STEEL BOX GIREDER BRIDGE
(7-SPAN)

SUBSTRUCTURE

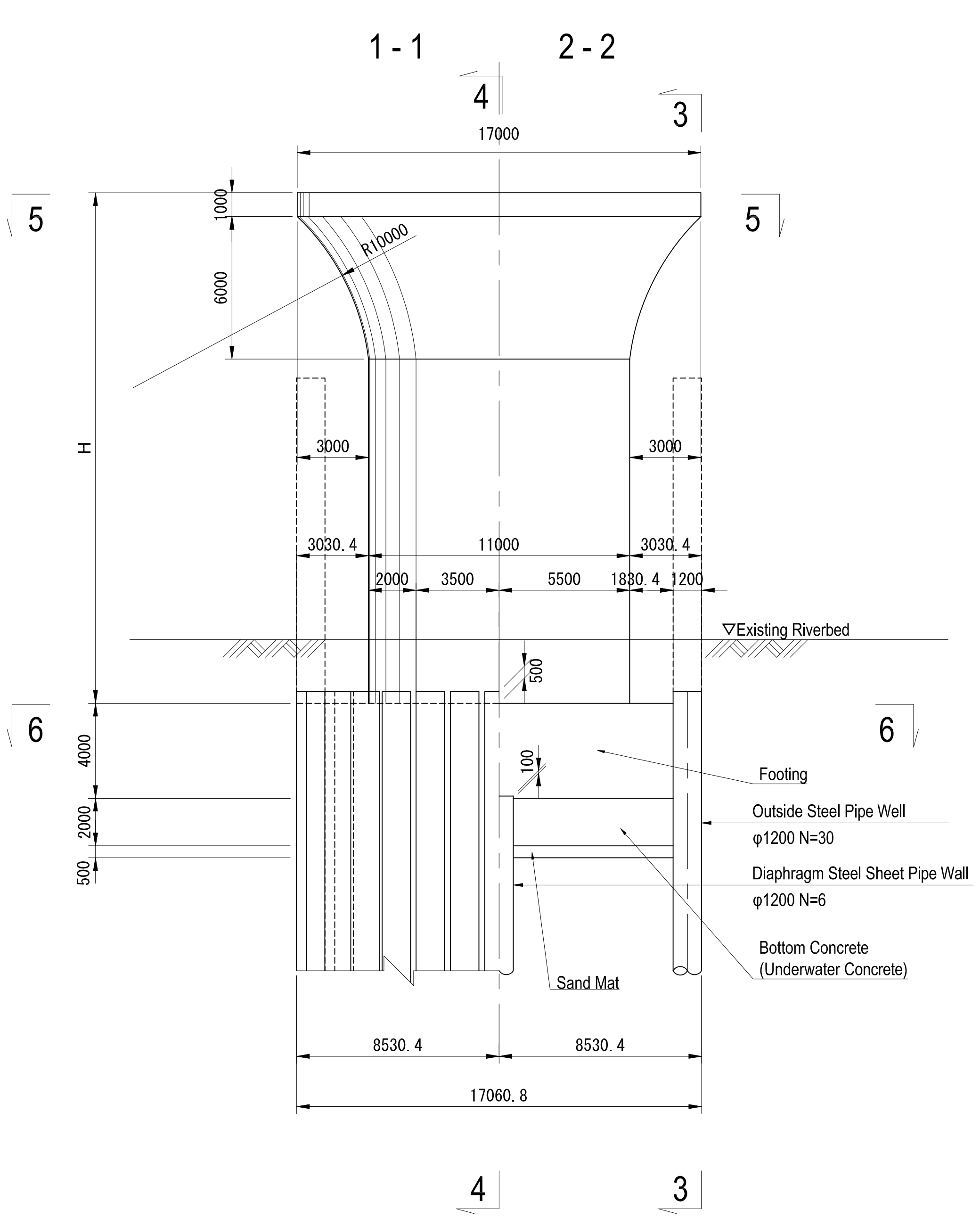
CONTENTS

CHAPTER 1. GENERAL

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

GENERAL DRAWING OF RC PIERS OF P14-P19 Scale: 1/300 in A3

FRONT ELEVATION



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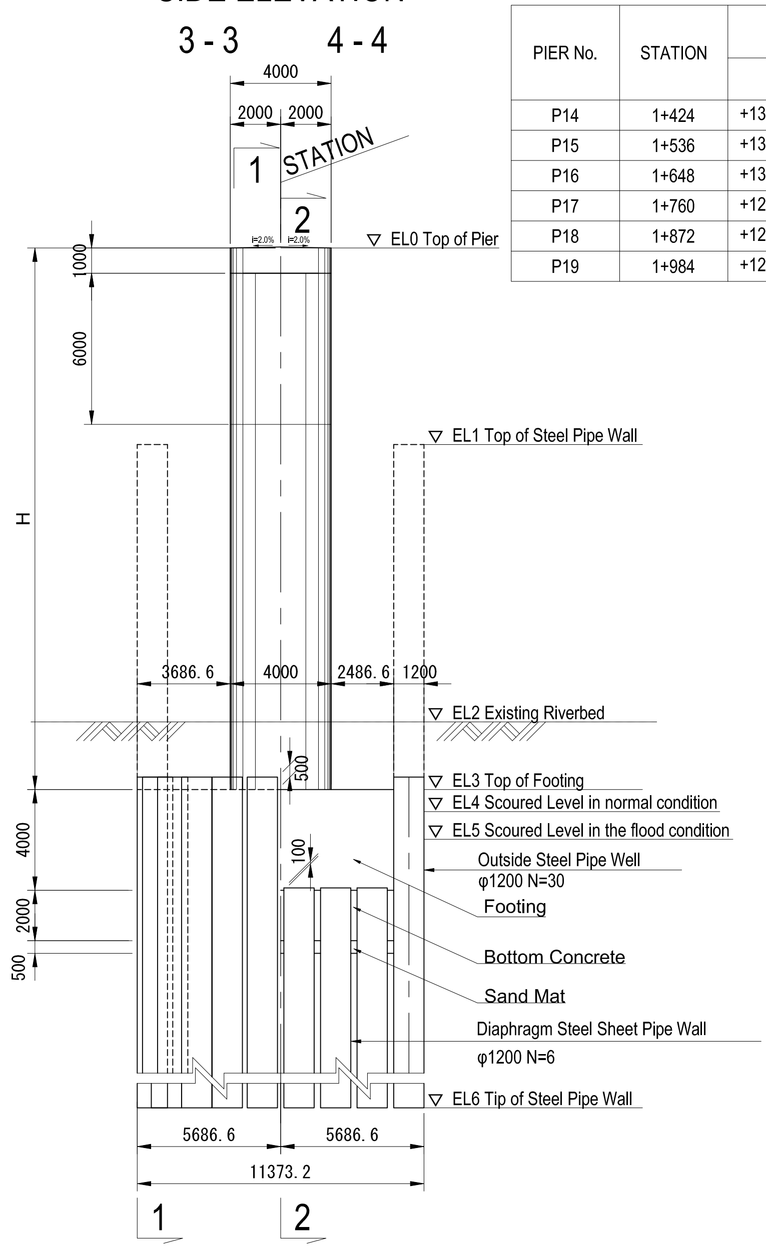
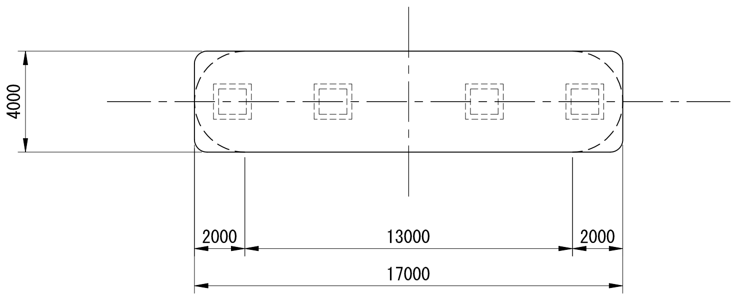
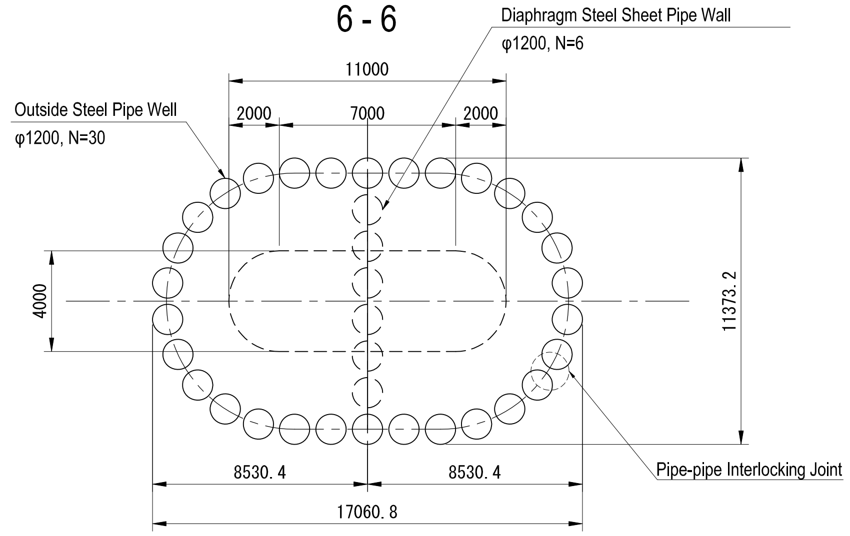


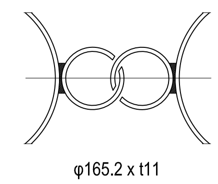
PIER No.	STATION	Elevation (m)						
		EL0 (H)	EL1	EL2	EL3	EL4	EL5	EL6
P14	1+424	+13.840m (21.9m)	+4.840m	-6.276m	-8.060m	-8.850m	-11.430m	-49.160m
P15	1+536	+13.540m (21.6m)	+4.840m	-5.091m	-8.060m	-7.970m	-10.840m	-52.160m
P16	1+648	+13.240m (21.3m)	+4.840m	-5.262m	-8.060m	-7.810m	-10.360m	-50.160m
P17	1+760	+12.840m (20.9m)	+4.840m	-6.695m	-8.060m	-8.200m	-9.700m	-50.160m
P18	1+872	+12.540m (20.6m)	+4.840m	-6.989m	-8.060m	-8.490m	-10.000m	-50.160m
P19	1+984	+12.240m (20.3m)	+4.840m	-6.878m	-8.060m	-8.330m	-9.780m	-48.660m

PLAN
5 - 5



PLAN
6 - 6





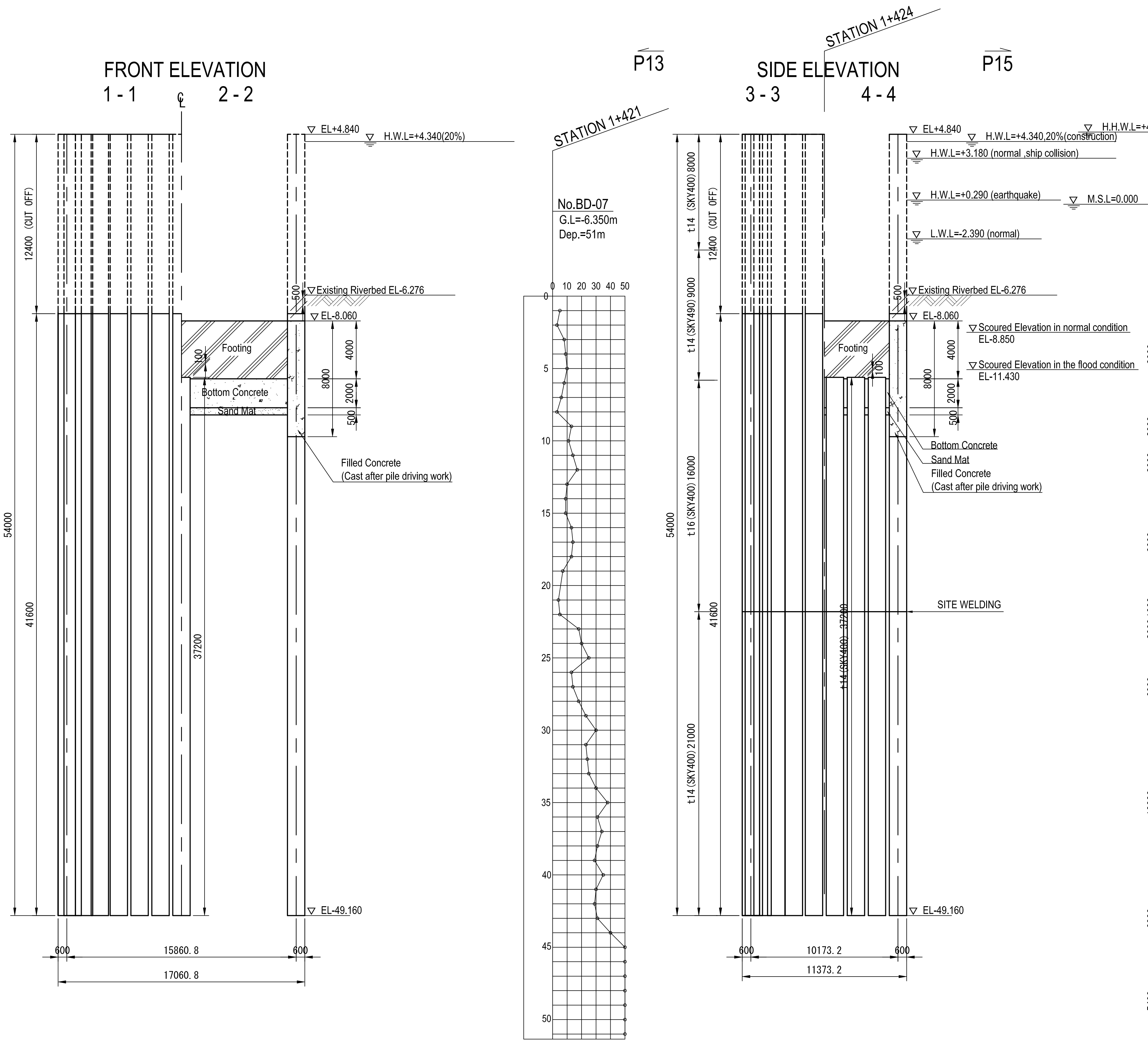
Details of Pipe-pipe Interlocking Joint
Scale: 1/20

PROJECT NAME	FINANCED BY	COUNTERPART	JICA STUDY TEAM		NAME	SIGNATURE	DATE	DRAWING TITLE	PACKAGE
DETAILED DESIGN ON BAGO RIVER BRIDGE CONSTRUCTION PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	REPUBLIC OF THE UNION OF MYANMAR MINISTRY OF CONSTRUCTION DEPARTMENT OF BRIDGE	NIPPON KOEI CO., LTD. ORIENTAL CONSULTANTS GLOBAL CO., LTD. METROPOLITAN EXPRESSWAY COMPANY LIMITED CHODAI CO.,LTD. NIPPON ENGINEERING CONSULTANTS CO.,LTD.	PREPARED BY	S. IMADA			General Drawing of RC Piers of P14-P19	2
				CHECKED BY	T. HAYAKAWA				DWG No.
				APPROVED BY	Y. SANO				P02-SB-2001

GENERAL DRAWING OF STEEL PIPE SHEET PILE FOUNDATION OF P14

Scale: 1/300 in A3

P14



Thickness	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
8000	Silty Sand River Sediments	3	18	0	29	1,200	Liquefaction D_E = 1/3
2000 / 3000	Silty Sand-I	13	18.0	0	33	5,200	Liquefaction D_E =1/3 (2000); Liquefaction D_E =1 (3000)
8000	Clay-AII	7	17.5	42	0	4,900	-
1000	Clayey Sand-B	13	18.0	0	32	9,100	-
2000	Clay-AII	7	17.5	42	0	4,900	-
6000	Clayey Sand-C	20	18.0	0	33	14,000	-
10000	Silty Sand-II	30	18.0	0	34	21,000	-
6000	Clayey-AIV	30	18.0	180	0	21,000	-
5400	Clayey Sand-II	50	20.0	0	34	35,000	-

3

PROJECT NAME	FINANCED BY	COUNTERPART	JICA STUDY TEAM
DETAILED DESIGN ON BAGO RIVER BRIDGE CONSTRUCTION PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	REPUBLIC OF THE UNION OF MYANMAR MINISTRY OF CONSTRUCTION DEPARTMENT OF BRIDGE	NIPPON KOEI CO., LTD. ORIENTAL CONSULTANTS GLOBAL CO., LTD. METROPOLITAN EXPRESSWAY COMPANY LIMITED CHODAI CO.,LTD. NIPPON ENGINEERING CONSULTANTS CO.,LTD.

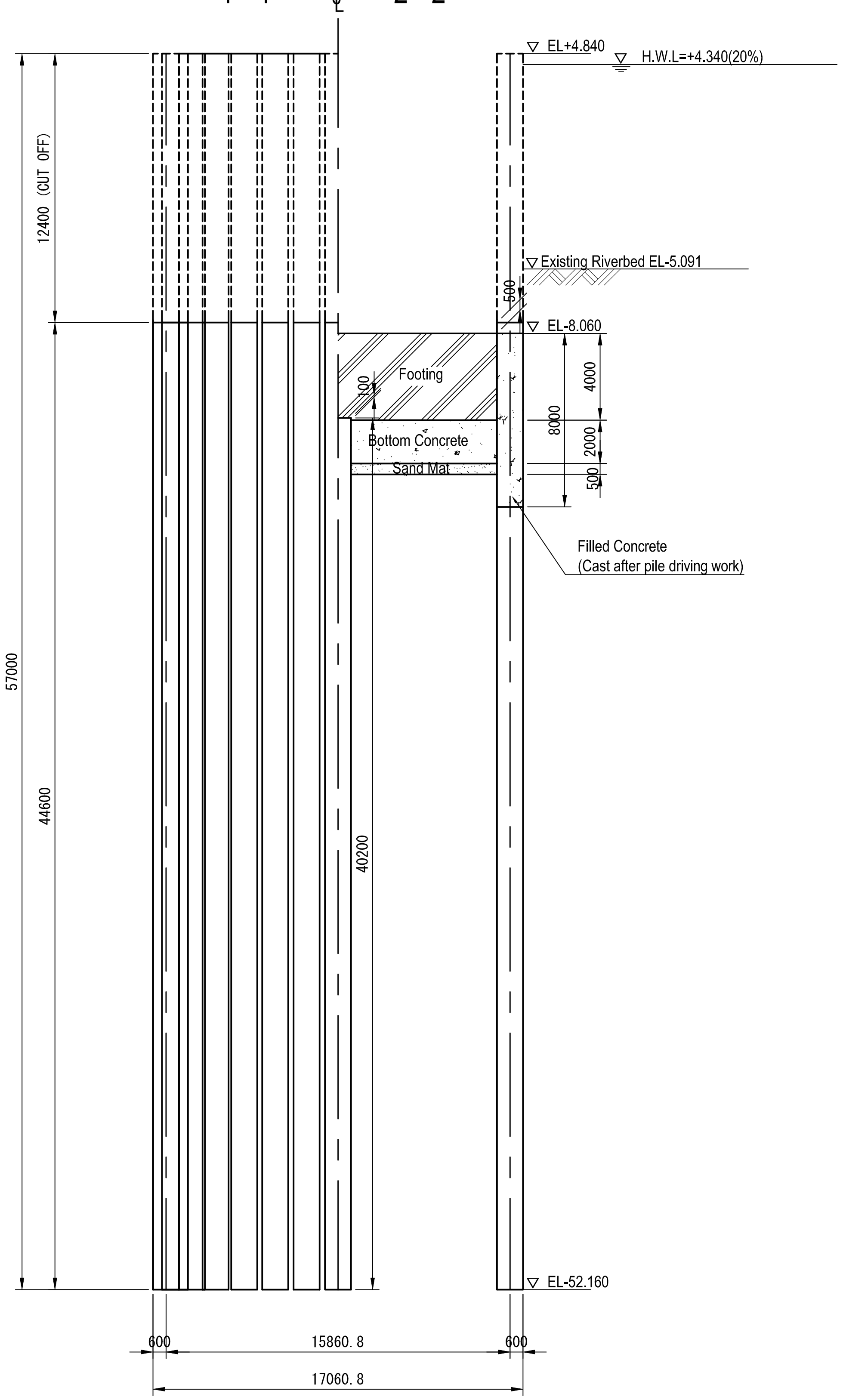
	NAME	SIGNATURE	DATE
PREPARED BY	S. IMADA		
CHECKED BY	T. HAYAKAWA		
APPROVED BY	Y. SANO		

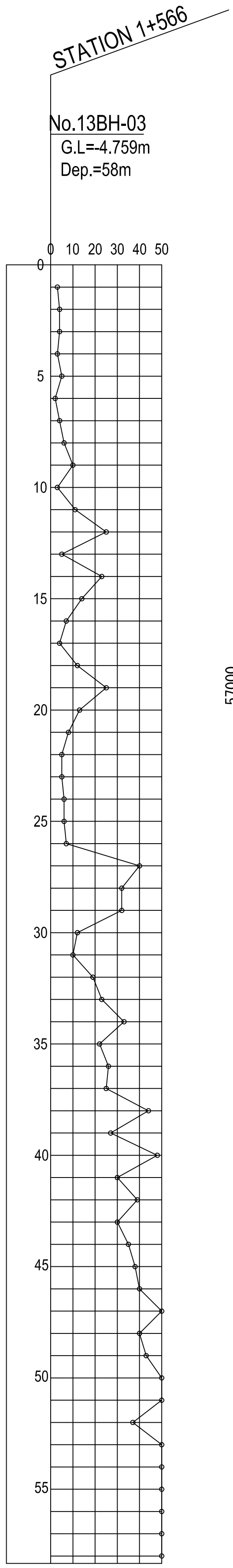
DRAWING TITLE	PACKAGE
General Drawing of Steel Pipe Sheet Pile Foundation of P14 Pier	2
	DWG No.
	P02-SB-2002

GENERAL DRAWING OF STEEL PIPE SHEET PILE FOUNDATION OF P15

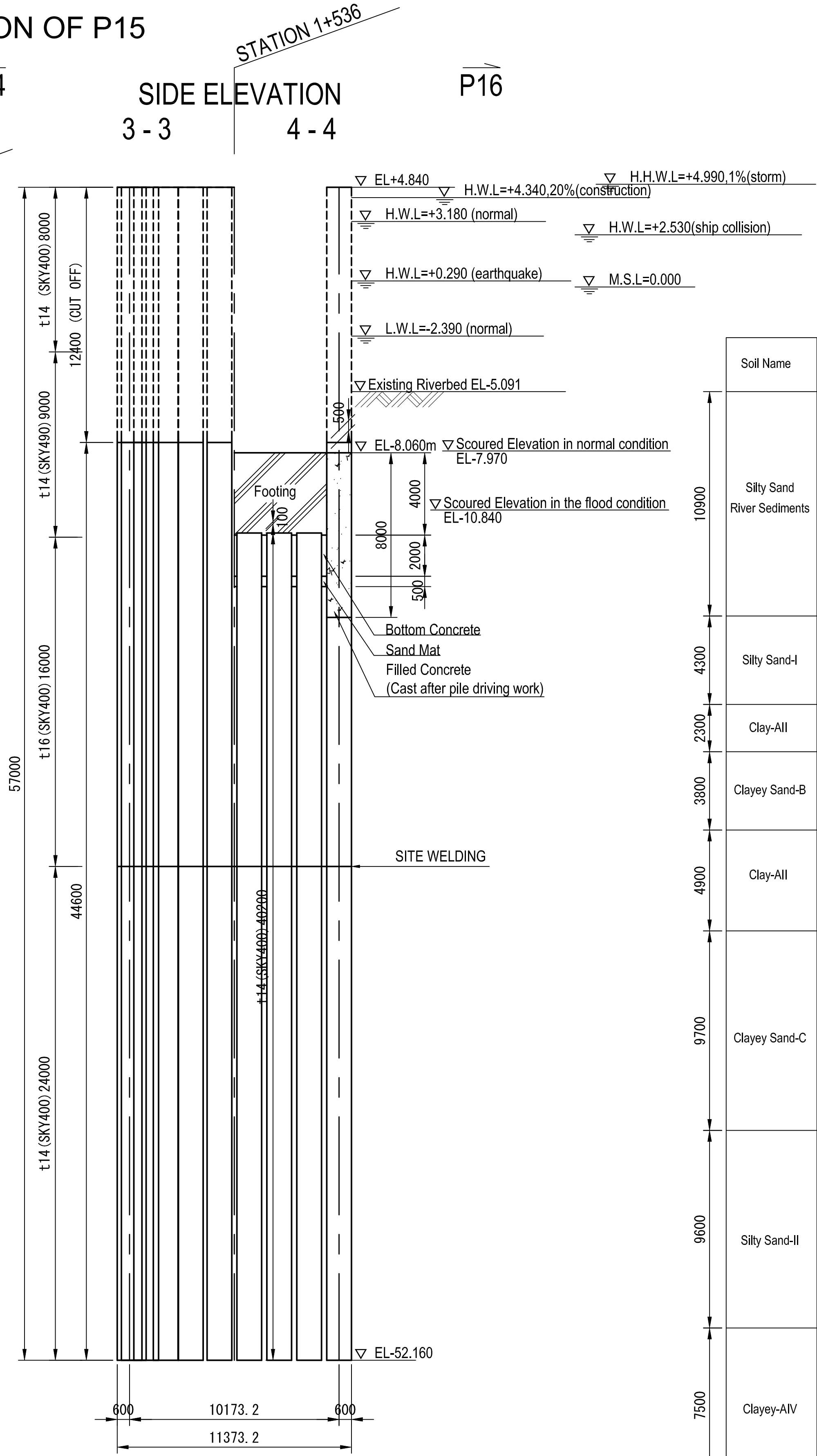
Scale: 1/300 in A3

FRONT ELEVATION





SIDE ELEVATION



Thickness	Soil Name	Average N-Value	Unit Weight γ_{Sat} (kN/m³)	Cohesion C_c (kN/m²)	Friction Angle φ (°)	Modulus of Elasticity E_0 (kN/m²)	Liquefaction Coefficient D_E
10900	Silty Sand River Sediments	3	18	0	29	1,200	Liquefaction D_E = 1/3
4300	Silty Sand-I	13	18.0	0	33	5,200	Liquefaction D_E =1
2300	Clay-AII	7	17.5	42	0	4,900	-
3800	Clayey Sand-B	13	18.0	0	32	9,100	-
4900	Clay-AII	7	17.5	42	0	4,900	-
9700	Clayey Sand-C	20	18.0	0	33	14,000	-
9600	Silty Sand-II	30	18.0	0	34	21,000	-
7500	Clayey-AIV	30	18.0	180	0	21,000	-
5600	Clayey Sand-II	50	20.0	0	34	35,000	-

PROJECT NAME	FINANCED BY	COUNTERPART	JICA STUDY TEAM
DETAILED DESIGN ON BAGO RIVER BRIDGE CONSTRUCTION PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	REPUBLIC OF THE UNION OF MYANMAR MINISTRY OF CONSTRUCTION DEPARTMENT OF BRIDGE	NIPPON KOEI CO., LTD. ORIENTAL CONSULTANTS GLOBAL CO., LTD. METROPOLITAN EXPRESSWAY COMPANY LIMITED CHODAI CO.,LTD. NIPPON ENGINEERING CONSULTANTS CO.,LTD.

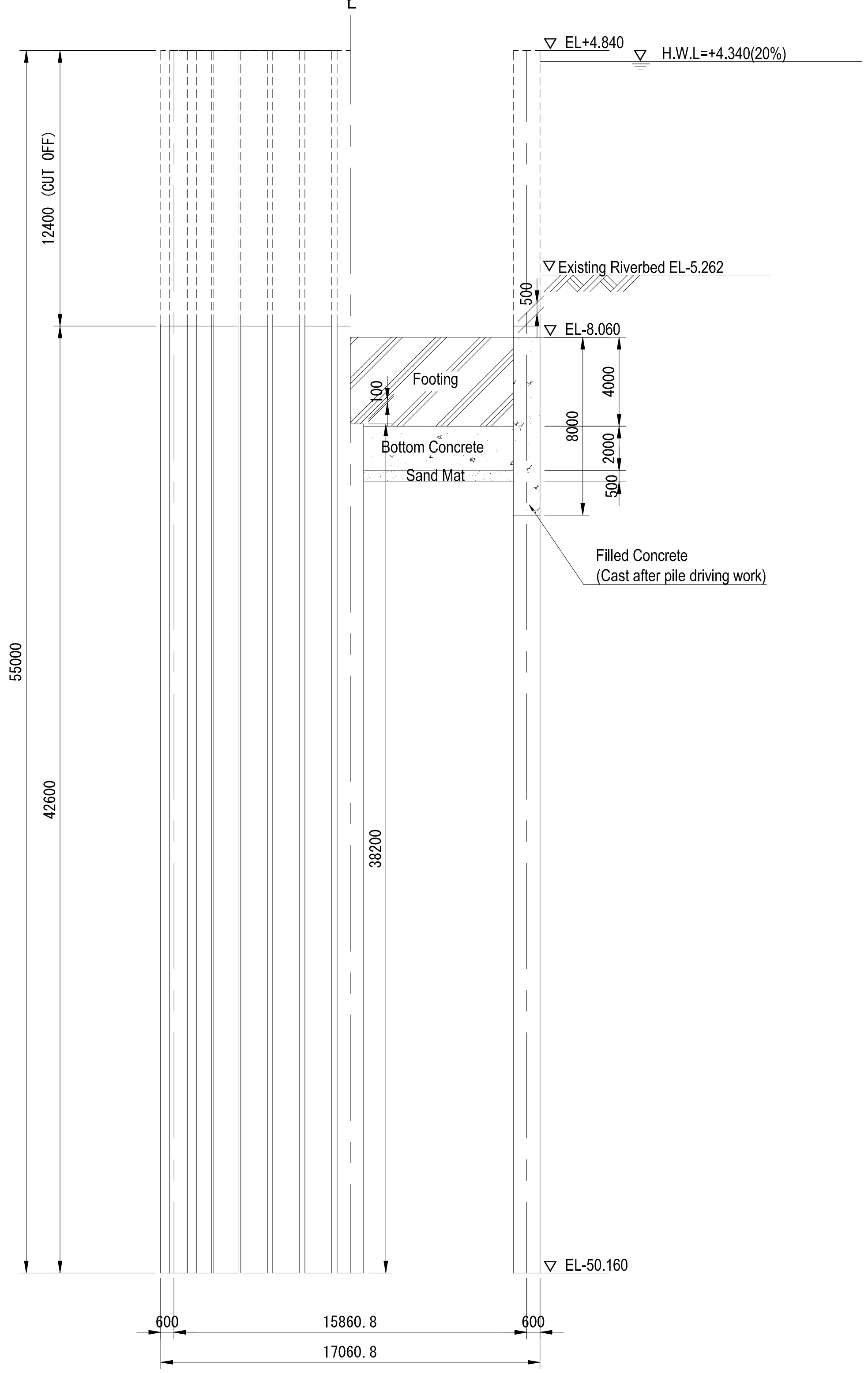
	NAME	SIGNATURE	DATE
PREPARED BY	S. IMADA		
CHECKED BY	T. HAYAKAWA		
APPROVED BY	Y. SANO		

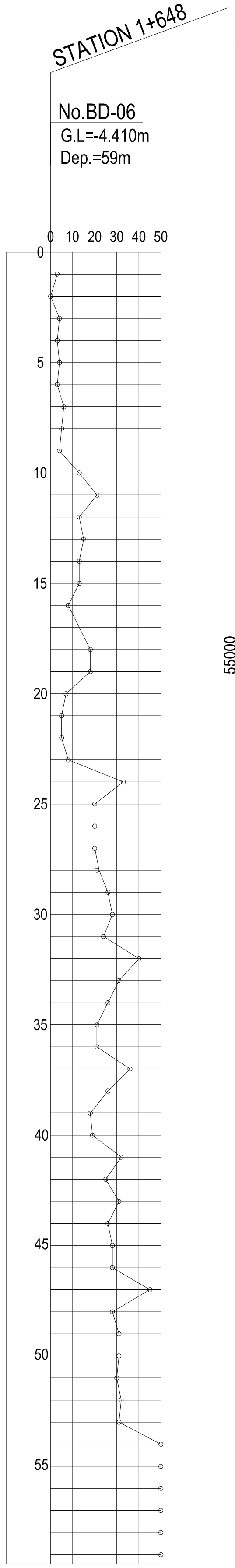
DRAWING TITLE	PACKAGE
General Drawing of Steel Pipe Sheet Pile Foundation of P15 Pier	2
	DWG No.
	P02-SB-2003

GENERAL DRAWING OF STEEL PIPE SHEET PILE FOUNDATION OF P16

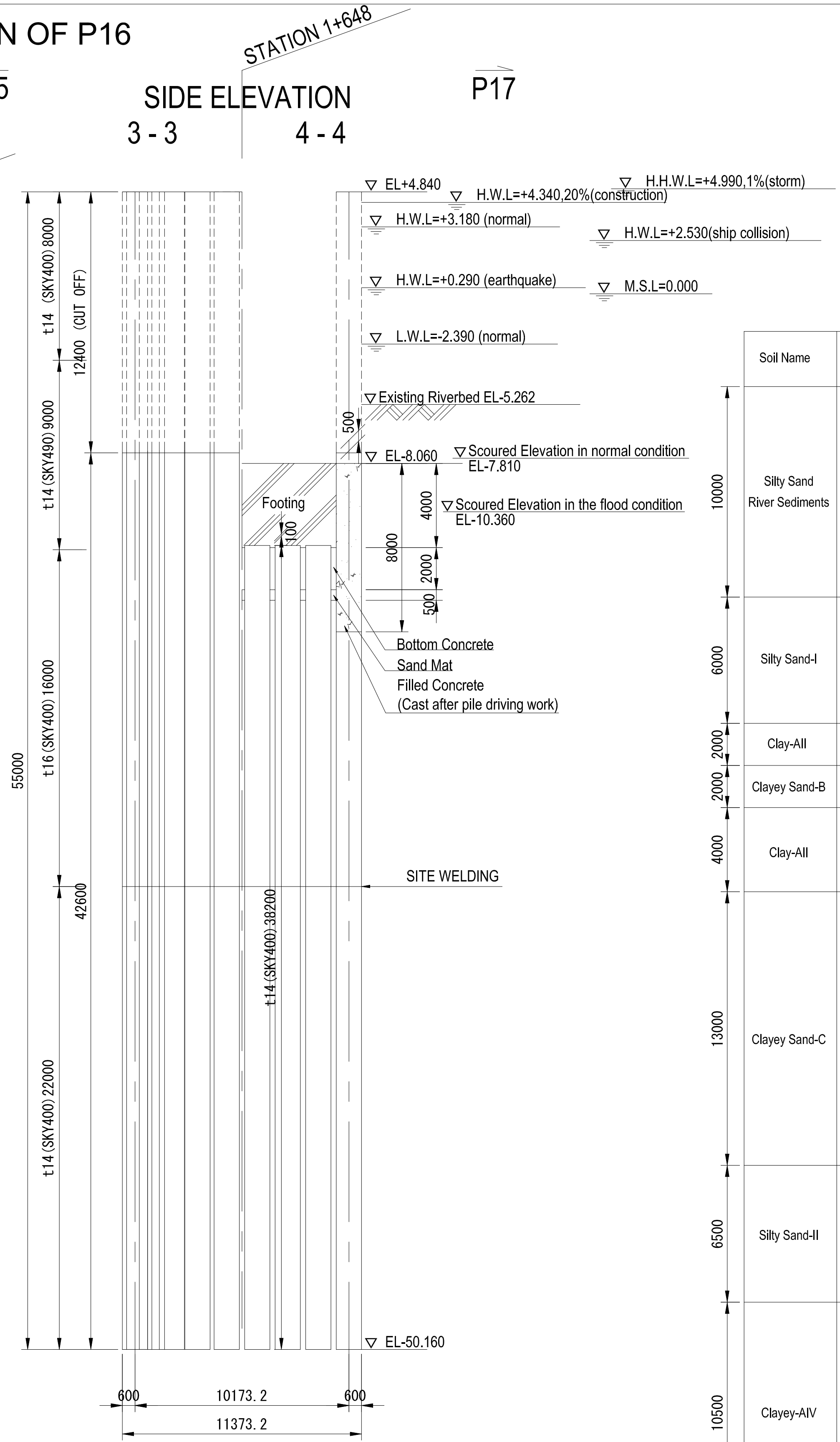
Scale: 1/300 in A3

FRONT ELEVATION





SIDE ELEVATION



Thickness	Soil Name	Average N-Value	Unit Weight γ_{Sat} (kN/m^3)	Cohesion C_u (kN/m^2)	Friction Angle φ (°)	Modulus of Elasticity E_0 (kN/m^2)	Liquefaction Coefficient D_E
10000	Silty Sand River Sediments	3	18	0	29	1,200	Liquefaction D_E = 1/3
6000	Silty Sand-I	13	18.0	0	33	5,200	Liquefaction D_E =1.0
2000	Clay-AII	7	17.5	42	0	4,900	-
2000	Clayey Sand-B	13	18.0	0	32	9,100	-
4000	Clay-AII	7	17.5	42	0	4,900	-
13000	Clayey Sand-C	20	18.0	0	33	14,000	-
6500	Silty Sand-II	30	18.0	0	34	21,000	-
10500	Clayey-AIV	30	18.0	180	0	21,000	-
5420	Clayey Sand-II	50	20.0	0	34	35,000	-

PROJECT NAME	FINANCED BY	COUNTERPART	JICA STUDY TEAM
DETAILED DESIGN ON BAGO RIVER BRIDGE CONSTRUCTION PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	REPUBLIC OF THE UNION OF MYANMAR MINISTRY OF CONSTRUCTION DEPARTMENT OF BRIDGE	NIPPON KOEI CO., LTD. ORIENTAL CONSULTANTS GLOBAL CO., LTD. METROPOLITAN EXPRESSWAY COMPANY LIMITED CHODAI CO.,LTD. NIPPON ENGINEERING CONSULTANTS CO.,LTD.

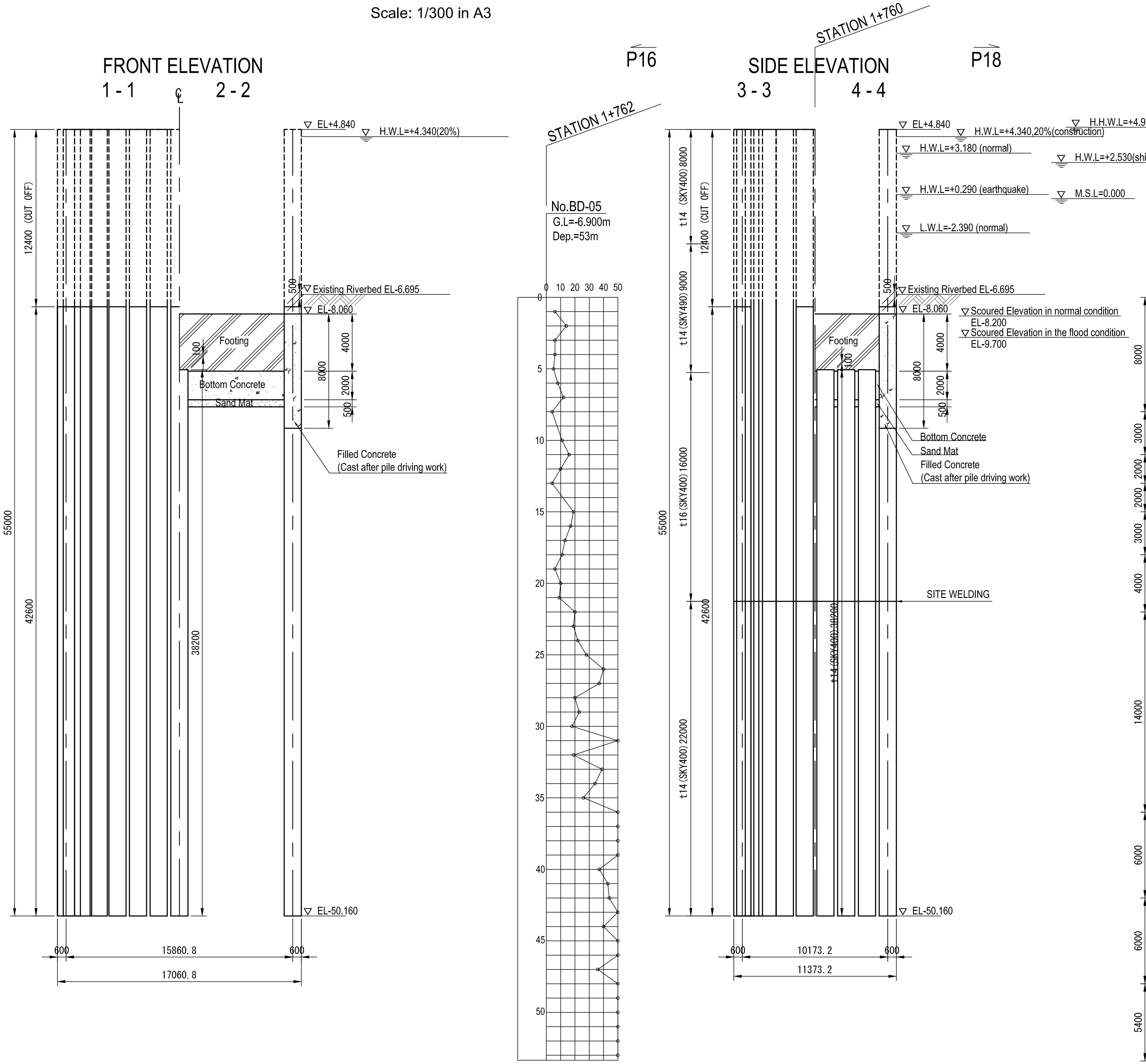
	NAME	SIGNATURE	DATE
PREPARED BY	S. IMADA		
CHECKED BY	T. HAYAKAWA		
APPROVED BY	Y. SANO		

DRAWING TITLE	PACKAGE
General Drawing of Steel Pipe Sheet Pile Foundation of P16 Pier	2
	DWG No.
	P02-SB-2004

GENERAL DRAWING OF STEEL PIPE SHEET PILE FOUNDATION OF P17

Scale: 1/300 in A3

P17



Layer thickness	Soil Name	Average N-Value	Unit Weight γ_{Sat} (kN/m^3)	Cohesion C_u (kN/m^2)	Friction Angle φ (°)	Modulus of Elasticity E_0 (kN/m^2)	Liquefaction Coefficient D_E
8000	Silty Sand River Sediments	3	18	0	29	1,200	Liquefaction D_E = 2/3
3000 / 2000	Silty Sand-I	13	18.0	0	33	5,200	- / Liquefaction D_E =1.0
2000	Clay-AII	7	17.5	42	0	4,900	-
3000	Clayey Sand-B	13	18.0	0	32	9,100	-
4000	Clay-AII	7	17.5	42	0	4,900	Liquefaction D_E =1.0
14000	Clayey Sand-C	20	18.0	0	33	14,000	-
6000	Silty Sand-II	30	18.0	0	34	21,000	-
6000	Clayey Sand-I	35	20.0	0	34	24,500	-
5400	Clayey Sand-II	50	20.0	0	34	35,000	-

PROJECT NAME	FINANCED BY	COUNTERPART	JICA STUDY TEAM
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	NAME	SIGNATURE	DATE
PREPARED BY	S. IMADA		
CHECKED BY	T. HAYAKAWA		
APPROVED BY	Y. SANO		

DRAWING TITLE: General Drawing of Steel Pipe Sheet Pile Foundation of P17 Pier

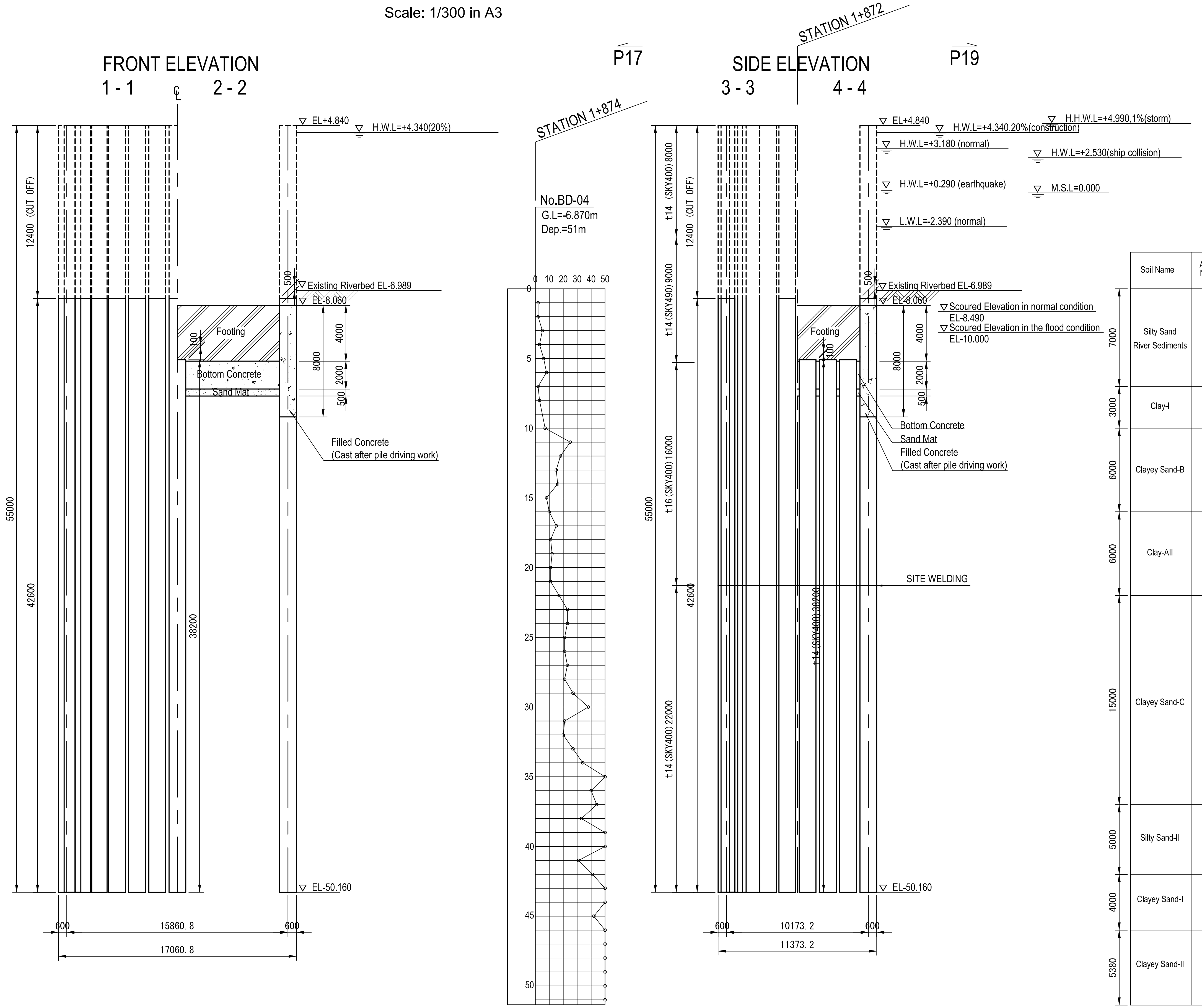
PACKAGE: 2

DWG No.: P02-SB-2005

GENERAL DRAWING OF STEEL PIPE SHEET PILE FOUNDATION OF P18

Scale: 1/300 in A3

P18



	Soil Name	Average N-Value	Unit Weight γ_{Sat} (kN/m^3)	Cohesion C_u (kN/m^2)	Friction Angle φ (°)	Modulus of Elasticity E_0 (kN/m^2)	Liquefaction Coefficient D_E
7000	Silty Sand River Sediments	3	18	0	29	1,200	Liquefaction D_E = 1/3
3000	Clay-I	1	17.5	10	0	900	Liquefaction D_E = 2/3
6000	Clayey Sand-B	13	18.0	0	32	9,100	-
6000	Clay-AII	7	17.5	42	0	4,900	-
15000	Clayey Sand-C	20	18.0	0	33	14,000	-
5000	Silty Sand-II	30	18.0	0	34	21,000	-
4000	Clayey Sand-I	35	20.0	0	34	24,500	-
5380	Clayey Sand-II	50	20.0	0	34	35,000	-

PROJECT NAME	FINANCED BY	COUNTERPART	JICA STUDY TEAM
DETAILED DESIGN ON BAGO RIVER BRIDGE CONSTRUCTION PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	REPUBLIC OF THE UNION OF MYANMAR MINISTRY OF CONSTRUCTION DEPARTMENT OF BRIDGE	NIPPON KOEI CO., LTD. ORIENTAL CONSULTANTS GLOBAL CO., LTD. METROPOLITAN EXPRESSWAY COMPANY LIMITED CHODAI CO.,LTD. NIPPON ENGINEERING CONSULTANTS CO.,LTD.

