo not consider
Front side(High water level) sediment on checkDo not consider
Back side(High water level) sediment on checkDo not consider

(4) case : Vessel Collision(abbreviation : Collision) load condition : Vessel Collision(increasing coefficient of allowable stress 1.50)
low water level : 9.530m high water level : 9.530m sediment height: 1.004m (from each Lower edge of column)
1) Load
super structural reaction force (operated to beam top edge * beam center)

load name	vertical force V(kN)	horizontal force H(kN)	eccentric distance e(m)	operated height h(m)	moment M(kN.m)
RD	21400.00	0.00	0.000	0.000	0.00
RL	5200.00	0.00	0.000	0.000	0.00
total 26600.00					

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Do not consider
Load directly operated to frame body
Flowing water pressure bridge axial direction not consider

Impact load load bridge axial direction
Height from column lower edge 10.330 (m)
Load strength 3800.00 (kN)
Upper load sediment on footing check
Front side(Low water level) sediment on checkDo not consider
Back side(Low water level) sediment on checkDo not consider
Front side(High water level) sediment on checkDo not consider
Back side(High water level) sediment on checkDo not consider

1.7.2 Axial perpendicular direction

(1) case : Ordinary(abbreviation : Ordinary) load condition : Ordinary(increasing coefficient of allowable stress 1.00)

low water level : 3.960m high water level : 9.530m sediment height: 1.004m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	21400.00
Live load reaction R_L	5200.00
Total	26600.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	2.574	0.00	3100.00	3100.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Upper load sediment on footing check

Left side(Low water level) sediment on checkDo not consider

Right side(Low water level) sediment on checkDo not consider

Left side(High water level) sediment on checkDo not consider

Right side(High water level) sediment on checkDo not consider

(2) case : Seismic Level1(abbreviation : Seismic) load condition : Lv1E.Q.(increasing coefficient of allowable stress 1.50)

low water level : 6.640m high water level : 6.640m sediment height: 0.000m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

	Vertical force (kN)
Dead load reaction R_D	21400.00
Total	21400.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
7000.00	2.574	18018.00	2500.00	20518.00

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition perpendicular direction rightward (plus direction)

Dynamic water pressure perpendicular direction rightward (plus direction)

Upper load sediment on footing check

Left side(Low water level) sediment on checkDo not consider

Right side(Low water level) sediment on checkDo not consider

Left side(High water level) sediment on checkDo not consider

Right side(High water level) sediment on checkDo not consider

(3) case : Vessel Collision(abbreviation : Collision) load condition : Vessel Collision(increasing coefficient of allowable stress 1.50)

low water level : 9.530m high water level : 9.530m sediment height: 1.004m (from each Lower edge of column)

1) Load

super structural reaction force (operated to beam top edge * beam center)

load name	vertical force V(kN)	horizontal force H(kN)	eccentric distance e(m)	operated height h(m)	moment M(kN.m)
RD	21400.00	0.00	0.000	0.000	0.00
RL	5200.00	0.00	0.000	0.000	0.00
total 26600.00					

Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.

Inertia force in seismic condition Do not consider

Load directly operated to frame body

Flowing water pressure Bridge axial perpendicular rightward direction

Flow velocity 0.000 (m/sec)

Impact load Load to bridge axial perpendicular direction

Height from column lower edge 10.330 (m)

Load strength 7500.00 (kN)

Upper load sediment on footing check

Left side(Low water level) sediment on checkDo not consider

Right side(Low water level) sediment on checkDo not consider

Left side(High water level) sediment on checkDo not consider

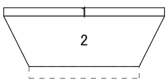
Right side(High water level) sediment on checkDo not consider

2 Column design(Allowable stress design method)

2.1 Cross section force of column base

2.1.1 Frame body own load

(1) Beam part



No.	Block name	Left height H1(m)	Right height H2(m)	Left upper width W1(m)	Left lower width B1(m)	Right upper width W2(m)	Right lower width B2(m)	Member length L(m)	Volume V(m3)
1	Drawn upper face	1.000	1.000	3.000	3.000	3.000	3.000	19.000	55.06858
2	Drawn parts	6.000	6.000	3.000	3.000	3.000	3.000	19.000	276.41150

No	volume V(m3)	Xg (m)	Yg (m)	Zg (m)	V*Xg (m4)	V*Yg (m4)	V*Zg (m4)
1	55.06858	0.0000	6.5000	0.0000	0.0000	357.9458	0.0000
2	276.41150	0.0000	3.1954	0.0000	0.0000	883.2345	0.0000
Σ	331.48008	------	------	------	0.0000	1241.1803	0.0000

Note : Table's center of figure (Xg,Yg,Zg) is the coordinated system that column center of beam lower edge position sets (0,0,0)

Height PH = 12.900 from column base to beam lower edge (m)

W = ΣV *γc = 331.48008*24.50 = 8121.26(kN)

Y = Σ(V*Yg)/ΣV + PH = 16.644(m)

Xc = Σ(V*Xg)/ΣV = 0.000(m)

(2) Column part

No	block name	Br1 (m)	Br2 (m)	Ba1 (m)	Ba2 (m)	H (m)	volume V(m3)
1	Oval Column	13.000	13.000	3.000	3.000	12.900	478.18473

No	volume V(m3)	Xg (m)	Yg (m)	Zg (m)	V*Xg (m4)	V*Yg (m4)	V*Zg (m4)
1	478.18473	0.0000	6.4500	0.0000	0.0000	3084.2915	0.0000
Σ	478.18473	------	------	------	0.0000	3084.2915	0.0000

Note : Table's center of figure (Xg,Yg,Zg) is the coordinated system that column center of column base (Ignore taper width) sets (0,0,0)

W = ΣV *γc = 478.18473*24.50 = 11715.53(kN)

Y = Σ(V*Yg)/ΣV = 6.450(m)

Xc = Σ(V*Xg)/ΣV = 0.000(m)

(3) Weight total

$\Sigma W =$ 19836.79(kN)

(4) Center of gravity position

$$Y = \frac{\Sigma W*Y}{\Sigma W} = 10.624(m)$$

$$Xc = \frac{\Sigma W*Xc}{\Sigma W} = 0.000(m)$$

2.1.2 Dynamic water pressure in seismic condition

(1) Axial direction

1) Case : Seismic Level1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 6.640(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 37.069 * 6.640 * \frac{13.000}{3.000} * \left(1 - \frac{13.000}{4 * 6.640}\right)$$

$$= 1200.71 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 2.846 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 2.846 \text{ (m)}$$

2) Case : Seismic Level1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 6.640(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 37.069 * 6.640 * \frac{13.000}{3.000} * \left(1 - \frac{13.000}{4 * 6.640}\right)$$

$$= 1200.71 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 2.846 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 2.846 \text{ (m)}$$

(2) Axial perpendicular direction

1) Case : Seismic Level1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 6.640(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 37.069 * 6.640 * \frac{3.000}{13.000} * \left(1 - \frac{3.000}{4 * 6.640}\right)$$

$$= 111.10 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 2.846 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 2.846 \text{ (m)}$$

2) Case : Seismic Level1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 6.640(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 37.069 * 6.640 * \frac{3.000}{13.000} * \left(1 - \frac{3.000}{4 * 6.640}\right)$$

$$= 111.10 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 2.846 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 2.846 \text{ (m)}$$

The following ;

P	: Total force of dynamic water pressure in seismic condition operated to structure (kN)
k_h	: Design horizontal seismic coefficient against level 1 earth quake vibration
w_0	: Water unit volume weight (kN/m^3)
h	: Water depth (m)
h_s	: Distance from column base to ground face (m) Note : ground face <= column base,then h_s= 0.0(m)
h_g	: The distance from ground face or column base to total force operated point of dynamic water pressure in seismic condition (m)
h_{g0}	: The distance from column base to total force operated point of dynamic water pressure in seismic condition (m)
b	: Frame body width, perpendicular direction against operated direction of dynamic water pressure in seismic condition (m)
a	: Frame body width of operated direction of dynamic water pressure in seismic condition (m)
A_0	: Section area of structure (m^2)

2.1.3 Flowing water pressure

(1) Axial perpendicular direction

1) Case : Vessel Collision(Low water level), Load plus direction (Upper load sediment height 1.004(m), water level 9.530(m))

$P = K * v^2 * A$

$= 0.4 * 0.000^2 * 25.578$

$= 0.00$ (kN)

$h_{g0} = 0.6 * h + h_s$

$= 0.6 * 8.526 + 1.004$

$= 0.000$ (m)

* Vertical projection area (column)

No	Height from column base (m)	Lower side column width (m)	Upper side column width (m)	Vertical projection area (m2)
1	1.004 - 9.530	3.000	3.000	25.578

2) Case : Vessel Collision(High water level), Load plus direction (Upper load sediment height 1.004(m), water level 9.530(m))

$P = K * v^2 * A$

$= 0.4 * 0.000^2 * 25.578$

$= 0.00$ (kN)

$h_{g0} = 0.6 * h + h_s$

$= 0.6 * 8.526 + 1.004$

$= 0.000$ (m)

* Vertical projection area (column)

No	Height from column base (m)	Lower side column width (m)	Upper side column width (m)	Vertical projection area (m2)
1	1.004 - 9.530	3.000	3.000	25.578

The following ;

P : Total force of flowing water pressure operated to structure (kN)

K : Resistance coefficient of pier

v : Maximum flow velocity (m/s)

A : Vertical projection area of pier (m^2)

h : Floating water depth (m)

h_s : Distance from column base to ground face (m) Note : ground face <= column base,then h_s= 0.0(m)

h_{g0} : Distance from column base to total force operated point of flowing water pressure (m)

2.1.4 Super structural reaction force detail of every each load cases (bridge axial direction)

Bridge axial direction

Pier top edge center and eccentric distance of column center e1 = 0.000(m)

Height e2 = 0.000 from pier top edge to horizontal reaction force operated position (m)

Height from column base to pier top edge hB = 19.900(m)

load case	vertical reaction force RV(kN)	horizontal reaction force	moment (kN.m)		
			eccentric moment RM	RV * e1	RH*hB RH * e2
Collision	26600.00	0.00	0.00	0.00	0.00 0.00

2.1.5 Super structural reaction force detail of every each load cases (perpendicular direction)

Bridge axial perpendicular direction

Pier top edge center and eccentric distance of column center e1 = 0.000(m)

Height e2 = 2.574 from pier top edge to horizontal reaction force operated position (m)

Height from column base to pier top edge hB = 19.900(m)

load case	vertical reaction force RV(kN)	horizontal reaction force	moment (kN.m)		
			eccentric moment RM	RV * e1	RH*hB RH * e2
Collision	26600.00	0.00	0.00	0.00	0.00 0.00

2.1.6 Section force of every each load cases (bridge axial direction)

Case:Ordinary

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		26600.00	0.00	19.900	0.00	0.00
Frame body		19836.79	0.00	10.624	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	46436.79	0.00	-------	----------	0.00
	High water level	46436.79	0.00	-------	----------	0.00

Case:Temperature Effect

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		26600.00	200.00	19.900	0.00	3980.00
Frame body		19836.79	0.00	10.624	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	46436.79	200.00	-------	----------	3980.00
	High water level	46436.79	200.00	-------	----------	3980.00

Case:Seismic Level1

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		21400.00	4400.00	19.900	0.00	87560.00
Frame body		19836.79	5951.04	10.624	0.00	63221.50
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Dynamic water pressure in seismic condition	Low water level	------	1200.71	2.846	----------	3416.86
Dynamic water pressure in seismic condition	High water level	------	1200.71	2.846	----------	3416.86
Total	Low water level	41236.79	11551.74	-------	----------	154198.37
	High water level	41236.79	11551.74	-------	----------	154198.37

Case:Vessel Collision

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		26600.00	0.00	19.900	0.00	0.00
Frame body		19836.79	0.00	10.624	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	3800.00	10.330	----------	39254.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	46436.79	3800.00	-------	----------	39254.00
	High water level	46436.79	3800.00	-------	----------	39254.00

2.1.7 Section force of every each load cases (perpendicular direction)

Case:Ordinary

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		26600.00	0.00	19.900	3100.00	3100.00
Frame body		19836.79	0.00	10.624	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Total	Low water level	46436.79	0.00	-------	----------	3100.00
	High water level	46436.79	0.00	-------	----------	3100.00

Case:Seismic Level1

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		21400.00	7000.00	19.900	20518.00	159818.00
Frame body		19836.79	5951.04	10.624	0.00	63221.50
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	0.00	0.000	----------	0.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Dynamic water pressure in seismic condition	Low water level	------	111.10	2.846	----------	316.15
Dynamic water pressure in seismic condition	High water level	------	111.10	2.846	----------	316.15
Total	Low water level	41236.79	13062.13	-------	----------	223355.66
	High water level	41236.79	13062.13	-------	----------	223355.66

Case:Vessel Collision

		V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force		26600.00	0.00	19.900	0.00	0.00
Frame body		19836.79	0.00	10.624	0.00	0.00
Load operated to beam top edge		0.00	0.00	0.000	0.00	0.00
Concentrated load operated to column		0.00	7500.00	10.330	----------	77475.00
Spread load operated to column		0.00	0.00	0.000	----------	0.00
Flowing water pressure ------	Low water level					
Flowing water pressure	High water level	------	0.00	0.000	----------	0.00
Total	Low water level	46436.79	7500.00	-------	----------	77475.00
	High water level	46436.79	7500.00	-------	----------	77475.00

2.1.8 Section force list(total with column center position)

Bridge axial direction

Case	Water level	Vertical force (kN)	Horizontal force (kN)	Bending moment (kN.m)
Ordinary	Low	46436.79	0.00	0.00
Ordinary	Height	46436.79	0.00	0.00
Temperature	Low	46436.79	200.00	3980.00
Temperature	Height	46436.79	200.00	3980.00
Seismic	Low	41236.79	11551.74	154198.37
Seismic	Height	41236.79	11551.74	154198.37
Collision	Low	46436.79	3800.00	39254.00
Collision	Height	46436.79	3800.00	39254.00

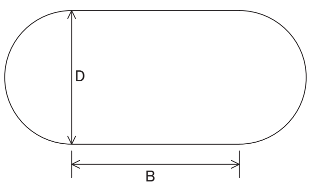
Bridge axial perpendicular direction

Case	Water level	Vertical force (kN)	Horizontal force (kN)	Bending moment (kN.m)
Ordinary	Low	46436.79	0.00	3100.00
Ordinary	Height	46436.79	0.00	3100.00
Seismic	Low	41236.79	13062.13	223355.66
Seismic	Height	41236.79	13062.13	223355.66
Collision	Low	46436.79	7500.00	77475.00
Collision	Height	46436.79	7500.00	77475.00

2.2 Consider of column base section

2.2.1 Axial direction

(1) Section shape and reinforcement arrangement



B = 10.000 (m) D = 3.000 (m)

Main reinforcement for section calculation(position is covering)

No.	Reinforcement position (mm)	Straight line part all reinforcement amount			Circle part part all reinforcement amount		
		Reinforcement diameter	Number sets	Reinforcement amount (mm2)	Reinforcement diameter	Number sets	Reinforcement amount (mm2)
1	150	D38	162	184680.0	D38	38	43320.0
2	250	D38	82	93480.0	----	----	------
					Total ΣAs1 = 278160.0	Total ΣAs2 = 43320.0	
					Reinforcement amount total ΣAs = 321480.0		

Total amount of rebar As = 321480.0(mm^2)

* minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (14712.4mm^2)] OK

* maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2224115.0mm^2)] OK

(2) Section check

1)Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
Load condition	------	Ordinary Ordinary			
Axial force N	kN	46436.79	46436.79	46436.79	46436.79
Bending moment M	kN.m	0.00	0.00	3980.00	3980.00
Compressive edge-middle axial x	mm	--------	--------	11047	11047
Compressive stress σc	N/mm2	1.11	1.11	1.28	1.28
Tensile stress σs	N/mm2	-16.63	-16.63	-14.28	-14.28
Increasing coefficient α	------	1.00	1.00	1.15	1.15
Allowable compressive stress σca	N/mm2	10.00	10.00	11.50	11.50
Allowable tensile stress σsa	N/mm2	-200.00	-200.00	-230.00	-230.00
Crack moment Mc	kN.m	61307.16	61307.16	61307.16	61307.16
First yield moment My0	kN.m	188235.79	188235.79	188235.79	188235.79
Ultimate bending moment Mu	kN.m	211595.65	211595.65	211595.65	211595.65
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm2	36781.6	36781.6	31984.0	31984.0
Axial force Nu	kN	41236.79	41236.79	41236.79	41236.79
0.008A1' (axial force Na=N)	mm2	36781.6	36781.6	31984.0	31984.0
0.008A2' (axial force Nu)	mm2	11673.5	11673.5	11673.5	11673.5
All reinforcement amount As >= Asmin	------	OK	OK	OK	OK
Maximum reinforcement amount check (My0<=Mu)	------	OK	OK	OK	OK

Items	Unit	Seismic LowWL	Seismic HeightWL	Collision LowWL	Collision HeightWL
Load condition	------	Lv1E.Q. Lv1E.Q.			
Axial force N	kN	41236.79	41236.79	46436.79	46436.79
Bending moment M	kN.m	154198.37	154198.37	39254.00	39254.00
Compressive edge-middle axial x	mm	1032	1032	2302	2302
Compressive stress σc	N/mm2	10.65	10.65	2.94	2.94
Tensile stress σs	N/mm2	281.26	281.26	10.49	10.49
Increasing coefficient α	------	1.50	1.50	1.50	1.50
Allowable compressive stress σca	N/mm2	15.00	15.00	15.00	15.00
Allowable tensile stress σsa	N/mm2	300.00	300.00	300.00	300.00
Crack moment Mc	kN.m	58831.10	58831.10	61307.16	61307.16
First yield moment My0	kN.m	182623.99	182623.99	188235.79	188235.79
Ultimate bending moment Mu	kN.m	204986.65	204986.65	211595.65	211595.65
Minimum rebar amount as bending member	------	Mc<=Mu	Mc<=Mu	Mc<=Mu	Mc<=Mu
Minimum rebar amount axial force member	mm2	21775.2	21775.2	24521.1	24521.1
Axial force Nu	kN	41236.79	41236.79	41236.79	41236.79
0.008A1' (axial force Na=N)	mm2	21775.2	21775.2	24521.1	24521.1
0.008A2' (axial force Nu)	mm2	11673.5	11673.5	11673.5	11673.5
All reinforcement amount As >= Asmin	------	OK	OK	OK	OK
Maximum reinforcement amount check (My0<=Mu)	------	OK	OK	OK	OK

Asmin(0.008A') : minimum reinforcement amount of member received axial direction force

2)Consider against shear force

items	unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
condition	--------	Ordinary	Ordinary	Dead+ Live + Temperature	Dead+ Live + Temperature
b	mm	12659	12659	12659	12659
d	mm	2772	2772	2772	2772
S	kN	0.00	0.00	200.00	200.00
N	kN	46436.79	46436.79	46436.79	46436.79
M	kN.m	0.00	0.00	3980.00	3980.00
α	-------	1.00	1.00	1.15	1.15
pt	%	0.458	0.458	0.458	0.458
ce	------	0.734	0.734	0.734	0.734
cpt	------	1.158	1.158	1.158	1.158
CN	------	1.000	1.000	1.000	1.000
τm	N/mm^2	0.000	0.000	0.006	0.006
τa_1	N/mm^2	0.213	0.213	0.244	0.244
τa_2	N/mm^2	1.900	1.900	2.185	2.185
σsa	N/mm^2	------------	------------	------------	------------
s	mm	------------	------------	------------	------------
Sca	kN	------------	------------	------------	------------
Sh'	kN	------------	------------	------------	------------
AwReq	mm^2	------------	------------	------------	------------
Aw	mm^2	------------	------------	------------	------------

items	unit	Seismic LowWL	Seismic HeightWL	Collision LowWL	Collision HeightWL
condition	--------	Lv1E.Q.	Lv1E.Q.	Vessel Collision	Vessel Collision
b	mm	12659	12659	12659	12659
d	mm	2772	2772	2772	2772
S	kN	11551.74	11551.74	3800.00	3800.00
N	kN	41236.79	41236.79	46436.79	46436.79
M	kN.m	154198.37	154198.37	39254.00	39254.00
α	-------	1.50	1.50	1.50	1.50
pt	%	0.458	0.458	0.458	0.458
ce	------	0.734	0.734	0.734	0.734
cpt	------	1.158	1.158	1.158	1.158
CN	------	1.000	1.000	1.000	1.000
τm	N/mm^2	0.329	0.329	0.108	0.108
τa_1	N/mm^2	0.315	0.315	0.315	0.315
τa_2	N/mm^2	2.850	2.850	2.850	2.850
σsa	N/mm^2	300.00	300.00	------------	------------
s	mm	150	150	------------	------------
Sca	kN	11039.24	11039.24	------------	------------
Sh'	kN	512.50	512.50	------------	------------
AwReq	mm^2	106.29	106.29	------------	------------
Aw	mm^2	5032.30	5032.30	------------	------------

The following ;

S : Shear force

N : Axial force

M : Bending moment

b : Member section width

d : Effective height

α : Increasing coefficient of allowable stress

pt : Tensile main reinforcement ratio

ce : Correction coefficient of allowable shear stress about effective height d

cpt : Correction coefficient of allowable shear stress about tensile reinforcement ratio

CN : Correction coefficient by axial direction compressive force

τm : Average shear stress

$\tau a1$: Allowable shear stress when share shear force by only concrete

$\tau a2$: Shear supplemental barAllowable shear stress when share the shear force with

σsa : Allowable tensile stress of reinforcement

s : Shear supplemental bar interval of

Sca : Concrete sharing shear force

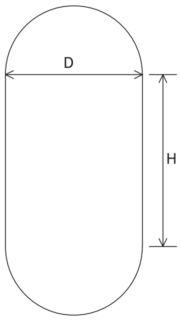
Sh' : Shear supplemental bar sharing shear force

Awreq : Necessary for $\tau a1 < \tau m$Shear supplemental barAmount

Aw : Shear supplemental barAmount

2.2.2 Axial perpendicular direction

(1) Section shape and reinforcement arrangement



H = 10.000 (m) D = 3.000 (m)

Main reinforcement for section calculation(position is covering)

No.	Reinforcement position (mm)	Straight line part all reinforcement amount			Circle part part all reinforcement amount		
		Reinforcement diameter	Number sets	Reinforcement amount (mm^2)	Reinforcement diameter	Number sets	Reinforcement amount (mm^2)
1	150	D38	162	184680.0	D38	38	43320.0
2	250	D38	82	93480.0	----	----	------
					Total ΣAs1 = 278160.0	Total ΣAs2 = 43320.0	
						Reinforcement amount total ΣAs = 321480.0	

Total amount of rebar As = 321480.0(mm^2)

* minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (14712.4mm^2)] OK

* maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2224115.0mm^2)] OK

(2) Section check

1)Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Seismic LowWL	Seismic HeightWL
Load condition	------	Ordinary Ordinary			
Axial force N	kN	46436.79	46436.79	41236.79	41236.79
Bending moment M	kN.m	3100.00	3100.00	223355.66	223355.66
Compressive edge-middle axial x	mm	197579	197579	6285	6285
Compressive stress σc	N/mm^2	1.15	1.15	4.94	4.94
Tensile stress σs	N/mm^2	-16.08	-16.08	77.41	77.41
Increasing coefficient α	------	1.00	1.00	1.50	1.50
Allowable compressive stress σca	N/mm^2	10.00	10.00	15.00	15.00
Allowable tensile stress σsa	N/mm^2	-200.00	-200.00	300.00	300.00
Crack moment Mc	kN.m	254190.93	254190.93	243924.76	243924.76
First yield moment My0	kN.m	547764.60	547764.60	526571.88	526571.88
Ultimate bending moment Mu	kN.m	834289.12	834289.12	811491.73	811491.73
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc	Mc<=Mu	Mc<=Mu
Minimum rebar amount axial force member	mm^2	36781.6	36781.6	21775.2	21775.2
Axial force Nu	kN	41236.79	41236.79	41236.79	41236.79
0.008A1' (axial force Na=N)	mm^2	36781.6	36781.6	21775.2	21775.2
0.008A2' (axial force Nu)	mm^2	11673.5	11673.5	11673.5	11673.5
All reinforcement amount As >= Asmin	------	OK	OK	OK	OK
Maximum reinforcement amount check (My0<=Mu)	------	OK	OK	OK	OK

Items	Unit	Collision LowWL	Collision HeightWL
Load condition	------	Vessel Collision	Vessel Collision
Axial force N	kN	46436.79	46436.79
Bending moment M	kN.m	77475.00	77475.00
Compressive edge-middle axial x	mm	14146	14146
Compressive stress σc	N/mm^2	2.05	2.05
Tensile stress σs	N/mm^2	-2.82	-2.82
Increasing coefficient α	------	1.50	1.50
Allowable compressive stress σca	N/mm^2	15.00	15.00
Allowable tensile stress σsa	N/mm^2	-300.00	-300.00
Crack moment Mc	kN.m	254190.93	254190.93
First yield moment My0	kN.m	547764.60	547764.60
Ultimate bending moment Mu	kN.m	834289.12	834289.12
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm^2	24521.1	24521.1
Axial force Nu	kN	41236.79	41236.79
0.008A1' (axial force Na=N)	mm^2	24521.1	24521.1
0.008A2' (axial force Nu)	mm^2	11673.5	11673.5
All reinforcement amount As >= Asmin	------	OK	OK
Maximum reinforcement amount check (My0<=Mu)	------	OK	OK

Asmin(0.008A') : minimum reinforcement amount of member received axial direction force

2)Consider against shear force

items	unit	Ordinary LowWL	Ordinary HeightWL	Seismic LowWL	Seismic HeightWL
condition	--------	Ordinary	Ordinary	Lv1E.Q.	Lv1E.Q.
b	mm	2928	2928	2928	2928
d	mm	12542	12542	12542	12542
S	kN	0.00	0.00	13062.13	13062.13
N	kN	46436.79	46436.79	41236.79	41236.79
M	kN.m	3100.00	3100.00	223355.66	223355.66
α	-------	1.00	1.00	1.50	1.50
pt	%	0.438	0.438	0.438	0.438
ce	------	0.500	0.500	0.500	0.500
cpt	------	1.138	1.138	1.138	1.138
CN	------	1.000	1.000	1.000	1.000
τm	N/mm^2	0.000	0.000	0.356	0.356
$τa_1$	N/mm^2	0.142	0.142	0.210	0.210
$τa_2$	N/mm^2	1.900	1.900	2.850	2.850
σsa	N/mm^2	------------	------------	300.00	300.00
s	mm	------------	------------	150	150
Sca	kN	------------	------------	7729.93	7729.93
Sh'	kN	------------	------------	5332.21	5332.21
AwReq	mm^2	------------	------------	244.46	244.46
Aw	mm^2	------------	------------	1548.40	1548.40

items	unit	Collision LowWL	Collision HeightWL
condition	--------	Vessel Collision	Vessel Collision
b	mm	2928	2928
d	mm	12542	12542
S	kN	7500.00	7500.00
N	kN	46436.79	46436.79
M	kN.m	77475.00	77475.00
α	-------	1.50	1.50
pt	%	0.438	0.438
ce	------	0.500	0.500
cpt	------	1.138	1.138
CN	------	1.000	1.000
τm	N/mm^2	0.204	0.204
$τa_1$	N/mm^2	0.210	0.210
$τa_2$	N/mm^2	2.850	2.850
σsa	N/mm^2	------------	------------
s	mm	------------	------------
Sca	kN	------------	------------
Sh'	kN	------------	------------
AwReq	mm^2	------------	------------
Aw	mm^2	------------	------------

The following ;
S : Shear force
N : Axial force
M : Bending moment
b : Member section width
d : Effective height
α : Increasing coefficient of allowable stress
pt : Tensile main reinforcement ratio
ce : Correction coefficient of allowable shear stress about effective height d
cpt : Correction coefficient of allowable shear stress about tensile reinforcement ratio
CN : Correction coefficient by axial direction compressive force
τm : Average shear stress
τa1 : Allowable shear stress when share shear force by only concrete
τa2 : Shear supplemental barAllowable shear stress when share the shear force with
σsa : Allowable tensile stress of reinforcement
s : Shear supplemental bar interval of
Sca : Concrete sharing shear force
Sh' : Shear supplemental bar sharing shear force
Awreq : Necessary for τa1 < τmShear supplemental barAmount
Aw : Shear supplemental barAmount

4.4 SUMMARY OF RC PIER BEAM DESIGN

1) Design Section

Since the distance from the front of the column to the loading point (bearing), l, is smaller than the height of beam, h, namely h/l=7000/1215=5.8≥1.0, this kind of beam will be designed as a corbel. And, design section (A-A) is set at 300 mm inside of column because of the oval column shape as shown in the figure below. It will be verified at A-A section in terms of bending moment and shear. The section at h/2 (=3500 mm) from A-A section is outside of the beam, so verification of shear force will be made only at A-A section.

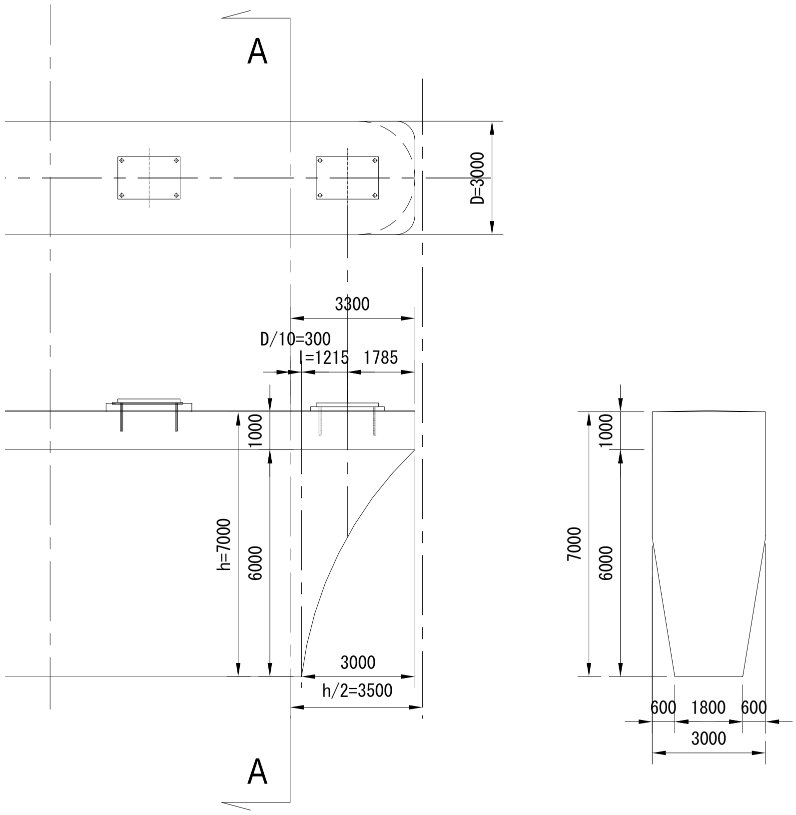


Figure Design Section of Pier Head Beam

2) Design Loads

Design loads for verification of the beam structure are summarized in the table below, and the largest values among piers for each condition are used for the verification.

Table Design Loads for Beam Design

Condition	Load Component	P6		P7	
		G1	G4	G1	G4
Vertical Section					
Ordinary Condition (Dead + Live Loads)	Dead Load	4,000	4,800	5,700	6,000
	Live Load with Impact	2,000	2,200	2,300	2,400
	Weight of Beam	1,223	1,223	1,223	1,223
	Total	**7,223**	**8,223**	**9,223**	**9,623**
Earthquake Condition (Dead Load + Effect of earthquake)	Dead Load	4,000	4,800	5,700	6,000
	Weight of Beam	1,223	1,223	1,223	1,223
	Vertical reaction force due to earthquake from Superstructure*1	700	800	900	1,000
	Total	**5,923**	**6,823**	**7,823**	**8,223**
Additional load in the earthquake condition for corbel design	Inertia force on superstructure	1,300	1,300	1,800	1,800
	Inertia force on the beam	400	400	400	400
	Total	**1,700**	**1,700**	**2,200**	**2,200**
Horizontal Section					
Effect of temperature change	Horizontal force due to temperature change	**100**	**100**	**100**	**100**
Earthquake Condition	Inertia force on superstructure	1,200	1,200	1,100	1,100
	Inertia force on the beam	400	400	400	400
	Total	**1,600**	**1,600**	**1,500**	**1,500**

*Note: *1: It is calculated in accordance with Chapter 15.4 of Specifications for Highway Bridges Part-V 2012 (Japan Road Association)*

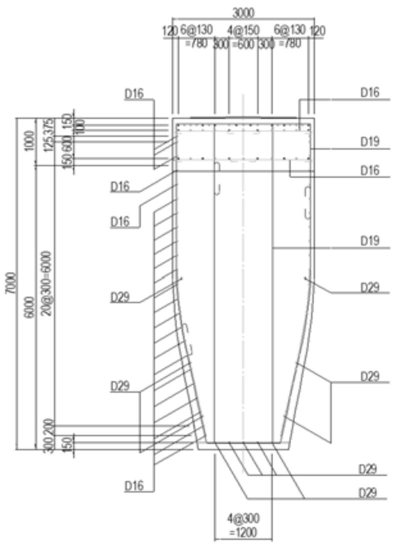
3) Design condition

- Applied reinforcement bar: SD345 for main reinforcement, stirrup
- Concrete design strength: 30 N/mm^2

4) Rebar Arrangement

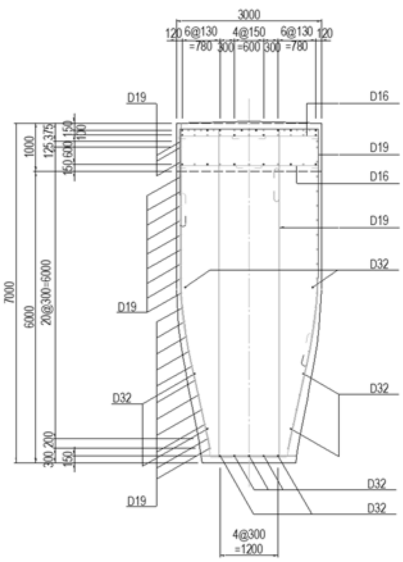
Main reinforcement and stirrup at the design section (A-A) is arranged as shown in the figure below.