	NAME	SIGNATURE	DATE
PREPARED BY	S. IMADA		
CHECKED BY	T. HAYAKAWA		
APPROVED BY	Y. SANO		

DRAWING TITLE: General Drawing of Steel Pipe Sheet Pile Foundation of P18 Pier

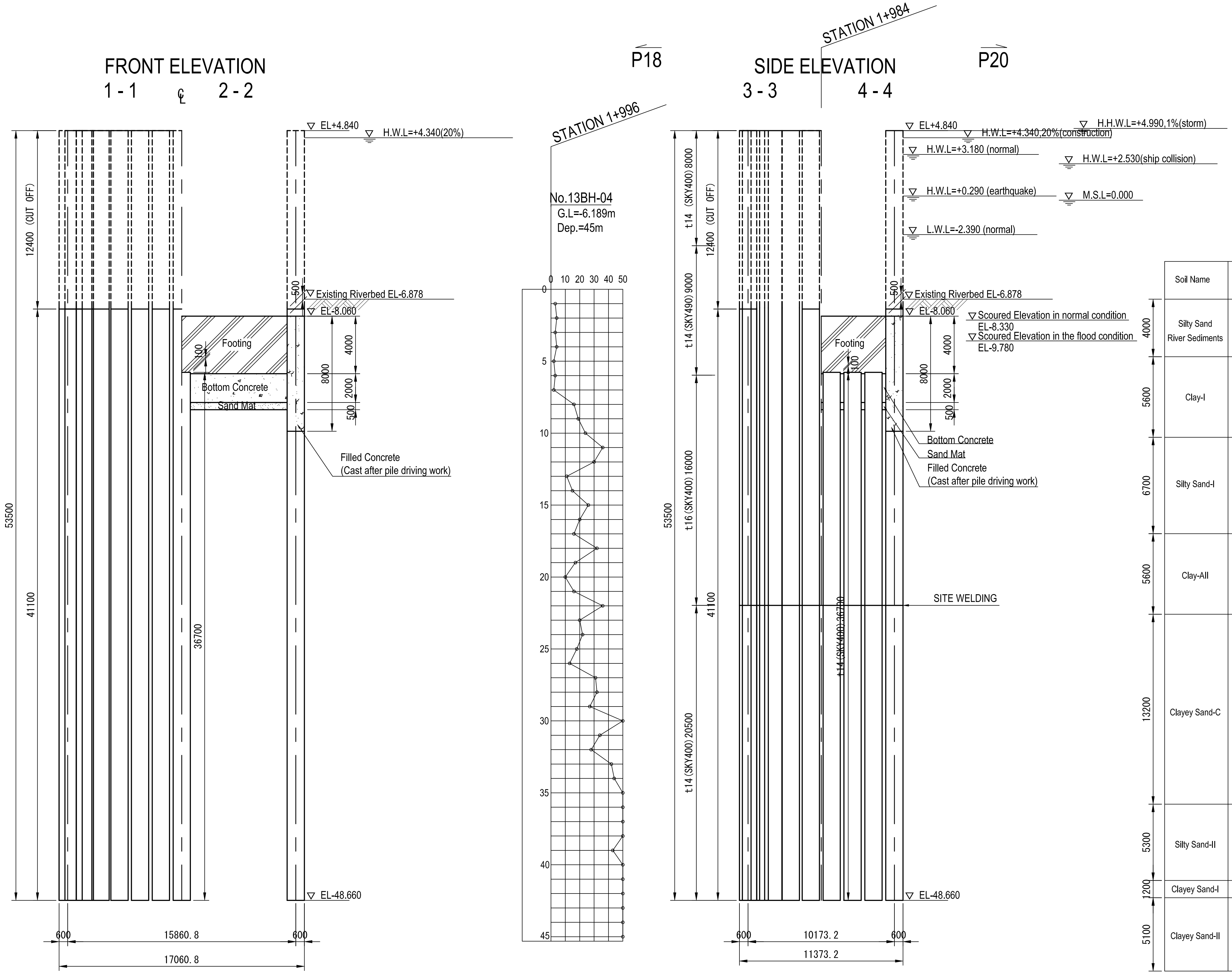
PACKAGE: 2

DWG No.: P02-SB-2006

GENERAL DRAWING OF STEEL PIPE SHEET PILE FOUNDATION OF P19

Scale: 1/300 in A3

P19



	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
4000	Silty Sand River Sediments	3	18	0	29	1,200	Liquefaction D_E = 2/3
5600	Clay-I	1	17.5	10	0	900	-
6700	Silty Sand-I	13	18.0	0	33	5,200	-
5600	Clay-AII	7	17.5	42	0	4,900	-
13200	Clayey Sand-C	20	18.0	0	33	14,000	-
5300	Silty Sand-II	30	18.0	0	34	21,000	-
1200	Clayey Sand-I	35	20.0	0	34	24,500	-
5100	Clayey Sand-II	50	20.0	0	34	35,000	-

8

PROJECT NAME	FINANCED BY	COUNTERPART	JICA STUDY TEAM		NAME	SIGNATURE	DATE	DRAWING TITLE	PACKAGE
DETAILED DESIGN ON BAGO RIVER BRIDGE CONSTRUCTION PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	REPUBLIC OF THE UNION OF MYANMAR MINISTRY OF CONSTRUCTION DEPARTMENT OF BRIDGE	NIPPON KOEI CO., LTD. ORIENTAL CONSULTANTS GLOBAL CO., LTD. METROPOLITAN EXPRESSWAY COMPANY LIMITED CHODAI CO.,LTD. NIPPON ENGINEERING CONSULTANTS CO.,LTD.	PREPARED BY	S. IMADA			General Drawing of Steel Pipe Sheet Pile Foundation of P19 Pier	2
				CHECKED BY	T. HAYAKAWA				DWG No.
				APPROVED BY	Y. SANO				P02-SB-2007

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]	2.35×10^4	2.50×10^4	2.80×10^4
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		Rebar for footing, pier head, shear reinforcement for pier column	main reinforcement of pier column

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	2.00×10^5
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 most members.	SPSP, this grade is used for the cofferdam and footing area which stress is large during construction.

CHAPTER 2. LOADS AND LOAD COMBINATIONS

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 P14	High tide in spring tide	3.18m	No consideration	No consideration	1.5
					1/2 of maximum	
	Vessel Collision for P15-P19	At maximum water flow	2.53m	1.19m/s	No consideration	
					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	P13	P14	P15	P16	P17	P18	P19	P20
Dead Load	8,600	24,300	20,400	21,600	21,300	20,800	23,200	7,500
Live Load with Impact	4,100	7,900	7,600	7,700	7,700	7,600	7,700	3,900
ΣD+L+I	**12,700**	**32,200**	**28,000**	**29,300**	**29,000**	**28,400**	**30,900**	**11,400**
Dead Load	8,600	24,300	20,400	21,600	21,300	20,800	23,200	7,500
Live Load w/o Impact	3,600	7,000	6,800	6,900	6,800	6,700	6,800	3,400
ΣD+L	**12,200**	**31,300**	**27,200**	**28,500**	**28,100**	**27,500**	**30,000**	**10,900**
Horizontal Force due to temperature change ±15°	900	5,400	3,100	1,200	900	3,100	5,800	800

Note: - Values of P13 and P20 are just for reference.

- Friction force (dead load x 0.1) is considered for horizontal force at movable supports at P13 and P20.

(2) Shared Weight of Superstructure on Substructures

Since the structure which can distribute inertial force of earthquake into several substructures is applied for the 7-continuous spans, a shared weight on each substructure is calculated by eigenvalue analysis by using framed structure model as shown in figure below.

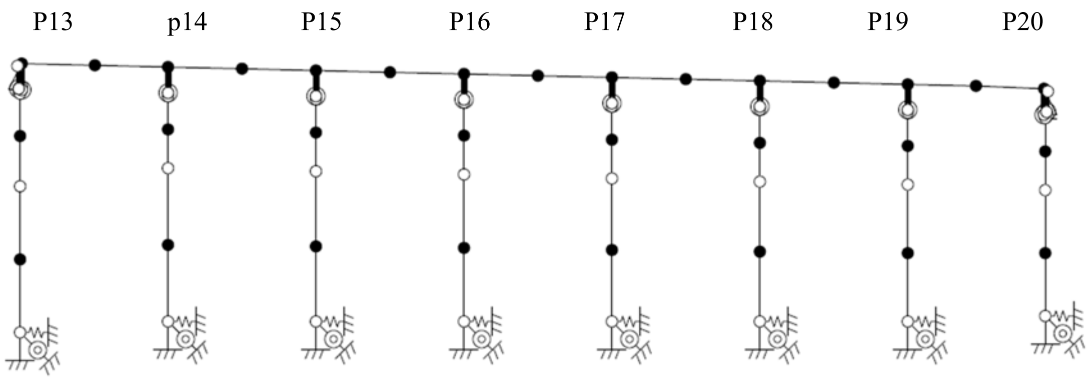


Figure Framed Structure Model

1) Coordinate of Nodes

Structure Component	Node No.	Coordinate X (m)	Coordinate Y (m)	Weight Wi(kN)
Superstructure	41	1.200	-0.757	5449.600
	43	56.600	-0.923	10519.400
	44	112.000	-1.089	10576.300
	46	168.000	-1.257	10633.300
	47	224.000	-1.425	10633.300
	49	280.000	-1.593	10633.300
	50	336.000	-1.761	10633.300
	52	392.000	-1.929	10633.300
	53	448.000	-2.097	10633.300
	55	504.000	-2.265	10633.300
	56	560.000	-2.433	10633.300
	58	616.000	-2.601	10633.300
	59	672.000	-2.769	10210.800
	61	723.550	-2.924	9788.300
	62	775.100	-3.200	5046.100
	42	1.200	-3.319	0.000
	45	112.000	-3.604	0.000
	48	224.000	-3.922	0.000
	51	336.000	-4.240	0.000
P13	1	0.000	-3.677	0.000
	2	0.000	-7.783	28297.500
	3	0.000	-12.677	0.000
	4	0.000	-19.777	27111.376
	5	0.000	-26.877	0.000
P14	6	112.000	-3.919	0.000
	7	112.000	-7.152	9898.000
	8	112.000	-10.919	0.000
	9	112.000	-18.369	14808.754
	10	112.000	-25.819	0.000
P15	11	224.000	-4.219	0.000
	12	224.000	-7.452	9898.000
	13	224.000	-11.219	0.000
	14	224.000	-18.519	14510.591
	15	224.000	-25.819	0.000
P16	16	336.000	-4.519	0.000
	17	336.000	-7.752	9898.000
	18	336.000	-11.519	0.000
	19	336.000	-18.669	14212.428
	20	336.000	-25.819	0.000

P17	21	448.000	-4.919	0.000
	22	448.000	-8.152	9898.000
	23	448.000	-11.919	0.000
	24	448.000	-18.869	13814.878
	25	448.000	-25.819	0.000
P18	26	560.000	-5.219	0.000
	27	560.000	-8.452	9898.000
	28	560.000	-12.219	0.000
	29	560.000	-19.019	13516.715
	30	560.000	-25.819	0.000
P19	31	672.000	-5.519	0.000
	32	672.000	-8.752	9898.000
	33	672.000	-12.519	0.000
	34	672.000	-19.169	13218.552
	35	672.000	-25.819	0.000
P20	36	776.000	-6.051	0.000
	37	776.000	-9.283	11135.250
	38	776.000	-13.051	0.000
	39	776.000	-19.166	13529.813
	40	776.000	-25.281	0.000

2) Span Arrangement

	Length (m)	Node
LL	1.000	----------
S1	110.800	1
S2	112.000	1
S3	112.000	1
S4	112.000	1
S5	112.000	1
S6	112.000	1
S7	103.100	1
LR	0.800	----------

3) Weight of Node

Node	H1 (m)	H2 (m) Point of Inertial Force from bottom frange	Weight(kN)	Dead Load(kN)
1	0.753	2.200	5449.600	8560.000
2	0.753	--------	10519.400	--------------
3	0.753	2.200	10576.300	24252.000
4	0.753	--------	10633.300	--------------
5	0.753	2.200	10633.300	20362.000
6	0.753	--------	10633.300	--------------
7	0.753	2.200	10633.300	21503.000
8	0.753	--------	10633.300	--------------
9	0.753	2.200	10633.300	21287.000
10	0.753	--------	10633.300	--------------
11	0.753	2.200	10633.300	20731.000
12	0.753	--------	10633.300	--------------
13	0.753	2.200	10210.800	23140.000
14	0.753	--------	9788.300	--------------
15	0.753	2.200	5046.100	7455.000
		$\sum$	147290.200	147290.000

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	41- 43	2.000E+008	7.700E+007	0.9936	1.7580
	43- 44			0.9936	1.7580
	44- 46			0.9936	1.7580
	46- 47			0.9936	1.7580
	47- 49			0.9936	1.7580
	49- 50			0.9936	1.7580
	50- 52			0.9936	1.7580
	52- 53			0.9936	1.7580
	53- 55			0.9936	1.7580
	55- 56			0.9936	1.7580
	56- 58			0.9936	1.7580
	58- 59			0.9936	1.7580
	59- 61			0.9936	1.7580
	61- 62			0.9936	1.7580
	42- 41	2.000E+008	7.700E+007	1000.0000	1000.0000
	45- 44				
	48- 47				
	51- 50				
	54- 53				
	57- 56				
	60- 59				
	63- 62				
P13	1- 2	2.800E+007	1.217E+007	77.9286	313.5187
	2- 3	2.800E+007	1.217E+007	77.9286	313.5187
	3- 4	2.800E+007	1.217E+007	77.9286	313.5187
	4- 5	2.800E+007	1.217E+007	77.9286	313.5187
P14	6- 7	2.800E+007	1.217E+007	40.5664	49.8997
	7- 8	2.800E+007	1.217E+007	40.5664	49.8997
	8- 9	2.800E+007	1.217E+007	40.5664	49.8997
	9- 10	2.800E+007	1.217E+007	40.5664	49.8997

P15	11- 12	2.800E+007	1.217E+007	40.5664	49.8997
	12- 13	2.800E+007	1.217E+007	40.5664	49.8997
	13- 14	2.800E+007	1.217E+007	40.5664	49.8997
	14- 15	2.800E+007	1.217E+007	40.5664	49.8997
P16	16- 17	2.800E+007	1.217E+007	40.5664	49.8997
	17- 18	2.800E+007	1.217E+007	40.5664	49.8997
	18- 19	2.800E+007	1.217E+007	40.5664	49.8997
	19- 20	2.800E+007	1.217E+007	40.5664	49.8997
P17	21- 22	2.800E+007	1.217E+007	40.5664	49.8997
	22- 23	2.800E+007	1.217E+007	40.5664	49.8997
	23- 24	2.800E+007	1.217E+007	40.5664	49.8997
	24- 25	2.800E+007	1.217E+007	40.5664	49.8997
P18	26- 27	2.800E+007	1.217E+007	40.5664	49.8997
	27- 28	2.800E+007	1.217E+007	40.5664	49.8997
	28- 29	2.800E+007	1.217E+007	40.5664	49.8997
	29- 30	2.800E+007	1.217E+007	40.5664	49.8997
P19	31- 32	2.800E+007	1.217E+007	40.5664	49.8997
	32- 33	2.800E+007	1.217E+007	40.5664	49.8997
	33- 34	2.800E+007	1.217E+007	40.5664	49.8997
	34- 35	2.800E+007	1.217E+007	40.5664	49.8997
P20	36- 37	2.800E+007	1.217E+007	45.1543	69.4883
	37- 38	2.800E+007	1.217E+007	45.1543	69.4883
	38- 39	2.800E+007	1.217E+007	45.1543	69.4883
	39- 40	2.800E+007	1.217E+007	45.1543	69.4883

<u>Axis Perpendicular Direction</u>

Structure Component	Node Nos.	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)	Level-1	
				Iy (m^4)	J (m^4)
Superstructure	41- 43	2.000E+008	7.700E+007	31.9000	1.7600
	43- 44			31.9000	1.7600
	44- 46			31.9000	1.7600
	46- 47			31.9000	1.7600
	47- 49			31.9000	1.7600
	49- 50			31.9000	1.7600
	50- 52			31.9000	1.7600
	52- 53			31.9000	1.7600
	53- 55			31.9000	1.7600
	55- 56			31.9000	1.7600
	56- 58			31.9000	1.7600
	58- 59			31.9000	1.7600
	59- 61			31.9000	1.7600
	61- 62			31.9000	1.7600
	42- 41	2.000E+008	7.700E+007	1000.0000	1000.0000
	45- 44				
	48- 47				
	51- 50				
	54- 53				
	57- 56				
	60- 59				
	63- 62				

P13	1- 2	2.800E+007	1.217E+007	752.3293	811.7399
	2- 3	2.800E+007	1.217E+007	752.3293	811.7399
	3- 4	2.800E+007	1.217E+007	752.3293	811.7399
	4- 5	2.800E+007	1.217E+007	752.3293	811.7399
P14	6- 7	2.800E+007	1.217E+007	355.5044	162.7024
	7- 8	2.800E+007	1.217E+007	355.5044	162.7024
	8- 9	2.800E+007	1.217E+007	355.5044	162.7024
	9- 10	2.800E+007	1.217E+007	355.5044	162.7024
P15	11- 12	2.800E+007	1.217E+007	355.5044	162.7024
	12- 13	2.800E+007	1.217E+007	355.5044	162.7024
	13- 14	2.800E+007	1.217E+007	355.5044	162.7024
	14- 15	2.800E+007	1.217E+007	355.5044	162.7024
P16	16- 17	2.800E+007	1.217E+007	355.5044	162.7024
	17- 18	2.800E+007	1.217E+007	355.5044	162.7024
	18- 19	2.800E+007	1.217E+007	355.5044	162.7024
	19- 20	2.800E+007	1.217E+007	355.5044	162.7024
P17	21- 22	2.800E+007	1.217E+007	355.5044	162.7024
	22- 23	2.800E+007	1.217E+007	355.5044	162.7024
	23- 24	2.800E+007	1.217E+007	355.5044	162.7024
	24- 25	2.800E+007	1.217E+007	355.5044	162.7024
P18	26- 27	2.800E+007	1.217E+007	355.5044	162.7024
	27- 28	2.800E+007	1.217E+007	355.5044	162.7024
	28- 29	2.800E+007	1.217E+007	355.5044	162.7024
	29- 30	2.800E+007	1.217E+007	355.5044	162.7024
P19	31- 32	2.800E+007	1.217E+007	355.5044	162.7024
	32- 33	2.800E+007	1.217E+007	355.5044	162.7024
	33- 34	2.800E+007	1.217E+007	355.5044	162.7024
	34- 35	2.800E+007	1.217E+007	355.5044	162.7024
P20	36- 37	2.800E+007	1.217E+007	389.8213	218.9687
	37- 38	2.800E+007	1.217E+007	389.8213	218.9687
	38- 39	2.800E+007	1.217E+007	389.8213	218.9687
	39- 40	2.800E+007	1.217E+007	389.8213	218.9687

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	Move(0.00)	Fix	Fix	Fix	Free	Free
2	Fix	Fix	Fix	Fix	Free	Free
3	Fix	Fix	Fix	Fix	Free	Free
4	Fix	Fix	Fix	Fix	Free	Free
5	Fix	Fix	Fix	Fix	Free	Free
6	Fix	Fix	Fix	Fix	Free	Free
7	Fix	Fix	Fix	Fix	Free	Free
8	Move (0.00)	Fix	Fix	Fix	Free	Free

6) Model of Substructure

[P13]

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	8.761100E+006	kN/m	Kx(Arr)	Elastic	1.508200E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	1.223000E+009	kN.m/rad	Kz(Ass)	Elastic	8.895200E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-7.163100E+007	kN/rad	Kxz(Ars)		-7.303000E+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							

[P14]

Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	9898.000
4	14808.754

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2327	40.56637	2.80E+007	1.22E+007
2 - 3	3.7673	40.56637	2.80E+007	1.22E+007
3 - 4	7.4500	40.56637	2.80E+007	1.22E+007
4 - 5	7.4500	40.56637	2.80E+007	1.22E+007

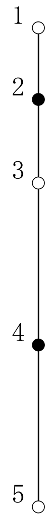
Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	49.89970	355.50441	162.70239			
2 - 3	49.89970	355.50441	162.70239			
3 - 4	49.89970	355.50441	162.70239			
4 - 5	49.89970	355.50441	162.70239			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	7.347900E+006	kN/m	Kx(Arr)	Elastic	1.168300E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	8.796600E+008	kN.m/rad	Kz(Ass)	Elastic	7.728700E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-5.781400E+007	kN/rad	Kxz(Ars)		-6.265100E+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							

[P15]



Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	9898.000
4	14510.591

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2327	40.56637	2.80E+007	1.22E+007
2 - 3	3.7673	40.56637	2.80E+007	1.22E+007
3 - 4	7.3000	40.56637	2.80E+007	1.22E+007
4 - 5	7.3000	40.56637	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	49.89970	355.50441	162.70239			
2 - 3	49.89970	355.50441	162.70239			
3 - 4	49.89970	355.50441	162.70239			
4 - 5	49.89970	355.50441	162.70239			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	6.734600E+006	kN/m	Kx(Arr)	Elastic	1.136100E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	8.548100E+008	kN.m/rad	Kz(Ass)	Elastic	7.108100E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-5.430600E+007	kN/rad	Kxz(Ars)		-5.920800E+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							

[P16]

Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	9898.000
4	14212.428

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2327	40.56637	2.80E+007	1.22E+007
2 - 3	3.7673	40.56637	2.80E+007	1.22E+007
3 - 4	7.1500	40.56637	2.80E+007	1.22E+007
4 - 5	7.1500	40.56637	2.80E+007	1.22E+007

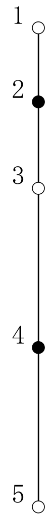
Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	49.89970	355.50441	162.70239			
2 - 3	49.89970	355.50441	162.70239			
3 - 4	49.89970	355.50441	162.70239			
4 - 5	49.89970	355.50441	162.70239			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	7.309400E+006	kN/m	Kx(Arr)	Elastic	1.166100E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	8.780400E+008	kN.m/rad	Kz(Ass)	Elastic	7.689600E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-5.758900E+007	kN/rad	Kxz(Ars)		-6.243500E+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							

[P17]



Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	9898.000
4	13814.878

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2327	40.56637	2.80E+007	1.22E+007
2 - 3	3.7673	40.56637	2.80E+007	1.22E+007
3 - 4	6.9500	40.56637	2.80E+007	1.22E+007
4 - 5	6.9500	40.56637	2.80E+007	1.22E+007

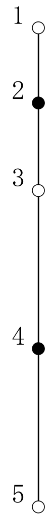
Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	49.89970	355.50441	162.70239			
2 - 3	49.89970	355.50441	162.70239			
3 - 4	49.89970	355.50441	162.70239			
4 - 5	49.89970	355.50441	162.70239			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	7.114000E+006	kN/m	Kx(Arr)	Elastic	1.156700E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	8.709100E+008	kN.m/rad	Kz(Ass)	Elastic	7.492500E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-5.653600E+007	kN/rad	Kxz(Ars)		-6.140700E+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							

[P18]



Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	9898.000
4	13516.715

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2327	40.56637	2.80E+007	1.22E+007
2 - 3	3.7673	40.56637	2.80E+007	1.22E+007
3 - 4	6.8000	40.56637	2.80E+007	1.22E+007
4 - 5	6.8000	40.56637	2.80E+007	1.22E+007

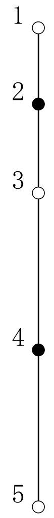
Node	Level-1 Axis Direction Iz (m^4)	Level-1 Axis Perp. Direction Iy (m^4)	Level-1 TorsionJ (m^4)			
1 - 2	49.89970	355.50441	162.70239			
2 - 3	49.89970	355.50441	162.70239			
3 - 4	49.89970	355.50441	162.70239			
4 - 5	49.89970	355.50441	162.70239			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	6.331200E+006	kN/m	Kx(Arr)	Elastic	1.115100E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	8.379800E+008	kN.m/rad	Kz(Ass)	Elastic	6.702200E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-5.190000E+007	kN/rad	Kxz(Ars)		-5.685700E+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							

[P19]



Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	9898.000
4	13218.552

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2327	40.56637	2.80E+007	1.22E+007
2 - 3	3.7673	40.56637	2.80E+007	1.22E+007
3 - 4	6.6500	40.56637	2.80E+007	1.22E+007
4 - 5	6.6500	40.56637	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	49.89970	355.50441	162.70239			
2 - 3	49.89970	355.50441	162.70239			
3 - 4	49.89970	355.50441	162.70239			
4 - 5	49.89970	355.50441	162.70239			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	6.211500E+006	kN/m	Kx(Arr)	Elastic	1.113900E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	8.380100E+008	kN.m/rad	Kz(Ass)	Elastic	6.581700E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-5.172600E+007	kN/rad	Kxz(Ars)		-5.665500E+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							

[P20]

Type

Ground Classification: Class III

weight

Node No.	Weight(kN)
2	11135.250
4	13529.813

Member

Node	Length(m)	Area(m^2)	Young's Modulus (kN/m^2)	Shear Modulus (kN/m^2)
1 - 2	3.2327	45.15431	2.80E+007	1.22E+007
2 - 3	3.7673	45.15431	2.80E+007	1.22E+007
3 - 4	6.1150	45.15431	2.80E+007	1.22E+007
4 - 5	6.1150	45.15431	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	69.48827	389.82132	218.96875			
2 - 3	69.48827	389.82132	218.96875			
3 - 4	69.48827	389.82132	218.96875			
4 - 5	69.48827	389.82132	218.96875			

Spring Constant

Calculation of Natural Period

Axis Direction				Axis Perp. Direction			
Kx(Ass)	Elastic	9.027900E+006	kN/m	Kx(Arr)	Elastic	1.176000E+009	kN.m/rad
Ky(Avv)	Fix		kN/m	Ky	Fix		kN.m/rad
Kz(Arr)	Elastic	8.862600E+008	kN.m/rad	Kz(Ass)	Elastic	9.448100E+006	kN/m
Kxy(Asv)		0.000000E+000	kN/m	Kxy		0.000000E+000	kN.m/rad
Kxz(Asr)		-6.495600E+007	kN/rad	Kxz(Ars)		-6.976000E+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		P13	P14	P15	P16	P17	P18	P19	P20
Bridge Axis Direction									
-	Shared Weight (kN)	900	23,200	23,200	24,200	25,000	25,500	26,400	800
-	Natural period of oscillation of the bridge (second)	0.790(s)							
Bridge Axis Perpendicular Direction									
-	Shared Weight (kN)	8,600	24,300	20,400	21,600	21,300	20,800	23,200	7,500
-	Natural period of oscillation of the bridge (second)	0.52(s)	0.57(s)	0.54(s)	0.53(s)	0.53(s)	0.53(s)	0.54(s)	0.46(s)

Note: - Values of P13 and P20 are only weight of 7-span bridge.

- The amount of the shared weight in bridge axis direction of P13 and P20 are considered as friction force which is calculated by dead load x 0.1.

<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	P14	0.790	0.24	0.3000	0.30	0.30	23177.695	6953.309	23177.695
		P15		0.24	0.3000	0.30		23196.954	6959.086	23196.954
		P16		0.24	0.3000	0.30		24184.604	7255.381	24184.604
		P17		0.24	0.3000	0.30		24962.055	7488.616	24962.055
		P18		0.24	0.3000	0.30		25452.821	7635.846	25452.821
		P19		0.24	0.3000	0.30		26316.071	7894.821	26316.071
2	1 pier	P13	0.494	0.24	0.3000	0.30	0.30	0.000	0.000	0.000
3	1 pier	P20	0.563	0.24	0.3000	0.30	0.30	11000.000	3300.000	11000.000 *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	1 pier	P13	0.523	1.128	0.24	0.3000	0.30	13860.000	4158.000	13860.000 *including dead load of neighbor
2	1 pier	P14	0.568	1.226	0.24	0.3000	0.30	24252.000	7275.600	24252.000
3	1 pier	P15	0.539	1.163	0.24	0.3000	0.30	20362.000	6108.600	20362.000
4	1 pier	P16	0.532	1.148	0.24	0.3000	0.30	21503.000	6450.900	21503.000
5	1 pier	P17	0.526	1.134	0.24	0.3000	0.30	21287.000	6386.100	21287.000
6	1 pier	P18	0.527	1.137	0.24	0.3000	0.30	20731.000	6219.300	20731.000

7	1 pier	P19	0.544	1.173	0.24	0.3000	0.30	23140.000	6942.000	23140.000
8	1 pier	P20	0.463	1.000	0.24	0.3000	0.30	19255.000	5776.500	19255.000 *including dead load of neighbor

8) Result of Natural Period

$$T = 2.01\sqrt{\delta} = 0.790 \text{ (s)}$$

$$\delta = \frac{\Sigma Wi \times Ui^2}{\Sigma Wi \times Ui} = \frac{6137.786}{39727.081} = 0.154 \text{ (m)}$$

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	5449.600	0.1884	1026.554	193.374
	2	10519.400	0.1870	1967.162	367.866
	3	10576.300	0.1824	1929.222	351.909
	4	10633.300	0.1814	1929.131	349.990
	5	10633.300	0.1775	1887.563	335.069
	6	10633.300	0.1771	1883.401	333.593
	7	10633.300	0.1737	1847.077	320.850
	8	10633.300	0.1741	1851.572	322.413
	9	10633.300	0.1715	1824.078	312.909
	10	10633.300	0.1730	1839.502	318.224
	11	10633.300	0.1715	1823.227	312.617
	12	10633.300	0.1741	1851.721	322.465
	13	10210.800	0.1737	1774.055	308.230
	14	9788.300	0.1775	1736.976	308.234
	15	5046.100	0.1790	903.384	161.729
P14	1	0.000	0.1741	0.000	0.000
	2	9898.000	0.1470	1454.979	213.878
	3	0.000	0.1163	0.000	0.000
	4	14808.754	0.0630	933.531	58.849
	5	0.000	0.0285	0.000	0.000
P15	1	0.000	0.1717	0.000	0.000
	2	9898.000	0.1451	1435.894	208.304
	3	0.000	0.1149	0.000	0.000
	4	14510.591	0.0635	921.458	58.515
	5	0.000	0.0299	0.000	0.000

P16	1	0.000	0.1674	0.000	0.000
	2	9898.000	0.1409	1394.535	196.477
	3	0.000	0.1109	0.000	0.000
	4	14212.428	0.0611	868.024	53.015
	5	0.000	0.0286	0.000	0.000
P17	1	0.000	0.1647	0.000	0.000
	2	9898.000	0.1384	1369.662	189.531
	3	0.000	0.1087	0.000	0.000
	4	13814.878	0.0607	838.222	50.859
	5	0.000	0.0292	0.000	0.000
P18	1	0.000	0.1654	0.000	0.000
	2	9898.000	0.1391	1376.722	191.490
	3	0.000	0.1094	0.000	0.000
	4	13516.715	0.0625	845.313	52.864
	5	0.000	0.0315	0.000	0.000
P19	1	0.000	0.1655	0.000	0.000
	2	9898.000	0.1391	1376.671	191.475
	3	0.000	0.1093	0.000	0.000
	4	13218.552	0.0634	837.446	53.055
	5	0.000	0.0327	0.000	0.000
Total				39727.081	6137.786

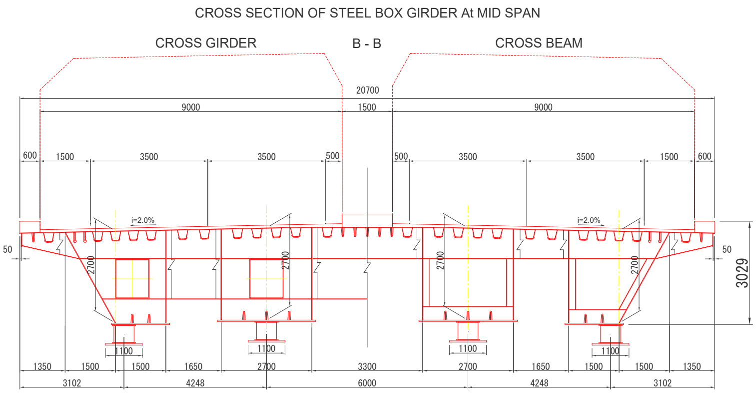
(3) Other Design External Forces

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



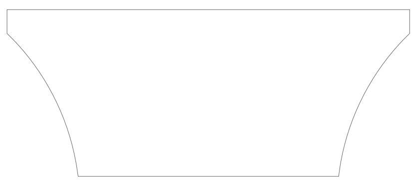
B: Width of bridge(m)	20.7
D:Height of Superstructure(m)	3.429
B/D	6.0
Wind Load (kN/m)	9.6

	P13	P14	P15	P16	P17	P18	P19	P20
Length of bridge in Bridge Axis Direction(m)	56	112	112	112	112	112	108	52
Wind load at support(kN)	537.6	**1075.2**	**1075.2**	**1075.2**	**1075.2**	**1075.2**	**1036.8**	499.2
Work Elevation(MSL+)	16.491	16.185	15.849	15.513	15.177	14.841	14.505	14.074
Height from Top of pier to working point(m)	25.591	**24.245**	**23.909**	**23.573**	**23.237**	**22.901**	**22.565**	21.608

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: 95.788m2

Bridge Axis Perpedicular Direction	P13	**P14**	**P15**	**P16**	**P17**	**P18**	**P19**	P20
Projected area(m2)		35.4	34.2	33	31.4	30.2	29	
Wind Load (kN)		**26.6**	**25.7**	**24.8**	**23.6**	**22.7**	**21.8**	
Pier Top Elevation （MSL+)		13.84	13.54	13.24	12.84	12.54	12.24	
Water Level （MSL+)		4.99	4.99	4.99	4.99	4.99	4.99	
Height from top of footing to collision		**17.475**	**17.325**	**17.175**	**16.975**	**16.825**	**16.675**	
Bridge Axis Direction								
Projected area(m2)		116.138	112.838	109.538	105.138	101.838	98.538	
Wind Load (kN)		**87.2**	**84.7**	**82.2**	**78.9**	**76.4**	**74.0**	
Height from water Level to loading point(m)		4.88	4.88	4.88	4.88	4.88	4.88	
Height from top of footing to loading point(m)		**17.930**	**17.930**	**17.930**	**17.930**	**17.930**	**17.930**	

2) Vessel Collision Load

Vessel Collision Force Based on AASHTO LRFD

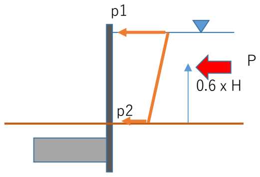
Pier		P14	P15-P19
Collision Force （k N）	Bridge Axis Perpedicular Direction	**7,288**	**6,175**
	Bridge Axis Direction	**3,644**	**3,088**
Elevation of Collision(MSL+)		3.98	3.33
Height from top of footing to collision point(m)		**12.04**	**11.39**
Speed at collision(m/s)		2.78	1.00

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	P14	P15	P16	P17	P18	P19
Water Level(MSL+)	4.34	4.34	4.34	4.34	4.34	4.34
Existing Ground Level(MSL+)	-6.276	-5.091	-5.262	-6.695	-6.989	-6.878
Water Depth H(m)	10.616	9.431	9.602	11.035	11.329	11.218
Pier Shape Factor K	0.4	0.4	0.4	0.4	0.4	0.4
velocity (m/s)	0.65	0.65	0.65	0.65	0.65	0.65
Projected Area(m2)	120.7358	107.2588	109.2035	125.5011	128.8447	127.5823
Flowing Water Pressure P(kN)	20.40434	18.12673	18.4554	21.20968	21.77476	21.56141
Working height(m) 0.6 x H	6.3696	5.6586	5.7612	6.621	6.7974	6.7308
Flowing Water Pressure, p1(kN/m)	**0.2704**	**0.2704**	**0.2704**	**0.2704**	**0.2704**	**0.2704**
Flowing Water Pressure, p2(kN/m)	**0.0676**	**0.0676**	**0.0676**	**0.0676**	**0.0676**	**0.0676**



2) Collision of Vessels (during service stage) ※For P14, no consideration of Flowing Water Pressure

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

Item	P14	**P15**	**P16**	**P17**	**P18**	**P19**
Water Level(MSL+)		2.530	2.530	2.530	2.530	2.530
Existing Ground Elevation (MSL+)		-5.091	-5.262	-6.695	-6.989	-6.878
Water Depth H(m)		7.621	7.792	9.225	9.519	9.408
Pier Shape Factor K		0.4	0.4	0.4	0.4	0.4
velocity (m/s)		1.19	1.19	1.19	1.19	1.19
Projected Area(m2)		30.484	31.168	36.9	38.076	37.632
Flowing Water Pressure P(kN)		**18.0**	**18.0**	**21.0**	**22.0**	**22.0**
Working height(m) 0.6 x H		4.5726	4.6752	5.535	5.7114	5.6448
Height from footing top to working point(m)		**7.542**	**7.473**	**6.900**	**6.782**	**6.827**

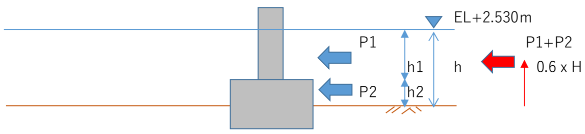
2-2) 1/2 of Maximum Scouring

I. A part of fooring above ground level after scouring (P17P18,P19)

Item	**P17**	**P18**	**P19**
Water Level(MSL+)	2.530	2.530	2.530
Footing top elevation (MSL+)	-8.06	-8.06	-8.06
1/2 of Maximum Scouring (MSL+)	-8.2	-8.49	-8.330
water depth, h1(m)	10.590	10.590	10.590
water depth, h2(m)	0.14	0.43	0.27
Shape factor K	0.4	0.4	0.4
velocity (m/s)	1.19	1.19	1.19
projected area, a1(m2)	42.36	42.36	42.36
projected area, a2(m2)	1.59222	4.89039	3.07071
Flowing Water Pressure P(kN)	**25.0**	**27.0**	**26.0**
Working height(m) 0.6 x H	6.438	6.612	6.516
Height from footing top to working point(m)	**6.298**	**6.182**	**6.246**

II. No part of fooring above ground level after scouring(P15,P16)

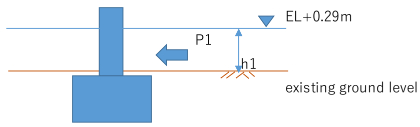
item	**P15**	**P16**
Water Level(MSL+)	2.530	2.530
1/2 of Maximum Scouring (MSL+)	-7.970	-7.810
water depth H(m)	10.500	10.340
Shape factor K	0.4	0.4
velocity (m/s)	1.19	1.19
projected area (m2)	42	41.36
Flowing Water Pressure P(kN)	**24.0**	**24.0**
Working height(m) 0.6 x H	6.3	6.204
Height from footing top to working point(m)	**6.390**	**6.454**



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)

kh=	0.3	
w0=	10	kN/m3
A0=	40.56	m2
a=	4	m
b=	11	m

	P14	P15	P16	P17	P18	P19	
h1(m)	6.566	5.381	5.552	6.985	7.279	7.168	
b/h1	1.7	2.0	2.0	1.6	1.5	1.5	
	<2.0						
P1(kN)	**958**	**661**	**704**	**1063**	**1137**	**1109**	
hg(m)	2.81	2.31	2.38	2.99	3.12	3.07	from ground level
	4.60	**5.28**	**5.18**	**4.36**	**4.19**	**4.25**	from footing top

2．Bridge Axis Perpedicular Direction

P1(k N)

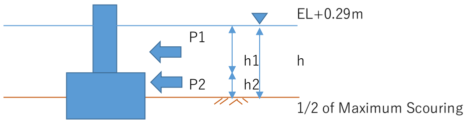
kh=	0.3	
w0=	10	kN/m3
A0=	40.56	m2
a=	11	m
b=	4	m

	P14	P15	P16	P17	P18	P19	
h1(m)	6.566	5.381	5.552	6.985	7.279	7.168	
b/h1	0.6	0.7	0.7	0.6	0.5	0.6	
	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
P1(kN)	**185**	**146**	**152**	**199**	**209**	**205**	
hg(m)	2.81	2.31	2.38	2.99	3.12	3.07	from ground level
	4.60	**5.28**	**5.18**	**4.36**	**4.19**	**4.25**	from footing top

1/2 of Maximum Scouring Case

I.A part of fooring above ground level after scouring(P14,P17P18,P19)

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=	40.56	m2
a=	4	m
b=	11	m

	P14	P17	P18	P19
h1(m)	8.35	8.35	8.35	8.35
b/h1	1.3	1.3	1.3	1.3
	<2.0	<2.0	<2.0	<2.0
P1(kN)	1406	1406	1406	1406

P2(k N)

kh=	0.3	
w0=	10	kN/m3
A0=	156.0596	m2
a=	11.373	m
b=	17.061	m

h2(m)	0.79	0.14	0.43	0.27	
b/h	1.9	2.0	1.9	2.0	
	<2.0	<2.0	<2.0	<2.0	
P2(kN)	417	74	227	143	
P1+P2(kN)	**1823**	**1480**	**1633**	**1549**	
hg(m)	3.92	3.64	3.76	3.69	from ground level
	3.13	**3.50**	**3.33**	**3.42**	from footing top

2．Bridge Axis Perpedicular Direction

P1(k N)

kh=	0.3	
w0=	10	kN/m3
A0=	40.56	m2
a=	11	m
b=	4	m

	P14	P17	P18	P19
h1(m)	8.35	8.35	8.35	8.35
b/h1	0.5	0.5	0.5	0.5
	<2.0	<2.0	<2.0	<2.0
P1(kN)	244	244	244	244

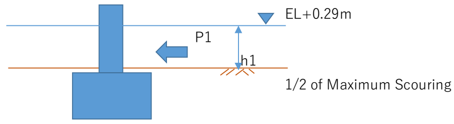
P2(k N)

kh=	0.3	
w0=	10	kN/m3
A0=	156.0596	m2
a=	17.061	m
b=	11.373	m

h2(m)	0.79	0.14	0.43	0.27	
b/h	1.2	1.3	1.3	1.3	
	<2.0	<2.0	<2.0	<2.0	
P2(kN)	185	33	101	64	
P1+P2(kN)	**429**	**277**	**345**	**308**	
hg(m)	3.92	3.64	3.76	3.69	from ground level
	3.13	**3.50**	**3.33**	**3.42**	from footing top

II.No part of fooring above ground level after scouring (P15,P16)

1．Bridge Axis Direction



※P1 works at hg（=3/7 x h1)

	P15	P16	
h1(m)	8.26	8.1	
b/h1	1.3	1.4	
	<2.0	<2.0	
P1(kN)	**1383**	**1343**	
hg(m)	3.54	3.47	from ground level
	3.63	**3.72**	from footing top

2．Bridge Axis Perpedicular Direction

	P15	P16	
h1(m)	8.26	8.1	
b/h1	0.5	0.5	
	<2.0	<2.0	
P1(kN)	**241**	**236**	
hg(m)	3.54	3.47	from ground level
	3.63	**3.72**	from footing top

2.3 DESIGN EXTERNAL FORCE FOR SPSP AND PIER COLUMN

Design external force acting as point forces through the axis of the centroid on the center of the footing is considered for the SPSP foundation design as shown in the figure below. The external force (V0,H0,M0) of the top of footing is considered. The vertical load V0 includes weights of footing, filled concrete inside steel piles, soil on the footing and buoyancy of pier. If the footing projects due to local scouring, inertial forces working on the projected parts will be considered as distributed load in addition to the external force (V0,H0,M0) of the top of footing.

Design external force acting as point forces through the axis of the centroid on the center of the bottom of the footing is considered for the SPSP foundation design as shown in the figure below.

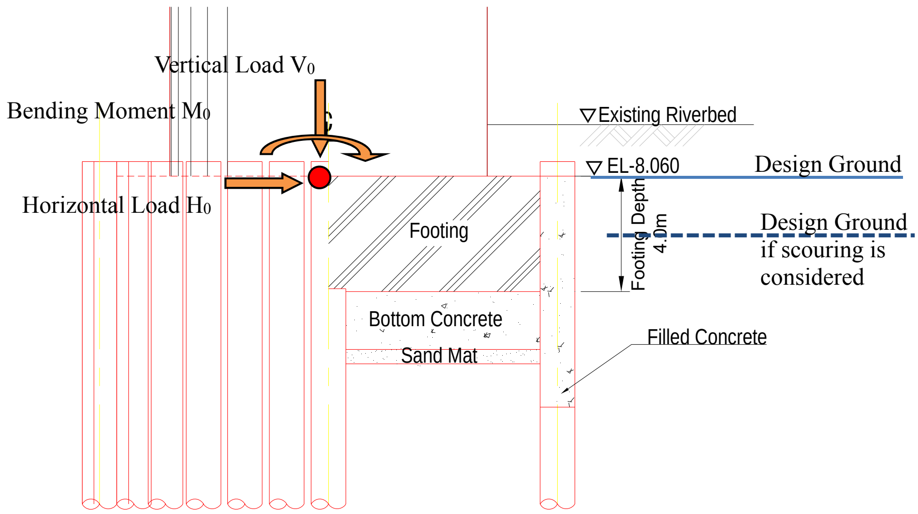


Figure Point of Loading of External Forces

External Forces at bottom of Pier Column
P14 Pier

Direction	Load Component		V（kN)	kh	H（kN)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	24,300.00				
		Live Load	7,000.00				
		Weight of Pier	24,200.00				
		Total	55,500.00		0.00		0.00
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	24,300.00				
		Live Load	7,000.00				
		Horizontal Force due to temperature change effect			5,400.00	21.9	118,260.00
		Weight of Pier	24,200.00				
		Total	55,500.00		5,400.00		118,300.00
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	24,300.00				
		Live Load	7,000.00				
		Horizontal Force due to wind			100.00	17.93	1,793.00
		Horizontal Force due to temperature change effect			5,400.00	21.90	118,260.00
		Weight of Pier	24,200.00				
		Total	55,500.00		5,500.00		120,100.00
	D.Ordinary Condition＋Collision Load	Dead Load	24,300.00				
		Live Load	7,000.00				
		Weight of Pier	24,200.00				
		Collision Load			3,700.00	12.04	44,548.00
			55,500.00		3,700.00		44,600.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	24,300.00				
		(shared weight)	(23200.00)	0.3	6,960.00	21.90	152,424.00
		Weight of Pier	24,200.00	0.3	7,260.00	11.79	85,566.36
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			1,900.00	3.13	5,941.57
		Total	48,500.00		16,200.00		244,000.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	24,300.00				
		(shared weight)	(23200.00)	0.3	6,960.00	21.90	152,424.00
		Weight of Pier	24,200.00	0.3	7,260.00	11.79	85,566.36
		Hydrodynamic Pressure during Earthquake(without scouring)			1,000.00	4.60	4,598.00
		Total	48,500.00		15,300.00		242,600.00
Bridge Axis Perpendicular Direction	A.Ordinary Condition	Dead Load	24,300.00				
		Live Load	7,000.00				
		Weight of Pier	24,200.00				
		Total	55,500.00		0.00		0.00
	C.Extreme wind situation	Dead Load	24,300.00				
		Live Load	7,000.00				
		Horizontal Force due to wind			1,100.00	24.24	26,668.95
		Horizontal Force due to wind			100.00	17.48	1,747.50
		Weight of Pier	24,200.00				
		Total	55,500.00		1,200.00		28,500.00
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	24,300.00				
		Live Load	7,000.00				
		Weight of Pier	24,200.00				
		Flowing Water Pressure(without scouring)			0.00	0.00	0.00
		Collision Load			7,300.00	12.04	87,892.00
		Total	55,500.00		7,300.00		87,900.00
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	24,300.00				
		Live Load	7,000.00				
		Weight of Pier	24,200.00				
		Flowing Water Pressure(1/2 of maximum scouring depth)			0.00	0.00	0.00
		Collision Load			7,300.00	12.04	87,892.00
		Total	55,500.00		7,300.00		87,900.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	24,300.00				
		(shared weight)	(24300.00)	0.3	7,290.00	24.73	180,281.70
		Weight of Pier	24,200.00	0.3	7,260.00	11.79	85,566.36
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			500.00	3.13	1,563.57
		Total	48,500.00		15,100.00		267,500.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	24,300.00				
		(shared weight)	(24300.00)	0.3	7,290.00	24.73	180,281.70
		Weight of Pier	24,200.00	0.3	7,260.00	11.79	85,566.36
		Hydrodynamic Pressure during Earthquake(without scouring)			200.00	4.60	919.60
		Total	48,500.00		14,800.00		266,800.00

P14

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		Earth Height	Water Level		
										Ordinary Condition	Earthquake Condition		Ordinary Condition	Earthquake Condition	During Construction
A.	Ordinary Condition	High tide in spring tide	3.18m	X	-	W/O Scouring	1.0	A1		EL-8.06		EL-6.276	EL+3.18		
						Maximum Scouring		A2		EL-11.43		EL-11.43			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-8.06		EL-6.276	EL-2.39		
						Maximum Scouring		A4		EL-11.43		EL-11.43			
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-8.06		EL-6.276	EL+3.18		
						Maximum Scouring		B2		EL-11.43		EL-11.43			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-8.06		EL-6.276	EL-2.39		
						Maximum Scouring		B4		EL-11.43		EL-11.43			
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-8.06		EL-6.276	EL+4.99		
						1/2 of Maximum Scouring		C2		EL-8.85		EL-8.85			
D.	Ordinary Condition＋Collision Load P14	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1		EL-8.06		EL-6.276	EL+3.18		
						1/2 of Maximum Scouring		D2		EL-8.85		EL-8.85			
	P15-P19	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-8.06	EL-6.276		EL+0.29	
						1/2 of Maximum Scouring		E2			EL-8.85	EL-8.85			
F.	During Construction	HWL(5%)	4.34m	○	0.65m/s ※Only Bridge Axis Perpedicular Direction	W/O Scouring	1.5	F1	EL-6.276						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

External Forces at bottom of Pier Column
P15 Pier

Direction	Load Component		V（ｋN)	kh	H（ｋN)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	20,400.00				
		Live Load	6,800.00				
		Weight of Pier	23,900.00				
		Total	51,100.00		0.00		0.00
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	20,400.00				
		Live Load	6,800.00				
		Horizontal Force due to temperature change effect			3,100.00	21.6	66,960.00
		Weight of Pier	23,900.00				
		Total	51,100.00		3,100.00		67,000.00
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	20,400.00				
		Live Load	6,800.00				
		Horizontal Force due to wind			100.00	17.93	1,793.00
		Horizontal Force due to temperature change effect			3,100.00	21.60	66,960.00
		Weight of Pier	23,900.00				
		Total	51,100.00		3,200.00		68,800.00
	D.Ordinary Condition＋Collision Load	Dead Load	20,400.00				
		Live Load	6,800.00				
		Weight of Pier	23,900.00				
		Collision Load			3,100.00	11.39	35,309.00
			51,100.00		3,100.00		35,400.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	20,400.00				
		(shared weight)	(23200.00)	0.3	6,960.00	21.60	150,336.00
		Weight of Pier	23,900.00	0.3	7,170.00	11.63	83,401.44
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			1,400.00	3.63	5,082.00
		Total	44,300.00		15,600.00		238,900.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	20,400.00				
		(shared weight)	(23200.00)	0.3	6,960.00	21.60	150,336.00
		Weight of Pier	23,900.00	0.3	7,170.00	11.63	83,401.44
		Hydrodynamic Pressure during Earthquake(without scouring)			700.00	5.28	3,692.60
		Total	44,300.00		14,900.00		237,500.00
Bridge Axis Perpedicular Direction	A.Ordinary Condition	Dead Load	20,400.00				
		Live Load	6,800.00				
		Weight of Pier	23,900.00				
		Total	51,100.00		0.00		0.00
	C.Extreme wind situation	Dead Load	20,400.00				
		Live Load	6,800.00				
		Horizontal Force due to wind			1,100.00	23.91	26,299.35
		Horizontal Force due to wind			100.00	17.33	1,732.50
		Weight of Pier	23,900.00				
		Total	51,100.00		1,200.00		28,100.00
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	20,400.00				
		Live Load	6,800.00				
		Weight of Pier	23,900.00				
		Flowing Water Pressure(without scouring)			100.00	7.54	754.16
		Collision Load			6,200.00	11.39	70,618.00
		Total	51,100.00		6,300.00		71,400.00
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	20,400.00				
		Live Load	6,800.00				
		Weight of Pier	23,900.00				
		Flowing Water Pressure(1/2 of maximum scouring depth)			100.00	6.39	639.00
		Collision Load			6,200.00	11.39	70,618.00
		Total	51,100.00		6,300.00		71,300.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	20,400.00				
		(shared weight)	(20400.00)	0.3	6,120.00	24.39	149,291.28
		Weight of Pier	23,900.00	0.3	7,170.00	11.63	83,401.44
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			300.00	3.63	1,089.00
		Total	44,300.00		13,600.00		233,800.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	20,400.00				
		(shared weight)	(20400.00)	0.3	6,120.00	24.39	149,291.28
		Weight of Pier	23,900.00	0.3	7,170.00	11.63	83,401.44
		Hydrodynamic Pressure during Earthquake(without scouring)			200.00	5.28	1,055.03
		Total	44,300.00		13,490.00		233,800.00

P15

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-8.06		EL-5.091	EL+3.18		
						Maximum Scouring		A2		EL-10.84		EL-10.84			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-8.06		EL-5.091	EL-2.39		
						Maximum Scouring		A4		EL-10.84		EL-10.84			
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-8.06		EL-5.091	EL+3.18		
						Maximum Scouring		B2		EL-10.84		EL-10.84			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-8.06		EL-5.091	EL-2.39		
						Maximum Scouring		B4		EL-10.84		EL-10.84			
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-8.06		EL-5.091	EL+4.99		
						1/2 of Maximum Scouring		C2				EL-7.970			
D.	Ordinary Condition＋Collision Load P14	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1							
						1/2 of Maximum Scouring		D2							
	P15-P19	Maximum Velocity	2.53m	○	1.19m/s ※Only Bridge Axis Perpedicular Direction	W/O Scouring		D3		EL-8.06		EL-5.091	EL+2.53		
						1/2 of Maximum Scouring		D4				EL-7.970			
E.	Earthquake Condition	Average Water Level	0.29m	○	0.6m/s ※same direction as inertial force	W/O Scouring	1.5	E1			EL-8.06	EL-5.091		EL+0.29	
						1/2 of Maximum Scouring		E2				EL-7.970			
F.	During Construction	HWL(5％)	4.34m	○	0.65m/s ※Only Bridge Axis Perpedicular Direction	W/O Scouring	1.5	F1	EL-5.091						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

External Forces at bottom of Pier Column
P16 Pier

Direction	Load Component		V（ｋN)	kh	H（ｋN)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	21,600.00				
		Live Load	6,900.00				
		Weight of Pier	23,600.00				
		Total	52,100.00		0.00		0.00
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	21,600.00				
		Live Load	6,900.00				
		Horizontal Force due to temperature change effect			1,200.00	21.3	25,560.00
		Weight of Pier	23,600.00				
		Total	52,100.00		1,200.00		25,600.00
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	21,600.00				
		Live Load	6,900.00				
		Horizontal Force due to wind			100.00	17.93	1,793.00
		Horizontal Force due to temperature change effect			1,200.00	21.30	25,560.00
		Weight of Pier	23,600.00				
		Total	52,100.00		1,300.00		27,400.00
	D.Ordinary Condition＋Collision Load	Dead Load	21,600.00				
		Live Load	6,900.00				
		Weight of Pier	23,600.00				
		Collision Load			3,100.00	11.39	35,309.00
			52,100.00		3,100.00		35,400.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	21,600.00				
		(shared weight)	(24200.00)	0.3	7,260.00	21.30	154,638.00
		Weight of Pier	23,600.00	0.3	7,080.00	11.48	81,257.16
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			1,400.00	3.72	5,210.00
		Total	45,200.00		15,800.00		241,200.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	21,600.00				
		(shared weight)	(24200.00)	0.3	7,260.00	21.30	154,638.00
		Weight of Pier	23,600.00	0.3	7,080.00	11.48	81,257.16
		Hydrodynamic Pressure during Earthquake(without scouring)			800.00	5.18	4,141.94
		Total	45,200.00		15,200.00		240,100.00
Bridge Axis Perpedicular Direction	A.Ordinary Condition	Dead Load	21,600.00				
		Live Load	6,900.00				
		Weight of Pier	23,600.00				
		Total	52,100.00		0.00		0.00
	C.Extreme wind situation	Dead Load	21,600.00				
		Live Load	6,900.00				
		Horizontal Force due to wind			1,100.00	23.57	25,929.75
		Horizontal Force due to wind			100.00	17.18	1,717.50
		Weight of Pier	23,600.00				
		Total	52,100.00		1,200.00		27,700.00
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	21,600.00				
		Live Load	6,900.00				
		Weight of Pier	23,600.00				
		Flowing Water Pressure(without scouring)			100.00	7.47	747.32
		Collision Load			6,200.00	11.39	70,618.00
		Total	52,100.00		6,300.00		71,400.00
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	21,600.00				
		Live Load	6,900.00				
		Weight of Pier	23,600.00				
		Flowing Water Pressure(1/2 of maximum scouring depth)			100.00	6.45	645.40
		Collision Load			6,200.00	11.39	70,618.00
		Total	52,100.00		6,300.00		71,300.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	21,600.00				
		(shared weight)	(21600.00)	0.3	6,480.00	24.06	155,895.84
		Weight of Pier	23,600.00	0.3	7,080.00	11.48	81,257.16
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			300.00	3.72	1,116.43
		Total	45,200.00		13,900.00		238,300.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	21,600.00				
		(shared weight)	(21600.00)	0.3	6,480.00	24.06	155,895.84
		Weight of Pier	23,600.00	0.3	7,080.00	11.48	81,257.16
		Hydrodynamic Pressure during Earthquake(without scouring)			200.00	5.18	1,035.49
		Total	45,200.00		13,800.00		238,200.00

P16

Load Combi		Water Level (MSL+m)		Flowing Water Pressure (velocitym/s)		Scouring	Increase Coefficient of Allowable Stress	Case No.	Existing Ground Level	Design Ground Level		Earth Height	Water Level		
										Ordinary Condition	Earthquake Condition		Ordinary Condition	Earthquake Condition	During Construction
A.	Ordinary Condition	High tide in spring tide	3.18m	X	-	W/O Scouring	1.0	A1		EL-8.06		EL-5.262	EL+3.18		
						Maximum Scouring		A2		EL-10.36		EL-10.36			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-8.06		EL-5.262	EL-2.39		
						Maximum Scouring		A4		EL-10.36		EL-10.36			
B.	Ordinary Condition＋Effect of Temperature Change ※Bridge Axis DirectionOnly	High tide in spring tide	3.18m	X	-	W/O Scouring	1.15	B1		EL-8.06		EL-5.262	EL+3.18		
						Maximum Scouring		B2		EL-10.36		EL-10.36			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-8.06		EL-5.262	EL-2.39		
						Maximum Scouring		B4		EL-10.36		EL-10.36			
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-8.06		EL-5.262	EL+4.99		
						1/2 of Maximum Scouring		C2				EL-7.810			
D.	Ordinary Condition＋Collision Load P14	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1							
						1/2 of Maximum Scouring		D2							
	P15-P19	Maximum Velocity	2.53m	○	1.19m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring		D3		EL-8.06		EL-5.262	EL+2.53		
						1/2 of Maximum Scouring		D4				EL-7.810			
E.	Earthquake Condition	Average Water Level	0.29m	○	0.6m/s ※same direction as inertial force	W/O Scouring	1.5	E1			EL-8.06	EL-5.262		EL+0.29	
						1/2 of Maximum Scouring		E2				EL-7.810			
F.	During Construction	HWL(5%)	4.34m	○	0.65m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring	1.5	F1	EL-5.262						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

External Forces at bottom of Pier Column
P17 Pier

Direction	Load Component		V（kN)	kh	H（kN)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	21,300.00				
		Live Load	6,800.00				
		Weight of Pier	23,200.00				
		Total	51,300.00		0.00		0.00
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	21,300.00				
		Live Load	6,800.00				
		Horizontal Force due to temperature change effect			900.00	20.9	18,810.00
		Weight of Pier	23,200.00				
		Total	51,300.00		900.00		18,900.00
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	21,300.00				
		Live Load	6,800.00				
		Horizontal Force due to wind			100.00	17.93	1,793.00
		Horizontal Force due to temperature change effect			900.00	20.90	18,810.00
		Weight of Pier	23,200.00				
		Total	51,300.00		1,000.00		20,700.00
	D.Ordinary Condition＋Collision Load	Dead Load	21,300.00				
		Live Load	6,800.00				
		Weight of Pier	23,200.00				
		Collision Load			3,100.00	11.39	35,309.00
			51,300.00		3,100.00		35,400.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	21,300.00				
		(shared weight)	(25000.00)	0.3	7,500.00	20.90	156,750.00
		Weight of Pier	23,200.00	0.3	6,960.00	11.27	78,446.16
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			1,500.00	3.50	5,247.86
		Total	44,500.00		16,000.00		240,500.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	21,300.00				
		(shared weight)	(25000.00)	0.3	7,500.00	20.90	156,750.00
		Weight of Pier	23,200.00	0.3	6,960.00	11.27	78,446.16
		Hydrodynamic Pressure during Earthquake(without scouring)			1,100.00	4.36	4,794.43
		Total	44,500.00		15,600.00		240,000.00
Bridge Axis Perpedicular Direction	A.Ordinary Condition	Dead Load	21,300.00				
		Live Load	6,800.00				
		Weight of Pier	23,200.00				
		Total	51,300.00		0.00		0.00
	C.Extreme wind situation	Dead Load	21,300.00				
		Live Load	6,800.00				
		Horizontal Force due to wind			1,100.00	23.24	25,560.15
		Horizontal Force due to wind			100.00	16.98	1,697.50
		Weight of Pier	23,200.00				
		Total	51,300.00		1,200.00		27,300.00
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	21,300.00				
		Live Load	6,800.00				
		Weight of Pier	23,200.00				
		Flowing Water Pressure(without scouring)			100.00	6.90	690.00
		Collision Load			6,200.00	11.39	70,618.00
		Total	51,300.00		6,300.00		71,400.00
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	21,300.00				
		Live Load	6,800.00				
		Weight of Pier	23,200.00				
		Flowing Water Pressure(1/2 of maximum scouring depth)			100.00	6.30	629.80
		Collision Load			6,200.00	11.39	70,618.00
		Total	51,300.00		6,300.00		71,300.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	21,300.00				
		(shared weight)	(21300.00)	0.3	6,390.00	23.72	151,583.58
		Weight of Pier	23,200.00	0.3	6,960.00	11.27	78,446.16
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			300.00	3.50	1,049.57
		Total	44,500.00		13,700.00		231,100.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	21,300.00				
		(shared weight)	(21300.00)	0.3	6,390.00	23.72	151,583.58
		Weight of Pier	23,200.00	0.3	6,960.00	11.27	78,446.16
		Hydrodynamic Pressure during Earthquake(without scouring)			200.00	4.36	871.71
		Total	44,500.00		13,600.00		231,000.00

P17

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		Earth Height	Water Level		
										Ordinary Condition	Earthquake Condition		Ordinary Condition	Earthquake Condition	During Construction
A.	Ordinary Condition	High tide in spring tide	3.18m	X	-	W/O Scouring	1.0	A1		EL-8.06		EL-6.695	EL+3.18		
						Maximum Scouring		A2		EL-9.70		EL-9.70			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-8.06		EL-6.695	EL-2.39		
						Maximum Scouring		A4		EL-9.70		EL-9.70			
B.	Ordinary Condition＋Effect of Temperature Change ※Bridge Axis DirectionOnly	High tide in spring tide	3.18m	X	-	W/O Scouring	1.15	B1		EL-8.06		EL-6.695	EL+3.18		
						Maximum Scouring		B2		EL-9.70		EL-9.70			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-8.06		EL-6.695	EL-2.39		
						Maximum Scouring		B4		EL-9.70		EL-9.70			
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-8.06		EL-6.695	EL+4.99		
						1/2 of Maximum Scouring		C2		EL-8.20		EL-8.20			
D.	Ordinary Condition＋Collision Load P14	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1							
						1/2 of Maximum Scouring		D2							
	P15-P19	Maximum Velocity	2.53m	○	1.19m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring		D3		EL-8.06		EL-6.695	EL+2.53		
						1/2 of Maximum Scouring		D4		EL-8.20		EL-8.20			
E.	Earthquake Condition	Average Water Level	0.29m	○	0.6m/s ※same direction as inertial force	W/O Scouring	1.5	E1			EL-8.06	EL-6.695		EL+0.29	
						1/2 of Maximum Scouring		E2			EL-8.20	EL-8.20			
F.	During Construction	HWL(5%)	4.34m	○	0.65m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring	1.5	F1	EL-6.695						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

External Forces at bottom of Pier Column
P18 Pier

Direction	Load Component		V（kN)	kh	H（kN)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	20,800.00				
		Live Load	6,700.00				
		Weight of Pier	22,900.00				
		Total	50,400.00		0.00		0.00
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	20,800.00				
		Live Load	6,700.00				
		Horizontal Force due to temperature change effect			3,100.00	20.6	63,860.00
		Weight of Pier	22,900.00				
		Total	50,400.00		3,100.00		63,900.00
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	20,800.00				
		Live Load	6,700.00				
		Horizontal Force due to wind			100.00	17.93	1,793.00
		Horizontal Force due to temperature change effect			3,100.00	20.60	63,860.00
		Weight of Pier	22,900.00				
		Total	50,400.00		3,200.00		65,700.00
	D.Ordinary Condition＋Collision Load	Dead Load	20,800.00				
		Live Load	6,700.00				
		Weight of Pier	22,900.00				
		Collision Load			3,100.00	11.39	35,309.00
			50,400.00		3,100.00		35,400.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	20,800.00				
		(shared weight)	(25500.00)	0.3	7,650.00	20.60	157,590.00
		Weight of Pier	22,900.00	0.3	6,870.00	11.12	76,373.79
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			1,700.00	3.33	5,665.86
		Total	43,700.00		16,300.00		239,700.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	20,800.00				
		(shared weight)	(25500.00)	0.3	7,650.00	20.60	157,590.00
		Weight of Pier	22,900.00	0.3	6,870.00	11.12	76,373.79
		Hydrodynamic Pressure during Earthquake(without scouring)			1,200.00	4.19	5,028.69
		Total	43,700.00		15,800.00		239,000.00
Bridge Axis Perpedicular Direction	A.Ordinary Condition	Dead Load	20,800.00				
		Live Load	6,700.00				
		Weight of Pier	22,900.00				
		Total	50,400.00		0.00		0.00
	C.Extreme wind situation	Dead Load	20,800.00				
		Live Load	6,700.00				
		Horizontal Force due to wind			1,100.00	22.90	25,190.55
		Horizontal Force due to wind			100.00	16.83	1,682.50
		Weight of Pier	22,900.00				
		Total	50,400.00		1,200.00		26,900.00
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	20,800.00				
		Live Load	6,700.00				
		Weight of Pier	22,900.00				
		Flowing Water Pressure(without scouring)			100.00	6.78	678.24
		Collision Load			6,200.00	11.39	70,618.00
		Total	50,400.00		6,300.00		71,300.00
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	20,800.00				
		Live Load	6,700.00				
		Weight of Pier	22,900.00				
		Flowing Water Pressure(1/2 of maximum scouring depth)			100.00	6.18	618.20
		Collision Load			6,200.00	11.39	70,618.00
		Total	50,400.00		6,300.00		71,300.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	20,800.00				
		(shared weight)	(20800.00)	0.3	6,240.00	23.39	145,928.64
		Weight of Pier	22,900.00	0.3	6,870.00	11.12	76,373.79
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			400.00	3.33	1,333.14
		Total	43,700.00		13,600.00		223,700.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	20,800.00				
		(shared weight)	(20800.00)	0.3	6,240.00	23.39	145,928.64
		Weight of Pier	22,900.00	0.3	6,870.00	11.12	76,373.79
		Hydrodynamic Pressure during Earthquake(without scouring)			300.00	4.19	1,257.17
		Total	43,700.00		13,500.00		223,600.00

P18

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		Earth Height	Water Level		
										Ordinary Condition	Earthquake Condition		Ordinary Condition	Earthquake Condition	During Construction
A.	Ordinary Condition	High tide in spring tide	3.18m	X	-	W/O Scouring	1.0	A1		EL-8.06		EL-6.989	EL+3.18		
						Maximum Scouring		A2		EL-10.0		EL-10.0			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-8.06		EL-6.989	EL-2.39		
						Maximum Scouring		A4		EL-10.0		EL-10.0			
B.	Ordinary Condition＋Effect of Temperature Change ※Bridge Axis DirectionOnly	High tide in spring tide	3.18m	X	-	W/O Scouring	1.15	B1		EL-8.06		EL-6.989	EL+3.18		
						Maximum Scouring		B2		EL-10.0		EL-10.0			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-8.06		EL-6.989	EL-2.39		
						Maximum Scouring		B4		EL-10.0		EL-10.0			
C.	Extreme wind situation＋Effect of Temperature Change※Wind load is only Bridge Axis Perpendicular Direction	HHWL（1%）	4.99m	X	-	W/O Scouring	1.35 ※1.25	C1		EL-8.06		EL-6.989	EL+4.99		
						1/2 of Maximum Scouring		C2		EL-8.49		EL-8.49			
D.	Ordinary Condition＋Collision Load P14	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1							
						1/2 of Maximum Scouring		D2							
	P15-P19	Maximum Velocity	2.53m	○	1.19m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring		D3		EL-8.06		EL-6.989	EL+2.53		
						1/2 of Maximum Scouring		D4		EL-8.49		EL-8.49			
E.	Earthquake Condition	Average Water Level	0.29m	○	0.6m/s ※same direction as inertial force	W/O Scouring	1.5	E1			EL-8.06	EL-6.989		EL+0.29	
						1/2 of Maximum Scouring		E2			EL-8.49	EL-8.49			
F.	During Construction	HWL(5%)	4.34m	○	0.65m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring	1.5	F1	EL-6.989						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

External Forces at bottom of Pier Column
P19 Pier

Direction	Load Component		V（kN)	kh	H（kN)	y(m)	M(kN・m)
Bridge Axis Direction	A.Ordinary Condition	Dead Load	23,200.00				
		Live Load	6,800.00				
		Weight of Pier	22,600.00				
		Total	52,600.00		0.00		0.00
	B.Ordinary Condition＋Effect of Temperature Change	Dead Load	23,200.00				
		Live Load	6,800.00				
		Horizontal Force due to temperature change effect			5,800.00	20.3	117,740.00
		Weight of Pier	22,600.00				
		Total	52,600.00		5,800.00		117,800.00
	C.Extreme wind situation＋Effect of Temperature Change	Dead Load	23,200.00				
		Live Load	6,800.00				
		Horizontal Force due to wind			100.00	17.93	1,793.00
		Horizontal Force due to temperature change effect			5,800.00	20.30	117,740.00
		Weight of Pier	22,600.00				
		Total	52,600.00		5,900.00		119,600.00
	D.Ordinary Condition＋Collision Load	Dead Load	23,200.00				
		Live Load	6,800.00				
		Weight of Pier	22,600.00				
		Collision Load			3,100.00	11.39	35,309.00
			52,600.00		3,100.00		35,400.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	23,200.00				
		(shared weight)	(26400.00)	0.3	7,920.00	20.30	160,776.00
		Weight of Pier	22,600.00	0.3	6,780.00	10.96	74,322.36
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			1,600.00	3.42	5,478.86
		Total	45,800.00		16,300.00		240,600.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	23,200.00				
		(shared weight)	(26400.00)	0.3	7,920.00	20.30	160,776.00
		Weight of Pier	22,600.00	0.3	6,780.00	10.96	74,322.36
		Hydrodynamic Pressure during Earthquake(without scouring)			1,200.00	4.25	5,104.80
		Total	45,800.00		15,900.00		240,300.00
Bridge Axis Perpedicular Direction	A.Ordinary Condition	Dead Load	23,200.00				
		Live Load	6,800.00				
		Weight of Pier	22,600.00				
		Total	52,600.00		0.00		0.00
	C.Extreme wind situation	Dead Load	23,200.00				
		Live Load	6,800.00				
		Horizontal Force due to wind			1,100.00	22.56	24,820.95
		Horizontal Force due to wind			100.00	16.68	1,667.50
		Weight of Pier	22,600.00				
		Total	52,600.00		1,200.00		26,500.00
	D.Ordinary Condition＋Collision Load (without scouring)	Dead Load	23,200.00				
		Live Load	6,800.00				
		Weight of Pier	22,600.00				
		Flowing Water Pressure(without scouring)			100.00	6.83	682.68
		Collision Load			6,200.00	11.39	70,618.00
		Total	52,600.00		6,300.00		71,400.00
	D.Ordinary Condition＋Collision Load (1/2 of maximum scouring depth)	Dead Load	23,200.00				
		Live Load	6,800.00				
		Weight of Pier	22,600.00				
		Flowing Water Pressure(1/2 of maximum scouring depth)			100.00	6.25	624.60
		Collision Load			6,200.00	11.39	70,618.00
		Total	52,600.00		6,300.00		71,300.00
	E.Earthquake Condition (Level-1) (1/2 of maximum scouring depth)	Dead Load	23,200.00				
		(shared weight)	(23200.00)	0.3	6,960.00	23.05	160,428.00
		Weight of Pier	22,600.00	0.3	6,780.00	10.96	74,322.36
		Hydrodynamic Pressure during Earthquake (1/2 of maximum scouring depth)			400.00	3.42	1,369.71
		Total	45,800.00		14,200.00		236,200.00
	E.Earthquake Condition (Level-1) (without scouring)	Dead Load	23,200.00				
		(shared weight)	(23200.00)	0.3	6,960.00	23.05	160,428.00
		Weight of Pier	22,600.00	0.3	6,780.00	10.96	74,322.36
		Hydrodynamic Pressure during Earthquake(without scouring)			300.00	4.25	1,276.20
		Total	45,800.00		14,100.00		236,100.00

P19

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		Earth Height	Water Level		
										Ordinary Condition	Earthquake Condition		Ordinary Condition	Earthquake Condition	During Construction
A.	Ordinary Condition	High tide in spring tide	3.18m	X	-	W/O Scouring	1.0	A1		EL-8.06		EL-6.878	EL+3.18		
						Maximum Scouring		A2		EL-9.78		EL-9.78			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		A3		EL-8.06		EL-6.878	EL-2.39		
						Maximum Scouring		A4		EL-9.78		EL-9.78			
B.	Ordinary Condition＋Effect of Temperature Change ※Bridge Axis DirectionOnly	High tide in spring tide	3.18m	X	-	W/O Scouring	1.15	B1		EL-8.06		EL-6.878	EL+3.18		
						Maximum Scouring		B2		EL-9.78		EL-9.78			
		Low tide in spring tide	-2.39m	X	-	W/O Scouring		B3		EL-8.06		EL-6.878	EL-2.39		
						Maximum Scouring		B4		EL-9.78		EL-9.78			
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-8.06		EL-6.878	EL+4.99		
						1/2 of Maximum Scouring		C2		EL-8.33		EL-8.33			
D.	Ordinary Condition＋Collision Load P14	High tide in spring tide	3.18m	X	-	W/O Scouring	1.5	D1							
						1/2 of Maximum Scouring		D2							
	P15-P19	Maximum Velocity	2.53m	○	1.19m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring		D3		EL-8.06		EL-6.878	EL+2.53		
						1/2 of Maximum Scouring		D4		EL-8.33		EL-8.33			
E.	Earthquake Condition	Average Water Level	0.29m	○	0.6m/s ※same direction as inertial force	W/O Scouring	1.5	E1			EL-8.06	EL-6.878		EL+0.29	
						1/2 of Maximum Scouring		E2			EL-8.33	EL-8.33			
F.	During Construction	HWL(5%)	4.34m	○	0.65m/s ※Bridge Axis Perpedicular DirectionOnly	W/O Scouring	1.5	F1	EL-6.878						EL+4.34
		Low tide in spring tide	-2.39m					F2							EL-2.39

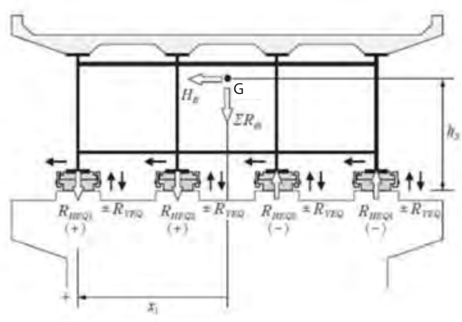
2.4 DESIGN EXTERNAL FORCE FOR PIER BEAM

Table Summary of Design Loads for Pier Beam Design

Condition	Load Component	P14	P15	P16	P17	P18	P19
Vertical direction							
Ordinary Condition (Dead + Live Loads)	Dead Load at G1 girder	6,100	5,100	5,500	5,400	5,200	5,800
	Live Load with Impact at G1 girder	2,100	2,000	2,100	2,100	2,000	2,000
	Weight of Beam	1,578	1,578	1,578	1,578	1,578	1,578
	Total	**9,778**	**8,678**	**9,178**	**9,078**	**8,778**	**9,378**
Earthquake Condition (Dead Load + Effect of earthquake)	Dead Load at G1 girder	6,100	5,100	5,500	5,400	5,200	5,800
	Weight of Beam	1,578	1,578	1,578	1,578	1,578	1,578
	Vertical reaction force due to earthquake from Superstructure*1	1,400	1,200	1,200	1,200	1,200	1,300
	Total	**9,078**	**7,878**	**8,278**	**8,178**	**7,978**	**8,678**
Bridge axis perpendicular direction							
Earthquake Condition	Inertia force of superstructure	**2,400**	**2,100**	**2,200**	**2,100**	**2,100**	**2,300**
Bridge axis direction							
Effect of temperature change	Horizontal force due to temperature change	**1,400**	**500**	**300**	**300**	**800**	**1,500**
Earthquake Condition	Inertia force on the beam	473	473	473	473	473	473
	Inertia force on superstructure	1,800	1,800	1,900	1,900	2,000	2,000
	Total	**2,273**	**2,273**	**2,373**	**2,373**	**2,473**	**2,473**

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:

$$R_{HEQi} = \frac{H_B h_S}{\Sigma x_i^2} x_i$$



Coefficient of Kv

	Level 1	Level 2	
		Type I	Type II
Coefficient	0.5	0.5	0.67

$$R_{VEQ} = \pm k_V R_D \cdots\cdots (15.4$$

Table Vertical reaction force due to earthquake from Superstructure

	P14		P15		P16		P17		P18		P19	
	G1,G4	G2,G3	G1,G4	G2,G3	G1,G4	G2,G3	G1,G4	G2,G3	G1,G4	G2,G3	G1,G4	G2,G3
RD (Reaction on bearing due to dead load of superstructure), kN	+6026	+6101	+5045	+5137	+5420	+5332	+5352	+5293	+5196	+5171	+5745	+5826
RVEQ (Inertial force in vertical direction), kN) (± kvRd＝0.24x0.5xRd)	±723.1	±732.1	±605.4	±616.4	±650.4	±639.8	±642.2	±635.2	±623.5	±620.5	±689.4	±699.1
RHEQ (Vertical reaction on the bearing due to horizontal inertial force) kN	+1127	+480	+946	+403	+999	+425	+989	+421	+963	+410	+1075	+458
	+1127		+946		+999		+989		+963		+1075	
Vertical reaction force due to earthquake from Superstructure √RVEQ2+ RHEQ2	1,339	1,344	1,123	1,129	1,192	1,187	1,179	1,176	1,148	1,146	1,277	1,283

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.

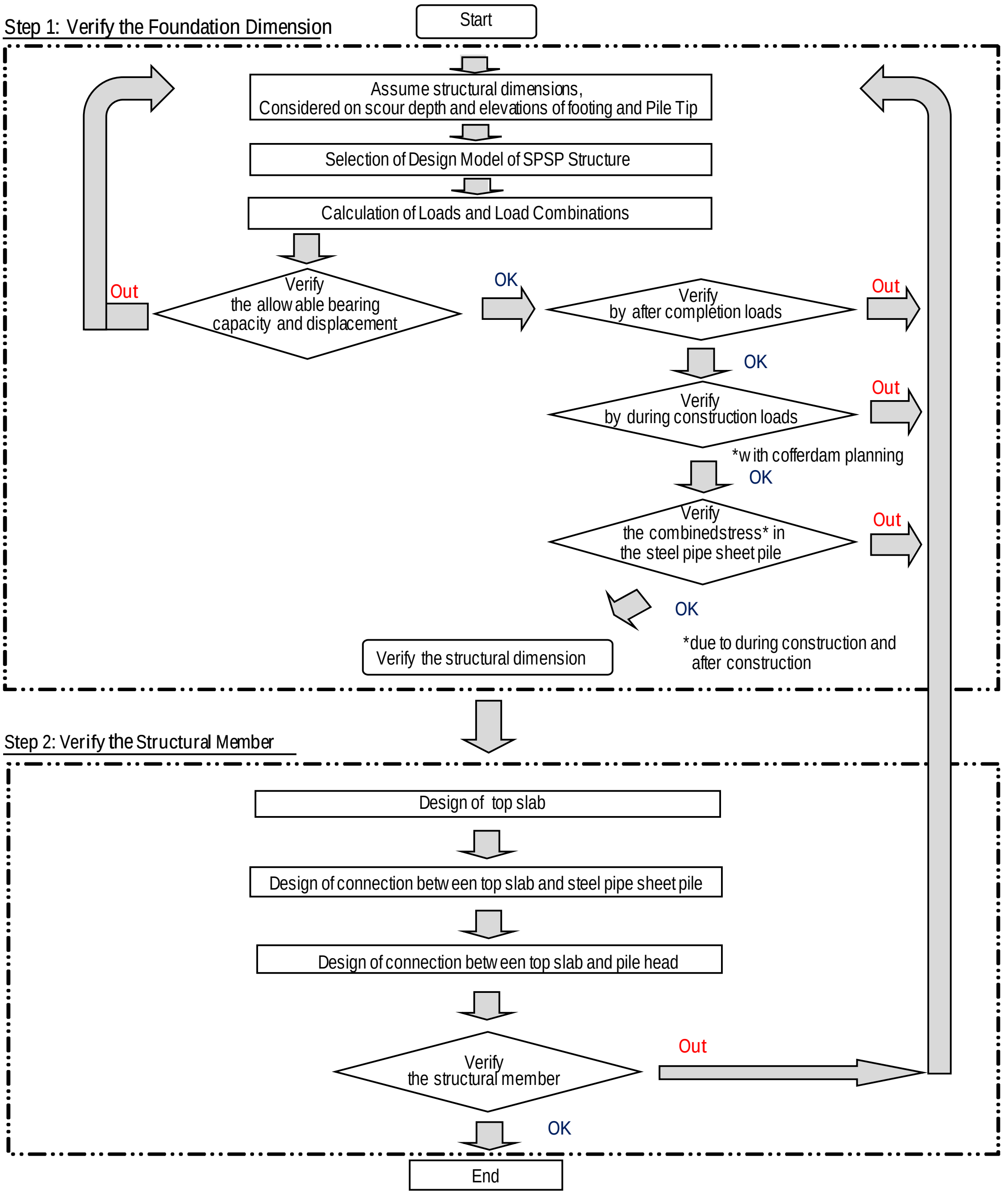


Figure Design Flow for the Basic Design of the SPSP Foundation

(2) Design Soil Condition

At the section of the steel box bridge, two boreholes in the F/S and four boreholes in D/D, a total of six boreholes, were performed. Boreholes at P15 and P19 are far from the center of the foundation, which are around 37 m and 28 m away, respectively. Soil profile and geotechnical design parameters were established based on the laboratory soil test results and field test results, and design parameters such as N-value, unit weight, internal friction angle, cohesive strength and deformation modulus are provided as the average value in Bago River section as presented in Chapter 2.1 Soil Investigation.

Table Borings at Steel Box Bridge Section

Pier No.	Boring No.	Boring Location
P14	No.BD-07 (D/D)	center of the foundation
P15	No.13BH-03 (F/S)	37 m from the center of the foundation
P16	No.BD-06 (D/D)	center of the foundation
P17	No.BD-05 (D/D)	center of the foundation
P18	No.BD-04 (D/D)	center of the foundation
P19	No.13BH-04 (F/S)	28 m from the center of the foundation

Since there is a saturated soil layer having ground water level higher than 10 m below the ground surface and located at a depth less than 20 m below the ground surface, liquefaction potential is evaluated and deduction factor due to liquefaction at the time of earthquake is considered in the foundation design.

(3) Footing Top Elevation

Setting of the footing top elevation is very important because it will affect the stability of the structure in the long term and construction cost. For the design of the SPSP, in general, deeper setting of footing below the riverbed may require a thicker steel pipe and/or higher grade pile due to larger displacement and stress during construction.

Therefore, in this Project, footing top elevation is set to more than 1 m from the lowest elevation of existing riverbed among piers as shown in the table below, and projection of the footing above the riverbed after local scouring will be allowed and finally, the stability during ordinary and earthquake conditions will be considered in the design.

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)			
P14	5.15	4.03	0.76	0.36	-6.28	-8.06	-11.43
P15	5.75	4.73	0.66	0.36	-5.09	-8.06	-10.84
P16	5.09	4.11	0.63	0.36	-5.26	-8.06	-10.36
P17	3.00	2.28	0.36	0.36	-6.70	-8.06	-9.70
P18	3.01	2.12	0.53	0.36	-6.99	-8.06	-10.00
P19	2.90	2.09	0.45	0.36	-6.88	-8.06	-9.78

(4) Pile Tip Elevation

The tip of the steel pipe pile foundation of the well type in principle has to be supported by good soil ground layer, which assumes an N-value greater than 30 for sand soil and 20 for clay soil. In addition, the supporting layer must have a sufficient thickness not to be affected by the lower layers. Pile tip is set into the bearing layer to more than the length of the diameter of pile, namely, 1.2 m as shown in the figure below.

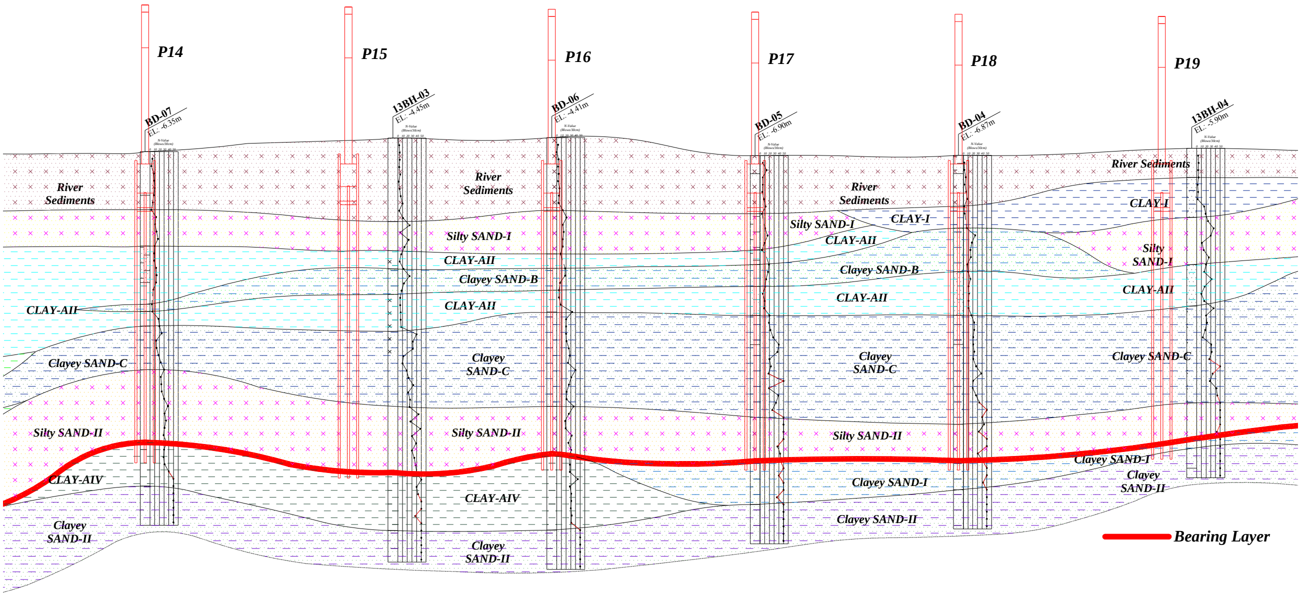


Figure Soil Profile and Pile Tip Position

(5) Design Model of SPSP Structure

As for the design model of the SPSP, if D < 30 m and L/D > 1 and βLe > 1, then finite-length beam on an elastic ground model is used, and if D > 30 m and L/D ≤ 1 and βLe ≤ 1, analysis by an imaginary well beam that considers shear slippage of the interlocking or three dimension model is applied.

Finite-length beam on an elastic ground is applied for the design model of the SPSP structure for all foundations from P14 to P19 based on the criteria mentioned above.