P6



Location	Cover (mm)	Diameter	Arrangement
Upper (main reinforcement)	150	D29	18@153 in average
	250	D29	10@276 in average
Lower	150	D29	4@300
Side	97	D16	(125+20@300+200) x 2 sides
Stirrup	-	D19	150mm pitch

P7



Location	Cover (mm)	Diameter	Arrangement
Upper (main reinforcement)	150	D32	18@153 in average
	250	D32	10@276 in average
Lower	150	D32	4@300
Side	103	D19	(125+20@300+200) x 2 sides
Stirrup	-	D19	150mm pitch

Figure Rebar Arrangement (Main Reinforcement)

5) Verification of Reinforcement Content (Vertical Bridge Axis Perpendicular Direction)

As for the section against bending moment at vertical bridge axis perpendicular direction, it is verified by the reinforcement content of tension rebar arranged at upper beam and side rebar by corbel design, and the result is summarized in the table below.

Table Verification of Reinforcement Content at Vertical Direction of Beam

P6

Item	Unit	Ordinary Condition (Dead Load)	Ordinary Condition (Dead and Live Loads)	Earthquake Condition
Design Tensile Force (T)	kN	1,604.1	2,196.0	3,519.3
Allowable Tension Stress (σ_{sa})	N/mm^2	100.00	180.00	300.00
Tensile Reinforcement Arranged Content (Asu) Required Content (AsuReq^{*1})	mm^2	Asu ≥ AsuReq OK 19,272.00 16,041.00	Asu ≥ AsuReq OK 19,272.00 12,199.73	Asu ≥ AsuReq OK 19,272.00 11,731.07
Reinforcement at Sides Arranged Content (Ass) Required Content (AssReq^{*2})	mm^2	Ass ≥ AssReq OK 9,135.00 7,708.80	Ass ≥ AssReq OK 9,135.00 7,708.80	Ass ≥ AssReq OK 9,135.00 7,708.80

P7

Item	Unit	Ordinary Condition (Dead Load)	Ordinary Condition (Dead and Live Loads)	Earthquake Condition
Design Tensile Force (T)	kN	1,882.4	2,510.2	4,344.0
Allowable Tension Stress (σ_{sa})	N/mm^2	100.00	180.00	300.00
Tensile Reinforcement Arranged Content (Asu) Required Content (AsuReq^{*1})	mm^2	Asu ≥ AsuReq OK 23,826.00 18,823.80	Asu ≥ AsuReq OK 23,826.00 13,945.64	Asu ≥ AsuReq OK 23,826.00 14,479.93
Reinforcement at Sides Arranged Content (Ass) Required Content (AssReq^{*2})	mm^2	Ass ≥ AssReq OK 13,179.00 9,530.40	Ass ≥ AssReq OK 13,179.00 9,530.40	Ass ≥ AssReq OK 13,179.00 9,530.40

*Note: *1: AsuReq = 1000 ・ T / σsa*

**2: AssReq = 0.4 ・ Asu*

6) Verification for Bending Moment (Horizontal Bridge Axis Direction)

As for the section against bending moment at horizontal bridge axis direction, it is verified by the compressive and tensile stress occurring at section A-A by the allowable stress method, and the result is summarized in the table below.Table Verification of Bending Moment Stress at Horizontal Direction of Beam

Table Verification of Bending Moment (Horizontal Bridge Axis Direction)

Item	Unit	P6		P7	
		Effect of Temperature Change	Earthquake Condition	Effect of Temperature Change	Earthquake Condition
Bending Moment (M)	kN.m	155.80	2,413.05	151.50	2,209.95
Distance between edge of compressive side and neutral axis (x)	mm	340	340	391	391
Compressive Stress σ_c Tensile Stress σ_s	N/mm^2 N/mm^2	0.09 <σ_{ca} 9.80 <σ_{sa}	1.34 <σ_{ca} 151.75 <σ_{sa}	0.07 <σ_{ca} 6.95 <σ_{sa}	1.05 <σ_{ca} 101.34 <σ_{sa}
Coefficient Increase of Allowable Stress α Allowable Compressive Stress σ_{ca} Allowable Tensile Stress σ_{sa}	- N/mm^2 N/mm^2	1.15 11.50 207.00	1.50 15.00 300.00	1.15 11.50 207.00	1.50 15.00 300.00

7) Verification of Shear Force (Horizontal Bridge Axis Direction)

As for the section against shear force at horizontal bridge axis direction, it is verified by the shear stress occurring at section A-A by the allowable stress method, and the result is summarized in the table below. Content of stirrup is 573.0mm^2, which is equivalent to approximately 0.2% at the minimum, although arrangement is not required.

Table Verification of Shear Stress at Horizontal Direction of Beam

Item	Unit	P6		P7	
		Effect of Temperature Change	Earthquake Condition	Effect of Temperature Change	Earthquake Condition
Section Force Shear Force (S) Bending Moment (M)	 kN kN.m	 100.00 155.80	 1,566.89 2,413.05	 100.00 151.50	 1,466.89 2,209.95
Effective Height (d)	mm	2,732	2,732	2,735	2,735
Shear Force considering Effective Height (Sh)*1	kN	100.00	1,566.89	100.00	1,466.89
Coefficient Increase of Allowable Stress (α) Ratio of rebar (pt)*2 Coefficient of allowable shear stress related to "d" (ce) Coefficient of allowable shear stress related to "pt"(cpt)	- % - -	1.15 0.038 0.740 0.576	1.50 0.038 0.740 0.576	1.15 0.052 0.740 0.605	1.50 0.052 0.740 0.605
τ_m τ_{a1} τ_{a2}	N/mm^2 N/mm^2 N/mm^2	0.006 < 0.123 2.185	0.092 < 0.158 2.850	0.006 < 0.129 2.185	0.086 < 0.166 2.850
Shear Reinforcement Content Aw AwReq	 mm^2 mm^2	 573.0 0.0	 573.0 0.0	 573.0 0.0	 573.0 0.0

*Note: *1: Sh=M-M/d x (tanβ+tanγ), β and γ = zero in this case   *2: pt=As/(b x d)*

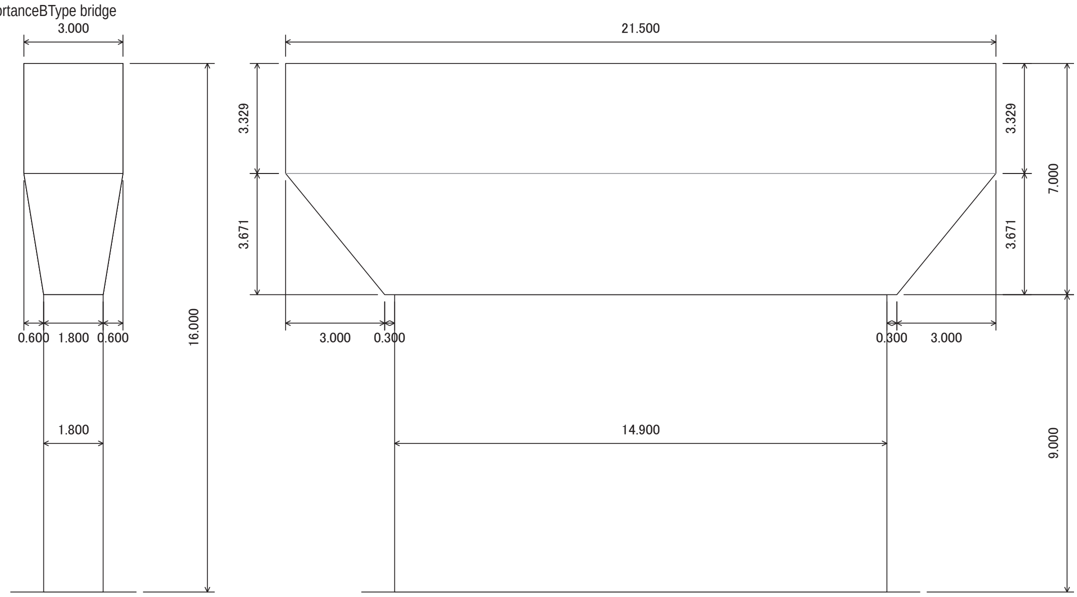
4.5 DETAIL CALCULATION SHEET OF RC PIER BEAM DESIGN OF P6

Contents

1 Design condition

1.1 Shape dimension

Type RCRectangleColumn pier (new consider)
Beam shape type Beam type(rectangle)
Foundation type Spread foundation
Division of importanceBType bridge



(right side is back side)

Items	Symbol	Dimension(m)
Beam height	H	7.000
Bridge axial direction beam width	B_L	3.000
Bridge axial perpendicular direction beam width	B_T	21.500
Beam upper face center - horizontal distance to the column upper face center	x	0.000
Lower face both direction drawn height	H_{t2}	3.671
Lower face bridge axial direction drawn width	B_{tL2}	0.600
Lower face bridge axial perpendicular direction drawn length (left side)	B_{tT2L}	3.000
Ditto (right side)	B_{tT2R}	3.000
Column height(column base - beam lower face)	H	9.000
Bridge axial direction column width	B_L	1.800
Bridge axial perpendicular direction column width	B_T	14.900
Surface (from column lower edge)	h_G	0.000

1.2 Beam

1.2.1 Material of use

Design standard strength of concrete σck 30.0(N/mm^2)

Young's modulus of concrete Ec 2.80x10^4(N/mm^2)

Main reinforcement material SD345

Stirrup material SD345

1.2.2 Rebar

(1) Main reinforcement

If get tensile reinforcement ratio of beam pt, not consider side face reinforcement (reinforcement crossing main reinforcement).

Upper face

covering (mm)	diameter (mm)	left side edge	bar arrangement	right side edge (mm)
150	D29	120	6@130+300+4@150+300+6@130	120
250	D29	120	3@260+4@300+3@260	120

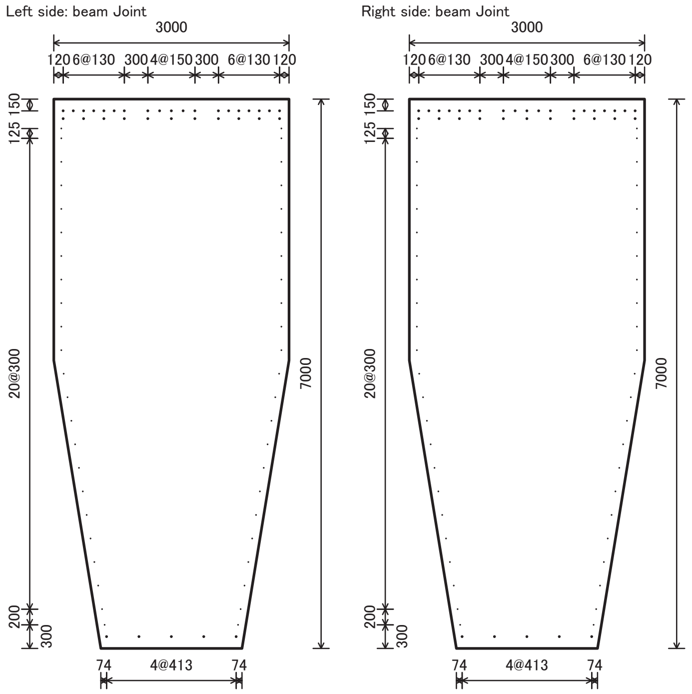
Lower face

covering (mm)	diameter (mm)	left side edge	bar arrangement	right side edge (mm)
150	D29	74	4@413	74

Side face

covering (mm)	diameter (mm)	upper side edge	bar arrangement	lower side edge (mm)
97	D16	375	125+20@300+200	300

4



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(2) Stirrup

Stirrup

Reinforcement diameter D19 inner circumference group number 1.0

Effective shear stiffening bars on horizontal direction check except for stirrup

Reinforcement diameter D19 number sets 0

Input method of stirrup : detail assign

Edge	Bar arrangement	Edge
250	150+138@150+150	250

1.2.3 Right side beam

(1) Vertical direction consider condition

About load of vertical direction, consider at following load case.

Note : Action position Xc is the distance from joint beam.

Note : Action position Yc is from the distance of upper side of beam.

1) Load case 1: Dead Load

Load type Dead Load Case

Allowable stress increasing coefficient 1.00

Super structural reaction force (vertical reaction)

No.	Operated position Xc(m)	Dead load reaction force RD(kN)	Vertical reaction Rex(kN)
1	1.558	4800.00	0.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.558 0.00	

2) Load case 2: Dead+Live Loads

Load type Ordinary(Consider live load)

Allowable stress increasing coefficient 1.00

Super structural reaction force (vertical reaction)

No.	Operated position Xc(m)	Dead load reaction force RD(kN)	Live load reaction force RL(kN)	Vertical reaction Rex(kN)
1	1.558	4800.00	2200.00	0.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.558 0.00	

3) Load case 3: SeismicLevel1

Load type Lv1E.Q.

Allowable stress increasing coefficient 1.50

Super structural reaction force (vertical reaction)

No.	Operated position Xc(m)	Dead load reaction force RD(kN)	Vertical reaction Rex(kN)
1	1.558	4800.00	800.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.558 1700.00	

(2) Horizontal direction consider condition

About horizontal load, considering the following load case.

Note : Action position Xc is the distance from joint beam.

1) Load case : SeismicLevel1

Load type Lv1E.Q.(Consider earth quake effect)

Design horizontal seismic coefficient kh 0.30

Allowable stress increasing coefficient 1.50

Super structural reaction force (horizontal reaction force)

bearing No.	operated position Xc(m)	super structural horizontal reaction force Rh (kN)
1	1.558	1200.00

2) Load case : Temperature

Load type Dead + Temperature

Allowable stress increasing coefficient 1.15

Super structural reaction force (horizontal reaction force)

bearing No.	operated position Xc(m)	super structural horizontal reaction force Rh (kN)
1	1.558	100.00

2 Design beam (right side)

2.1 Beam own weight

No.	Block name	Left height H1(m)	Right height H2(m)	Left upper width W1(m)	Left lower width B1(m)	Right upper width W2(m)	Right lower width B2(m)	Member length L(m)	Volume V(m^3)
1	Right sideOver hanged part(Top)	3.329	3.329	3.000	3.000	3.000	3.000	0.300	2.99610
2	Right sideOver hanged part(Bottom)	3.671	3.671	3.000	1.800	3.000	1.800	0.300	2.64312
3	Right sideDrawn parts(Top)	3.329	3.329	3.000	3.000	3.000	3.000	3.000	29.96100
4	Right sideDrawn parts(Bottom)	3.671	0.000	3.000	1.800	3.000	3.000	3.000	14.31690

No	volume V(m^3)	right angle center of figure Xg(m)	V*Xg (m^4)
1	2.99610	0.1500	0.4494
2	2.64312	0.1500	0.3965
3	29.96100	1.8000	53.9298
4	14.31690	1.3385	19.1626
Σ	49.91712	------	73.9383

Note : Table's center of figure Xg is the distance from beam joint

Weight $W = \Sigma V + \gamma c = 49.91712*24.50 = 1222.97$(kN)

Moment $M = |\Sigma(V*Xg)|*\gamma c = 1811.49$(kN.m)

Center of gravity $Xg = \frac{M}{W} = 1.481$(m)

2.2 Design vertical direction section(Design of Corbel)

2.2.1 Examination for the design tensile force

Enough for the ratio of beam height and the distance from joint to loading point is more than 1.0, considering the design tensile force as follow.

(1) Design tensile force

Tensile force by beam own weight and arbitrary load

Items	Vertical force V (kN)	Arm length x (m)	Bending moment M (kN.m)
Beam own load	1222.97	1.481	1811.49
Other horizontal concentrated load	--------	--------	1222.97

Tensile force by beam own weight $T_J = \frac{M}{\lambda} = 312.79$ (kN)

Tensile force by horizontal reactions at axial perpendicular direction

Items	Horizontal Force H (kN)	Arm length a (m)
Dead Load	0.00	1.558
Dead+Live Loads	0.00	1.558
SeismicLevel1	1700.00	1.558
Dead LoadΣ Dead+Live LoadsΣ SeismicLevel1Σ		0.00 --------

Dead LoadTensile force $T_H = H = 0.00$ (kN)

Dead+Live LoadsTensile force $T_H = H = 0.00$ (kN)

SeismicLevel1Tensile force $T_H = H = 1700.00$ (kN)

Tensile force by other horizontal reactions

Items	Horizontal Force Ht_i(kN)	Operated position x_i(m)	Operated position y_i(m)
Dead Load	0.00	0.000	0.000
Dead+Live Loads	0.00	0.000	0.000
SeismicLevel1	0.00	0.000	0.000

Dead LoadTensile force $T_{HT} = \Sigma\ Ht*\left(1+\frac{y_i}{\lambda}\right) = 0.00$ (kN)

Dead+Live LoadsTensile force $T_{HT} = \Sigma\ Ht*\left(1+\frac{y_i}{\lambda}\right) = 0.00$ (kN)

SeismicLevel1Tensile force $T_{HT} = \Sigma\ Ht*\left(1+\frac{y_i}{\lambda}\right) = 0.00$ (kN)

Tensile force by vertical reactions of super structure

Items	Vertical force Arm length P (kN)	
Dead Load	4800.00	1.558
Dead+Live Loads	7000.00	1.558
SeismicLevel1	5600.00	1.558
Dead LoadΣ Dead+Live LoadsΣ		4800.00 --------

Items	Vertical force Arm length P (kN) a (m)	
SeismicLevel1Σ		5600.00

Dead LoadTensile force $T_v = P*\frac{a}{\lambda} = 1291.31$ (kN)

Dead+Live LoadsTensile force $T_v = P*\frac{a}{\lambda} = 1883.16$ (kN)

SeismicLevel1Tensile force $T_v = P*\frac{a}{\lambda} = 1506.53$ (kN)

The following ;

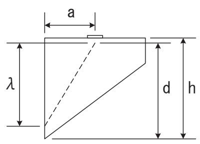
The vertical reactions of super structure: P (kN)

The truss width : a = 1558 (mm)

The truss height : λ = 0.85×d = 5791 (mm)

The height of beam joint : h = 7000 (mm)

The effective height of beam joint : d = 6813 (mm)



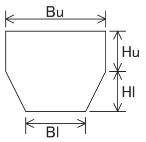
Design tensile force

Dead Load $T = T_J + T_H + T_{HT} + T_V = 1604.10$ (kN)

Dead+Live Loads $T = T_J + T_H + T_{HT} + T_V = 2195.95$ (kN)

SeismicLevel1 $T = T_J + T_H + T_{HT} + T_V = 3519.32$ (kN)

(2) Section shape and reinforcement arrangement



Bu = 3000 mm Bl = 1800 mm

Hu = 3329 mm Hl = 3671 mm

Main reinforcement(The position is the distance from beam top edge.)

No.	Reinforcement position (mm)	Reinforcement diameter	Number sets	Reinforcement amount (mm2)
1 2	150 250	D29 D29	19 11	12205.6 7066.4
		Reinforcement amount total ΣAs =		19272.0

(3) Check against Reinforcement arrangement, effective height

Effective height of beam joint : d = 6813 mm

Upper face rebar position Bottom step position hl d/4	mm	hl <= d/4 OK 250.00 1703.33
Effective height Load point position da d/2	mm	da >= d/2 OK 5273.93 3406.67
Side face core rebar Arrangement interval s Maximum interval smax	mm	s <= smax OK 300.00 300.00

(4) Check against reinforcement amount

Items	Unit	Dead Load	Dead+Live Loads	SeismicLevel1
Load condition	------	Dead Load Case Ordinary		
Design tensile force T	kN	1604.10	2195.95	3519.32
Allowable tensile stress σsa	N/mm2	100.00	180.00	300.00
Upper face tensile rebar Amount of use Asu Necessary amount AsuReq	mm2	Asu >= AsuReq OK 19272.00 16041.02	Asu >= AsuReq OK 19272.00 12199.73	Asu >= AsuReq OK 19272.00 11731.07
Side face core rebar Amount of use Ass Necessary amount AssReq	mm2	Ass >= AssReq OK 9135.60 7708.80	Ass >= AssReq OK 9135.60 7708.80	Ass >= AssReq OK 9135.60 7708.80

Note : AsuReq = 1000*T / σsa

Note : AssReq = 0.4*Asu

2.3 Design horizontal direction section(Allowable stress design method)

2.3.1 Consider against bending moment

About bending moment, considering at the position of beam joint.

(1) Section force from the beam joint

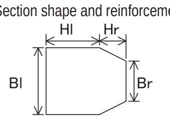
1) case SeismicLevel1

items	horizontal force H (kN)	arm length x (m)	bending moment H*x (kN.m)
Inertia force by beam own load	366.89	1.481	543.45
Super structural horizontal reaction force	1200.00	1.558	1869.60
Total (design section force)	1566.89	----------	2413.05

2) case Temperature

items	horizontal force H (kN)	arm length x (m)	bending moment H*x (kN.m)
Inertia force by beam own load	0.00	0.000	0.00
Super structural horizontal reaction force	100.00	1.558	155.80
Total (design section force)	100.00	----------	155.80

(2) Section shape and reinforcement arrangement



Bl = 3000 mm Br = 1800 mm

Hl = 3329 mm Hr = 3671 mm

Main reinforcement(Position is the distance form beam side face.)

No.	Reinforcement position (mm)	Reinforcement diameter	Number sets	Reinforcement amount (mm2)
1	97	D16	11	2184.6
2	120	D29	1	642.4
3	120	D29	1	642.4
4	395	D16	12	2383.2
5	680	D29	1	642.4
		Reinforcement amount total ΣAs =		6495.0

* Minimum reinforcement amount [Reinforcement amount total(6495.0mm^2) >= m: reinforcement amount of 500mm^2(3524.4mm^2)] OK

* Maximum reinforcement amount [tensile reinforcement amount (6495.0mm^2) <= balanced reinforcement amount Asb(892729.9mm^2)] OK

(3) Section check

Items	Unit	SeismicLevel 1	Temperature
Load condition	------	Lv1E.Q. Dead + Temperature	
Bending moment M	kN.m	2413.05	155.80
Compressive edge-middle axial x	mm	340	340
Compressive stress σc Tensile stress σs	N/mm^2 N/mm^2	1.34 151.75	0.09 9.80
Increasing coefficient α Allowable compressive stress σca Allowable tensile stress σsa	------ N/mm^2 N/mm^2	1.50 15.00 300.00	1.15 11.50 207.00
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc

Crack bending moment Mc = 19305.83 (kN.m) Ultimate bending moment Mu = 6091.04 (kN.m)

2.3.2 Consider against shear force

Against shear force, consider at joint position and bearing postion.