Table Selection of the Design Model of the SPSP Structure

Pier No.	P14	P15	P16	P17	P18	P19
D (m)	17.16	17.16	17.16	17.16	17.16	17.16
L/D	2.39	2.57	2.45	2.45	2.45	2.37
βL_e	1.49	1.60	1.57	1.57	1.57	1.52

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

Β (1/m): characteristic factor of foundation

(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 Vertical Reaction	Ordinary Condition*1 Allowable Value	Ordinary Condition*1 Judgement	Earthquake Condition*2 Vertical Reaction	Earthquake Condition*2 Allowable Value	Earthquake Condition*2 Judgement
P14	Axial compression resistance	1,821 <	2,855	OK	1,553 <	4.259	OK
	Pulling-out resistance	1,821 >	-1,043	OK	1,546 >	-1,661	OK
P15	Axial compression resistance	1,729 <	2,007	OK	1,496 <	3,011	OK
	Pulling-out resistance	1,729 >	-1,006	OK	1,375 >	-1,566	OK
P16	Axial compression resistance	1,752 <	2,406	OK	1,521 <	3,609	OK
	Pulling-out resistance	1,752 >	-991	OK	1,408 >	-1,558	OK
P17	Axial compression resistance	1,693 <	1,763	OK	1,510 <	2,644	OK
	Pulling-out resistance	1,693 >	-893	OK	1,367 >	-1,359	OK
P18	Axial compression resistance	1,660 <	1,747	OK	1,491 <	2,621	OK
	Pulling-out resistance	1,660 >	-875	OK	1,342 >	-1,323	OK
P19	Axial compression resistance	1,724 <	1,791	OK	1,574 <	2,687	OK
	Pulling-out resistance	1,724 >	-850	OK	1,375 >	-1,290	OK

Bridge Axis Perpendicular Direction — Unit: kN

Pier No.	Item	Ordinary Condition*1 Vertical Reaction	Ordinary Condition*1 Allowable Value	Ordinary Condition*1 Judgement	Earthquake Condition*2 Vertical Reaction	Earthquake Condition*2 Allowable Value	Earthquake Condition*2 Judgement
P14	Axial compression resistance	1,821 <	2,855	OK	1,801 <	4,259	OK
	Pulling-out resistance	1,821 >	-1,043	OK	1,299 >	-1,661	OK
P15	Axial compression resistance	1,729 <	2,007	OK	1,492 <	3,011	OK
	Pulling-out resistance	1,729 >	-1,006	OK	-1,379 >	-1,566	OK
P16	Axial compression resistance	1,752 <	2,406	OK	1,527 <	3,609	OK
	Pulling-out resistance	1,752 >	-991	OK	1,402 >	-1,558	OK
P17	Axial compression resistance	1,693 <	1,763	OK	1,481 <	2,644	OK
	Pulling-out resistance	1,693 >	-893	OK	1,396 >	-1,359	OK
P18	Axial compression resistance	1,660 <	1,747	OK	1,491 <	2,621	OK
	Pulling-out resistance	1,660 >	-875	OK	1,342 >	-1,323	OK
P19	Axial compression resistance	1,724 <	1,791	OK	1,528 <	2,687	OK
	Pulling-out resistance	1,724 >	-850	OK	1,421 >	-1,290	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

Unit: cm

Pier No.	Item	Earthquake Condition[*1]		
		Displacement[*2]	Allowable Value	Judgement
P14	Bride Axis Direction	3.3 <	5.0	OK
	Bridge axis perp. direction	3.0 <	5.0	OK
P15	Bride Axis Direction	3.2 <	5.0	OK
	Bridge axis perp. direction	2.5 <	5.0	OK
P16	Bride Axis Direction	2.8 <	5.0	OK
	Bridge axis perp. direction	2.2 <	5.0	OK
P17	Bride Axis Direction	2.6 <	5.0	OK
	Bridge axis perp. direction	2.0 <	5.0	OK
P18	Bride Axis Direction	2.9 <	5.0	OK
	Bridge axis perp. direction	2.1 <	5.0	OK
P19	Bride Axis Direction	2.5 <	5.0	OK
	Bridge axis perp. direction	2.0 <	5.0	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

In a steel pipe sheet pile foundation of the type that also serves as a temporary cofferdam, the steel pipe sheet piles are used as cofferdam walls during the work execution. Therefore, cofferdam walls shall be verified to be safe against the loads acting during temporary work.

As the top slab concrete is placed with the steel pipe sheet piles in a deformed state, the residual stress (σ1) due to and remaining after work execution and the stress (σ2) occurring due to the design external forces after completion should be added. The sum (σ) shall be equal to the allowable stress (σa) or less.

Because the stress occurring in the steel pipe sheet pile during drainage is influenced by the sequence of work execution, it is necessary to fully investigate the work sequence and execute the design according to that 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 P14 is shown in the figure below, and other cases have similar steps as that of P14.

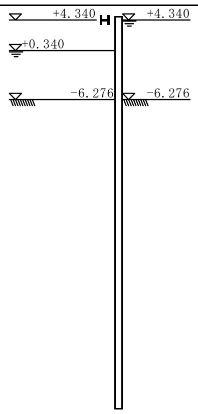
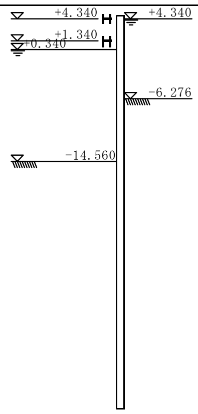
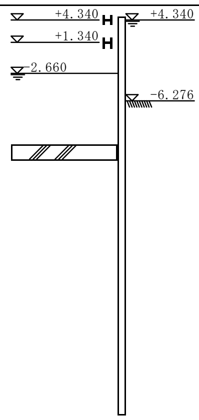
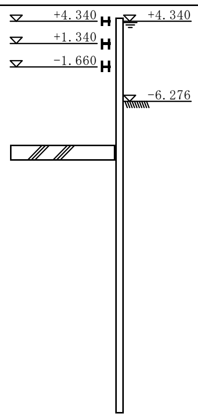
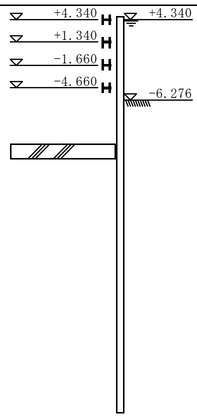
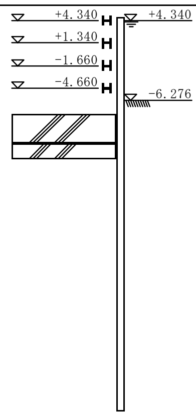
Schematic			
Work activities	Step-1: Install 1st support and drainage up to EL+0.34 m	Step-2: Install 2nd support and excavate up to EL-14.56 m	Step-3: Placement of bottom slab concrete and drainage up to EL-2.66 m
Schematic			
Work activities	Step-4: Install 3rd support and dry up inside well	Step-5: Install 4th support	Step-6: Construction of footing

Figure Construction Step of Temporary Cofferdam by Combined Underwater and Atmospheric Excavation (P14 Case)

As explained above, 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 P14 is shown in the figure below, and the maximum displacement due to moment occurs between the lowest support and bottom slab concrete.

<Step-5> Displacement (cm) Bending Moment (kN.m)

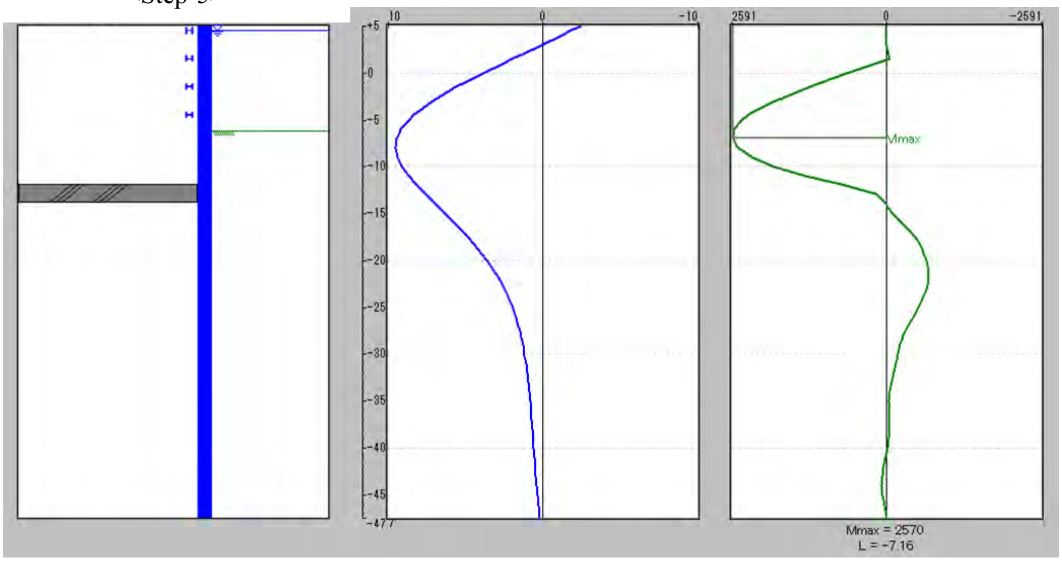
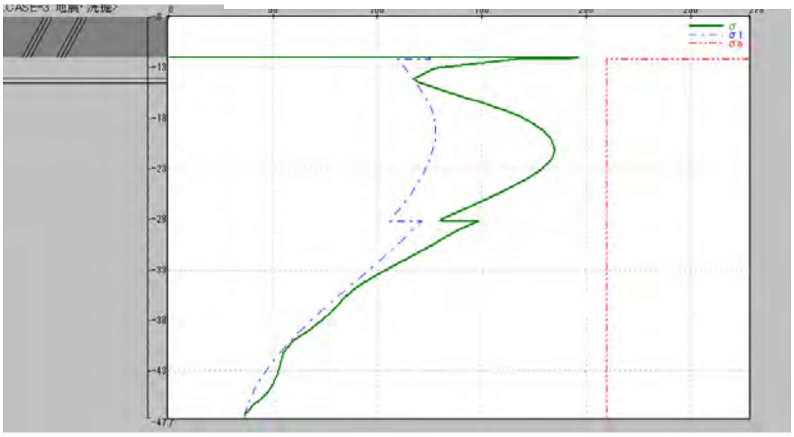


Figure Diagram of Displacement and Bending Moment at the Construction Step when Residual Stress of the Pile is Considered (P14 Case)

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

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

Earthquake Condition (Level-1) Stress (N/mm^2)



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 P14 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
P14	-22.09	35.86	58.61	94.48 <	140	OK
P15	-22.59	34.06	66.67	100.73 <	140	OK
P16	-12.16	34.52	64.26	98.78 <	140	OK
P17	-22.66	33.35	85.54	118.89 <	140	OK
P18	-20.16	32.71	81.03	113.74 <	140	OK
P19	-33.16	38.63	77.11	115.74 <	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
P14	-12.16	35.86	60.90	96.76 <	140	OK
P15	-22.59	34.06	68.65	102.71 <	140	OK
P16	-12.16	34.52	68.61	103.14 <	140	OK
P17	-22.66	33.35	87.63	120.98 <	140	OK
P18	-20.16	32.71	83.20	115.91 <	140	OK
P19	-33.16	38.63	77.11	115.74 <	140	OK

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

Table 3.1.1 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
P14	-21.16	126.74	58.58	185.32 <	210	OK
P15	-22.16	119.45	66.14	185.59 <	210	OK
P16	-22.06	113.95	62.61	176.56 <	210	OK
P17	-22.06	111.39	85.41	196.80 <	210	OK
P18	-20.16	125.14	81.03	206.18 <	210	OK
P19	-19.16	120.04	66.40	186.44 <	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
P14	-21.16	127.23	59.34	186.57 <	210	OK
P15	-22.59	111.90	68.65	180.55 <	210	OK
P16	-22.16	109.21	64.47	173.68 <	210	OK
P17	-22.16	105.36	87.00	193.02 <	210	OK
P18	-20.16	111.46	83.20	194.66 <	210	OK
P19	-19.16	112.04	68.44	180.48 <	210	OK

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

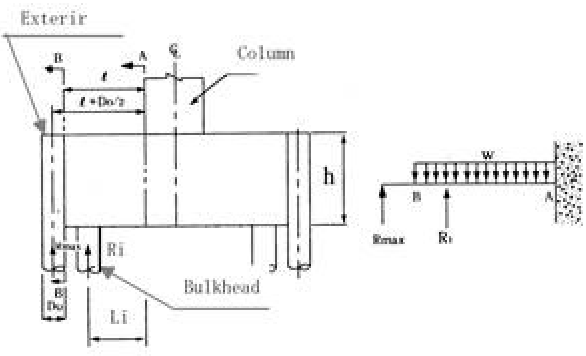
(7) Verification of Structural Members

1) Footing (Top Slab)

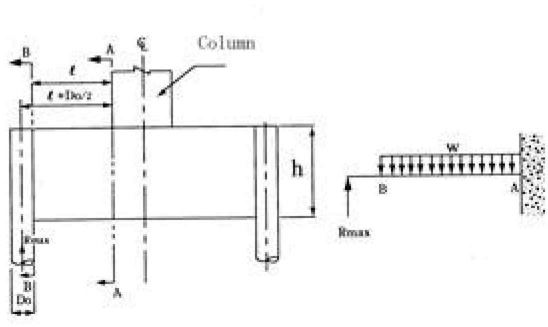
a) Design Sections

The footing of a steel pipe sheet pile foundation generally has a large rigidity and is rigidly connected to the steel pipe sheet piles. It can be calculated as a cantilever with the fixed end at the outer edge of the lower end of the body. Reaction by the soil under the footing inside the well will not be considered in the footing design for safety.

A verification of the sections of footing will be made at the section A-A for bending moment and section B-B for shear force as shown in figure below, and such section forces shall be calculated per unit width at the position of the steel pipe sheet pile that produces the maximum vertical reaction force.



(Bridge Axis Direction)



(Bridge Axis Perpendicular Direction)

Source: Design and Construction Manual Published by the Japanese Association for Steel Pipe Piles

Figure Section Calculation Model and Design Section of Footing

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

P14 and P19

Bridge Axis Direction

Upper tension: cover 150 mm D32@260
cover 300 mm D32@260

Lower tension: cover 300 mm D51@183
cover 500 mm D51@302

Bridge Axis Perpendicular Direction

Upper tension: cover 118 mm D32@209
cover 268 mm D32@408

Lower tension: cover 230 mm D51@209
cover 430 mm D51@408

P15-P18

Bridge Axis Direction

Upper tension: cover 150 mm D32@260
cover 300 mm D32@260

Lower tension: cover 300 mm D51@183
cover 500 mm D51@370

Bridge Axis Perpendicular Direction

Upper tension: cover 118 mm D32@209
cover 268 mm D32@408

Lower tension: cover 230 mm D51@209
cover 430 mm D51@408

It is noted that shear reinforcement is arranged by D22@600 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
P14	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 2.85 < σ_s:178.13<	12 300	OK OK
	Lower tensile stress	σ_c: 2.16 < σ_s: 71.81 <	8 160	OK OK	σ_c: 5.68 < σ_s:189.34<	12 300	OK OK
	Rebar Content	177.88 >	111.49	OK	177.88 >	157.11	OK
	Shear stress	τ_m: 0.33 <	1.00	OK	τ_m: 0.85<	1.51	OK
P15	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 2.89< σ_s:180.20<	12 300	OK OK
	Lower tensile stress	σ_c: 2.05 < σ_s:70.92 <	8 160	OK OK	σ_c: 5.51< σ_s:191.13<	12 300	OK OK
	Rebar Content	165.55 >	103.74	OK	165.55 >	149.10	OK
	Shear stress	τ_m: 0.31 <	0.98	OK	τ_m: 0.81 <	1.51	OK
P16	Upper tensile stress	σ_c:0.00< σ_s:0.00<	8 160	OK OK	σ_c:2.89< σ_s:180.48<	12 300	OK OK
	Lower tensile stress	σ_c:2.08< σ_s:72.19<	8 160	OK OK	σ_c:5.59< σ_s:193.72<	12 300	OK OK
	Rebar Content	165.55 >	105.59	OK	165.55 >	151.13	OK
	Shear stress	τ_m:0.31<	0.98	OK	τ_m:0.79<	1.51	OK
P17	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c:2.94< σ_s:183.79<	12 300	OK OK
	Lower tensile stress	σ_c:2.04 < σ_s: 70.67 <	8 160	OK OK	σ_c:5.57< σ_s:193.03<	12 300	OK OK
	Rebar Content	165.55 >	103.37	OK	165.55 >	150.59	OK
	Shear stress	τ_m: 0.30	0.98	OK	τ_m:0.81<	1.49	OK
P18	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c:3.01< σ_s:188.22<	12 300	OK OK
	Lower tensile stress	σ_c:2.00< σ_s:69.39<	8 160	OK OK	σ_c:5.56< σ_s:192.69<	12 300	OK OK
	Rebar Content	165.55 >	101.49	OK	165.55 >	150.32	OK
	Shear stress	τ_m:0.29<	0.98	OK	τ_m:0.81<	1.49	OK
P19	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c:2.91< σ_s:181.55<	12 300	OK OK
	Lower tensile stress	σ_c:2.04 σ_s:68.02<	8 160	OK OK	σ_c:5.52< σ_s:183.90<	12 300	OK OK
	Rebar Content	177.88 >	105.83	OK	177.88 >	152.60	OK
	Shear stress	τ_m:0.31<	1.00	OK	τ_m:0.83<	1.53	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
P14	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 2.37< σ_s:153.16<	12 300	OK OK
	Lower tensile stress	σ_c: 1.77 < σ_s: 66.50 <	8 160	OK OK	σ_c:4.74< σ_s:178.35<	12 300	OK OK
	Rebar Content	146.67 >	88.39	OK	146.67 >	126.43	OK
	Shear stress	τ_m: 0.32 <	0.98	OK	τ_m:0.81<	1.49	OK
P15	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c: 1.97< σ_s:127.35<	12 300	OK OK
	Lower tensile stress	σ_c: 1.64 < σ_s:61.72 <	8 160	OK OK	σ_c: 4.19 < σ_s:157.74<	12 300	OK OK
	Rebar Content	146.67 >	54.36	OK	146.67 >	111.82	OK
	Shear stress	τ_m: 0.30 <	0.98	OK	τ_m: 0.73<	1.49	OK
P16	Upper tensile stress	σ_c:0.00< σ_s:0.00<	8 160	OK OK	σ_c:2.01< σ_s:129.74<	12 300	OK OK
	Lower tensile stress	σ_c:1.67< σ_s:62.83<	8 160	OK OK	σ_c:4.28< σ_s:160.91<	12 300	OK OK
	Rebar Content	146.67 >	83.51	OK	146.67 >	114.07	OK
	Shear stress	τ_m:0.30<	0.98	OK	τ_m:0.74<	1.49	OK
P17	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c:1.94< σ_s:125.41<	12 300	OK OK
	Lower tensile stress	σ_c:1.64< σ_s:61.54<	8 160	OK OK	σ_c:4.18< σ_s:157.33<	12 300	OK OK
	Rebar Content	146.67 >	81.80	OK	146.67 >	111.53	OK
	Shear stress	τ_m:0.30<	0.98	OK	τ_m:0.72<	1.49	OK
P18	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c:1.89< σ_s:121.89<	12 300	OK OK
	Lower tensile stress	σ_c:1.61< σ_s:60.42<	8 160	OK OK	σ_c:4.09< σ_s:153.99<	12 300	OK OK
	Rebar Content	146.67 >	80.13	OK	146.67 >	109.17	OK
	Shear stress	τ_m:0.29<	0.98	OK	τ_m:0.71<	1.49	OK
P19	Upper tensile stress	σ_c: 0.00 < σ_s: 0.00 <	8 160	OK OK	σ_c:1.99< σ_s:128.50<	12 300	OK OK
	Lower tensile stress	σ_c:1.67< σ_s:62.99<	8 160	OK OK	σ_c:4.30< σ_s:161.65<	12 300	OK OK
	Rebar Content	146.67 >	83.73	OK	146.67 >	114.60	OK
	Shear stress	τ_m:0.3<	0.98	OK	τ_m:0.74<	1.49	OK

Note: Unit stress in N/mm^2, Rebar Content in cm^2

**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/mm^2
- Material of SPSP: SKY490
- Joint method: Reinforcement Stud Method

b) Required Number of Moment and Shear Reinforcement

The required number of reinforcement is 16-17 for moment and it ranges between 54 and 72 for shear. Therefore, 20 studs for moment for all piers, 72 studs for shear for P15-P19 and 76 studs for shear for P14 are arranged as shown in the figure below and it was verified by the allowable stress summarized in the table below.

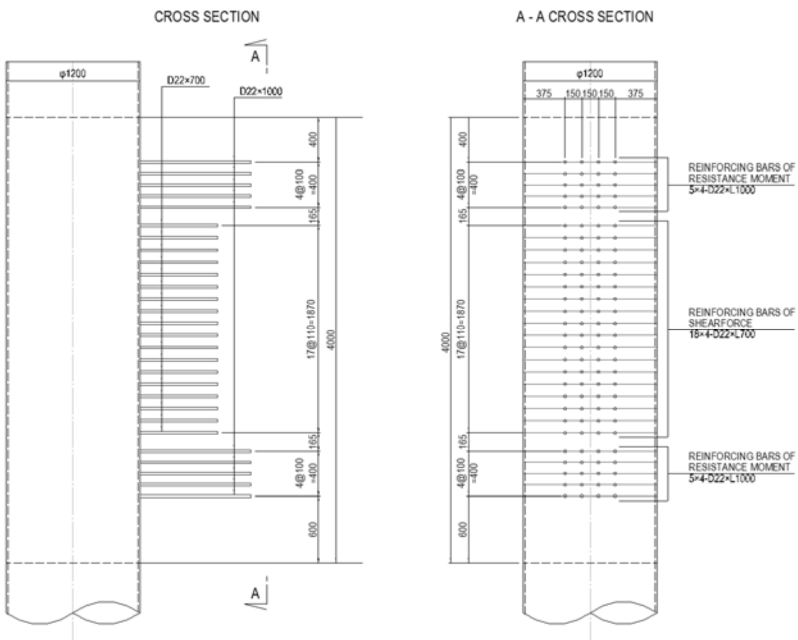


Figure Layout of Reinforcement Stud

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
P14	Wind+ Temperature	174.1<	216.0	20 ≥17	Temperature	103.3<	110.4	76 ≥72
P15	Wind+ Temperature	169.2<	216.0	20 ≥16	Earthquake	151.8<	180.0	72 ≥61
P16	Wind+ Temperature	165.1<	216.0	20 ≥16	Earthquake	153.9<	180.0	72 ≥62
P17	Wind+ Temperature	164.4<	216.0	20 ≥16	Earthquake	153.0<	180.0	72 ≥62
P18	Wind+ Temperature	169.2<	216.0	20 ≥16	Earthquake	152.7<	180.0	72 ≥62
P19	Wind+ Temperature	175.0<	216.0	20 ≥17	Earthquake	154.9<	180.0	72 ≥62

Bridge Axis Perpendicular Direction

Pier No.	Critical condition	σ_s	σ_{sa}	nb nba	Critical condition	τ_s	τ_{sa}	ns nsa
P14	Wind	152.9<	200.0	20 ≥16	Earthquake	147.7<	180.0	76 ≥63
P15	Wind	152.9<	200.0	20 ≥16	Earthquake	139.8<	180.0	72 ≥56
P16	Wind	152.9<	200.0	20 ≥16	Earthquake	142.3<	180.0	72 ≥57
P17	Wind	152.9<	200.0	20 ≥16	Earthquake	137.8<	180.0	72 ≥56
P18	Wind	152.9<	200.0	20 ≥16	Earthquake	134.9<	180.0	72 ≥54
P19	Wind	152.9<	200.0	20 ≥16	Earthquake	141.5<	180.0	72 ≥57

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

The pile head of the bulkhead part of the SPSP will be inserted and rigidly connected by reinforcing bars with the footing, and it has been 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 φ29 mm and filled concrete as shown in the figure below.

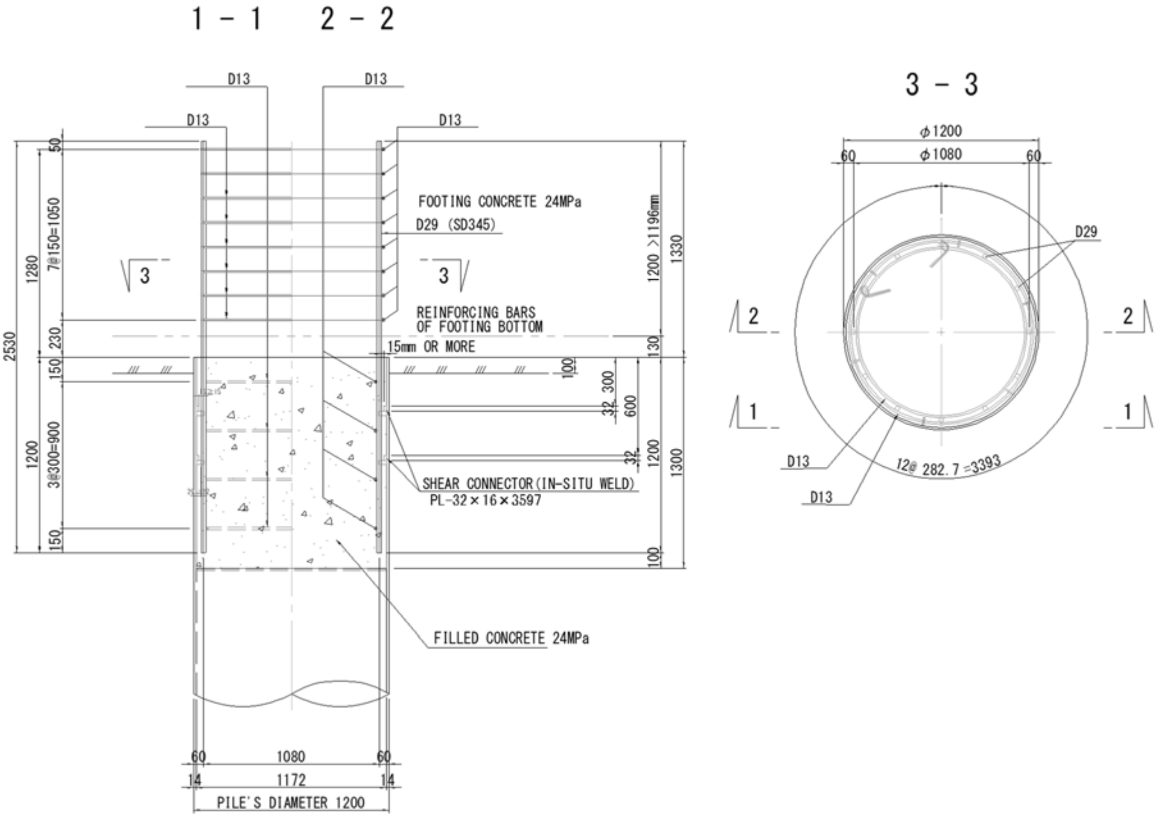


Figure　Detail of Pile Head Connection

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)				
P14	Earthquake	348.0	Min-718 Max 3588	77.1 >	56.7	222.8	300.0
P15	Earthquake	335.0	Min-747 Max 3395	77.1 >	57.1	223.7	300.0
P16	Earthquake	327.0	Min-676 Max 3370	77.1 >	53.3	209.5	300.0
P17	Earthquake	320.0	Min-655 Max 3306	77.1 >	51.8	204.0	300.0
P18	Earthquake	327.0	Min-719 Max 3322	77.1 >	55.2	216.8	300.0
P19	Earthquake	327.0	Min-660 Max 3380	77.1 >	52.6	207.0	300.0

d) Required Anchorage Length of Reinforcing Bars

Anchorage length of reinforcing bars, L = 1,200 mm, from the main reinforcement of footing must be longer than L0+10 x φ.

$$Lo = \frac{\sigma sa}{4 \cdot \tau oa} \phi = 906 \text{ (mm)}$$

L ≥ Lo + 10 x φ = 1,196 (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: φ29 mm

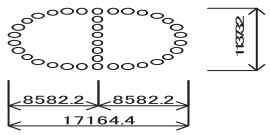
3.2 DETAIL CALCULATION SHEET OF SPSP FOUNDATION DESIGN

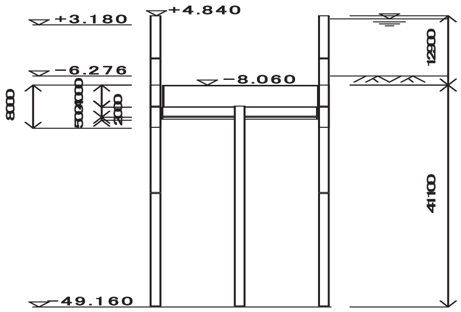
Detail calculation sheet of SPSP design of P14 and P15 cases is attached from next page.

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 = 54.000(m)
number = 30(number)

steel pipe thickness (mm)	length (m)	material
14.0	8.000	SKY400
14.0	9.000	SKY490
16.0	16.000	SKY400
14.0	21.000	SKY400

2)separation wall sheet pile

external diameter = 1200.0(mm)
pile length = 37.200(m)
number = 6(number)

steel pipe thickness (mm)	length (m)	material
14.0	37.200	SKY400

1.3 ground condition

No	soil	layer thick ness (m)	ave rage 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	sand	8.074	3.0	17.0	8.0	0.0	29.00	4800	9600	0.333	0.333	0.333
2	sand	2.000	13.0	17.0	8.0	0.0	33.00	20800	41600	0.333	0.333	0.333
3	sand	3.000	13.0	17.0	8.0	0.0	33.00	20800	41600	1.000	1.000	1.000
4	chsv	8.000	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
5	sand	1.000	13.0	17.0	8.0	0.0	32.00	36400	72800	1.000	1.000	1.000
6	chsv	2.000	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
7	sand	6.000	20.0	17.0	8.0	0.0	33.00	56000	112000	1.000	1.000	1.000
8	sand	10.000	30.0	17.0	8.0	0.0	34.00	84000	168000	1.000	1.000	1.000

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
9	chsv	6.000	30.0	18.0	8.0	180.0	0.00	84000	168000	1.000	1.000	1.000
10	sand	5.400	50.0	19.0	10.0	0.0	34.00	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 = 30

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
14.0	4.100	446.4	782242	13081	SKY490
16.0	16.000	519.9	908031	15184	SKY400
14.0	21.000	446.4	782242	13081	SKY400

2)separation wall sheet pile Do = 1200(mm) number = 6

to(mm)	L(m)	Ao(cm^2)	Io(cm^4)	Zo(cm^3)	material
14.0	37.100	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	491.60	903.99
separation wall sheet pile	36.96	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	4.100	17.976138	30.544184
2	16.000	20.724262	35.565970
3	21.000	17.976138	30.544184

foundation length = 41.100 (m)

(4)coordinates of cetroid of steel pipe sheet pile

1) periphery sheet pile

No	Y(m)	X(m)	number
1	5.0866	0.0000	2
2	5.0866	1.4478	4
3	5.0866	2.8956	4
4	0.7239	7.9304	4
5	2.1131	7.5225	4
6	3.3310	6.7398	4
7	4.2791	5.6456	4
8	4.8806	4.3287	4

2) separation wall sheet pile

No	Y(m)	X(m)	number
1	3.6333	0.0000	2
2	2.1800	0.0000	2
3	0.7267	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	0.000	------	0.000	------	----
1	6.290	4800	6.290	9600	0.333
2	2.000	20800	2.000	41600	0.333
3	3.000	20800	3.000	41600	1.000
4	8.000	19600	8.000	39200	1.000
5	1.000	36400	1.000	72800	1.000
6	2.000	19600	2.000	39200	1.000
7	6.000	56000	6.000	112000	1.000
8	10.000	84000	10.000	168000	1.000
9	2.810	84000	2.810	168000	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 = 84000

earthquake time = 168000

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	98995	197990
separation wall sheet pile	1200.0	98995	197990

(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 (cm^4)	1.7976E+009		3.0544E+009	
D (cm)	1716.44		1137.32	
Beta(cm^{-1})	0.000422	0.000422	0.000363	0.000363
1/Beta(cm)	2368.1	2368.1	2751.4	2751.4
average Alp.*Eo (N/cm^2)	1876.9	1876.9	2395.6	2395.6
BH, $\sqrt{De*Le}$ (cm)	2016.1 < 2656.0	2016.1 < 2656.0	1769.0 < 2162.0	1769.0 < 2162.0

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	6.290	6.290	4800	9600	1363	908	1504	1002
2	2.000	2.000	20800	41600	5908	3935	6517	4340
3	3.000	3.000	20800	41600	5908	11816	6517	13033
4	8.000	8.000	19600	39200	5567	11134	6141	12281
5	1.000	1.000	36400	72800	10339	20677	11404	22808
6	2.000	2.000	19600	39200	5567	11134	6141	12281
7	6.000	6.000	56000	112000	15906	31811	17545	35090
8	10.000	10.000	84000	168000	23859	47717	26317	52635
9	2.810	2.810	84000	168000	23859	47717	26317	52635

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	6.290	6.290	1363	908	1504	1002
2	2.000	2.000	5908	3935	6517	4340
3	3.000	3.000	5908	11816	6517	13033
4	8.000	8.000	5567	11134	6141	12281
5	1.000	1.000	10339	20677	11404	22808
6	2.000	2.000	5567	11134	6141	12281
7	6.000	6.000	15906	31811	17545	35090
8	10.000	10.000	23859	47717	26317	52635
9	2.810	2.810	23859	47717	26317	52635

(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	29698	59397
separation wall sheet pile	29698	59397

(5)spring constant at bottom of celler

1)vertical spring constant

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

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	30	1.1310	6	0.0000	0	4.0306E+006	8.0612E+006

2) shear spring constant

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

usual time	in quakes
1.2092E+006	2.4184E+006

3)rotational spring constant

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

where IB : celler composed with steel pipe sheet pile

sum of squared distance from centroid to neutral axis of horizontal section of celler (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	491.60	36.96	5.9178E+007	1.1836E+008
perpendicular direction	903.99	0.00	1.0121E+008	2.0242E+008

spring constant at bottom of celler(using value)

		usual time	in quakes
vertical spring Kv (kN/m)		4.0306E+006	8.0612E+006
shear spring Ks (kN/m)		1.2092E+006	2.4184E+006
rotational spring Kr (kN.m/rad)	bridge axis direction	5.9178E+007	1.1836E+008
	perpendicular direction	1.0121E+008	2.0242E+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)

$$\frac{\text{equivalent embedment depth to bearing strata}}{\text{pile diameter}} = \frac{2.810}{1.2000} = 2.34$$

qd / $\bar{N}$ = 140

$\bar{N}$:design N value in steel pipe sheet pile tip ground $\bar{N}$ = 30.0

qd = 140 * 30.0 = 4215 (kN/m^2)

n1 : celler part periphery steel pipe sheet pile number (number) n1 = 30

n2 : number of steel pipe sheet pile in separation wall part (number) n2 = 6

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

U1 : enveloping celler part periphery length (m) U1 = 47.312 (m)

U2 : enveloping celler part and separation wall part periphery length and sum of perimeter of intermediate driven single pile U2 = 55.319 (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 = 6.782 (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	sandy	3.0	6.290	0.0	0.0	0.333	0.0	0.0
2	sandy	13.0	2.000	26.0	26.0	0.333	52.0	17.3
3	sandy	13.0	3.000	26.0	26.0	1.000	78.0	78.0
4	cohesv	7.0	8.000	70.0	70.0	1.000	560.0	560.0
5	sandy	13.0	1.000	26.0	26.0	1.000	26.0	26.0
6	cohesv	7.0	2.000	70.0	70.0	1.000	140.0	140.0
7	sandy	20.0	6.000	40.0	40.0	1.000	240.0	240.0
8	sandy	30.0	10.000	60.0	60.0	1.000	600.0	600.0
9	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5
Sum			41.100				2117.5	2082.8

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	sandy	30.0	3.972	60.0	60.0	1.000	238.3	238.3
9	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5
Sum			6.782				659.8	659.8

DE: reduction coefficient in earthquake time

ultimate bearing capacity

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

= 4767 + 3797 = 8564 (kN/number) (usual time)

= 4767 + 3751 = 8518 (kN/number) (earthquake time)

allowable compressive bearing capacity

usual time Ra = (1 / 3) * 8564 = 2855 (kN/number)

earthquake Ra = (1 / 2) * 8518 = 4259 (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) =	130.8	130.8
joint weight	w2 (kN) =	0.0	0.0
soil weight inside of pipe	w3 (kN) =	279.6	279.6
filling concrete weight	w4 (kN) =	0.0	0.0
	W (kN) =	410.4	410.4

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	sandy	3.0	6.290	0.0	0.0	0.333	0.0	0.0
2	sandy	13.0	2.000	26.0	26.0	0.333	52.0	17.3
3	sandy	13.0	3.000	26.0	26.0	1.000	78.0	78.0
4	cohesv	7.0	8.000	70.0	70.0	1.000	560.0	560.0
5	sandy	13.0	1.000	26.0	26.0	1.000	26.0	26.0
6	cohesv	7.0	2.000	70.0	70.0	1.000	140.0	140.0
7	sandy	20.0	6.000	40.0	40.0	1.000	240.0	240.0
8	sandy	30.0	10.000	60.0	60.0	1.000	600.0	600.0
9	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5
Sum			41.100				2117.5	2082.8

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
8	sandy	30.0	3.972	60.0	60.0	1.000	238.3	238.3
9	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5
Sum			6.782				659.8	659.8

DE: reduction coefficient in earthquake time

ultimate uplifting force
Pu = 3797 (kN/number) (usual time time)
Pu = 3751 (kN/number) (earthquake time)

allowable uplifting force
usual time Pa - (1 / 6) * 3797 + 410 - 1043 (kN/number)
earthquake Pa - (1 / 3) * 3751 + 410 - 1661 (kN/number)

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

allowable compressive bearing capacity	usual time	2855
	in quakes	4259
allowable uplifting force bearing capacity	usual time	1043
	in quakes	1661

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 : 11.3732 (m) * 17.1644 (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 = 30
filling concrete cast height h2 = 8.000 (m)
leg column cross sectional area Ap = 40.570 (m^2)
shape : oval
dimension : a = 11.000 (m) perpendicular direction
: b = 4.000 (m) bridge axis direction
unit weight : backfilling soil(wet) Gam.t = 17.0 (kN/m^3)
backfilling soil(saturated) Gam.sat = 18.0 (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 = 0.000 (m) (depth from crest of)

1)bridge axis direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-6.276	3.180
2	Oridinary(low tide)	-6.276	-2.390
3	Ord+Temp(high tide)	-6.276	3.180

No	load name	backfilling soil height (m)	water table height (m)
4	Ord+Temp(low tide)	-6.276	-2.390
5	Wind+Temp	-6.276	4.990
6	Ord+Collision	-6.276	3.180
7	Earthquake	-6.276	0.290

2)perpendicular direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-6.276	3.180
2	Oridinary(low tide)	-6.276	-2.390
3	Wind	-6.276	4.990
4	Ord+Collision	-6.276	3.180
5	Earthquake	-6.276	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)	55500.0	0.0	0.0
2	Oridinary(low tide)	55500.0	0.0	0.0
3	Ord+Temp(high tide)	55500.0	5400.0	118300.0
4	Ord+Temp(low tide)	55500.0	5400.0	118300.0
5	Wind+Temp	55500.0	5500.0	120100.0
6	Ord+Collision	55500.0	3700.0	44600.0
7	Earthquake	48500.0	15300.0	242600.0

2)perpendicular direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Oridinary(high tide)	55500.0	0.0	0.0
2	Oridinary(low tide)	55500.0	0.0	0.0
3	Wind	55500.0	1200.0	28500.0
4	Ord+Collision	55500.0	7300.0	87900.0
5	Earthquake	48500.0	14800.0	266800.0

(3) pile cap area

oval

$$A1 = \frac{Pai}{4}*(B-D)^2 + (B-D)*(L-B) - \frac{Pai}{4}*D^2*\frac{n}{2} = 123.235\ (m^2)$$

filling concrete area

$$A2 = \frac{Pai}{4}*D^2*n = 33.929\ (m^2)$$

backfilling soil area

$A3 = A1 + A2 - Ap = 116.594\ (m^2)$

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)	11.240	1.784	7147.6	3528.6	1664.0	4560.1	7780.2
2	OD(LT)	5.670	1.784	7147.6	3528.6	1664.0	2300.3	10040.0
3	OD-TM(HT)	11.240	1.784	7147.6	3528.6	1664.0	4560.1	7780.2
4	OD-TM(LT)	5.670	1.784	7147.6	3528.6	1664.0	2300.3	10040.0
5	WN-TM	13.050	1.784	7147.6	3528.6	1664.0	5294.4	7045.9
6	OD-CL	11.240	1.784	7147.6	3528.6	1664.0	4560.1	7780.2
7	ETQ	8.350	1.784	7147.6	3528.6	1664.0	3387.6	8952.7

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)	11.240	1.784	7147.6	3528.6	1664.0	4560.1	7780.2
2	OD(LT)	5.670	1.784	7147.6	3528.6	1664.0	2300.3	10040.0
3	WN	13.050	1.784	7147.6	3528.6	1664.0	5294.4	7045.9
4	OD-CL	11.240	1.784	7147.6	3528.6	1664.0	4560.1	7780.2
5	ETQ	8.350	1.784	7147.6	3528.6	1664.0	3387.6	8952.7

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)	63280.2	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	65540.0	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	63280.2	5400.0	118300.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	65540.0	5400.0	118300.0	1.15	usual time	usual time
5	Wind+Temp	62545.9	5500.0	120100.0	1.35	usual time	usual time
6	Ord+Collision	63280.2	3700.0	44600.0	1.50	usual time	usual time
7	Earthquake	57452.7	15300.0	242600.0	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)	63280.2	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	65540.0	0.0	0.0	1.00	usual time	usual time
3	Wind	62545.9	1200.0	28500.0	1.25	usual time	usual time
4	Ord+Collision	63280.2	7300.0	87900.0	1.50	usual time	usual time
5	Earthquake	57452.7	14800.0	266800.0	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)	63280.2	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	65540.0	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	63280.2	5400.0	118300.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	65540.0	5400.0	118300.0	1.15	usual time	usual time
5	Wind+Temp	62545.9	5500.0	120100.0	1.35	usual time	usual time
6	Ord+Collision	63280.2	3700.0	44600.0	1.50	usual time	usual time
7	Earthquake	57452.7	15300.0	242600.0	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)	63280.2	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	65540.0	0.0	0.0	1.00	usual time	usual time
3	Wind	62545.9	1200.0	28500.0	1.25	usual time	usual time
4	Ord+Collision	63280.2	7300.0	87900.0	1.50	usual time	usual time
5	Earthquake	57452.7	14800.0	266800.0	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	63280.2	65540.0	63280.2
		Ho	kN	0.0	0.0	5400.0
		Mo	kN.m	0.0	0.0	118300.0
foundation crest	displacement	Del.1	cm	0.000	0.000	1.136
	deflexion angle	Theta.1	mrad	0.000	0.000	-0.875
design ground surface	displacement	Del.2	cm	0.000	0.000	1.136
	deflexion angle	Theta.2	mrad	0.000	0.000	-0.875
celler part maximum bending moment		Mmax	kN.m	0.0	0.0	-145704.0
Mmax accrue location		Lm	m	-8.060	-8.060	-16.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm^2	39.38	40.79	71.69
		Lm	m	-28.160	-28.160	-16.350
	periphery sheet pile(SKY490)	Sigmax	N/mm^2	39.38	40.79	79.15
		Lm	m	-8.060	-8.060	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm^2	39.38	40.79	71.10
		Lm	m	-8.060	-8.060	-12.160
	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	145.0
vertical reaction	maximum	Rmax	kN/num	1758	1821	1759
	minimum	Rmin	kN/num	1758	1821	1756
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2855	2855	2855
	uplifting force	Pa	kN/num	-1043	-1043	-1043
	stress(SKY400)	Sig.a	N/mm^2	140.00	140.00	161.00
	stress(SKY490)	Sig.a	N/mm^2	185.00	185.00	212.75

note)Lm is elevation

item			unit	OD-TM(LT)	WN-TM	OD-CL
working force		Vo	kN	65540.0	62545.9	63280.2
		Ho	kN	5400.0	5500.0	3700.0
		Mo	kN.m	118300.0	120100.0	44600.0
foundation crest	displacement	Del.1	cm	1.136	1.162	0.564
	deflexion angle	Theta.1	mrad	-0.875	-0.892	-0.409
design ground surface	displacement	Del.2	cm	1.136	1.162	0.564
	deflexion angle	Theta.2	mrad	-0.875	-0.892	-0.409
celler part maximum bending moment		Mmax	kN.m	-145704.0	-148117.0	-66547.0
Mmax accrue location		Lm	m	-16.350	-16.350	-18.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm^2	72.93	71.91	53.50
		Lm	m	-16.350	-16.350	-28.160
	periphery sheet pile(SKY490)	Sigmax	N/mm^2	80.56	79.33	56.17
		Lm	m	-12.160	-12.160	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm^2	72.50	71.14	52.77
		Lm	m	-12.160	-12.160	-12.160
	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	145.0	99.0	-103.0
vertical reaction	maximum	Rmax	kN/num	1822	1738	1759
	minimum	Rmin	kN/num	1819	1736	1757
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2855	2855	2855
	uplifting force	Pa	kN/num	-1043	-1043	-1043
	stress(SKY400)	Sig.a	N/mm^2	161.00	189.00	210.00
	stress(SKY490)	Sig.a	N/mm^2	212.75	249.75	277.50

note)Lm is elevation

item				unit	ETQ
working force			Vo	kN	57452.7
			Ho	kN	15300.0
			Mo	kN.m	242600.0
foundation crest	displacement		Del.1	cm	3.206
	deflexion angle		Theta.1	mrad	-2.261
design ground surface	displacement		Del.2	cm	3.206
	deflexion angle		Theta.2	mrad	-2.261
celler part maximum bending moment			Mmax	kN.m	-361171.0
Mmax accrue location			Lm	m	-19.060
stress	periphery sheet pile(SKY400)		Sigmax	N/mm²	123.32
			Lm	m	-19.060
	periphery sheet pile(SKY490)		Sigmax	N/mm²	123.50
			Lm	m	-12.160
	separation wall sheet pile(SKY400)		Sigmax	N/mm²	105.73
			Lm	m	-12.160
	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	302.0
vertical reaction	maximum		Rmax	kN/num	1599
	minimum		Rmin	kN/num	1593
allowable value	displacement		Del.a	cm	5.000
	compressive bearing capacity		Ra	kN/num	4259
	uplifting force		Pa	kN/num	-1661
	stress(SKY400)		Sig.a	N/mm²	210.00
	stress(SKY490)		Sig.a	N/mm²	277.50

note)Lm is elevation

2)perpendicular direction

item				unit	OD(HT)	OD(LT)	WN
working force			Vo	kN	63280.2	65540.0	62545.9
			Ho	kN	0.0	0.0	1200.0
			Mo	kN.m	0.0	0.0	28500.0
foundation crest	displacement		Del.1	cm	0.000	0.000	0.243
	deflexion angle		Theta.1	mrad	0.000	0.000	-0.154
design ground surface	displacement		Del.2	cm	0.000	0.000	0.243
	deflexion angle		Theta.2	mrad	0.000	0.000	-0.154
celler part maximum bending moment			Mmax	kN.m	0.0	0.0	-35516.0
Mmax accrue location			Lm	m	-8.060	-8.060	-17.060
stress	periphery sheet pile(SKY400)		Sigmax	N/mm²	39.38	40.79	46.50
			Lm	m	-28.160	-28.160	-28.160
	periphery sheet pile(SKY490)		Sigmax	N/mm²	39.38	40.79	47.87
			Lm	m	-8.060	-8.060	-12.160
	separation wall sheet pile(SKY400)		Sigmax	N/mm²	39.38	40.79	41.70
			Lm	m	-8.060	-8.060	-12.160
	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	-1392.0
vertical reaction	maximum		Rmax	kN/num	1758	1821	1750
	minimum		Rmin	kN/num	1758	1821	1725
allowable value	displacement		Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity		Ra	kN/num	2855	2855	2855
	uplifting force		Pa	kN/num	-1043	-1043	-1043
	stress(SKY400)		Sig.a	N/mm²	140.00	140.00	175.00
	stress(SKY490)		Sig.a	N/mm²	185.00	185.00	231.25

note)Lm is elevation

item				unit	OD-CL	ETQ
working force			Vo	kN	63280.2	57452.7
			Ho	kN	7300.0	14800.0
			Mo	kN.m	87900.0	266800.0
foundation crest	displacement		Del.1	cm	1.145	2.957
	deflexion angle		Theta.1	mrad	-0.653	-1.755
design ground surface	displacement		Del.2	cm	1.145	2.957
	deflexion angle		Theta.2	mrad	-0.653	-1.755
celler part maximum bending moment			Mmax	kN.m	-139375.0	-393073.0
Mmax accrue location			Lm	m	-19.350	-20.060
stress	periphery sheet pile(SKY400)		Sigmax	N/mm²	71.94	128.55
			Lm	m	-28.160	-28.160
	periphery sheet pile(SKY490)		Sigmax	N/mm²	70.75	124.43
			Lm	m	-12.160	-12.160
	separation wall sheet pile(SKY400)		Sigmax	N/mm²	49.49	64.56
			Lm	m	-28.160	-28.160
	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	-8530.0	-26361.0
vertical reaction	maximum		Rmax	kN/num	1833	1827
	minimum		Rmin	kN/num	1683	1365
allowable value	displacement		Del.a	cm	5.000	5.000
	compressive bearing capacity		Ra	kN/num	2855	4259
	uplifting force		Pa	kN/num	-1043	-1661
	stress(SKY400)		Sig.a	N/mm²	210.00	210.00
	stress(SKY490)		Sig.a	N/mm²	277.50	277.50

note)Lm is elevation

1.10 detail output

(1)bridge axis direction

1)Oridinary(high tide)

working force	vertical force	Vo	kN	63280.2
	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	1363	3048
2	5908	13211
3	5908	13211
4	5567	12448
5	10339	23119
6	5567	12448
7	15906	35567
8	23859	53350
9	23859	53350