1) Check section

Secion	Check position x(m)	Beam width (Reduced width) b(m)	Beam height H(m)	tanβ＋tanγ
1 2	0.000 1.558	6.266 5.213	3.000 3.000	0.000 0.000

2) Section check

Section[1] b = 6266mm h = 3000mm

Items	Unit	SeismicLevel1	Temperature
Condition	--------	Lv1E.Q. Dead + Temperature	
S M	kN kN.m	1566.89 2413.05	100.00 155.80
d	mm	2732	2732
Sh	kN	1566.89	100.00
α pt ce cpt	------- % ------- -------	1.50 0.038 0.740 0.576	1.15 0.038 0.740 0.576
τm $τa_1$ $τa_2$	N/mm^2 N/mm^2 N/mm^2	0.092 0.158 2.850	0.006 0.123 2.185

Section[2] b = 5213mm h = 3000mm

Items	Unit	SeismicLevel1	Temperature
Condition	--------	Lv1E.Q. Dead + Temperature	
S M	kN kN.m	1365.64 133.77	100.00 0.00
d	mm	2785	2785
Sh	kN	1365.64	100.00
α pt ce cpt	------- % ------- -------	1.50 0.038 0.732 0.576	1.15 0.038 0.732 0.576
τm $τa_1$ $τa_2$	N/mm^2 N/mm^2 N/mm^2	0.094 0.156 2.850	0.007 0.121 2.185

Note : $Sh = S - M/d*(\tan\beta + \tan\gamma)$

$\tau m = Sh / bd$

The following ;

S : Shear force

M : Bending moment

d : Effective height

$\tan\beta + \tan\gamma$: Change of effective height

Sh : Shear force to consider the change of effective height

α : Increasing coefficient of allowable stress

pt : Tensile main reinforcement ratio

ce : Correction coefficient of allowable shear stress about effective height d

cpt : Correction coefficient of allowable shear stress about tensile reinforcement ratio

τm : Average shear stress

$\tau a1$: Allowable shear stress when share shear force by only concrete

$\tau a2$: Allowable shear stress when share shear force with stirrup

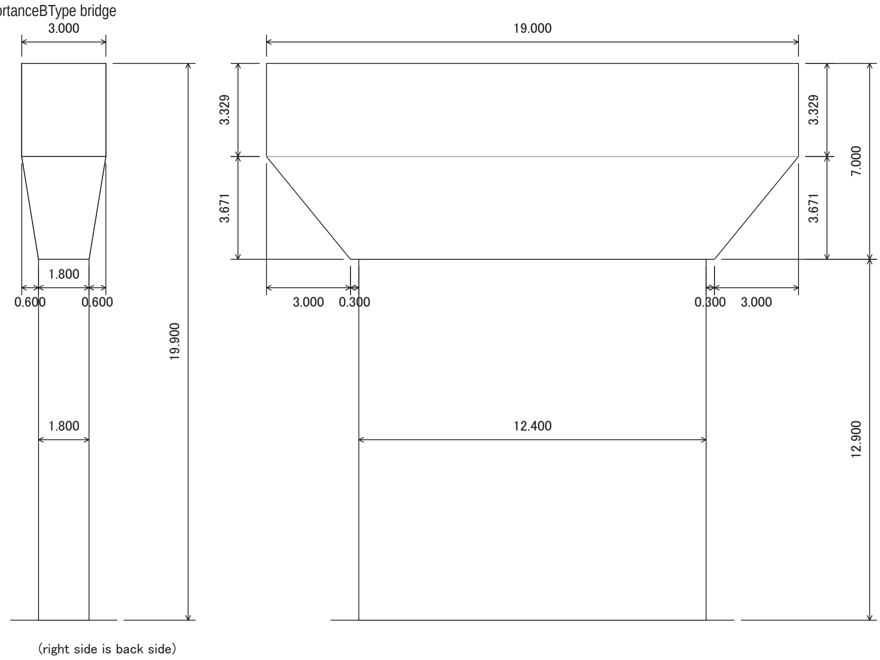
4.6 DETAIL CALCULATION SHEET OF RC PIER BEAM DESIGN OF P7

Contents

1 Design condition

1.1 Shape dimension

Type RCRectangleColumn pier (new consider)
Beam shape type Beam type(rectangle)
Foundation type Spread foundation
Division of importanceBType bridge



Items	Symbol	Dimension(m)
Beam height	H	7.000
Bridge axial direction beam width	B_L	3.000
Bridge axial perpendicular direction beam width	B_T	19.000
Beam upper face center - horizontal distance to the column upper face center	x	0.000
Lower face both direction drawn height	H_{t2}	3.671
Lower face bridge axial direction drawn width	B_{tL2}	0.600
Lower face bridge axial perpendicular direction drawn length (left side)	B_{tT2L}	3.000
Ditto (right side)	B_{tT2R}	3.000
Column height(column base - beam lower face)	H	12.900
Bridge axial direction column width	B_L	1.800
Bridge axial perpendicular direction column width	B_T	12.400
Surface (from column lower edge)	h_G	0.000

1.2 Beam

1.2.1 Material of use

Design standard strength of concrete σck 30.0(N/mm^2)

Young's modulus of concrete Ec 2.80x10^4(N/mm^2)

Main reinforcement material SD345

Stirrup material SD345

1.2.2 Rebar

(1) Main reinforcement

If get tensile reinforcement ratio of beam pt, not consider side face reinforcement (reinforcement crossing main reinforcement).

Upper face

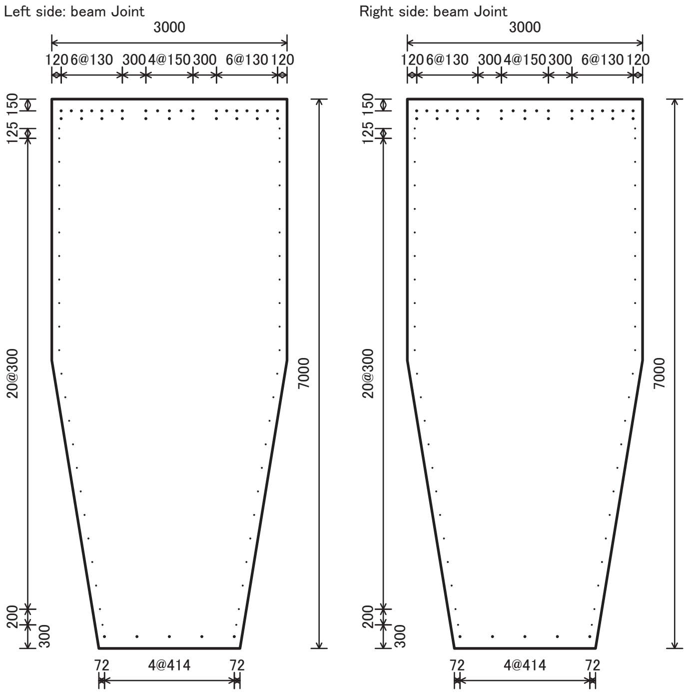
covering (mm)	diameter (mm)	left side edge	bar arrangement	right side edge (mm)
150	D32	120	6@130+300+4@150+300+6@130	120
250	D32	120	3@260+4@300+3@260	120

Lower face

covering (mm)	diameter (mm)	left side edge	bar arrangement	right side edge (mm)
150	D32	72	4@414	72

Side face

covering (mm)	diameter (mm)	upper side edge	bar arrangement	lower side edge (mm)
95	D19	375	125+20@300+200	300



(2) Stirrup

Stirrup

Reinforcement diameter D19 inner circumference group number 1.0

Effective shear stiffening bars on horizontal direction check except for stirrup

Reinforcement diameter D19 number sets 0

Input method of stirrup : detail assign

Edge	Bar arrangement	Edge
250	175+121@150+175	250

1.2.3 Right side beam

(1) Vertical direction consider condition

About load of vertical direction, consider at following load case.

Note : Action position Xc is the distance from joint beam.

Note : Action position Yc is from the distance of upper side of beam.

1) Load case 1: Dead Load

Load type Dead Load Case

Allowable stress increasing coefficient 1.00

Super structural reaction force (vertical reaction)

No.	Operated position Xc(m)	Dead load reaction force RD(kN)	Vertical reaction Rex(kN)
1	1.515	6000.00	0.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.515 0.00	

2) Load case 2: Dead+Live Loads

Load type Ordinary(Consider live load)

Allowable stress increasing coefficient 1.00

Super structural reaction force (vertical reaction)

No.	Operated position Xc(m)	Dead load reaction force RD(kN)	Live load reaction force RL(kN)	Vertical reaction Rex(kN)
1	1.515	6000.00	2400.00	0.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.515 0.00	

3) Load case 3: SeismicLevel1

Load type Lv1E.Q.

Allowable stress increasing coefficient 1.50

Super structural reaction force (vertical reaction)

No.	Operated position Xc(m)	Dead load reaction force RD(kN)	Vertical reaction Rex(kN)
1	1.515	6000.00	1000.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.515 2200.00	

(2) Horizontal direction consider condition

About horizontal load, considering the following load case.

Note : Action position Xc is the distance from joint beam.

1) Load case : SeismicLevel1

Load type Lv1E.Q.(Consider earth quake effect)

Design horizontal seismic coefficient kh 0.30

Allowable stress increasing coefficient 1.50

Super structural reaction force (horizontal reaction force)

bearing No.	operated position Xc(m)	super structural horizontal reaction force Rh (kN)
1	1.515	1100.00

2) Load case : Temperature

Load type Dead Load + Temperature

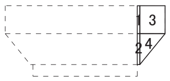
Allowable stress increasing coefficient 1.15

Super structural reaction force (horizontal reaction force)

bearing No.	operated position Xc(m)	super structural horizontal reaction force Rh (kN)
1	1.515	100.00

2 Design beam (right side)

2.1 Beam own weight



No.	Block name	Left height H1(m)	Right height H2(m)	Left upper width W1(m)	Left lower width B1(m)	Right upper width W2(m)	Right lower width B2(m)	Member length L(m)	Volume V(m3)
1	Right sideOver hanged part(Top)	3.329	3.329	3.000	3.000	3.000	3.000	0.300	2.99610
2	Right sideOver hanged part(Bottom)	3.671	3.671	3.000	1.800	3.000	1.800	0.300	2.64312
3	Right sideDrawn parts(Top)	3.329	3.329	3.000	3.000	3.000	3.000	3.000	29.96100
4	Right sideDrawn parts(Bottom)	3.671	0.000	3.000	1.800	3.000	3.000	3.000	14.31690

No	volume V(m3)	right angle center of figure Xg(m)	V*Xg (m4)
1	2.99610	0.1500	0.4494
2	2.64312	0.1500	0.3965
3	29.96100	1.8000	53.9298
4	14.31690	1.3385	19.1626
Σ	49.91712	------	73.9383

Note : Table's center of figure Xg is the distance from beam joint

Weight W = ΣV + γc = 49.91712*24.50 = 1222.97(kN)

Moment M = |Σ(V*Xg)|* γc = 1811.49(kN.m)

Center of gravity $X_g = \dfrac{M}{W} = 1.481(m)$

2.2 Design vertical direction section(Design of Corbel)

2.2.1 Examination for the design tensile force

Enough for the ratio of beam height and the distance from joint to loading point is more than 1.0, considering the design tensile force as follow.