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.000	0.000	0.0	0.0	39.38	39.38	*
-9.060	0.000	0.000	0.0	0.0	39.38	39.38	
-10.060	0.000	0.000	0.0	0.0	39.38	39.38	
-11.060	0.000	0.000	0.0	0.0	39.38	39.38	
-12.060	0.000	0.000	0.0	0.0	39.38	39.38	
-12.160	0.000	0.000	0.0	0.0	39.38	39.38	
-12.160	0.000	0.000	0.0	0.0	34.63	34.63	
-13.060	0.000	0.000	0.0	0.0	34.63	34.63	
-14.060	0.000	0.000	0.0	0.0	34.63	34.63	

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	34.63	34.63	
-14.560	0.000	0.000	0.0	0.0	34.63	34.63	
-15.060	0.000	0.000	0.0	0.0	34.63	34.63	
-16.060	0.000	0.000	0.0	0.0	34.63	34.63	
-16.350	0.000	0.000	0.0	0.0	34.63	34.63	
-17.060	0.000	0.000	0.0	0.0	34.63	34.63	
-18.060	0.000	0.000	0.0	0.0	34.63	34.63	
-19.060	0.000	0.000	0.0	0.0	34.63	34.63	
-19.350	0.000	0.000	0.0	0.0	34.63	34.63	
-20.060	0.000	0.000	0.0	0.0	34.63	34.63	
-21.060	0.000	0.000	0.0	0.0	34.63	34.63	
-22.060	0.000	0.000	0.0	0.0	34.63	34.63	
-23.060	0.000	0.000	0.0	0.0	34.63	34.63	
-24.060	0.000	0.000	0.0	0.0	34.63	34.63	
-25.060	0.000	0.000	0.0	0.0	34.63	34.63	
-26.060	0.000	0.000	0.0	0.0	34.63	34.63	
-27.060	0.000	0.000	0.0	0.0	34.63	34.63	
-27.350	0.000	0.000	0.0	0.0	34.63	34.63	
-28.060	0.000	0.000	0.0	0.0	34.63	34.63	
-28.160	0.000	0.000	0.0	0.0	34.63	34.63	
-28.160	0.000	0.000	0.0	0.0	39.38	39.38	
-28.350	0.000	0.000	0.0	0.0	39.38	39.38	
-29.060	0.000	0.000	0.0	0.0	39.38	39.38	
-30.060	0.000	0.000	0.0	0.0	39.38	39.38	
-30.350	0.000	0.000	0.0	0.0	39.38	39.38	
-31.060	0.000	0.000	0.0	0.0	39.38	39.38	
-32.060	0.000	0.000	0.0	0.0	39.38	39.38	
-33.060	0.000	0.000	0.0	0.0	39.38	39.38	
-34.060	0.000	0.000	0.0	0.0	39.38	39.38	
-35.060	0.000	0.000	0.0	0.0	39.38	39.38	
-36.060	0.000	0.000	0.0	0.0	39.38	39.38	
-36.350	0.000	0.000	0.0	0.0	39.38	39.38	
-37.060	0.000	0.000	0.0	0.0	39.38	39.38	
-38.060	0.000	0.000	0.0	0.0	39.38	39.38	
-39.060	0.000	0.000	0.0	0.0	39.38	39.38	
-40.060	0.000	0.000	0.0	0.0	39.38	39.38	
-41.060	0.000	0.000	0.0	0.0	39.38	39.38	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-42.060	0.000	0.000	0.0	0.0	39.38	39.38	
-43.060	0.000	0.000	0.0	0.0	39.38	39.38	
-44.060	0.000	0.000	0.0	0.0	39.38	39.38	
-45.060	0.000	0.000	0.0	0.0	39.38	39.38	
-46.060	0.000	0.000	0.0	0.0	39.38	39.38	
-46.350	0.000	0.000	0.0	0.0	39.38	39.38	
-47.060	0.000	0.000	0.0	0.0	39.38	39.38	
-48.060	0.000	0.000	0.0	0.0	39.38	39.38	
-49.060	0.000	0.000	0.0	0.0	39.38	39.38	
-49.160	0.000	0.000	0.0	0.0	39.38	39.38	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	39.38	-28.160
periphery sheet pile (SKY490)	39.38	-8.060
separation wall sheet pile (SKY400)	39.38	-8.060
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) = 23.593 (m^4)
periphery n1 = 30 (number) IB1 = 491.60 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (number) IB1 = 36.96 (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 = 5.087
maximum Rmax = 1758 (kN/number)
minimum Rmin = 1758 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	65540.0
	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	1363	3048
2	5908	13211
3	5908	13211
4	5567	12448
5	10339	23119
6	5567	12448
7	15906	35567
8	23859	53350
9	23859	53350

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	0.000	0.000	0.0	0.0	40.79	40.79	*
-9.060	0.000	0.000	0.0	0.0	40.79	40.79	
-10.060	0.000	0.000	0.0	0.0	40.79	40.79	
-11.060	0.000	0.000	0.0	0.0	40.79	40.79	
-12.060	0.000	0.000	0.0	0.0	40.79	40.79	
-12.160	0.000	0.000	0.0	0.0	40.79	40.79	
-12.160	0.000	0.000	0.0	0.0	35.86	35.86	
-13.060	0.000	0.000	0.0	0.0	35.86	35.86	
-14.060	0.000	0.000	0.0	0.0	35.86	35.86	
-14.350	0.000	0.000	0.0	0.0	35.86	35.86	
-14.560	0.000	0.000	0.0	0.0	35.86	35.86	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	0.000	0.000	0.0	0.0	35.86	35.86	
-16.060	0.000	0.000	0.0	0.0	35.86	35.86	
-16.350	0.000	0.000	0.0	0.0	35.86	35.86	
-17.060	0.000	0.000	0.0	0.0	35.86	35.86	
-18.060	0.000	0.000	0.0	0.0	35.86	35.86	
-19.060	0.000	0.000	0.0	0.0	35.86	35.86	
-19.350	0.000	0.000	0.0	0.0	35.86	35.86	
-20.060	0.000	0.000	0.0	0.0	35.86	35.86	
-21.060	0.000	0.000	0.0	0.0	35.86	35.86	
-22.060	0.000	0.000	0.0	0.0	35.86	35.86	
-23.060	0.000	0.000	0.0	0.0	35.86	35.86	
-24.060	0.000	0.000	0.0	0.0	35.86	35.86	
-25.060	0.000	0.000	0.0	0.0	35.86	35.86	
-26.060	0.000	0.000	0.0	0.0	35.86	35.86	
-27.060	0.000	0.000	0.0	0.0	35.86	35.86	
-27.350	0.000	0.000	0.0	0.0	35.86	35.86	
-28.060	0.000	0.000	0.0	0.0	35.86	35.86	
-28.160	0.000	0.000	0.0	0.0	35.86	35.86	
-28.160	0.000	0.000	0.0	0.0	40.79	40.79	
-28.350	0.000	0.000	0.0	0.0	40.79	40.79	
-29.060	0.000	0.000	0.0	0.0	40.79	40.79	
-30.060	0.000	0.000	0.0	0.0	40.79	40.79	
-30.350	0.000	0.000	0.0	0.0	40.79	40.79	
-31.060	0.000	0.000	0.0	0.0	40.79	40.79	
-32.060	0.000	0.000	0.0	0.0	40.79	40.79	
-33.060	0.000	0.000	0.0	0.0	40.79	40.79	
-34.060	0.000	0.000	0.0	0.0	40.79	40.79	
-35.060	0.000	0.000	0.0	0.0	40.79	40.79	
-36.060	0.000	0.000	0.0	0.0	40.79	40.79	
-36.350	0.000	0.000	0.0	0.0	40.79	40.79	
-37.060	0.000	0.000	0.0	0.0	40.79	40.79	
-38.060	0.000	0.000	0.0	0.0	40.79	40.79	
-39.060	0.000	0.000	0.0	0.0	40.79	40.79	
-40.060	0.000	0.000	0.0	0.0	40.79	40.79	
-41.060	0.000	0.000	0.0	0.0	40.79	40.79	
-42.060	0.000	0.000	0.0	0.0	40.79	40.79	
-43.060	0.000	0.000	0.0	0.0	40.79	40.79	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	0.000	0.000	0.0	0.0	40.79	40.79	
-45.060	0.000	0.000	0.0	0.0	40.79	40.79	
-46.060	0.000	0.000	0.0	0.0	40.79	40.79	
-46.350	0.000	0.000	0.0	0.0	40.79	40.79	
-47.060	0.000	0.000	0.0	0.0	40.79	40.79	
-48.060	0.000	0.000	0.0	0.0	40.79	40.79	
-49.060	0.000	0.000	0.0	0.0	40.79	40.79	
-49.160	0.000	0.000	0.0	0.0	40.79	40.79	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	40.79	-28.160
periphery sheet pile (SKY490)	40.79	-8.060
separation wall sheet pile (SKY400)	40.79	-8.060
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) = 23.593 (m^4)

periphery n1 = 30 (number) IB1 = 491.60 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (number) IB1 = 36.96 (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 = 5.087

maximum Rmax = 1821 (kN/number)
minimum Rmin = 1821 (kN/number)

3)Ord+Temp(high tide)

working force	vertical force	Vo	kN	63280.2
	horizontal force	Ho	kN	5400.0
	moment	Mo	kN.m	118300.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.143
	calculation displacement	Del.	cm	1.136

convergence rate (Del.1 - Del.) / Del.1 = 0.65 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1363	2850
2	5908	12355
3	5908	12355
4	5567	11642
5	10339	21622
6	5567	11642
7	15906	33264
8	23859	49896
9	23859	49896

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	1.136	-0.875	-5400.0	-118300.0	73.91	66.92	
-9.060	1.050	-0.841	-4865.4	-123429.2	75.41	68.11	
-10.060	0.968	-0.806	-4372.0	-128044.6	76.76	69.19	
-11.060	0.889	-0.770	-3918.1	-132186.4	77.97	70.15	
-12.060	0.814	-0.733	-3501.8	-135893.2	79.05	71.01	
-12.160	0.806	-0.729	-3462.1	-136241.4	79.15	71.10	
-12.160	0.806	-0.729	-3462.1	-136241.4	69.29	62.30	
-13.060	0.742	-0.699	-3121.4	-139201.9	70.04	62.90	
-14.060	0.674	-0.665	-2775.2	-142147.4	70.79	63.50	
-14.350	0.655	-0.655	-2680.9	-142938.5	70.99	63.66	
-14.560	0.641	-0.648	-2392.5	-143471.0	71.13	63.77	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	0.609	-0.631	-1729.9	-144500.2	71.39	63.98	
-16.060	0.548	-0.596	-504.1	-145606.4	71.67	64.20	
-16.350	0.531	-0.585	-172.6	-145704.3	71.69	64.22	*
-17.060	0.490	-0.561	595.3	-145550.6	71.65	64.19	
-18.060	0.436	-0.526	1575.9	-144455.4	71.38	63.97	
-19.060	0.385	-0.491	2445.0	-142435.9	70.86	63.56	
-19.350	0.371	-0.481	2677.3	-141693.0	70.67	63.41	
-20.060	0.337	-0.457	3179.3	-139611.1	70.14	62.98	
-21.060	0.293	-0.424	3808.8	-136109.7	69.25	62.27	
-22.060	0.253	-0.391	4353.7	-132021.7	68.21	61.44	
-23.060	0.215	-0.360	4820.4	-127428.3	67.04	60.51	
-24.060	0.181	-0.330	5215.2	-122404.8	65.77	59.49	
-25.060	0.149	-0.301	5544.0	-117020.0	64.40	58.40	
-26.060	0.120	-0.273	5812.7	-111336.8	62.95	57.24	
-27.060	0.094	-0.247	6026.8	-105412.8	61.44	56.04	
-27.350	0.087	-0.240	6079.4	-103657.3	61.00	55.68	
-28.060	0.071	-0.222	6287.4	-99264.5	59.88	54.79	
-28.160	0.069	-0.220	6313.3	-98634.5	59.72	54.66	
-28.160	0.069	-0.220	6313.3	-98634.5	68.17	62.34	
-28.350	0.065	-0.215	6360.2	-97430.4	67.82	62.06	
-29.060	0.050	-0.196	6441.3	-92884.7	66.50	61.00	
-30.060	0.032	-0.171	6522.3	-86399.8	64.60	59.49	
-30.350	0.027	-0.164	6539.2	-84505.9	64.05	59.05	
-31.060	0.016	-0.148	6624.6	-79830.1	62.68	57.96	
-32.060	0.002	-0.127	6673.6	-73174.4	60.74	56.41	
-33.060	-0.010	-0.107	6650.2	-66507.0	58.80	54.86	
-34.060	-0.020	-0.090	6565.4	-59894.5	56.86	53.32	
-35.060	-0.028	-0.074	6429.2	-53393.4	54.97	51.81	
-36.060	-0.034	-0.060	6250.7	-47050.2	53.12	50.33	
-36.350	-0.036	-0.056	6192.2	-45246.0	52.59	49.91	
-37.060	-0.040	-0.048	5960.6	-40930.4	51.33	48.91	
-38.060	-0.044	-0.037	5600.2	-35147.0	49.64	47.56	
-39.060	-0.047	-0.028	5207.8	-29740.7	48.06	46.30	
-40.060	-0.050	-0.021	4791.0	-24739.5	46.60	45.14	
-41.060	-0.052	-0.014	4356.5	-20164.5	45.27	44.07	
-42.060	-0.053	-0.009	3909.5	-16030.6	44.06	43.11	
-43.060	-0.053	-0.005	3454.4	-12348.2	42.99	42.26	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	-0.054	-0.003	2994.5	-9123.4	42.04	41.50	
-45.060	-0.054	0.000	2532.4	-6359.9	41.24	40.86	
-46.060	-0.054	0.001	2070.0	-4058.7	40.57	40.33	
-46.350	-0.054	0.001	1936.0	-3477.8	40.40	40.19	
-47.060	-0.054	0.002	1608.4	-2219.6	40.03	39.90	
-48.060	-0.054	0.002	1148.4	-841.4	39.63	39.58	
-49.060	-0.053	0.002	690.5	77.9	39.40	39.40	
-49.160	-0.053	0.002	644.8	144.7	39.42	39.41	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	1.136	-0.875	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	71.69	-16.350
periphery sheet pile (SKY490)	79.15	-12.160
separation wall sheet pile (SKY400)	71.10	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 144.7 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 23.593 (m⁴)
periphery n1 = 30 (number) IB1 = 491.60 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (number) IB1 = 36.96 (m²) Ao1 = 0.0446 (m²/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m²) Ao1 = 0.0000 (m²/number)
x = 5.087
maximum Rmax = 1759 (kN/number)
minimum Rmin = 1756 (kN/number)

4)Ord+Temp(low tide)

working force	vertical force	Vo	kN	65540.0
	horizontal force	Ho	kN	5400.0
	moment	Mo	kN.m	118300.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.143
	calculation displacement	Del.	cm	1.136

convergence rate (Del.1 - Del.) / Del.1 = 0.65 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1363	2850
2	5908	12355
3	5908	12355
4	5567	11642
5	10339	21622
6	5567	11642
7	15906	33264
8	23859	49896
9	23859	49896

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	1.136	-0.875	-5400.0	-118300.0	75.32	68.32	
-9.060	1.050	-0.841	-4865.4	-123429.2	76.82	69.52	
-10.060	0.968	-0.806	-4372.0	-128044.6	78.17	70.59	
-11.060	0.889	-0.770	-3918.1	-132186.4	79.37	71.56	
-12.060	0.814	-0.733	-3501.8	-135893.2	80.46	72.42	
-12.160	0.806	-0.729	-3462.1	-136241.4	80.56	72.50	
-12.160	0.806	-0.729	-3462.1	-136241.4	70.52	63.54	
-13.060	0.742	-0.699	-3121.4	-139201.9	71.28	64.14	
-14.060	0.674	-0.665	-2775.2	-142147.4	72.03	64.74	
-14.350	0.655	-0.655	-2680.9	-142938.5	72.23	64.90	
-14.560	0.641	-0.648	-2392.5	-143471.0	72.36	65.00	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	0.609	-0.631	-1729.9	-144500.2	72.62	65.21	
-16.060	0.548	-0.596	-504.1	-145606.4	72.91	65.44	
-16.350	0.531	-0.585	-172.6	-145704.3	72.93	65.46	*
-17.060	0.490	-0.561	595.3	-145550.6	72.89	65.43	
-18.060	0.436	-0.526	1575.9	-144455.4	72.61	65.20	
-19.060	0.385	-0.491	2445.0	-142435.9	72.10	64.79	
-19.350	0.371	-0.481	2677.3	-141693.0	71.91	64.64	
-20.060	0.337	-0.457	3179.3	-139611.1	71.38	64.22	
-21.060	0.293	-0.424	3808.8	-136109.7	70.49	63.51	
-22.060	0.253	-0.391	4353.7	-132021.7	69.45	62.68	
-23.060	0.215	-0.360	4820.4	-127428.3	68.28	61.75	
-24.060	0.181	-0.330	5215.2	-122404.8	67.00	60.73	
-25.060	0.149	-0.301	5544.0	-117020.0	65.63	59.63	
-26.060	0.120	-0.273	5812.7	-111336.8	64.19	58.48	
-27.060	0.094	-0.247	6026.8	-105412.8	62.68	57.27	
-27.350	0.087	-0.240	6079.4	-103657.3	62.23	56.92	
-28.060	0.071	-0.222	6287.4	-99264.5	61.12	56.03	
-28.160	0.069	-0.220	6313.3	-98634.5	60.96	55.90	
-28.160	0.069	-0.220	6313.3	-98634.5	69.58	63.75	
-28.350	0.065	-0.215	6360.2	-97430.4	69.23	63.47	
-29.060	0.050	-0.196	6441.3	-92884.7	67.90	62.41	
-30.060	0.032	-0.171	6522.3	-86399.8	66.01	60.90	
-30.350	0.027	-0.164	6539.2	-84505.9	65.46	60.46	
-31.060	0.016	-0.148	6624.6	-79830.1	64.09	59.37	
-32.060	0.002	-0.127	6673.6	-73174.4	62.15	57.82	
-33.060	-0.010	-0.107	6650.2	-66507.0	60.20	56.27	
-34.060	-0.020	-0.090	6565.4	-59894.5	58.27	54.73	
-35.060	-0.028	-0.074	6429.2	-53393.4	56.37	53.22	
-36.060	-0.034	-0.060	6250.7	-47050.2	54.52	51.74	
-36.350	-0.036	-0.056	6192.2	-45246.0	54.00	51.32	
-37.060	-0.040	-0.048	5960.6	-40930.4	52.74	50.31	
-38.060	-0.044	-0.037	5600.2	-35147.0	51.05	48.97	
-39.060	-0.047	-0.028	5207.8	-29740.7	49.47	47.71	
-40.060	-0.050	-0.021	4791.0	-24739.5	48.01	46.55	
-41.060	-0.052	-0.014	4356.5	-20164.5	46.67	45.48	
-42.060	-0.053	-0.009	3909.5	-16030.6	45.47	44.52	
-43.060	-0.053	-0.005	3454.4	-12348.2	44.39	43.66	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	-0.054	-0.003	2994.5	-9123.4	43.45	42.91	
-45.060	-0.054	0.000	2532.4	-6359.9	42.64	42.27	
-46.060	-0.054	0.001	2070.0	-4058.7	41.97	41.73	
-46.350	-0.054	0.001	1936.0	-3477.8	41.80	41.60	
-47.060	-0.054	0.002	1608.4	-2219.6	41.43	41.30	
-48.060	-0.054	0.002	1148.4	-841.4	41.03	40.98	
-49.060	-0.053	0.002	690.5	77.9	40.81	40.81	
-49.160	-0.053	0.002	644.8	144.7	40.83	40.82	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	1.136	-0.875	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	72.93	-16.350
periphery sheet pile (SKY490)	80.56	-12.160
separation wall sheet pile (SKY400)	72.50	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 144.7 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)

periphery	n1 = 30 (number)	IB1 = 491.60 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (number)	IB1 = 36.96 (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 = 5.087
maximum Rmax = 1822 (kN/number)
minimum Rmin = 1819 (kN/number)

5)Wind+Temp

working force	vertical force	Vo	kN	62545.9
	horizontal force	Ho	kN	5500.0
	moment	Mo	kN.m	120100.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.170
	calculation displacement	Del.	cm	1.162

convergence rate (Del.1 - Del.) / Del.1 = 0.64 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1363	2818
2	5908	12215
3	5908	12215
4	5567	11510
5	10339	21377
6	5567	11510
7	15906	32887
8	23859	49331
9	23859	49331

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	1.162	-0.892	-5500.0	-120100.0	73.98	66.88	
-9.060	1.075	-0.858	-4959.2	-125326.1	75.51	68.10	
-10.060	0.990	-0.823	-4459.9	-130032.2	76.88	69.19	
-11.060	0.910	-0.786	-4000.4	-134259.1	78.12	70.18	
-12.060	0.833	-0.748	-3578.9	-138045.6	79.22	71.06	
-12.160	0.826	-0.744	-3538.7	-138401.5	79.33	71.14	
-12.160	0.826	-0.744	-3538.7	-138401.5	69.43	62.34	
-13.060	0.760	-0.714	-3193.5	-141428.9	70.20	62.95	
-14.060	0.691	-0.679	-2842.8	-144444.2	70.97	63.56	
-14.350	0.671	-0.669	-2747.2	-145254.7	71.18	63.73	
-14.560	0.657	-0.662	-2454.8	-145800.8	71.32	63.84	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	0.624	-0.644	-1783.1	-146858.9	71.59	64.05	
-16.060	0.562	-0.608	-540.0	-148009.5	71.88	64.29	
-16.350	0.544	-0.598	-203.7	-148117.1	71.91	64.31	*
-17.060	0.503	-0.573	575.5	-147981.5	71.87	64.28	
-18.060	0.447	-0.537	1570.9	-146898.6	71.60	64.06	
-19.060	0.395	-0.502	2453.7	-144877.2	71.08	63.65	
-19.350	0.381	-0.492	2689.7	-144131.2	70.89	63.50	
-20.060	0.347	-0.467	3200.0	-142037.5	70.36	63.08	
-21.060	0.302	-0.433	3840.3	-138510.0	69.46	62.36	
-22.060	0.260	-0.401	4395.0	-134385.4	68.41	61.52	
-23.060	0.222	-0.369	4870.6	-129746.3	67.23	60.58	
-24.060	0.186	-0.338	5273.3	-124668.5	65.94	59.55	
-25.060	0.154	-0.309	5609.2	-119221.9	64.55	58.44	
-26.060	0.125	-0.280	5884.2	-113470.4	63.09	57.27	
-27.060	0.098	-0.254	6103.7	-107472.1	61.57	56.05	
-27.350	0.091	-0.246	6157.7	-105694.1	61.11	55.69	
-28.060	0.074	-0.229	6371.9	-101243.5	59.98	54.79	
-28.160	0.072	-0.226	6398.6	-100605.0	59.82	54.66	
-28.160	0.072	-0.226	6398.6	-100605.0	68.29	62.34	
-28.350	0.067	-0.221	6447.0	-99384.6	67.94	62.06	
-29.060	0.052	-0.202	6530.8	-94776.2	66.59	60.99	
-30.060	0.033	-0.176	6615.2	-88200.1	64.67	59.46	
-30.350	0.028	-0.169	6632.9	-86279.1	64.11	59.01	
-31.060	0.017	-0.153	6723.7	-81534.8	62.73	57.90	
-32.060	0.003	-0.131	6779.0	-74776.7	60.75	56.33	
-33.060	-0.009	-0.111	6760.3	-68001.4	58.77	54.75	
-34.060	-0.019	-0.093	6678.8	-61277.1	56.81	53.19	
-35.060	-0.028	-0.077	6544.7	-54661.3	54.88	51.65	
-36.060	-0.035	-0.063	6367.1	-48202.2	52.99	50.14	
-36.350	-0.037	-0.059	6308.6	-46364.1	52.46	49.72	
-37.060	-0.040	-0.050	6076.7	-41966.0	51.17	48.69	
-38.060	-0.045	-0.039	5714.5	-36067.2	49.45	47.32	
-39.060	-0.048	-0.030	5319.0	-30548.0	47.84	46.03	
-40.060	-0.051	-0.022	4898.0	-25437.7	46.35	44.85	
-41.060	-0.053	-0.016	4458.0	-20758.4	44.98	43.76	
-42.060	-0.054	-0.011	4004.6	-16526.1	43.75	42.77	
-43.060	-0.055	-0.007	3542.1	-12752.2	42.65	41.89	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	-0.056	-0.004	3073.9	-9443.9	41.68	41.12	
-45.060	-0.056	-0.001	2602.7	-6605.4	40.85	40.46	
-46.060	-0.056	0.000	2130.4	-4238.8	40.16	39.91	
-46.350	-0.056	0.001	1993.4	-3640.9	39.99	39.77	
-47.060	-0.056	0.001	1658.2	-2344.6	39.61	39.47	
-48.060	-0.056	0.002	1186.9	-922.2	39.19	39.14	
-49.060	-0.055	0.002	716.9	29.6	38.93	38.93	
-49.160	-0.055	0.002	670.0	98.9	38.95	38.95	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	1.162	-0.892	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	71.91	-16.350
periphery sheet pile (SKY490)	79.33	-12.160
separation wall sheet pile (SKY400)	71.14	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 98.9 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)
periphery n1 = 30 (number) IB1 = 491.60 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (number) IB1 = 36.96 (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 = 5.087
maximum Rmax = 1738 (kN/number)
minimum Rmin = 1736 (kN/number)

6)Ord+Collision

working force	vertical force	Vo	kN	63280.2
	horizontal force	Ho	kN	3700.0
	moment	Mo	kN.m	44600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.564

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1363	3048
2	5908	13211
3	5908	13211
4	5567	12448
5	10339	23119
6	5567	12448
7	15906	35567
8	23859	53350
9	23859	53350

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.564	-0.409	-3700.0	-44600.0	52.40	49.76	
-9.060	0.524	-0.396	-3415.6	-48156.1	53.44	50.59	
-10.060	0.485	-0.382	-3152.0	-51438.2	54.40	51.35	
-11.060	0.447	-0.367	-2908.3	-54466.7	55.28	52.06	
-12.060	0.411	-0.352	-2683.8	-57261.2	56.10	52.71	
-12.160	0.408	-0.350	-2662.4	-57528.5	56.17	52.77	
-12.160	0.408	-0.350	-2662.4	-57528.5	49.26	46.31	
-13.060	0.377	-0.337	-2477.8	-59840.5	49.85	46.78	
-14.060	0.344	-0.323	-2289.3	-62222.6	50.46	47.27	
-14.350	0.335	-0.318	-2237.9	-62879.0	50.62	47.40	
-14.560	0.328	-0.315	-2080.1	-63332.4	50.74	47.49	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-15.060	0.312	-0.307	-1717.2	-64281.0	50.98	47.68	
-16.060	0.282	-0.292	-1043.2	-65655.5	51.33	47.96	
-16.350	0.274	-0.287	-860.3	-65931.4	51.40	48.02	
-17.060	0.254	-0.276	-435.3	-66389.4	51.52	48.11	
-18.060	0.227	-0.260	110.1	-66546.9	51.56	48.14	*
-19.060	0.202	-0.244	596.7	-66188.8	51.47	48.07	
-19.350	0.195	-0.239	727.3	-65996.7	51.42	48.03	
-20.060	0.179	-0.228	1010.7	-65378.2	51.26	47.91	
-21.060	0.157	-0.212	1368.5	-64184.7	50.96	47.66	
-22.060	0.136	-0.197	1681.0	-62656.3	50.57	47.35	
-23.060	0.117	-0.182	1951.4	-60836.7	50.10	46.98	
-24.060	0.100	-0.167	2183.0	-58766.4	49.58	46.56	
-25.060	0.084	-0.153	2378.9	-56482.6	49.00	46.10	
-26.060	0.069	-0.140	2541.9	-54019.6	48.37	45.60	
-27.060	0.056	-0.127	2675.0	-51408.8	47.71	45.07	
-27.350	0.052	-0.124	2708.3	-50628.1	47.51	44.91	
-28.060	0.044	-0.115	2842.9	-48656.0	47.01	44.51	
-28.160	0.042	-0.114	2860.0	-48370.9	46.93	44.45	
-28.160	0.042	-0.114	2860.0	-48370.9	53.50	50.64	
-28.350	0.040	-0.112	2891.1	-47824.5	53.34	50.51	
-29.060	0.033	-0.102	2946.4	-45751.5	52.74	50.03	
-30.060	0.023	-0.090	3005.7	-42773.7	51.87	49.34	
-30.350	0.021	-0.087	3019.2	-41900.0	51.61	49.13	
-31.060	0.015	-0.079	3095.2	-39727.9	50.98	48.63	
-32.060	0.007	-0.068	3161.7	-36595.8	50.06	47.90	
-33.060	0.001	-0.058	3186.6	-33418.4	49.14	47.16	
-34.060	-0.004	-0.049	3175.9	-30234.5	48.21	46.42	
-35.060	-0.009	-0.041	3135.0	-27076.7	47.28	45.68	
-36.060	-0.013	-0.034	3068.8	-23972.9	46.38	44.96	
-36.350	-0.014	-0.032	3045.5	-23086.3	46.12	44.75	
-37.060	-0.016	-0.028	2949.6	-20957.2	45.50	44.26	
-38.060	-0.018	-0.023	2793.1	-18083.9	44.66	43.59	
-39.060	-0.020	-0.018	2615.7	-15378.0	43.87	42.96	
-40.060	-0.022	-0.014	2421.7	-12858.0	43.13	42.37	
-41.060	-0.023	-0.011	2214.8	-10538.8	42.46	41.83	
-42.060	-0.024	-0.008	1998.0	-8431.7	41.84	41.34	
-43.060	-0.025	-0.006	1773.6	-6545.4	41.29	40.90	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-44.060	-0.025	-0.005	1543.5	-4886.4	40.81	40.52	
-45.060	-0.026	-0.003	1309.3	-3459.7	40.39	40.19	
-46.060	-0.026	-0.003	1071.9	-2268.8	40.04	39.91	
-46.350	-0.026	-0.002	1002.6	-1968.0	39.96	39.84	
-47.060	-0.026	-0.002	832.2	-1316.6	39.76	39.69	
-48.060	-0.026	-0.002	590.5	-605.1	39.56	39.52	
-49.060	-0.027	-0.002	347.1	-136.2	39.42	39.41	
-49.160	-0.027	-0.002	322.7	-102.7	39.41	39.40	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.564	-0.409	5.000

maximum stress

	Sig.(N/mm^2)	elevation(m)
periphery sheet pile (SKY400)	53.50	-28.160
periphery sheet pile (SKY490)	56.17	-12.160
separation wall sheet pile (SKY400)	52.77	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -102.7 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)

periphery	n1 = 30 (number)	IB1 = 491.60 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (number)	IB1 = 36.96 (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 = 5.087
maximum Rmax = 1759 (kN/number)
minimum Rmin = 1757 (kN/number)

7)Earthquake

working force	vertical force	Vo	kN	57452.7
	horizontal force	Ho	kN	15300.0
	moment	Mo	kN.m	242600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	3.224
	calculation displacement	Del.	cm	3.206

convergence rate (Del.1 - Del.) / Del.1 = 0.54 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	908	1131
2	3935	4901
3	11816	14715
4	11134	13866
5	20677	25751
6	11134	13866
7	31811	39617
8	47717	59426
9	47717	59426

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	3.206	-2.261	-15300.0	-242600.0	106.57	92.23	
-9.060	2.984	-2.192	-14699.4	-257596.1	110.95	95.72	
-10.060	2.768	-2.118	-14141.2	-272012.9	115.16	99.07	
-11.060	2.560	-2.040	-13624.2	-285892.3	119.21	102.30	
-12.060	2.360	-1.959	-13146.8	-299274.5	123.12	105.42	
-12.160	2.341	-1.951	-13101.2	-300586.9	123.50	105.73	
-12.160	2.341	-1.951	-13101.2	-300586.9	107.90	92.49	
-13.060	2.168	-1.884	-12707.4	-312198.5	110.86	94.85	
-14.060	1.984	-1.807	-12304.6	-324701.5	114.04	97.39	
-14.350	1.932	-1.784	-12194.4	-328253.8	114.94	98.11	
-14.560	1.894	-1.768	-11856.5	-330779.0	115.59	98.62	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	1.807	-1.727	-11078.2	-336511.2	117.04	99.79	
-16.060	1.638	-1.645	-9629.8	-346853.4	119.67	101.89	
-16.350	1.591	-1.621	-9235.9	-349588.6	120.37	102.44	
-17.060	1.478	-1.560	-6484.7	-355157.4	121.79	103.57	
-18.060	1.326	-1.474	-2944.8	-359840.3	122.98	104.53	
-19.060	1.183	-1.387	222.9	-361171.1	123.32	104.80	*
-19.350	1.143	-1.362	1075.0	-360982.2	123.27	104.76	
-20.060	1.049	-1.300	2926.8	-359552.1	122.90	104.47	
-21.060	0.923	-1.213	5272.3	-355427.6	121.86	103.63	
-22.060	0.806	-1.128	7328.8	-349103.8	120.25	102.34	
-23.060	0.698	-1.045	9116.8	-340859.5	118.15	100.67	
-24.060	0.597	-0.964	10656.0	-330953.2	115.63	98.66	
-25.060	0.505	-0.886	11965.6	-319624.1	112.75	96.36	
-26.060	0.420	-0.810	13064.4	-307092.3	109.56	93.81	
-27.060	0.343	-0.737	13970.4	-293559.5	106.12	91.06	
-27.350	0.321	-0.717	14199.6	-289474.5	105.08	90.23	
-28.060	0.272	-0.668	15130.4	-279053.2	102.43	88.12	
-28.160	0.266	-0.662	15249.3	-277534.3	102.04	87.81	
-28.160	0.266	-0.662	15249.3	-277534.3	116.77	100.36	
-28.350	0.253	-0.647	15467.2	-274616.0	115.92	99.68	
-29.060	0.209	-0.594	15857.4	-263491.4	112.67	97.09	
-30.060	0.153	-0.523	16287.4	-247407.9	107.98	93.35	
-30.350	0.139	-0.503	16388.1	-242669.7	106.59	92.24	
-31.060	0.104	-0.456	16973.4	-230816.6	103.13	89.48	
-32.060	0.062	-0.395	17535.7	-213538.0	98.09	85.46	
-33.060	0.025	-0.338	17829.5	-195834.7	92.92	81.34	
-34.060	-0.006	-0.286	17893.4	-177955.6	87.70	77.18	
-35.060	-0.032	-0.239	17762.8	-160112.7	82.49	73.03	
-36.060	-0.054	-0.197	17469.7	-142484.1	77.35	68.92	
-36.350	-0.059	-0.185	17358.4	-137433.8	75.87	67.75	
-37.060	-0.071	-0.159	16884.7	-125272.2	72.32	64.92	
-38.060	-0.086	-0.127	16081.2	-108777.1	67.51	61.08	
-39.060	-0.097	-0.099	15148.0	-93153.0	62.95	57.44	
-40.060	-0.106	-0.075	14113.7	-78514.8	58.67	54.03	
-41.060	-0.112	-0.055	13002.7	-64951.1	54.71	50.87	
-42.060	-0.117	-0.039	11835.4	-52528.1	51.09	47.98	
-43.060	-0.120	-0.026	10628.4	-41293.5	47.81	45.37	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	-0.122	-0.016	9395.0	-31280.1	44.89	43.04	
-45.060	-0.123	-0.008	8145.5	-22508.8	42.32	40.99	
-46.060	-0.124	-0.003	6887.6	-14991.9	40.13	39.24	
-46.350	-0.124	-0.002	6522.0	-13047.5	39.56	38.79	
-47.060	-0.124	0.000	5626.5	-8734.8	38.30	37.79	
-48.060	-0.124	0.002	4365.6	-3738.8	36.85	36.62	
-49.060	-0.123	0.003	3106.8	-2.8	35.75	35.75	
-49.160	-0.123	0.003	2981.0	301.5	35.84	35.82	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	3.206	-2.261	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	123.32	-19.060
periphery sheet pile (SKY490)	123.50	-12.160
separation wall sheet pile (SKY400)	105.73	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 301.5 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 23.593 (m⁴)
periphery n1 = 30 (number) IB1 = 491.60 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (number) IB1 = 36.96 (m²) Ao1 = 0.0446 (m²/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m²) Ao1 = 0.0000 (m²/number)
x = 5.087
maximum Rmax = 1599 (kN/number)
minimum Rmin = 1593 (kN/number)

(2)perpendicular direction

1)Oridinary(high tide)

working force	vertical force	Vo	kN	63280.2
	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	1504	3363
2	6517	14572
3	6517	14572
4	6141	13731
5	11404	25501
6	6141	13731
7	17545	39232
8	26317	58847
9	26317	58847

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.000	0.000	0.0	0.0	39.38	39.38	*
-9.060	0.000	0.000	0.0	0.0	39.38	39.38	
-10.060	0.000	0.000	0.0	0.0	39.38	39.38	
-11.060	0.000	0.000	0.0	0.0	39.38	39.38	
-12.060	0.000	0.000	0.0	0.0	39.38	39.38	
-12.160	0.000	0.000	0.0	0.0	39.38	39.38	
-12.160	0.000	0.000	0.0	0.0	34.63	34.63	
-13.060	0.000	0.000	0.0	0.0	34.63	34.63	
-14.060	0.000	0.000	0.0	0.0	34.63	34.63	
-14.350	0.000	0.000	0.0	0.0	34.63	34.63	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-14.560	0.000	0.000	0.0	0.0	34.63	34.63	
-15.060	0.000	0.000	0.0	0.0	34.63	34.63	
-16.060	0.000	0.000	0.0	0.0	34.63	34.63	
-16.350	0.000	0.000	0.0	0.0	34.63	34.63	
-17.060	0.000	0.000	0.0	0.0	34.63	34.63	
-18.060	0.000	0.000	0.0	0.0	34.63	34.63	
-19.060	0.000	0.000	0.0	0.0	34.63	34.63	
-19.350	0.000	0.000	0.0	0.0	34.63	34.63	
-20.060	0.000	0.000	0.0	0.0	34.63	34.63	
-21.060	0.000	0.000	0.0	0.0	34.63	34.63	
-22.060	0.000	0.000	0.0	0.0	34.63	34.63	
-23.060	0.000	0.000	0.0	0.0	34.63	34.63	
-24.060	0.000	0.000	0.0	0.0	34.63	34.63	
-25.060	0.000	0.000	0.0	0.0	34.63	34.63	
-26.060	0.000	0.000	0.0	0.0	34.63	34.63	
-27.060	0.000	0.000	0.0	0.0	34.63	34.63	
-27.350	0.000	0.000	0.0	0.0	34.63	34.63	
-28.060	0.000	0.000	0.0	0.0	34.63	34.63	
-28.160	0.000	0.000	0.0	0.0	34.63	34.63	
-28.160	0.000	0.000	0.0	0.0	39.38	39.38	
-28.350	0.000	0.000	0.0	0.0	39.38	39.38	
-29.060	0.000	0.000	0.0	0.0	39.38	39.38	
-30.060	0.000	0.000	0.0	0.0	39.38	39.38	
-30.350	0.000	0.000	0.0	0.0	39.38	39.38	
-31.060	0.000	0.000	0.0	0.0	39.38	39.38	
-32.060	0.000	0.000	0.0	0.0	39.38	39.38	
-33.060	0.000	0.000	0.0	0.0	39.38	39.38	
-34.060	0.000	0.000	0.0	0.0	39.38	39.38	
-35.060	0.000	0.000	0.0	0.0	39.38	39.38	
-36.060	0.000	0.000	0.0	0.0	39.38	39.38	
-36.350	0.000	0.000	0.0	0.0	39.38	39.38	
-37.060	0.000	0.000	0.0	0.0	39.38	39.38	
-38.060	0.000	0.000	0.0	0.0	39.38	39.38	
-39.060	0.000	0.000	0.0	0.0	39.38	39.38	
-40.060	0.000	0.000	0.0	0.0	39.38	39.38	
-41.060	0.000	0.000	0.0	0.0	39.38	39.38	
-42.060	0.000	0.000	0.0	0.0	39.38	39.38	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.060	0.000	0.000	0.0	0.0	39.38	39.38	
-44.060	0.000	0.000	0.0	0.0	39.38	39.38	
-45.060	0.000	0.000	0.0	0.0	39.38	39.38	
-46.060	0.000	0.000	0.0	0.0	39.38	39.38	
-46.350	0.000	0.000	0.0	0.0	39.38	39.38	
-47.060	0.000	0.000	0.0	0.0	39.38	39.38	
-48.060	0.000	0.000	0.0	0.0	39.38	39.38	
-49.060	0.000	0.000	0.0	0.0	39.38	39.38	
-49.160	0.000	0.000	0.0	0.0	39.38	39.38	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	39.38	-28.160
periphery sheet pile (SKY490)	39.38	-8.060
separation wall sheet pile (SKY400)	39.38	-8.060
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) = 40.350 (m^4)

periphery	n1 = 30 (number)	IB1 = 903.99 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (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 = 7.930
maximum Rmax = 1758 (kN/number)
minimum Rmin = 1758 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	65540.0
	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	1504	3363
2	6517	14572
3	6517	14572
4	6141	13731
5	11404	25501
6	6141	13731
7	17545	39232
8	26317	58847
9	26317	58847

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	0.000	0.000	0.0	0.0	40.79	40.79	*
-9.060	0.000	0.000	0.0	0.0	40.79	40.79	
-10.060	0.000	0.000	0.0	0.0	40.79	40.79	
-11.060	0.000	0.000	0.0	0.0	40.79	40.79	
-12.060	0.000	0.000	0.0	0.0	40.79	40.79	
-12.160	0.000	0.000	0.0	0.0	40.79	40.79	
-12.160	0.000	0.000	0.0	0.0	35.86	35.86	
-13.060	0.000	0.000	0.0	0.0	35.86	35.86	
-14.060	0.000	0.000	0.0	0.0	35.86	35.86	
-14.350	0.000	0.000	0.0	0.0	35.86	35.86	
-14.560	0.000	0.000	0.0	0.0	35.86	35.86	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-15.060	0.000	0.000	0.0	0.0	35.86	35.86	
-16.060	0.000	0.000	0.0	0.0	35.86	35.86	
-16.350	0.000	0.000	0.0	0.0	35.86	35.86	
-17.060	0.000	0.000	0.0	0.0	35.86	35.86	
-18.060	0.000	0.000	0.0	0.0	35.86	35.86	
-19.060	0.000	0.000	0.0	0.0	35.86	35.86	
-19.350	0.000	0.000	0.0	0.0	35.86	35.86	
-20.060	0.000	0.000	0.0	0.0	35.86	35.86	
-21.060	0.000	0.000	0.0	0.0	35.86	35.86	
-22.060	0.000	0.000	0.0	0.0	35.86	35.86	
-23.060	0.000	0.000	0.0	0.0	35.86	35.86	
-24.060	0.000	0.000	0.0	0.0	35.86	35.86	
-25.060	0.000	0.000	0.0	0.0	35.86	35.86	
-26.060	0.000	0.000	0.0	0.0	35.86	35.86	
-27.060	0.000	0.000	0.0	0.0	35.86	35.86	
-27.350	0.000	0.000	0.0	0.0	35.86	35.86	
-28.060	0.000	0.000	0.0	0.0	35.86	35.86	
-28.160	0.000	0.000	0.0	0.0	35.86	35.86	
-28.160	0.000	0.000	0.0	0.0	40.79	40.79	
-28.350	0.000	0.000	0.0	0.0	40.79	40.79	
-29.060	0.000	0.000	0.0	0.0	40.79	40.79	
-30.060	0.000	0.000	0.0	0.0	40.79	40.79	
-30.350	0.000	0.000	0.0	0.0	40.79	40.79	
-31.060	0.000	0.000	0.0	0.0	40.79	40.79	
-32.060	0.000	0.000	0.0	0.0	40.79	40.79	
-33.060	0.000	0.000	0.0	0.0	40.79	40.79	
-34.060	0.000	0.000	0.0	0.0	40.79	40.79	
-35.060	0.000	0.000	0.0	0.0	40.79	40.79	
-36.060	0.000	0.000	0.0	0.0	40.79	40.79	
-36.350	0.000	0.000	0.0	0.0	40.79	40.79	
-37.060	0.000	0.000	0.0	0.0	40.79	40.79	
-38.060	0.000	0.000	0.0	0.0	40.79	40.79	
-39.060	0.000	0.000	0.0	0.0	40.79	40.79	
-40.060	0.000	0.000	0.0	0.0	40.79	40.79	
-41.060	0.000	0.000	0.0	0.0	40.79	40.79	
-42.060	0.000	0.000	0.0	0.0	40.79	40.79	
-43.060	0.000	0.000	0.0	0.0	40.79	40.79	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-44.060	0.000	0.000	0.0	0.0	40.79	40.79	
-45.060	0.000	0.000	0.0	0.0	40.79	40.79	
-46.060	0.000	0.000	0.0	0.0	40.79	40.79	
-46.350	0.000	0.000	0.0	0.0	40.79	40.79	
-47.060	0.000	0.000	0.0	0.0	40.79	40.79	
-48.060	0.000	0.000	0.0	0.0	40.79	40.79	
-49.060	0.000	0.000	0.0	0.0	40.79	40.79	
-49.160	0.000	0.000	0.0	0.0	40.79	40.79	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm^2)	elevation(m)
periphery sheet pile (SKY400)	40.79	-28.160
periphery sheet pile (SKY490)	40.79	-8.060
separation wall sheet pile (SKY400)	40.79	-8.060
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) = 40.350 (m^4)

periphery	n1 = 30 (number)	IB1 =	903.99 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (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 = 7.930
maximum Rmax = 1821 (kN/number)
minimum Rmin = 1821 (kN/number)

3)Wind

working force	vertical force	Vo	kN	62545.9
	horizontal force	Ho	kN	1200.0
	moment	Mo	kN.m	28500.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.243

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1504	3363
2	6517	14572
3	6517	14572
4	6141	13731
5	11404	25501
6	6141	13731
7	17545	39232
8	26317	58847
9	26317	58847

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.243	-0.154	-1200.0	-28500.0	46.72	41.34	
-9.060	0.228	-0.149	-1109.9	-29654.5	47.04	41.44	
-10.060	0.213	-0.144	-1025.6	-30721.8	47.33	41.53	
-11.060	0.199	-0.139	-946.7	-31707.4	47.60	41.62	
-12.060	0.186	-0.134	-873.1	-32616.9	47.85	41.69	
-12.160	0.184	-0.133	-866.0	-32703.8	47.87	41.70	
-12.160	0.184	-0.133	-866.0	-32703.8	41.97	36.68	
-13.060	0.172	-0.129	-804.7	-33455.4	42.15	36.73	
-14.060	0.160	-0.124	-741.1	-34227.9	42.33	36.79	
-14.350	0.156	-0.123	-723.6	-34440.2	42.39	36.81	
-14.560	0.154	-0.122	-669.7	-34586.5	42.42	36.82	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	0.148	-0.119	-544.9	-34890.0	42.49	36.84	
-16.060	0.136	-0.114	-310.0	-35315.8	42.59	36.87	
-16.350	0.133	-0.113	-245.4	-35396.3	42.61	36.88	
-17.060	0.125	-0.109	-94.0	-35516.2	42.64	36.89	*
-18.060	0.114	-0.104	103.9	-35509.8	42.64	36.89	
-19.060	0.104	-0.099	284.4	-35314.2	42.59	36.87	
-19.350	0.101	-0.098	333.7	-35224.6	42.57	36.86	
-20.060	0.094	-0.094	441.9	-34948.8	42.51	36.84	
-21.060	0.085	-0.090	581.8	-34435.8	42.38	36.81	
-22.060	0.076	-0.085	707.7	-33789.9	42.23	36.76	
-23.060	0.068	-0.080	820.3	-33024.8	42.05	36.70	
-24.060	0.060	-0.075	920.5	-32153.4	41.84	36.63	
-25.060	0.053	-0.071	1008.8	-31187.8	41.61	36.56	
-26.060	0.046	-0.067	1086.1	-30139.4	41.37	36.48	
-27.060	0.040	-0.063	1153.0	-29019.1	41.10	36.40	
-27.350	0.038	-0.061	1170.5	-28682.1	41.02	36.37	
-28.060	0.034	-0.059	1244.0	-27824.5	40.82	36.31	
-28.160	0.033	-0.058	1253.6	-27699.6	40.79	36.30	
-28.160	0.033	-0.058	1253.6	-27699.6	46.50	41.28	
-28.350	0.032	-0.057	1271.5	-27459.7	46.44	41.26	
-29.060	0.028	-0.054	1304.6	-26544.9	46.19	41.18	
-30.060	0.023	-0.050	1344.1	-25219.9	45.82	41.07	
-30.350	0.021	-0.049	1354.1	-24828.6	45.72	41.03	
-31.060	0.018	-0.046	1416.1	-23844.6	45.45	40.95	
-32.060	0.014	-0.042	1486.2	-22391.8	45.05	40.83	
-33.060	0.009	-0.039	1537.5	-20878.5	44.64	40.70	
-34.060	0.006	-0.035	1571.5	-19322.6	44.21	40.56	
-35.060	0.002	-0.032	1589.8	-17740.8	43.78	40.43	
-36.060	-0.001	-0.029	1593.6	-16147.9	43.34	40.30	
-36.350	-0.001	-0.029	1592.2	-15685.9	43.22	40.26	
-37.060	-0.003	-0.027	1580.4	-14559.1	42.91	40.16	
-38.060	-0.006	-0.025	1548.4	-12993.3	42.48	40.03	
-39.060	-0.008	-0.023	1499.8	-11467.9	42.06	39.90	
-40.060	-0.011	-0.021	1436.1	-9998.7	41.66	39.77	
-41.060	-0.013	-0.019	1358.2	-8600.4	41.28	39.65	
-42.060	-0.014	-0.018	1267.4	-7286.6	40.92	39.54	
-43.060	-0.016	-0.017	1164.4	-6069.7	40.58	39.44	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	-0.018	-0.016	1050.0	-4961.5	40.28	39.35	
-45.060	-0.019	-0.015	924.8	-3973.2	40.01	39.26	
-46.060	-0.021	-0.015	789.3	-3115.3	39.78	39.19	
-46.350	-0.021	-0.015	748.1	-2892.4	39.72	39.17	
-47.060	-0.022	-0.014	643.8	-2397.9	39.58	39.13	
-48.060	-0.024	-0.014	488.7	-1830.9	39.42	39.08	
-49.060	-0.025	-0.014	324.2	-1423.6	39.31	39.04	
-49.160	-0.025	-0.014	307.3	-1392.1	39.30	39.04	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.243	-0.154	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	46.50	-28.160
periphery sheet pile (SKY490)	47.87	-12.160
separation wall sheet pile (SKY400)	41.70	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -1392.1 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 40.350 (m⁴)
periphery n1 = 30 (number) IB1 = 903.99 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (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 = 7.930
maximum Rmax = 1750 (kN/number)
minimum Rmin = 1725 (kN/number)

4)Ord+Collision

working force	vertical force	Vo	kN	63280.2
	horizontal force	Ho	kN	7300.0
	moment	Mo	kN.m	87900.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.149
	calculation displacement	Del.	cm	1.145

convergence rate (Del.1 - Del.) / Del.1 = 0.35 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1504	3137
2	6517	13594
3	6517	13594
4	6141	12810
5	11404	23790
6	6141	12810
7	17545	36600
8	26317	54900
9	26317	54900

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	1.145	-0.653	-7300.0	-87900.0	63.43	46.85	
-9.060	1.080	-0.638	-6903.1	-94999.6	65.37	47.45	
-10.060	1.017	-0.622	-6528.9	-101713.7	67.21	48.02	
-11.060	0.956	-0.605	-6176.8	-108064.7	68.95	48.56	
-12.060	0.897	-0.586	-5846.4	-114074.6	70.59	49.07	
-12.160	0.891	-0.584	-5814.5	-114657.6	70.75	49.12	
-12.160	0.891	-0.584	-5814.5	-114657.6	61.79	43.22	
-13.060	0.839	-0.570	-5536.9	-119764.5	63.00	43.60	
-14.060	0.783	-0.552	-5247.7	-125155.1	64.28	44.00	
-14.350	0.767	-0.547	-5167.5	-126665.3	64.64	44.12	
-14.560	0.755	-0.544	-4920.5	-127724.4	64.89	44.20	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	0.728	-0.534	-4347.1	-130040.4	65.43	44.37	
-16.060	0.676	-0.516	-3261.9	-133838.2	66.33	44.65	
-16.350	0.661	-0.510	-2962.3	-134740.5	66.55	44.72	
-17.060	0.625	-0.497	-2256.6	-136590.9	66.99	44.86	
-18.060	0.576	-0.478	-1328.0	-138376.9	67.41	44.99	
-19.060	0.530	-0.458	-473.3	-139271.6	67.62	45.06	
-19.350	0.516	-0.452	-238.8	-139374.7	67.65	45.07	*
-20.060	0.485	-0.438	278.9	-139358.5	67.64	45.07	
-21.060	0.442	-0.419	953.7	-138737.0	67.50	45.02	
-22.060	0.401	-0.399	1567.5	-137471.5	67.20	44.93	
-23.060	0.362	-0.380	2123.0	-135621.5	66.76	44.79	
-24.060	0.325	-0.361	2623.2	-133243.9	66.19	44.61	
-25.060	0.290	-0.343	3070.7	-130392.7	65.52	44.39	
-26.060	0.256	-0.325	3468.2	-127119.2	64.74	44.15	
-27.060	0.225	-0.307	3818.4	-123472.0	63.88	43.88	
-27.350	0.216	-0.302	3911.5	-122351.1	63.61	43.79	
-28.060	0.195	-0.290	4306.0	-119431.5	62.92	43.57	
-28.160	0.192	-0.288	4358.3	-118998.3	62.82	43.54	
-28.160	0.192	-0.288	4358.3	-118998.3	71.94	49.49	
-28.350	0.187	-0.285	4455.6	-118160.9	71.71	49.42	
-29.060	0.167	-0.271	4638.3	-114931.3	70.83	49.14	
-30.060	0.141	-0.253	4862.1	-110178.0	69.53	48.74	
-30.350	0.133	-0.247	4920.0	-108759.5	69.14	48.62	
-31.060	0.116	-0.235	5288.7	-105132.4	68.15	48.31	
-32.060	0.094	-0.218	5724.9	-99617.8	66.64	47.84	
-33.060	0.073	-0.202	6070.2	-93712.9	65.02	47.34	
-34.060	0.053	-0.188	6331.2	-87505.4	63.32	46.81	
-35.060	0.035	-0.174	6514.1	-81076.5	61.56	46.27	
-36.060	0.018	-0.161	6624.6	-74501.3	59.77	45.71	
-36.350	0.014	-0.158	6643.9	-72577.2	59.24	45.55	
-37.060	0.003	-0.149	6680.0	-67844.4	57.94	45.14	
-38.060	-0.012	-0.139	6651.7	-61171.0	56.12	44.58	
-39.060	-0.025	-0.129	6536.7	-54569.8	54.31	44.02	
-40.060	-0.038	-0.121	6340.8	-48124.6	52.55	43.47	
-41.060	-0.049	-0.114	6069.2	-41913.5	50.85	42.94	
-42.060	-0.060	-0.107	5726.7	-36009.8	49.23	42.44	
-43.060	-0.071	-0.102	5317.1	-30482.5	47.72	41.97	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	-0.081	-0.097	4843.9	-25396.8	46.33	41.54	
-45.060	-0.090	-0.093	4309.9	-20815.0	45.08	41.15	
-46.060	-0.099	-0.090	3717.5	-16796.5	43.98	40.81	
-46.350	-0.102	-0.090	3535.1	-15744.8	43.69	40.72	
-47.060	-0.108	-0.088	3068.6	-13398.8	43.05	40.52	
-48.060	-0.117	-0.086	2364.8	-10677.6	42.30	40.29	
-49.060	-0.126	-0.084	1607.3	-8687.1	41.76	40.12	
-49.160	-0.126	-0.084	1528.6	-8530.3	41.71	40.11	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	1.145	-0.653	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	71.94	-28.160
periphery sheet pile (SKY490)	70.75	-12.160
separation wall sheet pile (SKY400)	49.49	-28.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -8530.3 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 40.350 (m⁴)

periphery n1 = 30 (number) IB1 = 903.99 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (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 = 7.930

maximum Rmax = 1833 (kN/number)
minimum Rmin = 1683 (kN/number)

5)Earthquake

working force	vertical force	Vo	kN	57452.7
	horizontal force	Ho	kN	14800.0
	moment	Mo	kN.m	266800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	2.980
	calculation displacement	Del.	cm	2.957

convergence rate (Del.1 - Del.) / Del.1 = 0.77 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1002	1297
2	4340	5622
3	13033	16882
4	12281	15908
5	22808	29543
6	12281	15908
7	35090	45450
8	52635	68175
9	52635	68175

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	2.957	-1.755	-14800.0	-266800.0	108.76	58.42	
-9.060	2.784	-1.710	-14376.5	-281386.1	112.75	59.66	
-10.060	2.615	-1.662	-13978.2	-295561.4	116.63	60.86	
-11.060	2.452	-1.613	-13604.5	-309350.8	120.40	62.03	
-12.060	2.293	-1.561	-13254.5	-322778.3	124.07	63.17	
-12.160	2.277	-1.556	-13220.8	-324102.1	124.43	63.28	
-12.160	2.277	-1.556	-13220.8	-324102.1	108.22	55.72	
-13.060	2.139	-1.514	-12927.6	-335867.5	111.01	56.60	
-14.060	1.990	-1.466	-12623.1	-348641.0	114.03	57.55	
-14.350	1.948	-1.452	-12538.8	-352289.5	114.90	57.83	
-14.560	1.917	-1.441	-12279.3	-354895.3	115.51	58.02	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-15.060	1.846	-1.416	-11677.8	-360883.6	116.93	58.47	
-16.060	1.707	-1.365	-10542.3	-371986.3	119.56	59.30	
-16.350	1.668	-1.349	-10229.4	-374998.0	120.28	59.53	
-17.060	1.573	-1.312	-8020.8	-381469.2	121.81	60.01	
-18.060	1.445	-1.257	-5124.6	-388021.3	123.36	60.50	
-19.060	1.322	-1.203	-2469.7	-391798.8	124.26	60.79	
-19.350	1.287	-1.187	-1743.5	-392409.2	124.40	60.83	
-20.060	1.204	-1.147	-143.7	-393072.9	124.56	60.88	*
-21.060	1.092	-1.092	1932.8	-392161.5	124.34	60.81	
-22.060	0.986	-1.037	3811.7	-389273.2	123.66	60.60	
-23.060	0.885	-0.983	5502.9	-384600.7	122.55	60.25	
-24.060	0.789	-0.929	7016.3	-378326.6	121.07	59.78	
-25.060	0.699	-0.877	8361.6	-370624.1	119.24	59.20	
-26.060	0.614	-0.825	9548.2	-361656.4	117.12	58.53	
-27.060	0.534	-0.775	10585.6	-351577.4	114.73	57.77	
-27.350	0.512	-0.761	10859.8	-348467.5	113.99	57.54	
-28.060	0.459	-0.726	12016.7	-340338.9	112.07	56.93	
-28.160	0.452	-0.721	12169.6	-339129.6	111.78	56.84	
-28.160	0.452	-0.721	12169.6	-339129.6	128.55	64.56	
-28.350	0.438	-0.711	12453.5	-336790.3	127.91	64.36	
-29.060	0.389	-0.672	12984.2	-327756.2	125.43	63.59	
-30.060	0.324	-0.620	13628.4	-314440.1	121.79	62.46	
-30.350	0.306	-0.605	13793.8	-310463.7	120.70	62.13	
-31.060	0.265	-0.569	14841.3	-300289.1	117.92	61.26	
-32.060	0.210	-0.522	16067.1	-284811.4	113.68	59.95	
-33.060	0.160	-0.476	17023.1	-268244.9	109.15	58.54	
-34.060	0.115	-0.434	17732.8	-250847.4	104.39	57.06	
-35.060	0.074	-0.394	18218.1	-232854.2	99.47	55.53	
-36.060	0.036	-0.358	18499.6	-214479.2	94.44	53.97	
-36.350	0.026	-0.347	18545.8	-209107.2	92.97	53.52	
-37.060	0.002	-0.324	18621.2	-195905.2	89.36	52.39	
-38.060	-0.029	-0.293	18514.6	-177317.3	84.27	50.82	
-39.060	-0.057	-0.266	18180.3	-158951.8	79.25	49.26	
-40.060	-0.082	-0.241	17639.6	-141025.5	74.34	47.73	
-41.060	-0.105	-0.220	16911.6	-123735.0	69.61	46.26	
-42.060	-0.126	-0.201	16013.1	-107259.1	65.10	44.86	
-43.060	-0.145	-0.185	14958.7	-91760.8	60.86	43.55	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	-0.163	-0.171	13761.1	-77389.5	56.93	42.33	
-45.060	-0.180	-0.159	12431.0	-64282.8	53.34	41.21	
-46.060	-0.195	-0.150	10977.4	-52568.7	50.14	40.22	
-46.350	-0.199	-0.147	10533.8	-49449.3	49.28	39.95	
-47.060	-0.210	-0.142	9407.6	-42366.8	47.35	39.35	
-48.060	-0.224	-0.136	7727.9	-33790.1	45.00	38.62	
-49.060	-0.237	-0.131	5942.9	-26946.1	43.13	38.04	
-49.160	-0.238	-0.130	5758.8	-26361.0	42.97	37.99	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	2.957	-1.755	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	128.55	-28.160
periphery sheet pile (SKY490)	124.43	-12.160
separation wall sheet pile (SKY400)	64.56	-28.160
separation wall sheet pile (SKY490)	------	--------

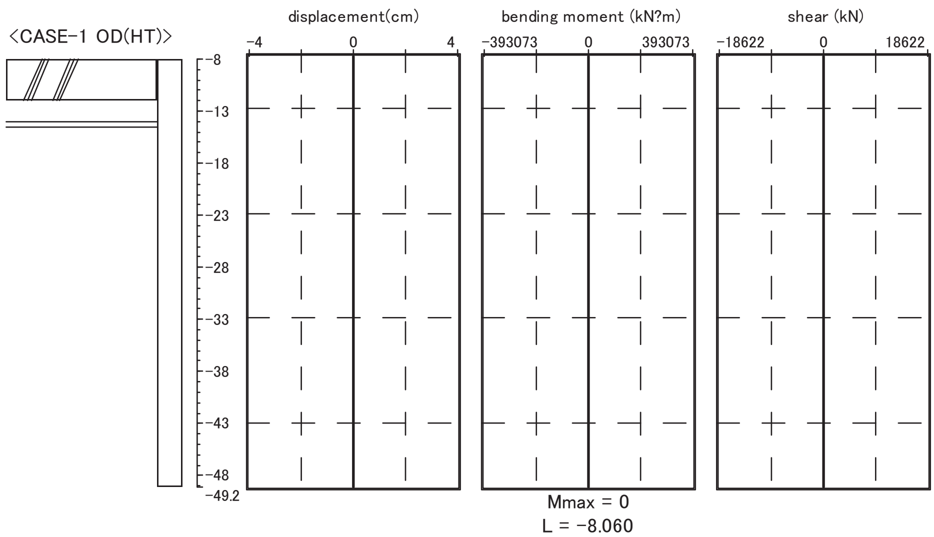
vertical reaction

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

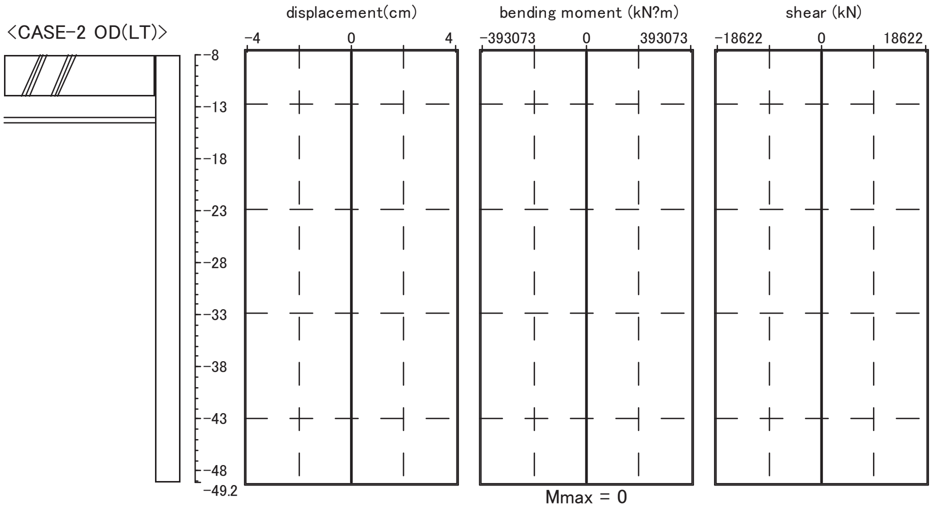
MB = -26361.0 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 40.350 (m⁴)
periphery n1 = 30 (number) IB1 = 903.99 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (number) IB1 = 0.00 (m²) Ao1 = 0.0446 (m²/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m²) Ao1 = 0.0000 (m²/number)
x = 7.930
maximum Rmax = 1827 (kN/number)
minimum Rmin = 1365 (kN/number)

1.11 displacement / member force diagram

bridge axis direction

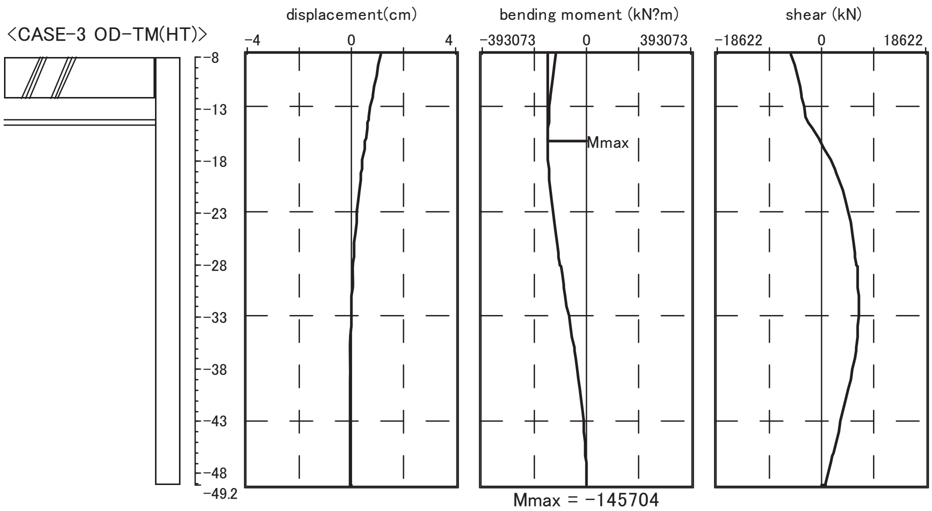


<CASE-2 OD(LT)>

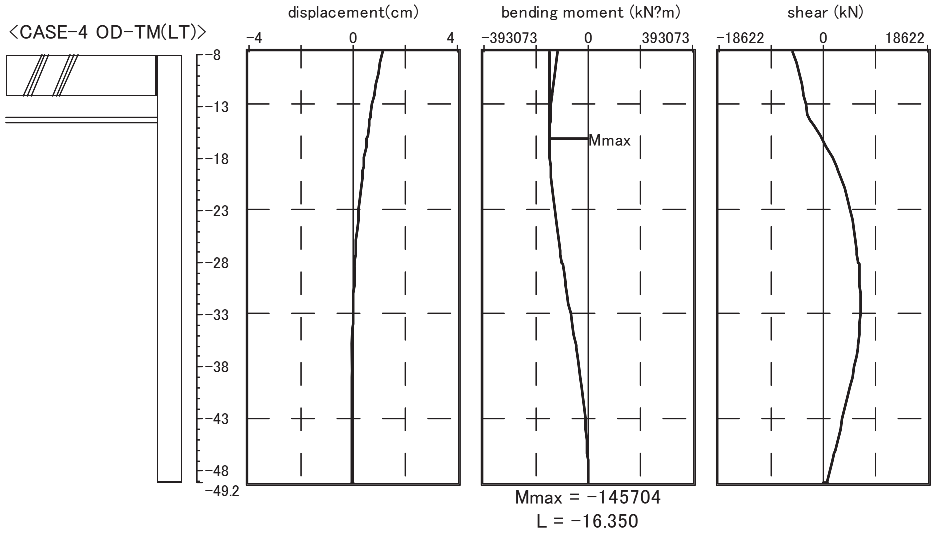


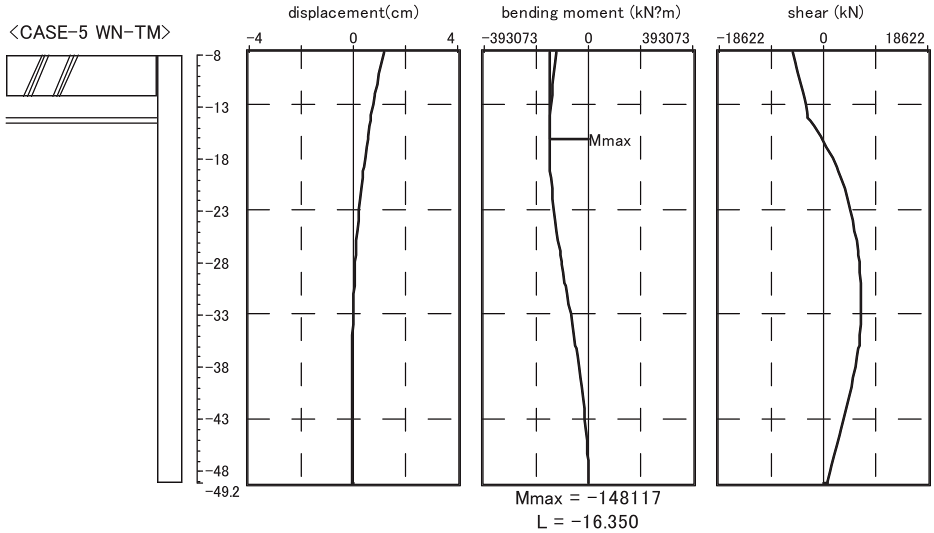
Mmax = 0
L = −8.060

<CASE-3 OD-TM(HT)>

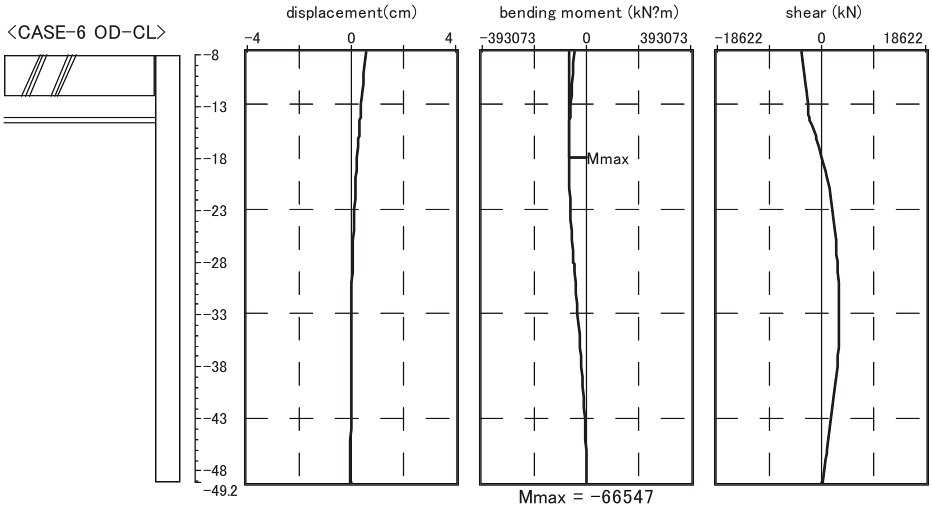


Mmax = −145704
L = −16.350


<CASE-4 OD-TM(LT)>
displacement(cm)
-4
0
4
bending moment (kN?m)
-393073
0
393073
shear (kN)
-18622
0
18622
-8
-13
-18
-23
-28
-33
-38
-43
-48
-49.2
Mmax
Mmax = -145704
L = -16.350

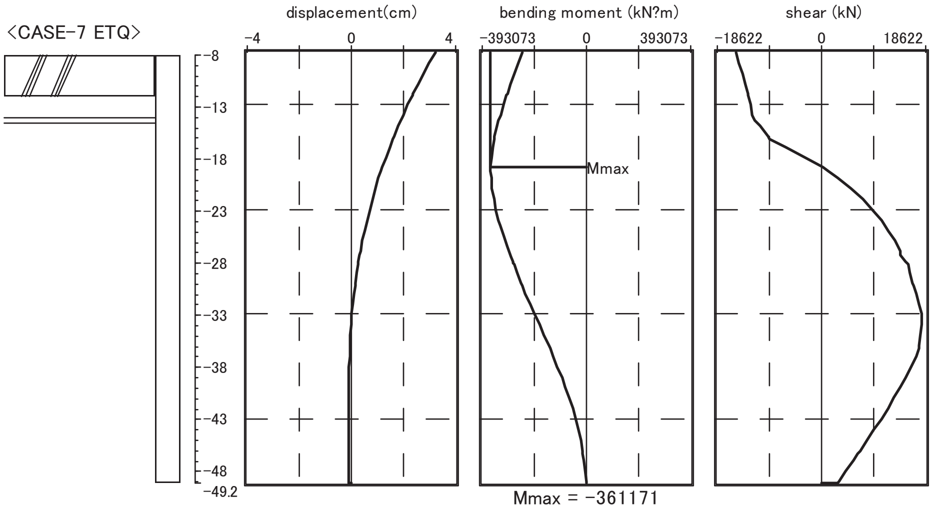

<CASE-5 WN-TM>
displacement(cm)
-4
0
4
bending moment (kN?m)
-393073
0
393073
shear (kN)
-18622
0
18622
-8
-13
-18
-23
-28
-33
-38
-43
-48
-49.2
Mmax
Mmax = -148117
L = -16.350

<CASE-6 OD-CL>



Mmax = -66547
L = -18.060

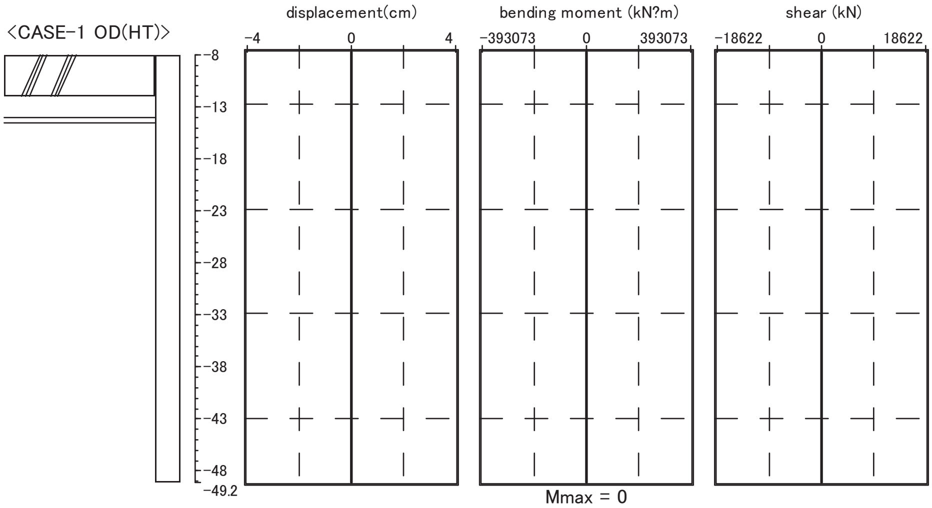
<CASE-7 ETQ>



Mmax = -361171
L = -19.060

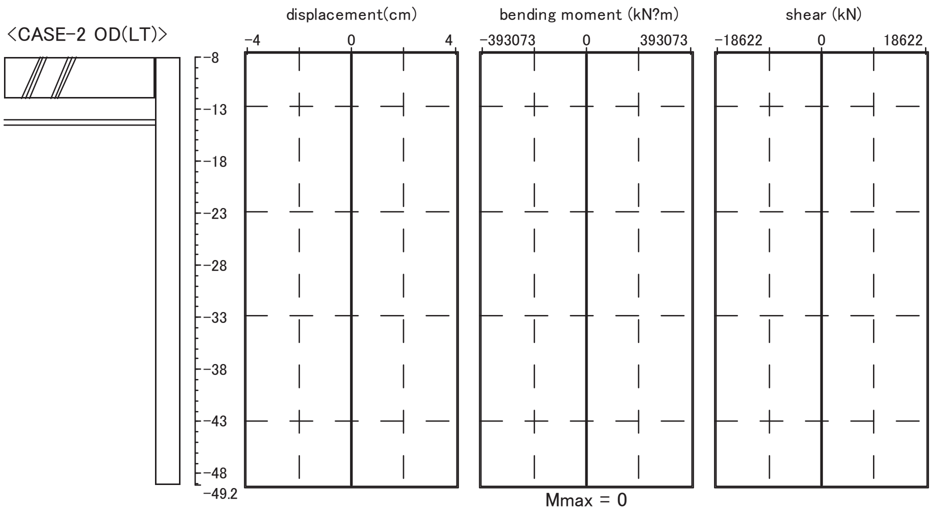
perpendicular direction

<CASE-1 OD(HT)>

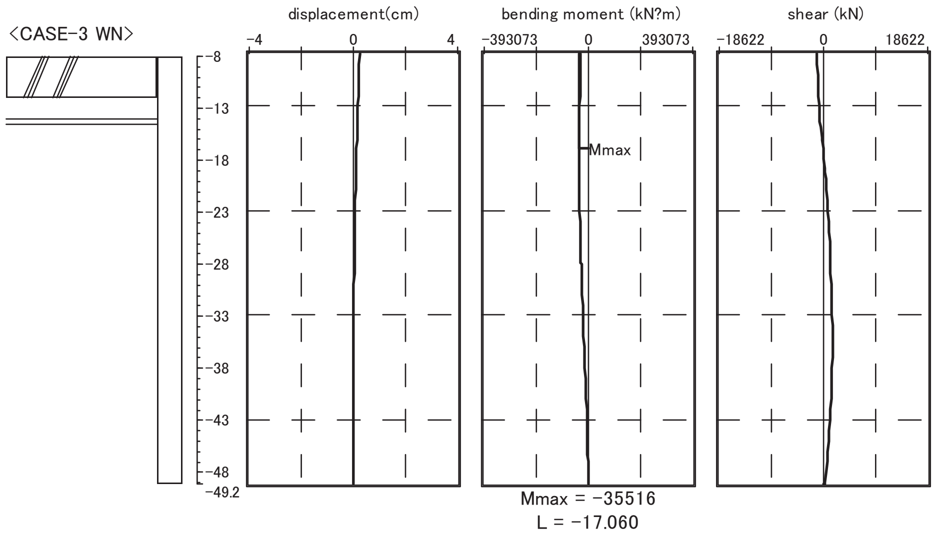


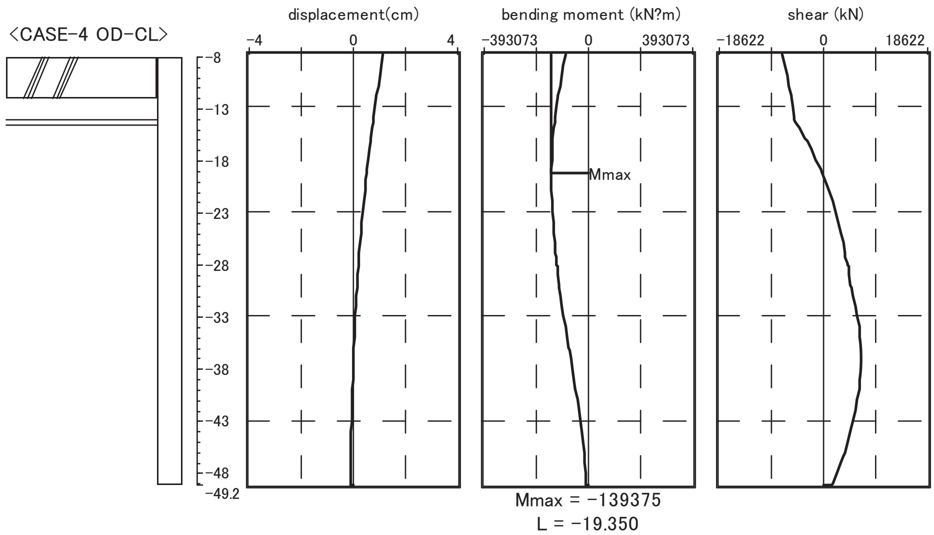
Mmax = 0
L = -8.060

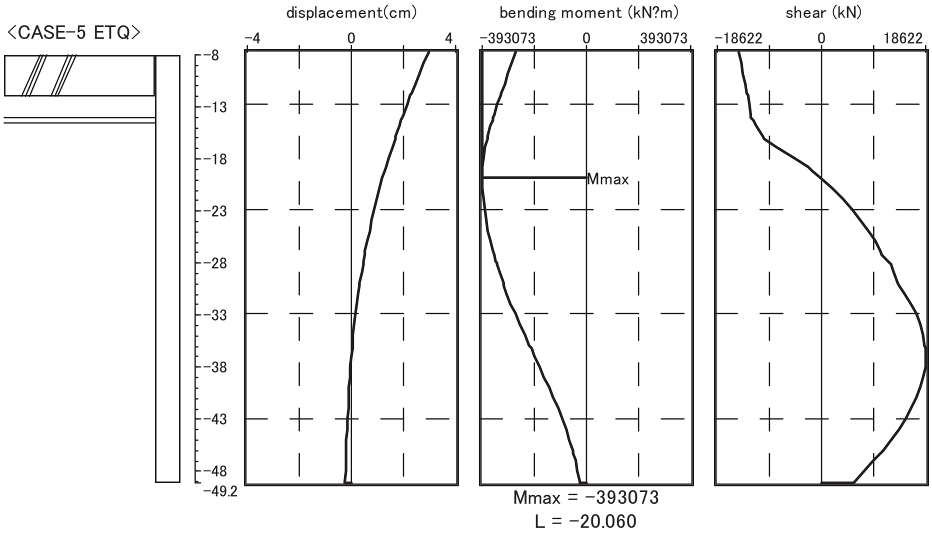
<CASE-2 OD(LT)>



Mmax = 0
L = -8.060

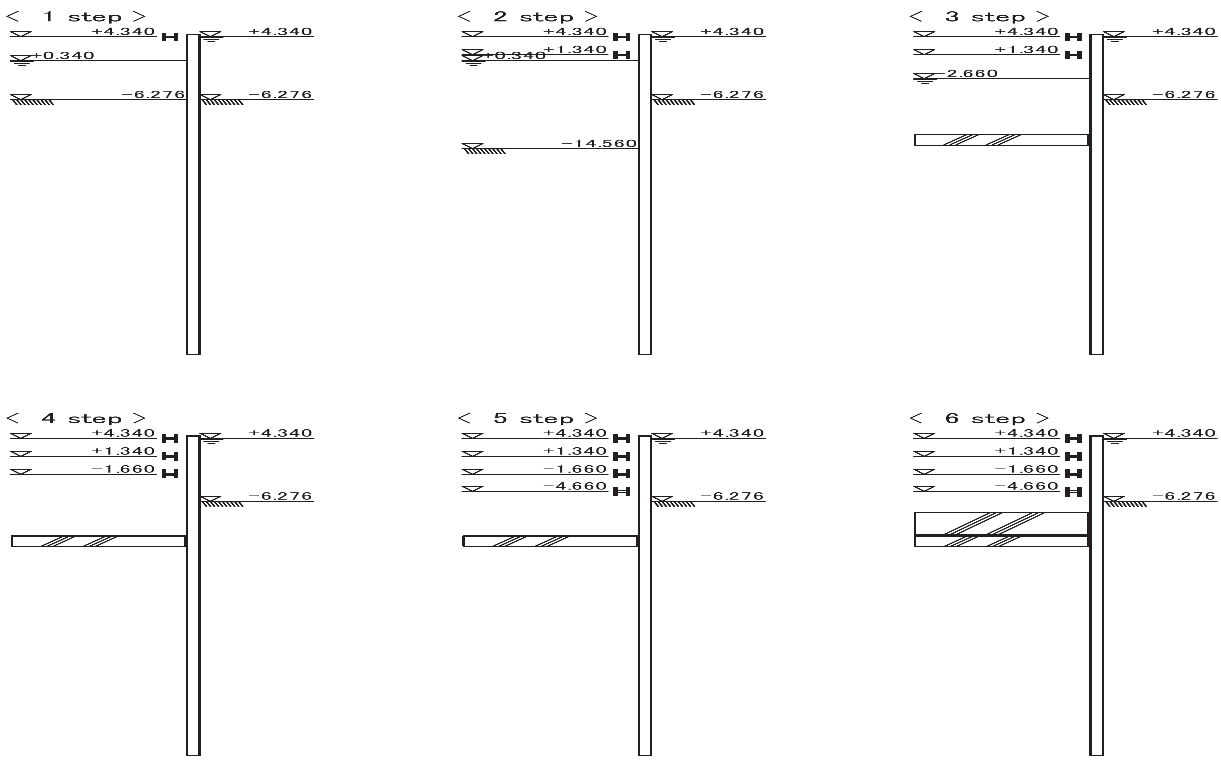

<CASE-3 WN>
displacement(cm)
bending moment (kN?m)
shear (kN)
−4
0
4
−393073
0
393073
−18622
0
18622
−8
−13
−18
−23
−28
−33
−38
−43
−48
−49.2
Mmax
Mmax = −35516
L = −17.060


<CASE-4 OD-CL>
displacement(cm)
bending moment (kN?m)
shear (kN)
−4
0
4
−393073
0
393073
−18622
0
18622
−8
−13
−18
−23
−28
−33
−38
−43
−48
−49.2
Mmax
Mmax = −139375
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	8.000	633569.6	10559.5	633569.6	10559.5	SKY400
2	9.000	633569.6	10559.5	633569.6	10559.5	SKY490
3	16.000	720452.4	12007.5	720452.4	12007.5	SKY400
4	21.000	633569.6	10559.5	633569.6	10559.5	SKY400
						Sig.= 54.000 (m)

2.3 soil condition

current ground surface elevation -6.276 (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	sandy	8.074	3.0	17.0	8.0	0.0	29.0	0
2	sandy	2.000	13.0	17.0	8.0	0.0	33.0	0
3	sandy	3.000	13.0	17.0	8.0	0.0	33.0	0
4	cohesv	8.000	7.0	17.5	7.5	42.0	0.0	0
5	sandy	1.000	13.0	17.0	8.0	0.0	32.0	0
6	cohesv	2.000	7.0	17.5	7.5	42.0	0.0	0
7	sandy	6.000	20.0	17.0	8.0	0.0	33.0	0
8	sandy	10.000	30.0	17.0	8.0	0.0	34.0	0
9	cohesv	2.810	30.0	18.0	8.0	180.0	0.0	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	1153	1153	1153	1153	0
2	4998	4998	4998	4998	0
3	4998	4998	4998	4998	0
4	4710	4710	4710	4710	0
5	8746	8746	8746	8746	0
6	4710	4710	4710	4710	0
7	13456	13456	13456	13456	0
8	20184	20184	20184	20184	0
9	20184	20184	20184	20184	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-400*400*13*21	2H-400*400*13*21	2H-400*400*13*21
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	-6.276	+0.340
2	-14.560	+0.340
3	-14.560	-2.660
4	-14.560	-14.560
5	-14.560	-14.560
6	-14.560	-14.560

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	10.616	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

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

linear part

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

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	8.623	4.000	1.9935E+005
2	437.40	8.573	4.000	5.1019E+005
3	118.40	8.673	4.000	1.3651E+005
4	118.40	8.673	4.000	1.3651E+005

arc part

row	A1 (cm^2)	r (m)	K (kN/m/m)
1	171.90	4.312	1.8494E+005
2	437.40	4.287	4.7608E+005
3	118.40	4.337	1.2592E+005
4	118.40	4.337	1.2592E+005

(2)footing concrete spring constant

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

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 = 8.973

perpendicular direction B = 14.764

1)bridge axis direction

K = 5.2378E+005 (kN/m/m)

2)perpendicular direction

K = 3.1833E+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	1.9935E+005	1.8494E+005
timbering 2row	invld	5.1019E+005	4.7608E+005
timbering 3row	invld	1.3651E+005	1.2592E+005
timbering 4row	invld	1.3651E+005	1.2592E+005
footing concrete	invld	5.2378E+005	3.1833E+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

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

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 = 54.000 (m)

design water tableelevation +4.340 (m)

design ground elevation -6.276 (m)