(1) Design tensile force

Tensile force by beam own weight and arbitrary load

Items	Vertical force V (kN)	Arm length x (m)	Bending moment M (kN.m)
Beam own load	1222.97	1.481	1811.49
Other horizontal concentrated load	--------	--------	1222.97

Tensile force by beam own weight $T_J = \dfrac{M}{\lambda} = 312.79$ (kN)

Tensile force by horizontal reactions at axial perpendicular direction

Items	Horizontal Force H (kN)	Arm length a (m)
Dead Load	0.00	1.515
Dead+Live Loads	0.00	1.515
SeismicLevel1	2200.00	1.515
Dead LoadΣ Dead+Live LoadsΣ SeismicLevel1Σ		0.00 --------

Dead LoadTensile force T_H = H = 0.00 (kN)

Dead+Live LoadsTensile force T_H = H = 0.00 (kN)

SeismicLevel1Tensile force T_H = H = 2200.00 (kN)

Tensile force by other horizontal reactions

Items	Horizontal Force Hti(kN)	Operated position xi(m)	Operated position yi(m)
Dead Load	0.00	0.000	0.000
Dead+Live Loads	0.00	0.000	0.000
SeismicLevel1	0.00	0.000	0.000

Dead LoadTensile force $T_{HT} = \Sigma\ Ht*\left(1+\dfrac{y_i}{\lambda}\right) = 0.00$ (kN)

Dead+Live LoadsTensile force $T_{HT} = \Sigma\ Ht*\left(1+\dfrac{y_i}{\lambda}\right) = 0.00$ (kN)

SeismicLevel1Tensile force $T_{HT} = \Sigma\ Ht*\left(1+\dfrac{y_i}{\lambda}\right) = 0.00$ (kN)

Tensile force by vertical reactions of super structure

Items	Vertical force Arm length P (kN)	
Dead Load	6000.00	1.515
Dead+Live Loads	8400.00	1.515
SeismicLevel1	7000.00	1.515
Dead LoadΣ Dead+Live LoadsΣ		6000.00 --------

Items	Vertical force Arm length P (kN) a (m)	
SeismicLevel1Σ		7000.00

Dead LoadTensile force $T_v = P*\frac{a}{\lambda}$ = 1569.59 (kN)

Dead+Live LoadsTensile force $T_v = P*\frac{a}{\lambda}$ = 2197.42 (kN)

SeismicLevel1Tensile force $T_v = P*\frac{a}{\lambda}$ = 1831.18 (kN)

The following ;

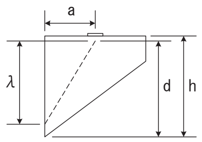
The vertical reactions of super structure: P (kN)

The truss width : a = 1515 (mm)

The truss height : λ = 0.85×d = 5791 (mm)

The height of beam joint : h = 7000 (mm)

The effective height of beam joint : d = 6813 (mm)



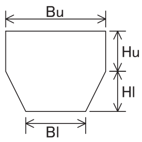
Design tensile force

Dead Load $T = T_J + T_H + T_{HT} + T_V$ = 1882.38 (kN)

Dead+Live Loads $T = T_J + T_H + T_{HT} + T_V$ = 2510.21 (kN)

SeismicLevel1 $T = T_J + T_H + T_{HT} + T_V$ = 4343.98 (kN)

(2) Section shape and reinforcement arrangement



Bu = 3000 mm Bl = 1800 mm

Hu = 3329 mm Hl = 3671 mm

Main reinforcement(The position is the distance from beam top edge.)

No.	Reinforcement position (mm)	Reinforcement diameter	Number sets	Reinforcement amount (mm^2)
1	150	D32	19	15089.8
2	250	D32	11	8736.2
		Reinforcement amount total ΣAs =		23826.0

(3) Check against Reinforcement arrangement, effective height

Effective height of beam joint : d = 6813 mm

Upper face rebar position Bottom step position hl d/4	mm	hl <= d/4 OK 250.00 1703.33
Effective height Load point position da d/2	mm	da >= d/2 OK 5326.53 3406.67
Side face core rebar Arrangement interval s Maximum interval smax	mm	s <= smax OK 300.00 300.00

(4) Check against reinforcement amount

Items	Unit	Dead Load	Dead+Live Loads	SeismicLevel1
Load condition	------	Dead Load Case Ordinary		
Design tensile force T	kN	1882.38	2510.21	4343.98
Allowable tensile stress σsa	N/mm^2	100.00	180.00	300.00
Upper face tensile rebar Amount of use Asu Necessary amount AsuReq	mm^2	Asu >= AsuReq OK 23826.00 18823.80	Asu >= AsuReq OK 23826.00 13945.64	Asu >= AsuReq OK 23826.00 14479.93
Side face core rebar Amount of use Ass Necessary amount AssReq	mm^2	Ass >= AssReq OK 13179.00 9530.40	Ass >= AssReq OK 13179.00 9530.40	Ass >= AssReq OK 13179.00 9530.40

Note : AsuReq = 1000*T / σsa

Note : AssReq = 0.4*Asu

2.3 Design horizontal direction section(Allowable stress design method)

2.3.1 Consider against bending moment

About bending moment, considering at the position of beam joint.

(1) Section force from the beam joint

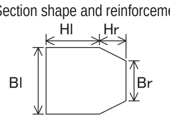
1) case SeismicLevel1

items	horizontal force H (kN)	arm length x (m)	bending moment H*x (kN.m)
Inertia force by beam own load	366.89	1.481	543.45
Super structural horizontal reaction force	1100.00	1.515	1666.50
Total (design section force)	1466.89	----------	2209.95

2) case Temperature

items	horizontal force H (kN)	arm length x (m)	bending moment H*x (kN.m)
Inertia force by beam own load	0.00	0.000	0.00
Super structural horizontal reaction force	100.00	1.515	151.50
Total (design section force)	100.00	----------	151.50

(2) Section shape and reinforcement arrangement



Bl = 3000 mm Br = 1800 mm

Hl = 3329 mm Hr = 3671 mm

Main reinforcement(Position is the distance form beam side face.)

No.	Reinforcement position (mm)	Reinforcement diameter	Number sets	Reinforcement amount (mm^2)
1	95	D19	11	3151.5
2	120	D32	1	794.2
3	120	D32	1	794.2
4	393	D19	12	3438.0
5	679	D32	1	794.2
		Reinforcement amount total ΣAs =		8972.1

* Minimum reinforcement amount [Reinforcement amount total(8972.1mm^2) >= m: reinforcement amount of 500mm^2(3524.4mm^2)] OK

* Maximum reinforcement amount [tensile reinforcement amount (8972.1mm^2) <= balanced reinforcement amount Asb(891860.5mm^2)] OK

(3) Section check

Items	Unit	SeismicLevel 1	Temperature
Load condition	------	Lv1E.Q.	Dead Load + Temperature
Bending moment M	kN.m	2209.95	151.50
Compressive edge-middle axial x	mm	391	391
Compressive stress σc Tensile stress σs	N/mm2 N/mm2	1.05 101.34	0.07 6.95
Increasing coefficient α Allowable compressive stress σca Allowable tensile stress σsa	------ N/mm2 N/mm2	1.50 15.00 300.00	1.15 11.50 207.00
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc

Crack bending moment Mc = 19305.83 (kN.m) Ultimate bending moment Mu = 8408.46 (kN.m)

2.3.2 Consider against shear force

Against shear force, consider at joint position and bearing postion.

1) Check section

Secion	Check position x(m)	Beam width (Reduced width) b(m)	Beam height H(m)	tanβ＋tanγ
1	0.000	6.266	3.000	0.000
2	1.515	5.253	3.000	0.000

2) Section check

Section[1] b = 6266mm h = 3000mm

Items	Unit	SeismicLevel1	Temperature
Condition	--------	Lv1E.Q.	Dead Load + Temperature
S M	kN kN.m	1466.89 2209.95	100.00 151.50
d	mm	2735	2735
Sh	kN	1466.89	100.00
α pt ce cpt	------- % ------- -------	1.50 0.052 0.740 0.605	1.15 0.052 0.740 0.605
τm τa1 τa2	N/mm2 N/mm2 N/mm2	0.086 0.166 2.850	0.006 0.129 2.185

Section[2] b = 5253mm h = 3000mm

Items	Unit	SeismicLevel1	Temperature
Condition	--------	Lv1E.Q.	Dead Load + Temperature
S M	kN kN.m	1270.60 141.00	100.00 0.00
d	mm	2791	2791
Sh	kN	1270.60	100.00
α pt ce cpt	------- % ------- -------	1.50 0.051 0.731 0.603	1.15 0.051 0.731 0.603
τm τa1 τa2	N/mm2 N/mm2 N/mm2	0.087 0.163 2.850	0.007 0.127 2.185

Note : $Sh = S - M/d*(\tan\beta + \tan\gamma)$

$\tau m = Sh / bd$

The following ;

S : Shear force

M : Bending moment

d : Effective height

$\tan\beta + \tan\gamma$: Change of effective height

Sh : Shear force to consider the change of effective height

α : Increasing coefficient of allowable stress

pt : Tensile main reinforcement ratio

ce : Correction coefficient of allowable shear stress about effective height d

cpt : Correction coefficient of allowable shear stress about tensile reinforcement ratio

τm : Average shear stress

$\tau a1$: Allowable shear stress when share shear force by only concrete

$\tau a2$: Allowable shear stress when share shear force with stirrup

4.7 BRIDGE SEAT DESIGN

(1) Seating Length at P5 and P10

The seating length, which is defined as the distance between the edge of the girder and the edge of the top of substructure in longitudinal direction, should be long enough to prevent departure and unseating of the superstructure from the top of the substructure. The required value (S_{EM}) can be calculated at the equation below as specified in the JSBH.

$S_{EM} = 0.7 + 0.005$ x span length (m)

Table Verification of Seating Lenght

Pier No.	P5	P10
Span Length	75.6m	102.8m
Required Seating Length (S_{EM})	1.078m	1.214m
Seating Length	2.150m	3.550m
Judge	OK	OK

(2) Bearing Edge Distance (S)

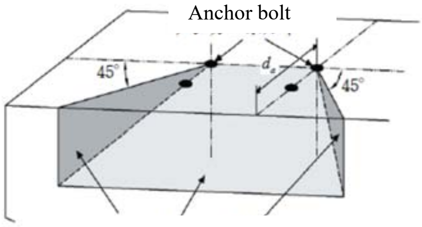
The bearing edge distance (S), which is defined as the distance between the center of anchor bolt of bearing and the edge of the top of the substructure, shall be equal to or larger than the following value:

$S \geq 0.2+0.005$ x span length (m)

Pier No.	P5	P6	P7	P10
Span Length	75.6m	76.5m	102.8m	102.8m
Minimum Edge Distance	0.578m	0.583m	0.714m	0.714m
Edge Distance (S)	0.620m	1.016m	1.040m	0.918m
Judge	OK	OK	OK	OK

(3) Bridge Seat Strength

Bridge seats is designed with sufficient strength to withstand the vertical and horizontal forces through bearings. Horizontal force (design horizontal seismic force) transmitted from the bearings is resisted by concrete and reinforcement. The resisting area of concrete is the summation of three planes in directions of sideward and downward with edge angles of 45 degrees as shown in figure below.



Source: JSAB

Figure Image of Resisting area of Concrete

The bridge seats against design horizontal seismic force is verified as follows:

Evaluation of strength

P_{bs} = Pc + Ps (Pc ≧ Ps), P_{bs} ≧ Design horizontal seismic force (P_h (N))

Where,

P_{bs} : Strength of bridge seat (N)
Note that the strength is determined under the condition that the strength borne by reinforcements does not exceed that borne by concrete.

P_c : Strength borne by concrete (N)
$Pc = (\alpha \cdot 0.32 \cdot \sqrt{\sigma_{ck}} \cdot Ac) / 1000.0$

P_s : Strength borne by reinforcement (N)
$Ps = \Sigma\{\beta \cdot (1 - h_i / da) \cdot \sigma_{sy} \cdot A_{si}\} / 1000.0$

α : Coefficient for determining the strength borne by concrete
σ_n : Bearing stress at bottom of bearing support against vertical force (N/mm^2)
σ_{ck} : Design strength of concrete (N/mm^2)
A_c : Resistance area of concrete (mm^2)
β : Correction factor associated with the strength borne by reinforcement
h_i : Distance from bridge seat surface of i^{th} reinforcement (m)
d_a : Distance from center of anchor bolt in the rear side of bearing support to bridge seat edge
σ_{sy} : Yield point of reinforcement (N/mm^2)
A_{si} : Cross sectional area of i^{th} reinforcement (mm^2)

The calculation result is summarized in table below.

Table Verification Result of Bridge Seat Strength

Pier No.	P6		P7	
Girder	G1	G4	G1	G4
Design horizontal seismic force Ph (kN) *per bearing	1,200	1,200	1,100	1,100
Resistance area of concrete Ac (mm^2)	6,657,000	8,218,000	6,234,000	8,330,000
Bearing stress at bottom of bearing support against vertical force σ n (N/mm^2)	2.07	2.50	2.80	2.97
Coefficient for determining the strength borne by concrete	0.27	0.30	0.31	0.32
Strength borne by concrete Pc (kN)	3,160	4,260	3,420	4,710
Strength borne by reinforcement Ps (kN)	1,890	1,890	1,790	1,980
Strength of bridge seat Pbs (kN)	5,050	6,150	5,210	6,690
Judge (Pbs≧Ph)	OK	OK	OK	OK

Detailed calculation is referred to following pages.