(4)sum up

1) 1 step

excavation area elevation = -6.276 (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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	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	-6.276 -14.350	8.074	106.16 206.51	66.16 364.56	66.16 178.80	40.00 27.71	0.00 185.76
4	-14.350 -16.350	2.000	203.56 227.69	423.39 511.88	175.09 204.11	28.47 23.58	248.30 307.77
5	-16.350 -19.350	3.000	227.69 263.88	511.88 644.62	204.11 247.63	23.58 16.25	307.77 396.99
6	-19.350 -23.647	4.297	197.05 242.17	372.42 447.62	184.98 242.17	12.07 0.00	187.44 205.45
7	-23.647 -24.624	0.977	242.17 252.42	447.62 464.71	242.17 252.42	0.00 0.00	205.45 212.29
8	-24.624 -27.350	2.726	252.42 281.05	464.71 512.42	252.42 281.05	0.00 0.00	212.29 231.37
9	-27.350 -28.350	1.000	363.46 375.61	973.66 1015.85	375.08 389.73	0.00 0.00	598.58 626.12
10	-28.350 -30.350	2.000	291.25 312.25	529.42 564.42	291.25 312.25	0.00 0.00	238.17 252.17
11	-30.350 -34.444	4.094	398.05 447.43	1155.77 1336.89	417.60 479.90	0.00 0.00	738.17 856.99
12	-34.444 -36.350	1.906	447.43 470.43	1336.89 1421.24	479.90 505.04	0.00 0.00	856.99 916.20
13	-36.350 -37.065	0.715	467.83 476.39	1490.27 1523.50	501.90 511.25	0.00 0.00	988.37 1012.25
14	-37.065 -46.350	9.285	476.39 587.62	1523.50 1955.14	511.25 632.76	0.00 0.00	1012.25 1322.38
15	-46.350 -49.160	2.810	396.21 421.50	1112.42 1163.00	396.21 421.50	0.00 0.00	716.21 741.50

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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	40.00 40.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	66.16 364.56	66.16 178.51	40.00 28.00	0.00 186.05

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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
4	-14.350 -16.350	2.000	203.56 227.69	423.39 511.88	174.84 203.58	28.72 24.11	248.55 308.30
5	-16.350 -19.350	3.000	227.69 263.88	511.88 644.62	203.58 246.70	24.11 17.18	308.30 397.92
6	-19.350 -23.647	4.297	197.05 242.17	372.42 447.62	183.76 239.71	13.29 2.46	188.66 207.91
7	-23.647 -24.624	0.977	242.17 252.42	447.62 464.71	239.71 252.42	2.46 0.00	207.91 212.29
8	-24.624 -27.350	2.726	252.42 281.05	464.71 512.42	252.42 281.05	0.00 0.00	212.29 231.37
9	-27.350 -28.350	1.000	363.46 375.61	973.66 1015.85	372.31 386.82	0.00 0.00	601.35 629.03
10	-28.350 -30.350	2.000	291.25 312.25	529.42 564.42	291.25 312.25	0.00 0.00	238.17 252.17
11	-30.350 -34.444	4.094	398.05 447.43	1155.77 1336.89	414.35 475.79	0.00 0.00	741.42 861.10
12	-34.444 -36.350	1.906	447.43 470.43	1336.89 1421.24	475.79 504.40	0.00 0.00	861.10 916.84
13	-36.350 -37.065	0.715	467.83 476.39	1490.27 1523.50	500.01 511.25	0.00 0.00	990.26 1012.25
14	-37.065 -46.350	9.285	476.39 587.62	1523.50 1955.14	511.25 632.76	0.00 0.00	1012.25 1322.38
15	-46.350 -49.160	2.810	396.21 421.50	1112.42 1163.00	396.21 421.50	0.00 0.00	716.21 741.50

2) 2 step

excavation area elevation = -14.560 (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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	40.00 40.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	66.16 146.90	66.16 146.90	40.00 59.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	146.90 149.00	146.90 149.00	56.66 57.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	149.00 228.20	149.00 174.97	57.09 52.72	0.00 53.23
6	-16.350 -19.350	3.000	227.69 263.88	228.20 360.93	174.97 218.49	52.72 45.39	53.23 142.44
7	-19.350 -27.350	8.000	176.59 260.59	314.43 454.43	146.59 253.05	30.00 7.54	167.84 201.38
8	-27.350 -28.350	1.000	363.46 375.61	707.00 749.19	344.99 359.65	18.46 15.96	362.01 389.54
9	-28.350 -30.350	2.000	270.79 291.79	471.43 506.43	264.99 291.61	5.80 0.18	206.44 214.82
10	-30.350 -33.392	3.042	398.05 434.75	872.08 1006.66	388.46 434.75	9.59 0.00	483.62 571.91
11	-33.392 -34.616	1.225	434.75 449.52	1006.66 1060.84	434.75 453.38	0.00 0.00	571.91 607.46
12	-34.616 -36.350	1.734	449.52 470.43	1060.84 1137.55	453.38 479.77	0.00 0.00	607.46 657.79
13	-36.350 -45.084	8.734	467.83 572.46	1188.01 1594.04	476.16 616.19	0.00 0.00	711.86 977.85
14	-45.084 -46.350	1.266	572.46 587.62	1594.04 1652.88	616.19 632.76	0.00 0.00	977.85 1020.13
15	-46.350 -49.160	2.810	375.75 401.04	1054.43 1105.01	396.21 421.50	0.00 0.00	658.22 683.51

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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	40.00 40.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	66.16 146.90	66.16 146.90	40.00 59.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	146.90 149.00	146.90 149.00	56.66 57.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	149.00 228.20	149.00 174.72	57.09 52.96	0.00 53.47
6	-16.350 -19.350	3.000	227.69 263.88	228.20 360.93	174.72 217.84	52.96 46.04	53.47 143.09
7	-19.350 -27.350	8.000	176.59 260.59	314.43 454.43	145.73 249.89	30.86 10.70	168.70 204.54
8	-27.350 -28.350	1.000	363.46 375.61	707.00 749.19	342.52 357.03	20.94 18.58	364.48 392.16
9	-28.350 -30.350	2.000	270.79 291.79	471.43 506.43	261.65 287.69	9.14 4.10	209.78 218.74
10	-30.350 -33.392	3.042	398.05 434.75	872.08 1006.66	385.49 431.14	12.57 3.61	486.60 575.52
11	-33.392 -34.616	1.225	434.75 449.52	1006.66 1060.84	431.14 449.52	3.61 0.00	575.52 611.32
12	-34.616 -36.350	1.734	449.52 470.43	1060.84 1137.55	449.52 475.54	0.00 0.00	611.32 662.01
13	-36.350 -45.084	8.734	467.83 572.46	1188.01 1594.04	472.07 609.46	0.00 0.00	715.94 984.58
14	-45.084 -46.350	1.266	572.46 587.62	1594.04 1652.88	609.46 629.37	0.00 0.00	984.58 1023.51
15	-46.350 -49.160	2.810	375.75 401.04	1054.43 1105.01	396.21 421.50	0.00 0.00	658.22 683.51

3) 3 step

excavation area elevation = -14.560 (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/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						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 -6.276	3.616	70.00 106.16	0.00 36.16	0.00 36.16	70.00 70.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	36.16 116.90	36.16 116.90	70.00 89.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	116.90 119.00	116.90 119.00	86.66 87.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	270.66 349.85	133.12 159.08	72.98 68.61	137.54 190.77
6	-16.350 -19.350	3.000	227.69 263.88	349.85 482.59	159.08 202.60	68.61 61.28	190.77 279.98
7	-19.350 -27.350	8.000	176.59 260.59	315.43 455.43	147.19 253.65	29.40 6.94	168.24 201.78
8	-27.350 -28.350	1.000	363.46 375.61	819.55 861.74	329.57 344.22	33.89 31.39	489.99 517.52
9	-28.350 -30.201	1.851	270.79 290.23	472.43 504.83	265.59 290.23	5.20 0.00	206.84 214.60
10	-30.201 -30.350	0.149	290.23 291.79	504.83 507.43	290.23 292.21	0.00 0.00	214.60 215.22
11	-30.350 -36.350	6.000	398.05 470.43	993.74 1259.21	372.58 463.88	25.48 6.55	621.16 795.33
12	-36.350 -38.325	1.975	467.83 491.49	1319.60 1411.42	459.82 491.49	8.01 0.00	859.78 919.93
13	-38.325 -39.574	1.249	491.49 506.45	1411.42 1469.48	491.49 511.52	0.00 0.00	919.93 957.97
14	-39.574 -46.350	6.776	506.45 587.62	1469.48 1784.47	511.52 620.15	0.00 0.00	957.97 1164.32
15	-46.350 -49.160	2.810	375.75 401.04	1055.43 1106.01	396.21 421.50	0.00 0.00	659.22 684.51

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 -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 -6.276	3.616	70.00 106.16	0.00 36.16	0.00 36.16	70.00 70.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	36.16 116.90	36.16 116.90	70.00 89.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	116.90 119.00	116.90 119.00	86.66 87.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	270.66 349.85	133.12 158.84	72.98 68.85	137.54 191.01
6	-16.350 -19.350	3.000	227.69 263.88	349.85 482.59	158.84 201.96	68.85 61.92	191.01 280.63
7	-19.350 -27.350	8.000	176.59 260.59	315.43 455.43	146.33 250.49	30.26 10.10	169.10 204.94
8	-27.350 -28.350	1.000	363.46 375.61	819.55 861.74	327.09 341.60	36.37 34.01	492.46 520.14
9	-28.350 -30.201	1.851	270.79 290.23	472.43 504.83	262.25 286.36	8.54 3.87	210.18 218.47
10	-30.201 -30.350	0.149	290.23 291.79	504.83 507.43	286.36 288.29	3.87 3.50	218.47 219.14
11	-30.350 -36.350	6.000	398.05 470.43	993.74 1259.21	369.60 459.66	28.45 10.78	624.14 799.55
12	-36.350 -38.325	1.975	467.83 491.49	1319.60 1411.42	455.73 486.80	12.10 4.69	863.87 924.61
13	-38.325 -39.574	1.249	491.49 506.45	1411.42 1469.48	486.80 506.45	4.69 0.00	924.61 963.03
14	-39.574 -46.350	6.776	506.45 587.62	1469.48 1784.47	506.45 613.04	0.00 0.00	963.03 1171.43
15	-46.350 -49.160	2.810	375.75 401.04	1055.43 1106.01	396.21 421.50	0.00 0.00	659.22 684.51

4) 4 step

excavation area elevation = -14.560 (m)

landside water table elevation = -14.560 (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	10.616	0.00	0.00	0.00	0.00	0.00
	-6.276		106.16	0.00	0.00	106.16	0.00
2	-6.276	8.074	106.16	0.00	0.00	106.16	0.00
	-14.350		206.51	0.00	0.00	206.51	0.00
3	-14.350	0.210	203.56	0.00	0.00	203.56	0.00
	-14.560		206.09	0.00	0.00	206.09	0.00
4	-14.560	1.790	206.09	151.66	14.12	191.98	137.54
	-16.350		227.69	230.85	40.08	187.61	190.77
5	-16.350	3.000	227.69	230.85	40.08	187.61	190.77
	-19.350		263.88	363.59	83.60	180.28	279.98
6	-19.350	8.000	176.59	196.43	75.79	100.80	120.64
	-27.350		260.59	336.43	182.25	78.34	154.18
7	-27.350	1.000	363.46	700.55	210.57	152.89	489.99
	-28.350		375.61	742.74	225.22	150.39	517.52
8	-28.350	2.000	270.79	353.43	194.19	76.60	159.24
	-30.350		291.79	388.43	220.81	70.98	167.62
9	-30.350	6.000	398.05	874.74	253.58	144.48	621.16
	-36.350		470.43	1140.21	344.88	125.55	795.33
10	-36.350	10.000	467.83	1200.60	340.82	127.01	859.78
	-46.350		587.62	1665.47	501.15	86.47	1164.32
11	-46.350	0.891	375.75	936.43	366.81	8.94	569.62
	-47.241		383.77	952.47	383.77	0.00	568.70
12	-47.241	0.999	383.77	952.47	383.77	0.00	568.70
	-48.240		392.75	970.44	402.77	0.00	567.67
13	-48.240	0.920	392.75	970.44	402.77	0.00	567.67
	-49.160		401.04	987.01	420.29	0.00	566.72

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	10.616	0.00	0.00	0.00	0.00	0.00
	-6.276		106.16	0.00	0.00	106.16	0.00
2	-6.276	8.074	106.16	0.00	0.00	106.16	0.00
	-14.350		206.51	0.00	0.00	206.51	0.00
3	-14.350	0.210	203.56	0.00	0.00	203.56	0.00
	-14.560		206.09	0.00	0.00	206.09	0.00
4	-14.560	1.790	206.09	151.66	14.12	191.98	137.54
	-16.350		227.69	230.85	39.84	187.85	191.01
5	-16.350	3.000	227.69	230.85	39.84	187.85	191.01
	-19.350		263.88	363.59	82.96	180.92	280.63
6	-19.350	8.000	176.59	196.43	74.93	101.66	121.50
	-27.350		260.59	336.43	179.09	81.50	157.34
7	-27.350	1.000	363.46	700.55	208.09	155.37	492.46
	-28.350		375.61	742.74	222.60	153.01	520.14
8	-28.350	2.000	270.79	353.43	190.85	79.94	162.58
	-30.350		291.79	388.43	216.89	74.90	171.54
9	-30.350	6.000	398.05	874.74	250.60	147.45	624.14
	-36.350		470.43	1140.21	340.66	129.78	799.55
10	-36.350	10.000	467.83	1200.60	336.73	131.10	863.87
	-46.350		587.62	1665.47	494.04	93.58	1171.43
11	-46.350	0.891	375.75	936.43	358.74	17.01	577.69
	-47.241		383.77	952.47	374.78	8.99	577.69
12	-47.241	0.999	383.77	952.47	374.78	8.99	577.69
	-48.240		392.75	970.44	392.75	0.00	577.69
13	-48.240	0.920	392.75	970.44	392.75	0.00	577.69
	-49.160		401.04	987.01	409.32	0.00	577.69

5) 5 step

excavation area elevation = -14.560 (m)

landside water table elevation = -14.560 (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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 40.08	191.98 187.61	137.54 190.77
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	40.08 83.60	187.61 180.28	190.77 279.98
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	75.79 182.25	100.80 78.34	120.64 154.18
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	210.57 225.22	152.89 150.39	489.99 517.52
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	194.19 220.81	76.60 70.98	159.24 167.62
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	253.58 344.88	144.48 125.55	621.16 795.33
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	340.82 501.15	127.01 86.47	859.78 1164.32
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	366.81 383.77	8.94 0.00	569.62 568.70
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	383.77 402.77	0.00 0.00	568.70 567.67
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	402.77 420.29	0.00 0.00	567.67 566.72

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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 39.84	191.98 187.85	137.54 191.01
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	39.84 82.96	187.85 180.92	191.01 280.63
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	74.93 179.09	101.66 81.50	121.50 157.34
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	208.09 222.60	155.37 153.01	492.46 520.14
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	190.85 216.89	79.94 74.90	162.58 171.54
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	250.60 340.66	147.45 129.78	624.14 799.55
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	336.73 494.04	131.10 93.58	863.87 1171.43
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	358.74 374.78	17.01 8.99	577.69 577.69
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	374.78 392.75	8.99 0.00	577.69 577.69
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	392.75 409.32	0.00 0.00	577.69 577.69

6) 6 step

excavation area elevation = -14.560 (m)

landside water table elevation = -14.560 (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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 40.08	191.98 187.61	137.54 190.77
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	40.08 83.60	187.61 180.28	190.77 279.98
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	75.79 182.25	100.80 78.34	120.64 154.18
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	210.57 225.22	152.89 150.39	489.99 517.52
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	194.19 220.81	76.60 70.98	159.24 167.62
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	253.58 344.88	144.48 125.55	621.16 795.33
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	340.82 501.15	127.01 86.47	859.78 1164.32
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	366.81 383.77	8.94 0.00	569.62 568.70
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	383.77 402.77	0.00 0.00	568.70 567.67
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	402.77 420.29	0.00 0.00	567.67 566.72

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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 39.84	191.98 187.85	137.54 191.01
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	39.84 82.96	187.85 180.92	191.01 280.63
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	74.93 179.09	101.66 81.50	121.50 157.34
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	208.09 222.60	155.37 153.01	492.46 520.14
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	190.85 216.89	79.94 74.90	162.58 171.54
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	250.60 340.66	147.45 129.78	624.14 799.55
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	336.73 494.04	131.10 93.58	863.87 1171.43
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	358.74 374.78	17.01 8.99	577.69 577.69
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	374.78 392.75	8.99 0.00	577.69 577.69
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	392.75 409.32	0.00 0.00	577.69 577.69

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 -6.276	6.616	----	----	----	----
3	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
4	sandy	-14.350 -16.350	2.000	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -23.647	4.297	17.5	42.0	0.00	7.0
7	cohesv	-23.647 -24.625	0.978	17.5	42.0	0.00	7.0
8	cohesv	-24.625 -27.350	2.725	17.5	42.0	0.00	7.0
9	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
10	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
11	sandy	-30.350 -34.445	4.095	17.0	0.0	33.00	20.0
12	sandy	-34.445 -36.350	1.905	17.0	0.0	33.00	20.0
13	sandy	-36.350 -37.066	0.716	17.0	0.0	34.00	30.0
14	sandy	-37.066 -46.350	9.284	17.0	0.0	34.00	30.0
15	cohesv	-46.350 -49.160	2.810	18.0	180.0	0.00	30.0

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 -6.276	6.616	0.00 0.00	-------- --------	40.00 106.16	------- -------	------- -------	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	0.000 0.000	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51
4	sandy	-14.350 -16.350	2.000	243.42 277.42	0.000 0.000	186.90 206.90	0.2948 0.2948	------- -------	16.66 20.79	203.56 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -23.647	4.297	328.42 403.62	222.258 297.460	-------- --------	0.6000 0.6000	0.6000 0.6000	197.05 242.17	197.05 242.17
7	cohesv	-23.647 -24.625	0.978	403.62 420.73	297.460 314.573	-------- --------	0.6000 0.6000	0.6000 0.6000	242.17 252.44	242.17 252.44
8	cohesv	-24.625 -27.350	2.725	420.73 468.42	314.573 362.258	-------- --------	0.6000 0.6000	0.6000 0.6000	252.44 281.05	252.44 281.05
9	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
10	cohesv	-28.350 -30.350	2.000	485.42 520.42	379.258 414.258	-------- --------	0.6000 0.6000	0.6000 0.6000	291.25 312.25	291.25 312.25
11	sandy	-30.350 -34.445	4.095	520.42 590.03	0.000 0.000	346.90 387.85	0.2948 0.2948	------- -------	51.15 59.60	398.05 447.45
12	sandy	-34.445 -36.350	1.905	590.03 622.42	0.000 0.000	387.85 406.90	0.2948 0.2948	------- -------	59.60 63.53	447.45 470.43
13	sandy	-36.350 -37.066	0.716	622.42 634.60	0.000 0.000	406.90 414.06	0.2827 0.2827	------- -------	60.93 62.35	467.83 476.41
14	sandy	-37.066 -46.350	9.284	634.60 792.42	0.000 0.000	414.06 506.90	0.2827 0.2827	------- -------	62.35 80.72	476.41 587.62
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	686.258 736.838	-------- --------	0.5000 0.5000	0.5000 0.5000	396.21 421.50	396.21 421.50

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	6.616	0.00 0.00	0.00 66.16	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	66.16 203.42	66.16 146.90	3.8511 3.8511	0.00 217.66	66.16 364.56
4	sandy	-14.350 -16.350	2.000	203.42 237.42	146.90 166.90	4.8921 4.8921	276.49 344.98	423.39 511.88
5	sandy	-16.350 -19.350	3.000	237.42 288.42	166.90 196.90	4.8921 4.8921	344.98 447.72	511.88 644.62
6	cohesv	-19.350 -23.647	4.297	288.42 363.62	-------- --------	1.0000 1.0000	372.42 447.62	372.42 447.62
7	cohesv	-23.647 -24.625	0.978	363.62 380.73	-------- --------	1.0000 1.0000	447.62 464.73	447.62 464.73
8	cohesv	-24.625 -27.350	2.725	380.73 428.42	-------- --------	1.0000 1.0000	464.73 512.42	464.73 512.42
9	sandy	-27.350 -28.350	1.000	428.42 445.42	276.90 286.90	4.5985 4.5985	696.76 728.95	973.66 1015.85
10	cohesv	-28.350 -30.350	2.000	445.42 480.42	-------- --------	1.0000 1.0000	529.42 564.42	529.42 564.42
11	sandy	-30.350 -34.445	4.095	480.42 550.03	306.90 347.85	4.8921 4.8921	848.87 989.09	1155.77 1336.93
12	sandy	-34.445 -36.350	1.905	550.03 582.42	347.85 366.90	4.8921 4.8921	989.09 1054.34	1336.93 1421.24
13	sandy	-36.350 -37.066	0.716	582.42 594.60	366.90 374.06	5.2124 5.2124	1123.37 1149.51	1490.27 1523.57
14	sandy	-37.066 -46.350	9.284	594.60 752.42	374.06 466.90	5.2124 5.2124	1149.51 1488.24	1523.57 1955.14
15	cohesv	-46.350 -49.160	2.810	752.42 803.00	-------- --------	1.0000 1.0000	1112.42 1163.00	1112.42 1163.00

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -6.276	6.616	0.00 0.00	40.00 106.16	0.0000 0.0000	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
4	sandy	-14.350 -16.350	2.000	243.42 277.42	186.90 206.90	0.4554 0.4554	25.74 32.11	212.64 239.01
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -23.647	4.297	328.42 403.62	-------- --------	0.6000 0.6000	197.05 242.17	197.05 242.17
7	cohesv	-23.647 -24.625	0.978	403.62 420.73	-------- --------	0.6000 0.6000	242.17 252.44	242.17 252.44
8	cohesv	-24.625 -27.350	2.725	420.73 468.42	-------- --------	0.6000 0.6000	252.44 281.05	252.44 281.05
9	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
10	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
11	sandy	-30.350 -34.445	4.095	520.42 590.03	346.90 387.85	0.4554 0.4554	79.01 92.07	425.91 479.91
12	sandy	-34.445 -36.350	1.905	590.03 622.42	387.85 406.90	0.4554 0.4554	92.07 98.14	479.91 505.04
13	sandy	-36.350 -37.066	0.716	622.42 634.60	406.90 414.06	0.4408 0.4408	95.00 97.21	501.90 511.28
14	sandy	-37.066 -46.350	9.284	634.60 792.42	414.06 506.90	0.4408 0.4408	97.21 125.86	511.28 632.76
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	-------- --------	0.5000 0.5000	396.21 421.50	396.21 421.50

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (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	4.000	0.00	0.00	-------	--------	0.0000	0.00	0.00
		+0.340		0.00	0.00		--------	0.0000	0.00	0.00
2	-------	+0.340	6.616	0.00	0.00	-------	--------	0.0000	0.00	0.00
		-6.276		0.00	66.16		--------	0.0000	0.00	66.16
3	sandy	-6.276	8.074	66.16	66.16	3.00	0.00	0.5152	0.00	66.16
		-14.350		203.42	146.90		24.22	0.5152	31.90	178.80
4	sandy	-14.350	2.000	203.42	146.90	13.00	24.22	0.4554	28.19	175.09
		-16.350		237.42	166.90		50.22	0.4554	37.21	204.11
5	sandy	-16.350	3.000	237.42	166.90	13.00	50.22	0.4554	37.21	204.11
		-19.350		288.42	196.90		89.22	0.4554	50.73	247.63
6	cohesv	-19.350	4.297	288.42	--------	21.00	89.22	0.6000	184.98	184.98
		-23.647		363.62	--------		179.46	0.6000	242.17	242.17
7	cohesv	-23.647	0.978	363.62	--------	21.00	179.46	0.6000	242.17	242.17
		-24.625		380.73	--------		200.00	0.6000	255.19	255.19
8	cohesv	-24.625	2.725	380.73	--------	21.00	200.00	0.6000	255.19	255.19
		-27.350		428.42	--------		257.22	0.6000	291.45	291.45
9	sandy	-27.350	1.000	428.42	276.90	13.00	257.22	0.4701	98.18	375.08
		-28.350		445.42	286.90		270.22	0.4701	102.83	389.73
10	cohesv	-28.350	2.000	445.42	--------	21.00	270.22	0.6000	303.39	303.39
		-30.350		480.42	--------		312.22	0.6000	330.00	330.00
11	sandy	-30.350	4.095	480.42	306.90	20.00	312.22	0.4554	110.70	417.60
		-34.445		550.03	347.85		394.11	0.4554	132.07	479.91
12	sandy	-34.445	1.905	550.03	347.85	20.00	394.11	0.4554	132.07	479.91
		-36.350		582.42	366.90		432.22	0.4554	142.01	508.91
13	sandy	-36.350	0.716	582.42	366.90	30.00	432.22	0.4408	137.47	504.37
		-37.066		594.60	374.06		453.71	0.4408	141.79	515.85
14	sandy	-37.066	9.284	594.60	374.06	30.00	453.71	0.4408	141.79	515.85
		-46.350		752.42	466.90		732.22	0.4408	197.80	664.70

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	cohesv	-46.350	2.810	752.42	--------	90.00	732.22	0.5000	457.81	457.81
		-49.160		803.00	--------		985.12	0.5000	511.28	511.28

friction force B7027influence range B = 4.487 (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	4.000	0.00	0.00	-------	--------	0.0000	0.00	0.00
		+0.340		0.00	0.00		--------	0.0000	0.00	0.00
2	-------	+0.340	6.616	0.00	0.00	-------	--------	0.0000	0.00	0.00
		-6.276		0.00	66.16		--------	0.0000	0.00	66.16
3	sandy	-6.276	8.074	66.16	66.16	3.00	0.00	0.5152	0.00	66.16
		-14.350		203.42	146.90		24.22	0.5152	31.61	178.51
4	sandy	-14.350	2.000	203.42	146.90	13.00	24.22	0.4554	27.94	174.84
		-16.350		237.42	166.90		50.22	0.4554	36.68	203.58
5	sandy	-16.350	3.000	237.42	166.90	13.00	50.22	0.4554	36.68	203.58
		-19.350		288.42	196.90		89.22	0.4554	49.80	246.70
6	cohesv	-19.350	4.297	288.42	--------	21.00	89.22	0.6000	183.76	183.76
		-23.647		363.62	--------		179.46	0.6000	239.71	239.71
7	cohesv	-23.647	0.978	363.62	--------	21.00	179.46	0.6000	239.71	239.71
		-24.625		380.73	--------		200.00	0.6000	252.44	252.44
8	cohesv	-24.625	2.725	380.73	--------	21.00	200.00	0.6000	252.44	252.44
		-27.350		428.42	--------		257.22	0.6000	287.92	287.92
9	sandy	-27.350	1.000	428.42	276.90	13.00	257.22	0.4701	95.41	372.31
		-28.350		445.42	286.90		270.22	0.4701	99.92	386.82
10	cohesv	-28.350	2.000	445.42	--------	21.00	270.22	0.6000	299.68	299.68
		-30.350		480.42	--------		312.22	0.6000	325.72	325.72
11	sandy	-30.350	4.095	480.42	306.90	20.00	312.22	0.4554	107.45	414.35
		-34.445		550.03	347.85		394.11	0.4554	127.96	475.80

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	sandy	-34.445 -36.350	1.905	550.03 582.42	347.85 366.90	20.00	394.11 432.22	0.4554 0.4554	127.96 137.50	475.80 504.40
13	sandy	-36.350 -37.066	0.716	582.42 594.60	366.90 374.06	30.00	432.22 453.71	0.4408 0.4408	133.11 137.21	500.01 511.28
14	sandy	-37.066 -46.350	9.284	594.60 752.42	374.06 466.90	30.00	453.71 732.22	0.4408 0.4408	137.21 190.41	511.28 657.31
15	cohesv	-46.350 -49.160	2.810	752.42 803.00	-------- --------	90.00	732.22 985.12	0.5000 0.5000	449.43 500.01	449.43 500.01

friction force B7027influence range B = 5.000 (m)

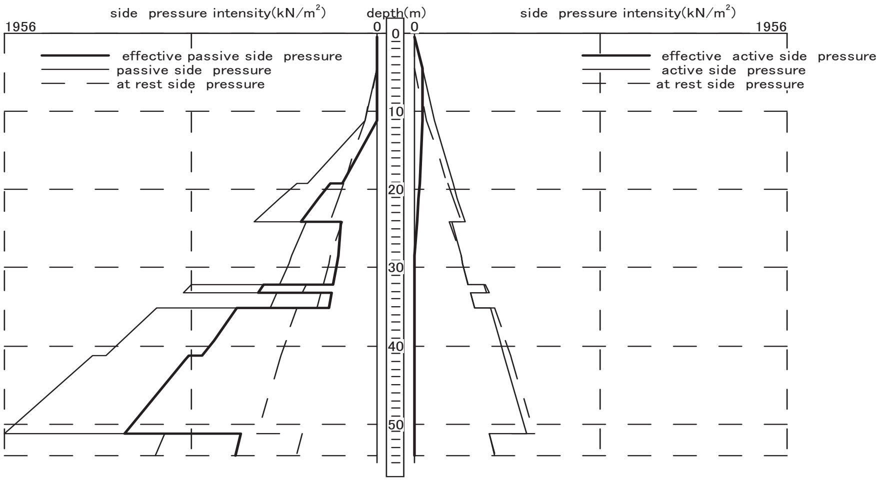
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

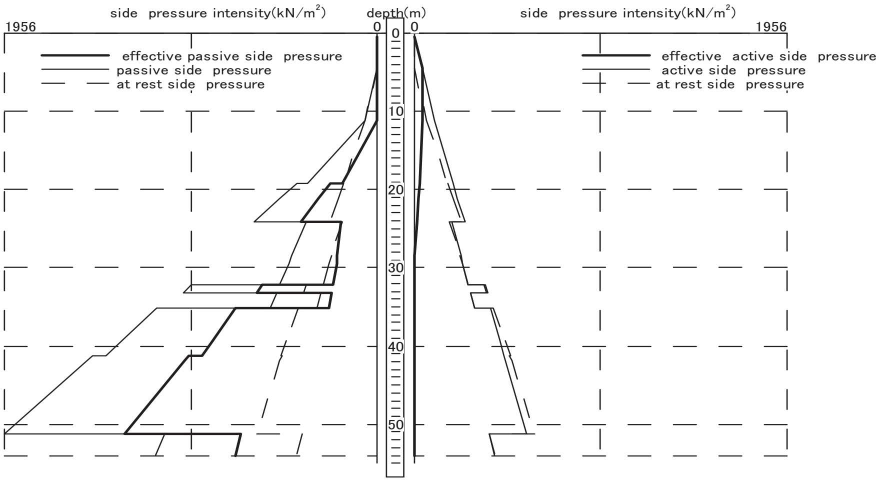
bridge axis direction

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 -6.276	6.616	----	----	----	----
3	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
4	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
5	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
6	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
7	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
8	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
9	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
10	sandy	-30.350 -33.392	3.042	17.0	0.0	33.00	20.0
11	sandy	-33.392 -34.616	1.225	17.0	0.0	33.00	20.0
12	sandy	-34.616 -36.350	1.734	17.0	0.0	33.00	20.0
13	sandy	-36.350 -45.084	8.734	17.0	0.0	34.00	30.0
14	sandy	-45.084 -46.350	1.266	17.0	0.0	34.00	30.0
15	cohesv	-46.350 -49.160	2.810	18.0	180.0	0.00	30.0

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 -6.276	6.616	0.00 0.00	-------- --------	40.00 106.16	------- -------	------- -------	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51
4	sandy	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
5	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
6	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
8	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
9	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
10	sandy	-30.350 -33.392	3.042	520.42 572.12	0.000 0.000	346.90 377.32	0.2948 0.2948	------- -------	51.15 57.43	398.05 434.75
11	sandy	-33.392 -34.616	1.225	572.12 592.94	0.000 0.000	377.32 389.56	0.2948 0.2948	------- -------	57.43 59.96	434.75 449.52
12	sandy	-34.616 -36.350	1.734	592.94 622.42	0.000 0.000	389.56 406.90	0.2948 0.2948	------- -------	59.96 63.53	449.52 470.43
13	sandy	-36.350 -45.084	8.734	622.42 770.90	0.000 0.000	406.90 494.24	0.2827 0.2827	------- -------	60.93 78.22	467.83 572.46
14	sandy	-45.084 -46.350	1.266	770.90 792.42	0.000 0.000	494.24 506.90	0.2827 0.2827	------- -------	78.22 80.72	572.46 587.62
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	545.430 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 401.04	375.75 401.04

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	6.616	0.00 0.00	0.00 66.16	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	66.16 146.90	0.0000 0.0000	0.00 0.00	66.16 146.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	146.90 149.00	0.0000 0.0000	0.00 0.00	146.90 149.00
5	sandy	-14.560 -16.350	1.790	149.00 179.43	149.00 166.90	4.8921 4.8921	0.00 61.30	149.00 228.20
6	sandy	-16.350 -19.350	3.000	179.43 230.43	166.90 196.90	4.8921 4.8921	61.30 164.03	228.20 360.93
7	cohesv	-19.350 -27.350	8.000	230.43 370.43	-------- --------	1.0000 1.0000	314.43 454.43	314.43 454.43
8	sandy	-27.350 -28.350	1.000	370.43 387.43	276.90 286.90	4.5985 4.5985	430.10 462.29	707.00 749.19
9	cohesv	-28.350 -30.350	2.000	387.43 422.43	-------- --------	1.0000 1.0000	471.43 506.43	471.43 506.43
10	sandy	-30.350 -33.392	3.042	422.43 474.14	306.90 337.32	4.8921 4.8921	565.18 669.34	872.08 1006.66
11	sandy	-33.392 -34.616	1.225	474.14 494.95	337.32 349.56	4.8921 4.8921	669.34 711.28	1006.66 1060.84
12	sandy	-34.616 -36.350	1.734	494.95 524.43	349.56 366.90	4.8921 4.8921	711.28 770.65	1060.84 1137.55
13	sandy	-36.350 -45.084	8.734	524.43 672.91	366.90 454.24	5.2124 5.2124	821.11 1139.80	1188.01 1594.04
14	sandy	-45.084 -46.350	1.266	672.91 694.43	454.24 466.90	5.2124 5.2124	1139.80 1185.98	1594.04 1652.88
15	cohesv	-46.350 -49.160	2.810	694.43 745.01	-------- --------	1.0000 1.0000	1054.43 1105.01	1054.43 1105.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -6.276	6.616	0.00 0.00	40.00 106.16	0.0000 0.0000	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
4	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
5	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01
6	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
8	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
9	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
10	sandy	-30.350 -33.392	3.042	520.42 572.12	346.90 377.32	0.4554 0.4554	79.01 88.71	425.91 466.02
11	sandy	-33.392 -34.616	1.225	572.12 592.94	377.32 389.56	0.4554 0.4554	88.71 92.61	466.02 482.17
12	sandy	-34.616 -36.350	1.734	592.94 622.42	389.56 406.90	0.4554 0.4554	92.61 98.14	482.17 505.04
13	sandy	-36.350 -45.084	8.734	622.42 770.90	406.90 494.24	0.4408 0.4408	95.00 121.95	501.90 616.19
14	sandy	-45.084 -46.350	1.266	770.90 792.42	494.24 506.90	0.4408 0.4408	121.95 125.86	616.19 632.76
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	-------- --------	0.5000 0.5000	396.21 421.50	396.21 421.50

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 -6.276	6.616	0.00 0.00	0.00 66.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	66.16 146.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	66.16 146.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	146.90 149.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	146.90 149.00
5	sandy	-14.560 -16.350	1.790	149.00 179.43	149.00 166.90	13.00	0.00 23.27	0.4554 0.4554	0.00 8.07	149.00 174.97
6	sandy	-16.350 -19.350	3.000	179.43 230.43	166.90 196.90	13.00	23.27 62.27	0.4554 0.4554	8.07 21.59	174.97 218.49
7	cohesv	-19.350 -27.350	8.000	230.43 370.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	146.59 253.05	146.59 253.05
8	sandy	-27.350 -28.350	1.000	370.43 387.43	276.90 286.90	13.00	230.27 243.27	0.4701 0.4701	68.09 72.75	344.99 359.65
9	cohesv	-28.350 -30.350	2.000	387.43 422.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	264.99 291.61	264.99 291.61
10	sandy	-30.350 -33.392	3.042	422.43 474.14	306.90 337.32	20.00	285.27 346.10	0.4554 0.4554	81.56 97.43	388.46 434.75
11	sandy	-33.392 -34.616	1.225	474.14 494.95	337.32 349.56	20.00	346.10 370.59	0.4554 0.4554	97.43 103.82	434.75 453.38
12	sandy	-34.616 -36.350	1.734	494.95 524.43	349.56 366.90	20.00	370.59 405.27	0.4554 0.4554	103.82 112.87	453.38 479.77
13	sandy	-36.350 -45.084	8.734	524.43 672.91	366.90 454.24	30.00	405.27 667.30	0.4408 0.4408	109.26 161.95	476.16 616.19
14	sandy	-45.084 -46.350	1.266	672.91 694.43	454.24 466.90	30.00	667.30 705.27	0.4408 0.4408	161.95 169.59	616.19 636.49

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	cohesv	-46.350 -49.160	2.810	694.43 745.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	425.81 479.29	425.81 479.29

friction force B7027influence range B = 4.487 (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 -6.276	6.616	0.00 0.00	0.00 66.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	66.16 146.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	66.16 146.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	146.90 149.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	146.90 149.00
5	sandy	-14.560 -16.350	1.790	149.00 179.43	149.00 166.90	13.00	0.00 23.27	0.4554 0.4554	0.00 7.82	149.00 174.72
6	sandy	-16.350 -19.350	3.000	179.43 230.43	166.90 196.90	13.00	23.27 62.27	0.4554 0.4554	7.82 20.94	174.72 217.84
7	cohesv	-19.350 -27.350	8.000	230.43 370.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	145.73 249.89	145.73 249.89
8	sandy	-27.350 -28.350	1.000	370.43 387.43	276.90 286.90	13.00	230.27 243.27	0.4701 0.4701	65.62 70.13	342.52 357.03
9	cohesv	-28.350 -30.350	2.000	387.43 422.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	261.65 287.69	261.65 287.69
10	sandy	-30.350 -33.392	3.042	422.43 474.14	306.90 337.32	20.00	285.27 346.10	0.4554 0.4554	78.59 93.82	385.49 431.14
11	sandy	-33.392 -34.616	1.225	474.14 494.95	337.32 349.56	20.00	346.10 370.59	0.4554 0.4554	93.82 99.96	431.14 449.52

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	sandy	-34.616 -36.350	1.734	494.95 524.43	349.56 366.90	20.00	370.59 405.27	0.4554 0.4554	99.96 108.64	449.52 475.54
13	sandy	-36.350 -45.084	8.734	524.43 672.91	366.90 454.24	30.00	405.27 667.30	0.4408 0.4408	105.17 155.22	472.07 609.46
14	sandy	-45.084 -46.350	1.266	672.91 694.43	454.24 466.90	30.00	667.30 705.27	0.4408 0.4408	155.22 162.47	609.46 629.37
15	cohesv	-46.350 -49.160	2.810	694.43 745.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	417.74 468.32	417.74 468.32

friction force B7027influence range B = 5.000 (m)

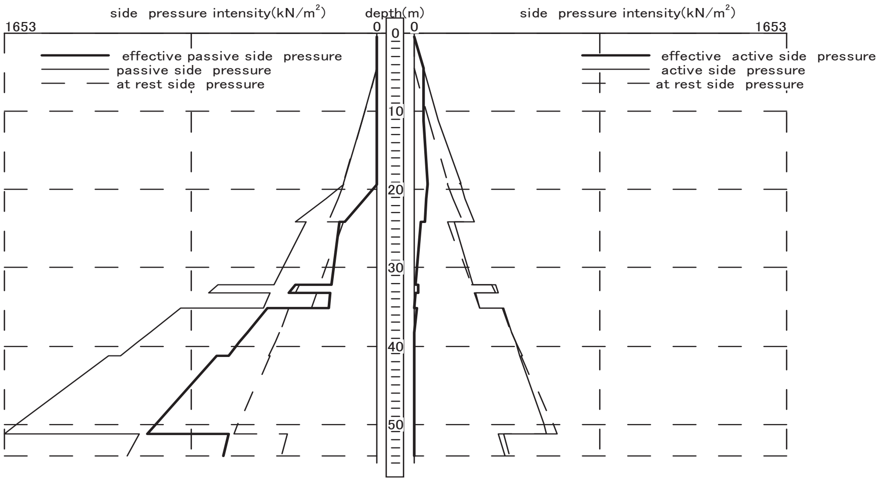
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

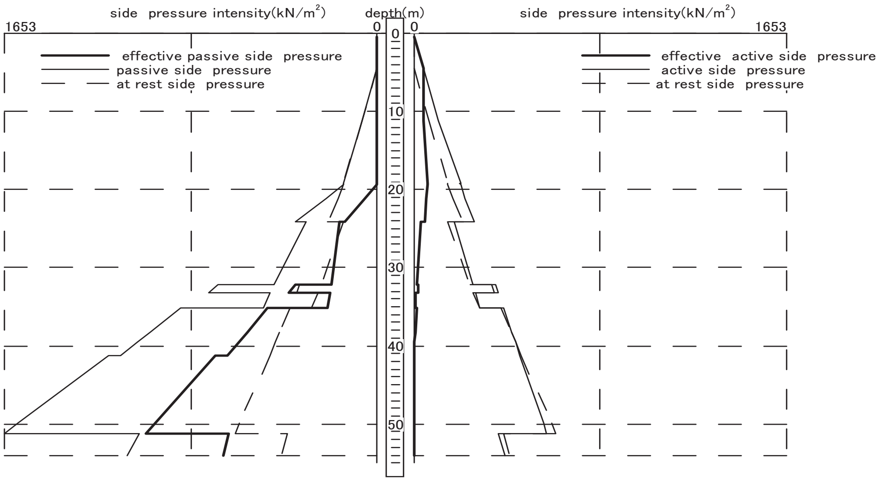
bridge axis direction

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/m^3)	c (kN/m^2)	Phi. (angle)	N
1	-------	+4.340 -2.660	7.000	----	----	----	----
2	-------	-2.660 -6.276	3.616	----	----	----	----
3	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
4	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
5	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
6	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
7	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
8	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
9	cohesv	-28.350 -30.201	1.851	17.5	42.0	0.00	7.0
10	cohesv	-30.201 -30.350	0.149	17.5	42.0	0.00	7.0
11	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
12	sandy	-36.350 -38.325	1.975	17.0	0.0	34.00	30.0
13	sandy	-38.325 -39.574	1.249	17.0	0.0	34.00	30.0
14	sandy	-39.574 -46.350	6.776	17.0	0.0	34.00	30.0
15	cohesv	-46.350 -49.160	2.810	18.0	180.0	0.00	30.0

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 -2.660	7.000	0.00 0.00	-------- --------	0.00 70.00	------- -------	------- -------	0.00 0.00	0.00 70.00
2	----	-2.660 -6.276	3.616	0.00 0.00	-------- --------	70.00 106.16	------- -------	------- -------	0.00 0.00	70.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51
4	sandy	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
5	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
6	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
8	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
9	cohesv	-28.350 -30.201	1.851	485.42 517.82	238.430 270.830	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 290.23	270.79 290.23
10	cohesv	-30.201 -30.350	0.149	517.82 520.42	270.830 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	290.23 291.79	290.23 291.79
11	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
12	sandy	-36.350 -38.325	1.975	622.42 655.99	0.000 0.000	406.90 426.65	0.2827 0.2827	------- -------	60.93 64.84	467.83 491.49
13	sandy	-38.325 -39.574	1.249	655.99 677.23	0.000 0.000	426.65 439.14	0.2827 0.2827	------- -------	64.84 67.31	491.49 506.45
14	sandy	-39.574 -46.350	6.776	677.23 792.42	0.000 0.000	439.14 506.90	0.2827 0.2827	------- -------	67.31 80.72	506.45 587.62
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	545.430 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 401.04	375.75 401.04

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -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 -6.276	3.616	0.00 0.00	0.00 36.16	0.0000 0.0000	0.00 0.00	0.00 36.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	36.16 116.90	0.0000 0.0000	0.00 0.00	36.16 116.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	116.90 119.00	0.0000 0.0000	0.00 0.00	116.90 119.00
5	sandy	-14.560 -16.350	1.790	150.00 180.43	119.00 136.90	4.8921 4.8921	151.66 212.95	270.66 349.85
6	sandy	-16.350 -19.350	3.000	180.43 231.43	136.90 166.90	4.8921 4.8921	212.95 315.69	349.85 482.59
7	cohesv	-19.350 -27.350	8.000	231.43 371.43	-------- --------	1.0000 1.0000	315.43 455.43	315.43 455.43
8	sandy	-27.350 -28.350	1.000	371.43 388.43	246.90 256.90	4.5985 4.5985	572.65 604.84	819.55 861.74
9	cohesv	-28.350 -30.201	1.851	388.43 420.83	-------- --------	1.0000 1.0000	472.43 504.83	472.43 504.83
10	cohesv	-30.201 -30.350	0.149	420.83 423.43	-------- --------	1.0000 1.0000	504.83 507.43	504.83 507.43
11	sandy	-30.350 -36.350	6.000	423.43 525.43	276.90 336.90	4.8921 4.8921	716.84 922.31	993.74 1259.21
12	sandy	-36.350 -38.325	1.975	525.43 559.01	336.90 356.65	5.2124 5.2124	982.70 1054.76	1319.60 1411.42
13	sandy	-38.325 -39.574	1.249	559.01 580.24	356.65 369.14	5.2124 5.2124	1054.76 1100.34	1411.42 1469.48
14	sandy	-39.574 -46.350	6.776	580.24 695.43	369.14 436.90	5.2124 5.2124	1100.34 1347.57	1469.48 1784.47
15	cohesv	-46.350 -49.160	2.810	695.43 746.01	-------- --------	1.0000 1.0000	1055.43 1106.01	1055.43 1106.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -2.660	7.000	0.00 0.00	0.00 70.00	0.0000 0.0000	0.00 0.00	0.00 70.00
2	-------	-2.660 -6.276	3.616	0.00 0.00	70.00 106.16	0.0000 0.0000	0.00 0.00	70.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
4	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
5	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01
6	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
8	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
9	cohesv	-28.350 -30.201	1.851	485.42 517.82	-------- --------	0.6000 0.6000	291.25 310.69	291.25 310.69
10	cohesv	-30.201 -30.350	0.149	517.82 520.42	-------- --------	0.6000 0.6000	310.69 312.25	310.69 312.25
11	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
12	sandy	-36.350 -38.325	1.975	622.42 655.99	406.90 426.65	0.4408 0.4408	95.00 101.10	501.90 527.75
13	sandy	-38.325 -39.574	1.249	655.99 677.23	426.65 439.14	0.4408 0.4408	101.10 104.95	527.75 544.09
14	sandy	-39.574 -46.350	6.776	677.23 792.42	439.14 506.90	0.4408 0.4408	104.95 125.86	544.09 632.76
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	-------- --------	0.5000 0.5000	396.21 421.50	396.21 421.50