Table Detail Calculation Sheet of Bridge Seat Design for P6

Detail Calculation Sheet of Bridge Seat Design for P6

G4 Girder

1. Force

・Horizontal Seismic Force : H

4581 kN/pier
1200 kN/bearing *100kN Roundup

・Dead load on Bearing : V

4774 kN／bearing@G4

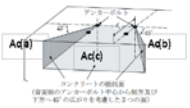
2. Strength of Bridge Seat

Strength borne by concrete : Pc

Pc=0.32・α・√σck・Ac

Dimension of Base Plate of Bearing: 1130 1690 mm

σn :	2.4998691 N/mm2			
σck :	30 N/mm2			
σn／√σck :	0.456412			
α :	0.295846			
Ac	8,225,000 mm2	Ac(a)	=a1xa2/2=	3,848,922
		Ac(b)	=b1xb2/2=	807,594
		Ac©	=(c1+c2)x√2xc 3 /2 =	3,568,598
		Total		8,225,114



Pc= 4,264,930 N
4260 kN > H:1200kN

Strength borne by reinforcement : Ps

Ps=Σβ(1-hi/da) σsy・Asi

β :		0.5	Diameter	
hi :	h1	0.126 m	D19	
	h2	0.273 m	D16	
	h3	0.873 m	D16	
da:		1.96 m		
σsy :		345 N/mm2		nos. *C2/150mm
Asi :	D22	387.1 mm2	x	0
	D19	286.5 mm2	x	20
	D16	198.6 mm2	x	20

Ps= 1894608.7 N
1890 kN *Shall be less than 50% of Pbs OK

Pbs=Pc+Ps=
6150 kN > H:1200kN OK

G1 Girder

1. Force

・Horizontal Seismic Force : H

4581 kN/pier
1200 kN/bearing *100kN Roundup

・Dead load on Bearing : V

3960 kN／bearing@G4

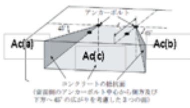
2. Strength of Bridge Seat

Strength borne by concrete : Pc

Pc=0.32・α・√σck・Ac

Dimension of Base Plate of Bearing: 1130 1690 mm

σn :	2.07362413 N/mm2			
σck :	30 N/mm2			
σn／√σck :	0.37859			
α :	0.270978			
Ac	6,657,000 mm2	Ac(a)	=a1xa2/2=	867,230
		Ac(b)	=b1xb2/2=	1,858,592
		Ac©	=(c1+c2)x√2xc 3 /2 =	3,931,973
		Total		6,657,794



Pc= 3,161,719 N
3160 kN > H:1200kN

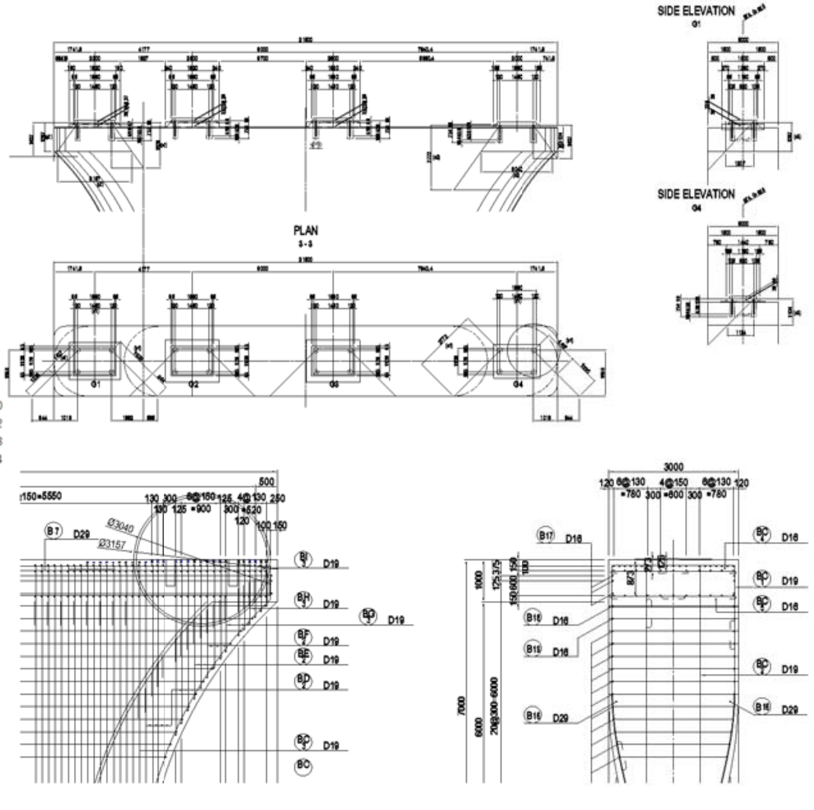
Strength borne by reinforcement : Ps

Ps=Σβ(1-hi/da) σsy・Asi

β :		0.5	Diameter	
hi :	h1	0.126 m	D19	
	h2	0.273 m	D16	
	h3	0.873 m	D16	
da:		1.96 m		
σsy :		345 N/mm2		nos. *C2/150mm
Asi :	D22	387.1 mm2	x	0
	D19	286.5 mm2	x	20
	D16	198.6 mm2	x	20

Ps= 1894608.69 N
1890 kN *Shall be less than 50% of Pbs OK

Pbs=Pc+Ps=
5050 kN > H:1200kN OK



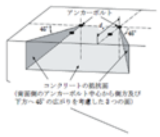


図-解 8.6.4 コンクリートの抵抗面積 A_c

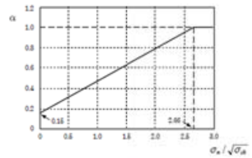


図-解 8.6.3 コンクリートの負担分を算出するための係数α

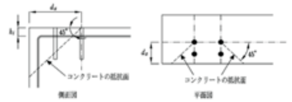


図-解 8.6.5 h_iとd_aの取り方

Table Detail Calculation Sheet of Bridge Seat Design for P7

Detail Calculation Sheet of Bridge Seat Design for P7

G4 Girder

1. Force

・Horizontal Seismic Force : H

4329 kN/pier
1100 kN/bearing *100kN Roundup

・Dead load on Bearing : V

5951 k N／bearing@G4

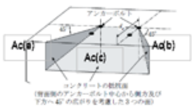
2. Strength of Bridge Seat

Strength borne by concrete : Pc

Pc=0.32・α・√σck・Ac

Dimension of Base Plate of Bearing: 1160 1730 mm

σn :	2.9654176 N/mm2			
σck :	30 N/mm2			
σn／√σck :	0.541409			
α :	0.323007			
Ac	8,330,000 mm2	Ac(a)	=a1xa2/2=	3,839,221
		Ac(b)	=b1xb2/2=	817,705
		Ac©	=(c1+c2)x√2xc 3 /2 =	3,673,662
		Total		8,330,587



Pc= 4,715,925 N
4710 kN > H:1200kN

Strength borne by reinforcement : Ps

Ps=Σβ(1-hi/da) σsy・Asi

β :		0.5	Diameter
hi :	h1	0.125 m	D19
	h2	0.274 m	D16
	h3	0.874 m	D16
da:		1.96 m	
σsy :		345 N/mm2	nos. *C2/150mm
Asi :	D22	387.1 mm2 x	0
	D19	286.5 mm2 x	21
	D16	198.6 mm2 x	21

Ps= 1989134.5 N
1980 kN *Shall be less than 50% of Pbs OK

Pbs=Pc+Ps=
6690 kN > H:1200kN OK

G1 Girder

1. Force

・Horizontal Seismic Force : H

4329 kN/pier
1100 kN/bearing *100kN Roundup

・Dead load on Bearing : V

5629 k N／bearing@G4

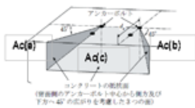
2. Strength of Bridge Seat

Strength borne by concrete : Pc

Pc=0.32・α・√σck・Ac

Dimension of Base Plate of Bearing: 1160 1730 mm

σn :	2.80496313 N/mm2			
σck :	30 N/mm2			
σn／√σck :	0.512114			
α :	0.313645			
Ac	6,234,000 mm2	Ac(a)	=a1xa2/2=	837,192
		Ac(b)	=b1xb2/2=	1,858,592
		Ac©	=(c1+c2)x√2xc 3 /2	3,538,475
		Total		6,234,259



Pc= 3,427,018 N
3420 kN > H:1200kN

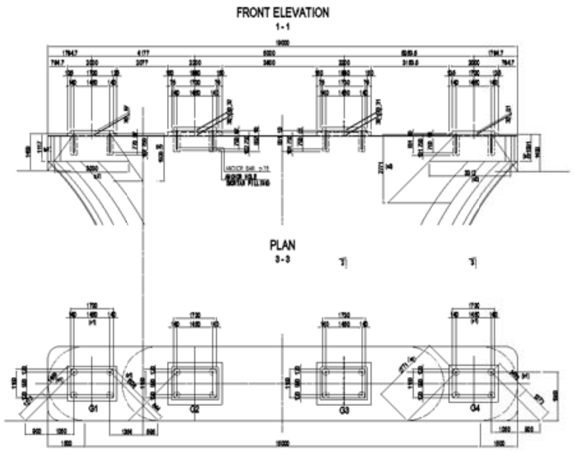
Strength borne by reinforcement : Ps

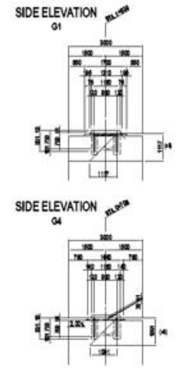
Ps=Σβ(1-hi/da) σsy・Asi

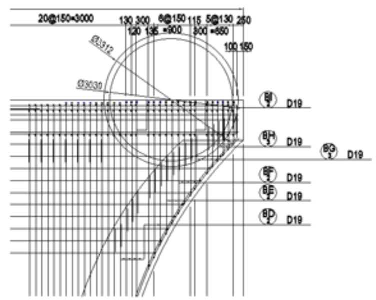
β :		0.5	Diameter
hi :	h1	0.125 m	D19
	h2	0.274 m	D16
	h3	0.874 m	D16
da:		1.96 m	
σsy :		345 N/mm2	nos. *C2/150mm
Asi :	D22	387.1 mm2 x	0
	D19	286.5 mm2 x	19
	D16	198.6 mm2 x	19

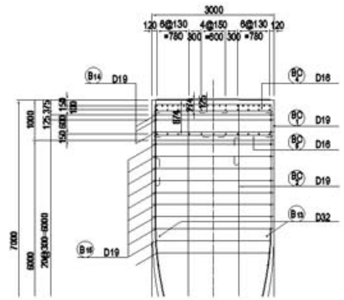
Ps= 1799693.14 N
1790 kN *Shall be less than 50% of Pbs OK

Pbs=Pc+Ps=
5210 kN > H:1200kN OK









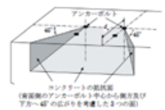


図-解 8.6.4 コンクリートの抵抗面積 A_c

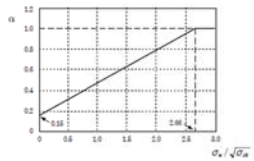


図-解 8.6.3 コンクリートの負担分を算出するための係数α

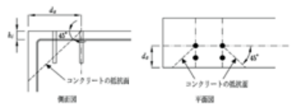


図-解 8.6.5 h_i と d_a の取り方