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (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 -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 -6.276	3.616	0.00 0.00	0.00 36.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 36.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	36.16 116.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	36.16 116.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	116.90 119.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	116.90 119.00
5	sandy	-14.560 -16.350	1.790	150.00 180.43	119.00 136.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	133.12 159.08
6	sandy	-16.350 -19.350	3.000	180.43 231.43	136.90 166.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	159.08 202.60
7	cohesv	-19.350 -27.350	8.000	231.43 371.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	147.19 253.65	147.19 253.65
8	sandy	-27.350 -28.350	1.000	371.43 388.43	246.90 256.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	329.57 344.22
9	cohesv	-28.350 -30.201	1.851	388.43 420.83	-------- --------	21.00	243.27 282.15	0.6000 0.6000	265.59 290.23	265.59 290.23
10	cohesv	-30.201 -30.350	0.149	420.83 423.43	-------- --------	21.00	282.15 285.27	0.6000 0.6000	290.23 292.21	290.23 292.21
11	sandy	-30.350 -36.350	6.000	423.43 525.43	276.90 336.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	372.58 463.88
12	sandy	-36.350 -38.325	1.975	525.43 559.01	336.90 356.65	30.00	405.27 464.52	0.4408 0.4408	122.92 134.84	459.82 491.49
13	sandy	-38.325 -39.574	1.249	559.01 580.24	356.65 369.14	30.00	464.52 502.00	0.4408 0.4408	134.84 142.38	491.49 511.52
14	sandy	-39.574 -46.350	6.776	580.24 695.43	369.14 436.90	30.00	502.00 705.27	0.4408 0.4408	142.38 183.25	511.52 620.15

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	cohesv	-46.350 -49.160	2.810	695.43 746.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	426.31 479.79	426.31 479.79

friction force B7027influence range B = 4.487 (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 -6.276	3.616	0.00 0.00	0.00 36.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 36.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	36.16 116.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	36.16 116.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	116.90 119.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	116.90 119.00
5	sandy	-14.560 -16.350	1.790	150.00 180.43	119.00 136.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	133.12 158.84
6	sandy	-16.350 -19.350	3.000	180.43 231.43	136.90 166.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	158.84 201.96
7	cohesv	-19.350 -27.350	8.000	231.43 371.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	146.33 250.49	146.33 250.49
8	sandy	-27.350 -28.350	1.000	371.43 388.43	246.90 256.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	327.09 341.60
9	cohesv	-28.350 -30.201	1.851	388.43 420.83	-------- --------	21.00	243.27 282.15	0.6000 0.6000	262.25 286.36	262.25 286.36
10	cohesv	-30.201 -30.350	0.149	420.83 423.43	-------- --------	21.00	282.15 285.27	0.6000 0.6000	286.36 288.29	286.36 288.29
11	sandy	-30.350 -36.350	6.000	423.43 525.43	276.90 336.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	369.60 459.66

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	sandy	-36.350 -38.325	1.975	525.43 559.01	336.90 356.65	30.00	405.27 464.52	0.4408 0.4408	118.83 130.15	455.73 486.80
13	sandy	-38.325 -39.574	1.249	559.01 580.24	356.65 369.14	30.00	464.52 502.00	0.4408 0.4408	130.15 137.31	486.80 506.45
14	sandy	-39.574 -46.350	6.776	580.24 695.43	369.14 436.90	30.00	502.00 705.27	0.4408 0.4408	137.31 176.14	506.45 613.04
15	cohesv	-46.350 -49.160	2.810	695.43 746.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	418.24 468.82	418.24 468.82

friction force B7027influence range B = 5.000 (m)

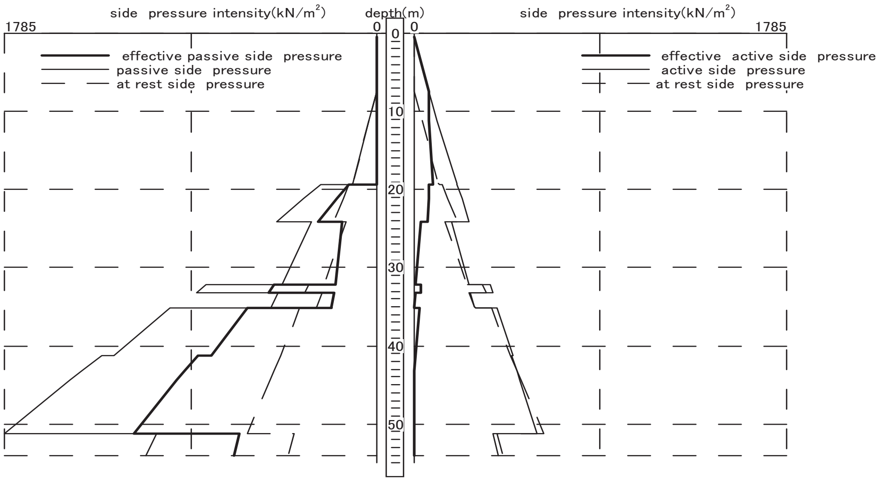
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

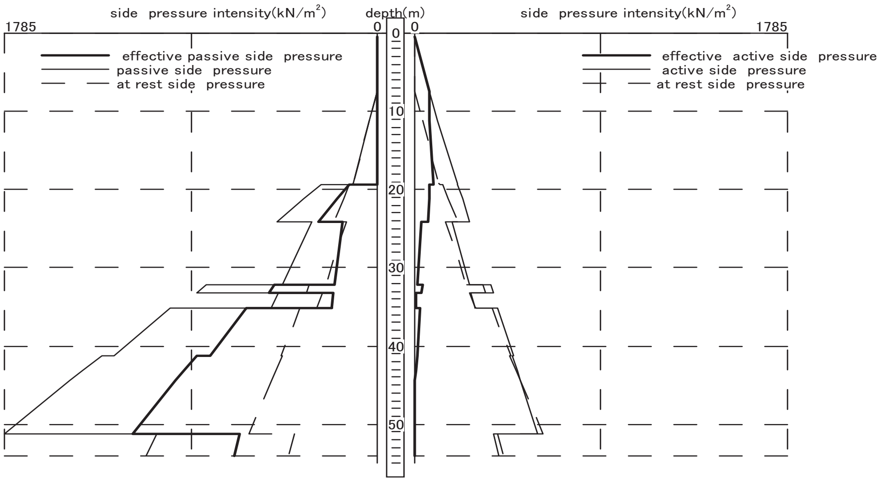
bridge axis direction

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 -6.276	10.616	----	----	----	----
2	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
3	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
4	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
7	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
8	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
9	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
10	sandy	-36.350 -46.350	10.000	17.0	0.0	34.00	30.0
11	cohesv	-46.350 -47.241	0.891	18.0	180.0	0.00	30.0
12	cohesv	-47.241 -48.240	0.999	18.0	180.0	0.00	30.0
13	cohesv	-48.240 -49.160	0.920	18.0	180.0	0.00	30.0

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 -6.276	10.616	0.00 0.00	-------- --------	0.00 106.16	------- -------	------- -------	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51

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	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
4	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
7	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
9	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
10	sandy	-36.350 -46.350	10.000	622.42 792.42	0.000 0.000	406.90 506.90	0.2827 0.2827	------- -------	60.93 80.72	467.83 587.62
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	545.430 561.467	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 383.77	375.75 383.77
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	561.467 579.443	-------- --------	0.4172 0.4172	0.5000 0.5000	383.77 392.75	383.77 392.75
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	579.443 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	392.75 401.04	392.75 401.04

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	10.616	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.350 -14.560	0.210	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	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	4.8921 4.8921	151.66 212.95	151.66 230.85
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	4.8921 4.8921	212.95 315.69	230.85 363.59
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	1.0000 1.0000	196.43 336.43	196.43 336.43
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	4.5985 4.5985	572.65 604.84	700.55 742.74
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	1.0000 1.0000	353.43 388.43	353.43 388.43
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	4.8921 4.8921	716.84 922.31	874.74 1140.21
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	5.2124 5.2124	982.70 1347.57	1200.60 1665.47
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	1.0000 1.0000	936.43 952.47	936.43 952.47
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	1.0000 1.0000	952.47 970.44	952.47 970.44
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	1.0000 1.0000	970.44 987.01	970.44 987.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -6.276	10.616	0.00 0.00	0.00 106.16	0.0000 0.0000	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
3	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
4	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
7	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
9	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
10	sandy	-36.350 -46.350	10.000	622.42 792.42	406.90 506.90	0.4408 0.4408	95.00 125.86	501.90 632.76
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	-------- --------	0.5000 0.5000	396.21 404.23	396.21 404.23
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	-------- --------	0.5000 0.5000	404.23 413.22	404.23 413.22
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	-------- --------	0.5000 0.5000	413.22 421.50	413.22 421.50

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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	14.12 40.08

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	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	40.08 83.60
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	75.79 182.25	75.79 182.25
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	210.57 225.22
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	194.19 220.81	194.19 220.81
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	253.58 344.88
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	122.92 183.25	340.82 501.15
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	366.81 383.77	366.81 383.77
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	383.77 402.77	383.77 402.77
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	402.77 420.29	402.77 420.29

friction force B7027influence range B = 4.487 (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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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)
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	14.12 39.84
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	39.84 82.96
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	74.93 179.09	74.93 179.09
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	208.09 222.60
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	190.85 216.89	190.85 216.89
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	250.60 340.66
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	118.83 176.14	336.73 494.04
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	358.74 374.78	358.74 374.78
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	374.78 392.75	374.78 392.75
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	392.75 409.32	392.75 409.32

friction force B7027influence range B = 5.000 (m)

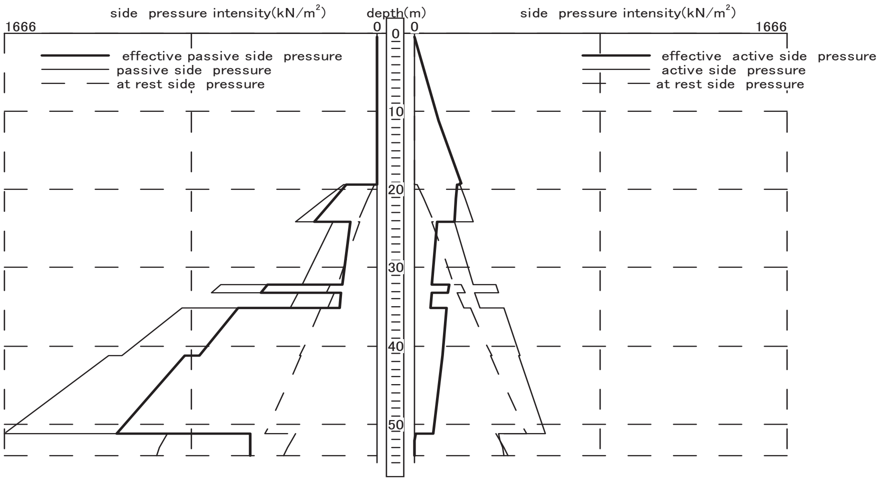
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

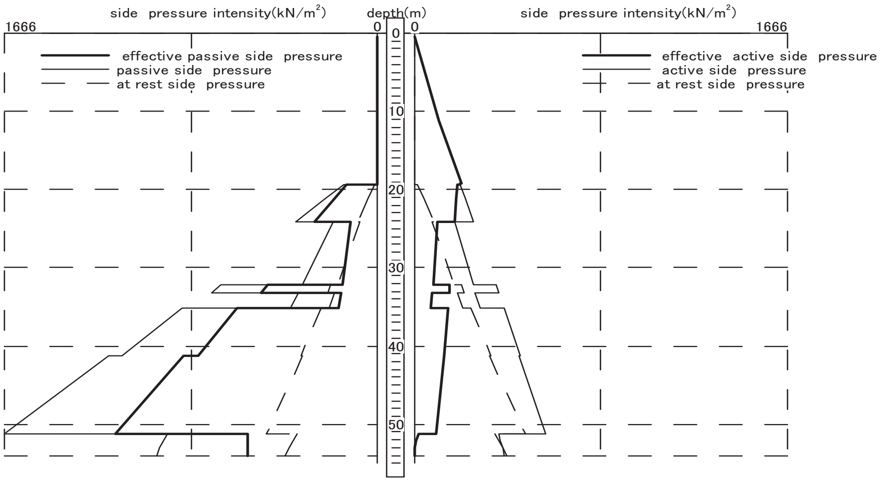
bridge axis direction

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 -6.276	10.616	----	----	----	----
2	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
3	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
4	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
7	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
8	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
9	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
10	sandy	-36.350 -46.350	10.000	17.0	0.0	34.00	30.0
11	cohesv	-46.350 -47.241	0.891	18.0	180.0	0.00	30.0
12	cohesv	-47.241 -48.240	0.999	18.0	180.0	0.00	30.0
13	cohesv	-48.240 -49.160	0.920	18.0	180.0	0.00	30.0

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 -6.276	10.616	0.00 0.00	-------- --------	0.00 106.16	------- -------	------- -------	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51

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	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
4	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
7	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
9	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
10	sandy	-36.350 -46.350	10.000	622.42 792.42	0.000 0.000	406.90 506.90	0.2827 0.2827	------- -------	60.93 80.72	467.83 587.62
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	545.430 561.467	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 383.77	375.75 383.77
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	561.467 579.443	-------- --------	0.4172 0.4172	0.5000 0.5000	383.77 392.75	383.77 392.75
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	579.443 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	392.75 401.04	392.75 401.04

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	10.616	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.350 -14.560	0.210	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	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	4.8921 4.8921	151.66 212.95	151.66 230.85
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	4.8921 4.8921	212.95 315.69	230.85 363.59
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	1.0000 1.0000	196.43 336.43	196.43 336.43
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	4.5985 4.5985	572.65 604.84	700.55 742.74
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	1.0000 1.0000	353.43 388.43	353.43 388.43
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	4.8921 4.8921	716.84 922.31	874.74 1140.21
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	5.2124 5.2124	982.70 1347.57	1200.60 1665.47
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	1.0000 1.0000	936.43 952.47	936.43 952.47
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	1.0000 1.0000	952.47 970.44	952.47 970.44
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	1.0000 1.0000	970.44 987.01	970.44 987.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -6.276	10.616	0.00 0.00	0.00 106.16	0.0000 0.0000	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
3	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
4	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
7	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
9	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
10	sandy	-36.350 -46.350	10.000	622.42 792.42	406.90 506.90	0.4408 0.4408	95.00 125.86	501.90 632.76
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	-------- --------	0.5000 0.5000	396.21 404.23	396.21 404.23
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	-------- --------	0.5000 0.5000	404.23 413.22	404.23 413.22
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	-------- --------	0.5000 0.5000	413.22 421.50	413.22 421.50

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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	14.12 40.08

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	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	40.08 83.60
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	75.79 182.25	75.79 182.25
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	210.57 225.22
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	194.19 220.81	194.19 220.81
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	253.58 344.88
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	122.92 183.25	340.82 501.15
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	366.81 383.77	366.81 383.77
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	383.77 402.77	383.77 402.77
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	402.77 420.29	402.77 420.29

friction force B7027influence range B = 4.487 (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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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)
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	14.12 39.84
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	39.84 82.96
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	74.93 179.09	74.93 179.09
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	208.09 222.60
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	190.85 216.89	190.85 216.89
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	250.60 340.66
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	118.83 176.14	336.73 494.04
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	358.74 374.78	358.74 374.78
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	374.78 392.75	374.78 392.75
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	392.75 409.32	392.75 409.32

friction force B7027influence range B = 5.000 (m)

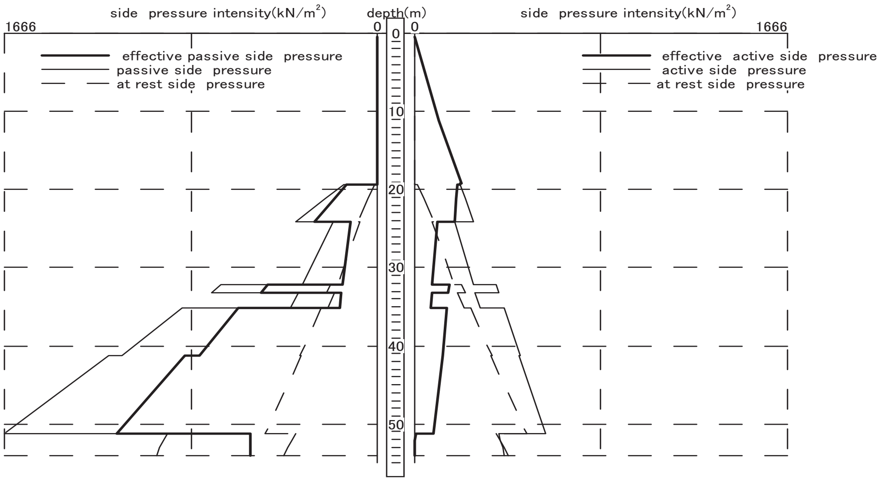
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

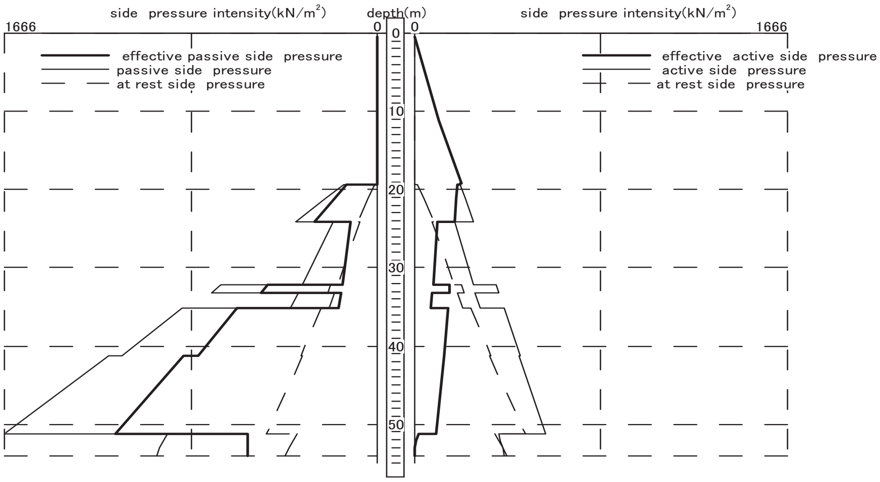
bridge axis direction

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 -6.276	10.616	----	----	----	----
2	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
3	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
4	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
7	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
8	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
9	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
10	sandy	-36.350 -46.350	10.000	17.0	0.0	34.00	30.0
11	cohesv	-46.350 -47.241	0.891	18.0	180.0	0.00	30.0
12	cohesv	-47.241 -48.240	0.999	18.0	180.0	0.00	30.0
13	cohesv	-48.240 -49.160	0.920	18.0	180.0	0.00	30.0

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 -6.276	10.616	0.00 0.00	-------- --------	0.00 106.16	------- -------	------- -------	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51

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	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
4	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
7	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
9	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
10	sandy	-36.350 -46.350	10.000	622.42 792.42	0.000 0.000	406.90 506.90	0.2827 0.2827	------- -------	60.93 80.72	467.83 587.62
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	545.430 561.467	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 383.77	375.75 383.77
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	561.467 579.443	-------- --------	0.4172 0.4172	0.5000 0.5000	383.77 392.75	383.77 392.75
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	579.443 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	392.75 401.04	392.75 401.04

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/m^2)	pw2 (kN/m^2)	Kp	Pp1 (kN/m^2)	Pp (kN/m^2)
1	----	+4.340 -6.276	10.616	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.350 -14.560	0.210	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	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	4.8921 4.8921	151.66 212.95	151.66 230.85
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	4.8921 4.8921	212.95 315.69	230.85 363.59
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	1.0000 1.0000	196.43 336.43	196.43 336.43
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	4.5985 4.5985	572.65 604.84	700.55 742.74
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	1.0000 1.0000	353.43 388.43	353.43 388.43
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	4.8921 4.8921	716.84 922.31	874.74 1140.21
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	5.2124 5.2124	982.70 1347.57	1200.60 1665.47
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	1.0000 1.0000	936.43 952.47	936.43 952.47
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	1.0000 1.0000	952.47 970.44	952.47 970.44
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	1.0000 1.0000	970.44 987.01	970.44 987.01

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/m^2)	pw1 (kN/m^2)	Ko	Po1 (kN/m^2)	Po (kN/m^2)
1	-------	+4.340 -6.276	10.616	0.00 0.00	0.00 106.16	0.0000 0.0000	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
3	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
4	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
7	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
9	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
10	sandy	-36.350 -46.350	10.000	622.42 792.42	406.90 506.90	0.4408 0.4408	95.00 125.86	501.90 632.76
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	-------- --------	0.5000 0.5000	396.21 404.23	396.21 404.23
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	-------- --------	0.5000 0.5000	404.23 413.22	404.23 413.22
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	-------- --------	0.5000 0.5000	413.22 421.50	413.22 421.50

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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	14.12 40.08

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	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	40.08 83.60
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	75.79 182.25	75.79 182.25
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	210.57 225.22
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	194.19 220.81	194.19 220.81
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	253.58 344.88
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	122.92 183.25	340.82 501.15
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	366.81 383.77	366.81 383.77
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	383.77 402.77	383.77 402.77
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	402.77 420.29	402.77 420.29

friction force B7027influence range B = 4.487 (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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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)
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	14.12 39.84
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	39.84 82.96
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	74.93 179.09	74.93 179.09
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	208.09 222.60
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	190.85 216.89	190.85 216.89
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	250.60 340.66
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	118.83 176.14	336.73 494.04
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	358.74 374.78	358.74 374.78
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	374.78 392.75	374.78 392.75
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	392.75 409.32	392.75 409.32

friction force B7027influence range B = 5.000 (m)

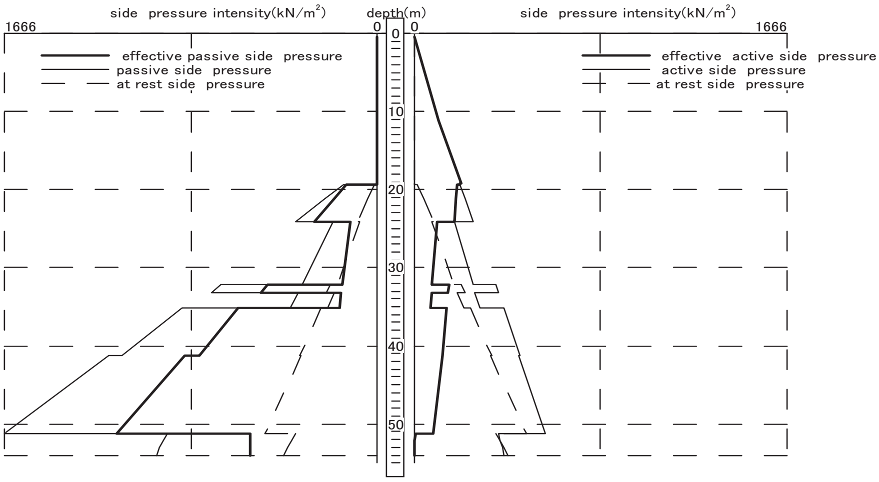
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

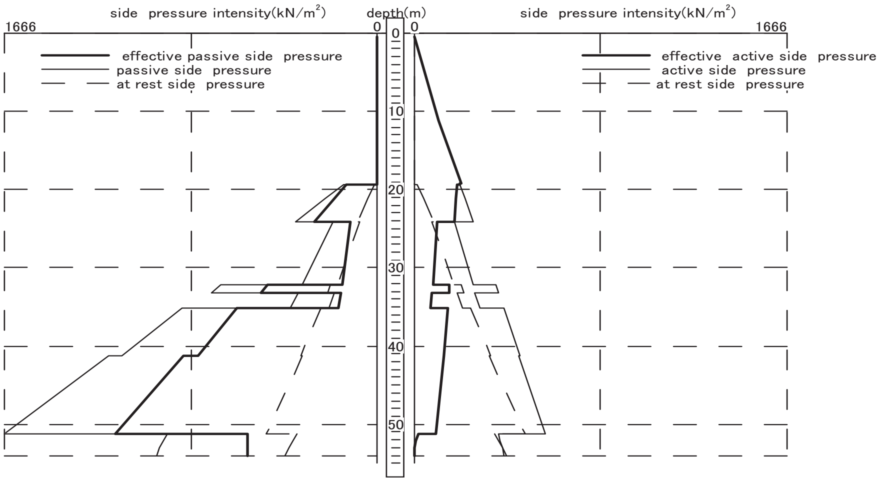
bridge axis direction

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	3.800	8.491	9.376	9.499
	accrue location	Lm	m	-5.160	-9.160	-8.160	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	1107.0	1851.0	2435.0	2570.0
		Sig.	N/mm²	104.81	175.32	230.64	243.43
		Lm	m	-3.160	-8.060	-7.160	-7.160
	SKY400	M	kN.m	1107.0	1305.0	1849.0	1887.0
		Sig.max	N/mm²	104.81	123.56	175.08	178.71
		Lm	m	-3.160	-3.160	-3.160	-3.160
	SKY490	M	kN.m	1107.0	1851.0	2435.0	2570.0
		Sig.max	N/mm²	104.81	175.32	230.64	243.43
		Lm	m	-3.160	-8.060	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	703.0	1852.0	2411.0	2491.0
		Sig.	N/mm²	66.60	175.39	228.33	235.94
		Lm	m	-8.060	-8.160	-8.060	-8.060
	SKY400	M	kN.m	-442.0	1492.0	1511.0	-704.0
		Sig.max	N/mm²	36.81	124.25	125.88	58.61
		Lm	m	-18.160	-12.160	-12.160	-22.091
	SKY490	M	kN.m	703.0	1852.0	2411.0	2491.0
		Sig.max	N/mm²	66.60	175.39	228.33	235.94
		Lm	m	-8.060	-8.160	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	232.6	0.0	0.0	0.0
		2nd row	kN/m	------	431.7	568.4	550.2
		3rd row	kN/m	------	------	------	80.3
		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	22.1	1129.1

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	9.499	9.487
	accrue location	Lm	m	-8.060	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	2570.0	2578.0
		Sig.	N/mm²	243.43	244.11
		Lm	m	-7.160	-7.160
	SKY400	M	kN.m	1887.0	1892.0
		Sig.max	N/mm²	178.71	179.17
		Lm	m	-3.160	-3.160
	SKY490	M	kN.m	2570.0	2578.0
		Sig.max	N/mm²	243.43	244.11
		Lm	m	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	2491.0	2499.0
		Sig.	N/mm²	235.94	236.68
		Lm	m	-8.060	-8.060
	SKY400	M	kN.m	-704.0	-702.0
		Sig.max	N/mm²	58.61	58.50
		Lm	m	-22.089	-22.105
	SKY490	M	kN.m	2491.0	2499.0
		Sig.max	N/mm²	235.94	236.68
		Lm	m	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	550.2	551.5
		3rd row	kN/m	80.3	79.6
		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	1129.1	1126.4

note)Lm shows elevation

2)perpendicular direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	3.812	8.519	9.408	9.629
	accrue location	Lm	m	-5.160	-9.160	-8.160	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	1106.0	1851.0	2437.0	2583.0
		Sig.	N/mm²	104.77	175.32	230.82	244.57
		Lm	m	-3.160	-8.060	-7.160	-7.160
	SKY400	M	kN.m	1106.0	1305.0	1850.0	1870.0
		Sig.max	N/mm²	104.77	123.56	175.18	177.09
		Lm	m	-3.160	-3.160	-3.160	-3.160
	SKY490	M	kN.m	1106.0	1851.0	2437.0	2583.0
		Sig.max	N/mm²	104.77	175.32	230.82	244.57
		Lm	m	-3.160	-8.060	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	703.0	1852.0	2413.0	2510.0
		Sig.	N/mm²	66.54	175.39	228.53	237.71
		Lm	m	-8.060	-8.160	-8.060	-8.060
	SKY400	M	kN.m	-439.0	1492.0	1515.0	731.0
		Sig.max	N/mm²	36.56	124.25	126.13	60.90
		Lm	m	-18.160	-12.160	-12.160	-12.160
	SKY490	M	kN.m	703.0	1852.0	2413.0	2510.0
		Sig.max	N/mm²	66.54	175.39	228.53	237.71
		Lm	m	-8.060	-8.160	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	232.6	0.0	0.0	0.0
		2nd row	kN/m	------	431.7	568.7	540.9
		3rd row	kN/m	------	------	------	97.0
		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	20.1	1111.4

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	9.629	9.617
	accrue location	Lm	m	-8.060	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	2583.0	2590.0
		Sig.	N/mm²	244.57	245.28
		Lm	m	-7.160	-7.160
	SKY400	M	kN.m	1870.0	1875.0
		Sig.max	N/mm²	177.09	177.55
		Lm	m	-3.160	-3.160
	SKY490	M	kN.m	2583.0	2590.0
		Sig.max	N/mm²	244.57	245.28
		Lm	m	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	2510.0	2518.0
		Sig.	N/mm²	237.71	238.47
		Lm	m	-8.060	-8.060
	SKY400	M	kN.m	731.0	743.0
		Sig.max	N/mm²	60.90	61.90
		Lm	m	-12.160	-12.160
	SKY490	M	kN.m	2510.0	2518.0
		Sig.max	N/mm²	237.71	238.47
		Lm	m	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	540.9	542.2
		3rd row	kN/m	97.0	96.3
		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	1111.4	1109.0

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	-0.190	6.131	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.117	6.131	0.0	0.0	0.00	0.0	0.0	
232.6										
	+4.340	0.3	0.117	6.131	0.0	232.6	0.00	0.0	0.0	
	+3.840	5.3	0.423	6.108	116.1	231.2	10.99	0.0	0.0	
	+2.840	15.2	1.026	5.927	343.0	221.0	32.48	0.0	0.0	
	+1.840	25.2	1.602	5.571	554.7	200.8	52.53	0.0	0.0	
	+1.340	30.2	1.875	5.333	651.7	186.9	61.72	0.0	0.0	
	+0.840	35.2	2.135	5.058	741.2	170.5	70.19	0.0	0.0	
	+0.340	40.2	2.380	4.749	821.9	151.7	77.83	0.0	0.0	
	-0.160	40.2	2.609	4.410	892.7	131.6	84.54	0.0	0.0	
	-1.160	40.2	3.014	3.659	1004.2	91.4	95.10	0.0	0.0	
	-1.660	40.2	3.187	3.255	1044.9	71.3	98.95	0.0	0.0	
	-2.160	40.1	3.339	2.836	1075.6	51.3	101.86	0.0	0.0	
	-3.160	40.1	3.580	1.972	1106.8	11.1	104.81	0.0	0.0	
	-3.160	40.1	3.580	1.972	1106.8	11.1	104.81	0.0	0.0	
	-4.160	40.1	3.733	1.100	1097.8	-29.0	103.97	0.0	0.0	
	-4.660	40.1	3.777	0.670	1078.3	-49.0	102.12	0.0	0.0	
	-5.160	40.1	3.800	0.250	1048.8	-69.1	99.32	0.0	0.0	
	-6.160	40.1	3.785	-0.545	959.7	-109.2	90.88	0.0	0.0	
	-6.276	40.1	3.778	-0.632	946.7	-113.8	89.66	0.0	0.0	
	-6.276	40.0	3.778	-0.632	946.7	-113.8	89.66	0.0	0.0	*
	-7.160	38.7	3.694	-1.255	833.3	-139.6	78.92	20.3	20.3	*
	-8.060	37.3	3.556	-1.801	703.3	-146.1	66.60	41.0	41.0	*
	-8.060	37.3	3.556	-1.801	703.3	-146.1	66.60	41.0	41.0	
	-8.160	37.1	3.538	-1.856	688.7	-145.8	65.22	40.8	43.3	
	-9.160	35.6	3.327	-2.342	544.6	-142.5	51.58	38.4	66.4	
	-10.160	34.1	3.073	-2.716	403.2	-140.4	38.19	35.4	89.4	
	-11.160	32.6	2.787	-2.979	263.2	-140.0	24.93	32.1	112.4	
	-12.060	31.2	2.512	-3.121	136.8	-141.1	12.96	29.0	133.1	
	-12.160	31.0	2.481	-3.131	122.7	-141.4	11.62	28.6	135.4	
	-12.160	31.0	2.481	-3.131	122.7	-141.4	10.22	28.6	135.4	
	-13.060	29.7	2.197	-3.168	-5.8	-144.4	0.48	25.3	156.1	
	-13.160	29.5	2.165	-3.167	-20.3	-144.9	1.69	25.0	158.4	

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
	-14.160	28.0	1.851	-3.102	-167.8	-150.5	13.97	21.3	181.4	
	-14.350	28.5	1.792	-3.078	-196.5	-151.8	16.36	89.6	248.3	
	-15.160	26.5	1.548	-2.937	-300.5	-106.5	25.03	77.4	272.4	
	-16.060	24.3	1.293	-2.723	-377.2	-65.5	31.41	64.6	299.1	
	-16.160	24.0	1.266	-2.697	-383.6	-61.5	31.94	63.3	302.1	
	-16.350	23.6	1.215	-2.645	-394.6	-54.3	32.86	60.7	307.8	
	-17.160	21.6	1.010	-2.413	-427.3	-27.6	35.58	50.5	331.9	
	-18.160	19.2	0.784	-2.110	-442.0	-3.3	36.81	39.2	361.6	
	-19.160	16.7	0.588	-1.805	-436.5	12.9	36.35	29.4	391.3	
	-19.350	12.1	0.554	-1.747	-433.8	15.2	36.13	26.1	187.4	
	-20.160	9.8	0.423	-1.508	-417.4	24.9	34.76	19.9	190.8	
	-21.160	7.0	0.286	-1.228	-388.0	33.1	32.31	13.5	195.0	
	-22.160	4.2	0.176	-0.971	-352.1	38.3	29.32	8.3	199.2	
	-23.160	1.4	0.091	-0.740	-311.9	41.8	25.98	4.3	203.4	
	-23.647	0.0	0.057	-0.638	-291.2	43.1	24.25	2.7	205.5	
	-24.160	0.0	0.027	-0.538	-268.8	44.1	22.39	1.3	209.0	
	-24.624	0.0	0.004	-0.455	-248.3	44.5	20.68	0.2	212.3	
	-25.160	0.0	-0.018	-0.367	-224.4	44.3	18.69	0.0	216.0	
	-26.160	0.0	-0.047	-0.227	-180.8	42.7	15.06	0.0	223.0	
	-27.160	0.0	-0.064	-0.116	-139.4	40.1	11.61	0.0	230.0	
	-27.350	0.0	-0.066	-0.098	-131.8	39.5	10.98	0.0	598.6	
	-28.160	0.0	-0.071	-0.032	-101.8	34.6	8.48	0.0	620.9	
	-28.160	0.0	-0.071	-0.032	-101.8	34.6	9.64	0.0	620.9	
	-28.350	0.0	-0.072	-0.018	-95.4	33.4	9.03	0.0	238.2	
	-29.160	0.0	-0.071	0.035	-69.4	30.7	6.57	0.0	243.8	
	-30.160	0.0	-0.065	0.078	-40.4	27.4	3.83	0.0	250.8	
	-30.350	0.0	-0.063	0.084	-35.2	26.9	3.34	0.0	738.2	
	-31.160	0.0	-0.056	0.100	-16.2	20.3	1.53	0.0	761.7	
	-32.160	0.0	-0.046	0.106	0.6	13.5	0.06	0.0	790.7	
	-33.160	0.0	-0.035	0.101	11.3	8.1	1.07	0.0	819.7	
	-34.160	0.0	-0.026	0.089	17.3	4.0	1.63	0.0	848.8	
	-34.444	0.0	-0.023	0.085	18.3	3.1	1.73	0.0	857.0	
	-35.160	0.0	-0.017	0.074	19.7	1.1	1.87	0.0	879.2	
	-36.160	0.0	-0.011	0.059	19.8	-0.8	1.88	0.0	910.3	
	-36.350	0.0	-0.010	0.056	19.7	-1.0	1.86	0.0	988.4	
	-37.065	0.0	-0.006	0.045	18.5	-2.2	1.75	0.0	1012.2	

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
	-37.160	0.0	-0.006	0.043	18.3	-2.3	1.73	0.0	1015.4	
	-38.160	0.0	-0.002	0.030	15.6	-3.0	1.47	0.0	1048.8	
	-39.160	0.0	0.000	0.019	12.4	-3.2	1.17	0.1	1082.2	
	-40.160	0.0	0.002	0.010	9.3	-3.0	0.88	0.4	1115.6	
	-41.160	0.0	0.003	0.004	6.5	-2.5	0.62	0.5	1149.0	
	-42.160	0.0	0.003	0.000	4.3	-2.0	0.40	0.5	1182.4	
	-43.160	0.0	0.003	-0.003	2.6	-1.5	0.24	0.5	1215.8	
	-44.160	0.0	0.002	-0.004	1.3	-1.0	0.13	0.4	1249.2	
	-45.160	0.0	0.002	-0.005	0.6	-0.6	0.06	0.4	1282.6	
	-46.160	0.0	0.001	-0.005	0.2	-0.3	0.02	0.2	1316.0	
	-46.350	0.0	0.001	-0.005	0.1	-0.2	0.01	0.2	716.2	
	-47.160	0.0	0.001	-0.005	0.0	-0.1	0.00	0.1	723.5	
	-48.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.0	732.5	
	-49.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.0	741.5	

*showing plastic

(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	-1.589	10.135	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.082	10.135	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.082	10.135	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.576	10.135	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.438	10.137	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.452	10.149	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.960	10.163	-46.1	-45.7	4.37	0.0	0.0	
431.7										
	+1.340	30.2	1.960	10.163	-46.1	386.0	4.37	0.0	0.0	
	+0.840	35.2	2.468	10.143	142.9	369.6	13.53	0.0	0.0	
	+0.340	40.2	2.973	10.051	323.1	350.8	30.60	0.0	0.0	
	-0.160	40.2	3.472	9.890	493.4	330.7	46.73	0.0	0.0	
	-1.160	40.2	4.437	9.375	804.0	290.5	76.14	0.0	0.0	
	-1.660	40.2	4.897	9.030	944.3	270.4	89.42	0.0	0.0	
	-2.160	40.1	5.339	8.631	1074.5	250.4	101.75	0.0	0.0	
	-3.160	40.1	6.157	7.690	1304.8	210.2	123.56	0.0	0.0	
	-3.160	40.1	6.157	7.690	1304.8	210.2	123.56	0.0	0.0	
	-4.160	40.1	6.872	6.583	1494.9	170.1	141.57	0.0	0.0	
	-4.660	40.1	7.186	5.977	1574.9	150.0	149.15	0.0	0.0	
	-5.160	40.1	7.469	5.341	1645.0	130.0	155.78	0.0	0.0	
	-6.160	40.1	7.936	3.997	1754.9	89.9	166.19	0.0	0.0	
	-6.276	40.0	7.982	3.836	1765.1	85.3	167.15	0.0	0.0	
	-7.160	42.1	8.266	2.582	1824.5	49.0	172.79	0.0	0.0	
	-8.060	44.3	8.439	1.274	1851.2	10.0	175.32	0.0	0.0	
	-8.160	44.6	8.451	1.128	1852.0	5.6	175.39	0.0	0.0	
	-9.160	47.0	8.491	-0.330	1834.9	-40.2	173.77	0.0	0.0	
	-10.160	49.4	8.386	-1.756	1770.8	-88.4	167.70	0.0	0.0	
	-11.160	51.9	8.142	-3.112	1657.3	-139.1	156.95	0.0	0.0	
	-12.060	54.0	7.811	-4.239	1510.9	-186.7	143.08	0.0	0.0	
	-12.160	54.3	7.768	-4.358	1491.9	-192.1	141.29	0.0	0.0	
	-12.160	54.3	7.768	-4.358	1491.9	-192.1	124.25	0.0	0.0	
	-13.060	56.5	7.335	-5.231	1296.7	-242.0	107.99	0.0	0.0	
	-13.160	56.7	7.283	-5.320	1272.2	-247.6	105.95	0.0	0.0	
	-14.160	59.1	6.709	-6.111	995.8	-305.6	82.93	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
	-14.350	56.7	6.592	-6.238	936.7	-316.9	78.01	0.0	0.0	
	-14.560	57.1	6.460	-6.370	868.9	-328.8	72.36	0.0	0.0	
	-14.560	57.1	6.460	-6.370	868.9	-328.8	72.36	0.0	0.0	*
	-15.160	55.6	6.067	-6.689	662.5	-357.3	55.17	17.8	17.8	*
	-16.060	53.4	5.450	-7.000	329.6	-378.2	27.45	44.6	44.6	*
	-16.160	53.2	5.380	-7.022	291.7	-379.0	24.29	47.6	47.6	*
	-16.350	52.7	5.246	-7.055	219.6	-379.4	18.29	53.2	53.2	*
	-17.160	50.7	4.672	-7.093	-84.7	-368.5	7.05	77.3	77.3	*
	-18.160	48.3	3.970	-6.910	-434.5	-325.8	36.19	107.1	107.1	*
	-19.160	45.9	3.297	-6.503	-725.6	-251.0	60.43	136.8	136.8	*
	-19.350	45.4	3.175	-6.405	-771.6	-233.1	64.26	142.4	142.4	*
	-19.350	30.0	3.175	-6.405	-771.6	-233.1	64.26	149.5	167.8	
	-20.160	27.7	2.675	-5.925	-923.6	-145.0	76.92	126.0	171.2	
	-21.160	24.9	2.116	-5.244	-1023.5	-58.8	85.24	99.7	175.4	
	-22.160	22.1	1.627	-4.521	-1048.5	5.6	87.32	76.6	179.6	
	-23.160	19.3	1.211	-3.801	-1018.6	51.4	84.83	57.1	183.8	
	-24.160	16.5	0.866	-3.116	-950.7	82.2	79.17	40.8	188.0	
	-25.160	13.7	0.586	-2.488	-858.2	101.0	71.47	27.6	192.2	
	-26.160	10.9	0.366	-1.928	-751.6	110.9	62.59	17.2	196.4	
	-27.160	8.1	0.198	-1.446	-638.4	114.6	53.17	9.3	200.6	
	-27.350	18.5	0.171	-1.363	-616.6	114.7	51.35	15.0	362.0	
	-28.160	16.4	0.074	-1.042	-525.6	109.1	43.77	6.5	384.3	
	-28.160	16.4	0.074	-1.042	-525.6	109.1	49.77	6.5	384.3	
	-28.350	5.8	0.055	-0.965	-505.0	107.1	47.83	2.6	206.4	
	-29.160	3.5	-0.011	-0.670	-419.4	104.1	39.72	0.0	209.8	
	-30.160	0.7	-0.062	-0.379	-317.3	100.2	30.05	0.0	214.0	
	-30.350	9.6	-0.069	-0.333	-298.3	99.5	28.25	0.0	483.6	
	-31.160	7.0	-0.089	-0.167	-224.0	84.0	21.21	0.0	507.1	
	-32.160	3.9	-0.098	-0.021	-149.2	65.8	14.13	0.0	536.2	
	-33.160	0.7	-0.095	0.073	-91.4	50.4	8.66	0.0	565.2	
	-33.392	0.0	-0.093	0.089	-80.1	47.4	7.58	0.0	571.9	
	-34.160	0.0	-0.085	0.127	-47.3	38.2	4.48	0.0	594.2	
	-34.616	0.0	-0.079	0.141	-31.0	33.2	2.94	0.0	607.5	
	-35.160	0.0	-0.071	0.151	-14.5	27.7	1.37	0.0	623.2	
	-36.160	0.0	-0.055	0.152	8.9	19.3	0.84	0.0	652.3	
	-36.350	0.0	-0.052	0.151	12.4	17.9	1.17	0.0	711.9	

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
	-37.160	0.0	-0.041	0.139	23.7	10.3	2.24	0.0	736.5	
	-38.160	0.0	-0.028	0.117	30.3	3.4	2.87	0.0	767.0	
	-39.160	0.0	-0.017	0.093	31.3	-1.1	2.97	0.0	797.4	
	-40.160	0.0	-0.009	0.069	28.8	-3.7	2.73	0.0	827.9	
	-41.160	0.0	-0.003	0.048	24.4	-4.9	2.31	0.0	858.3	
	-42.160	0.0	0.000	0.030	19.3	-5.2	1.83	0.1	888.8	
	-43.160	0.0	0.003	0.017	14.3	-4.8	1.35	0.6	919.2	
	-44.160	0.0	0.004	0.008	9.8	-4.1	0.93	0.8	949.7	
	-45.084	0.0	0.004	0.002	6.4	-3.3	0.60	0.9	977.8	
	-45.160	0.0	0.004	0.001	6.1	-3.2	0.58	0.9	980.4	
	-46.160	0.0	0.004	-0.002	3.3	-2.3	0.31	0.9	1013.8	
	-46.350	0.0	0.004	-0.003	2.9	-2.2	0.27	0.9	658.2	
	-47.160	0.0	0.004	-0.004	1.4	-1.5	0.13	0.8	665.5	
	-48.160	0.0	0.004	-0.005	0.3	-0.7	0.03	0.7	674.5	
	-49.160	0.0	0.003	-0.005	0.0	0.0	0.00	0.6	683.5	

*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	-2.366	12.431	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.744	12.431	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.744	12.431	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.123	12.431	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.120	12.433	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.364	12.445	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.987	12.459	-46.1	-45.7	4.37	0.0	0.0	
568.4										
	+1.340	30.2	1.987	12.459	-46.1	522.7	4.37	0.0	0.0	
	+0.840	35.2	2.609	12.426	211.2	506.4	20.00	0.0	0.0	
	-0.160	45.2	3.837	12.064	698.3	466.2	66.13	0.0	0.0	
	-1.160	55.2	5.010	11.336	1140.2	416.0	107.98	0.0	0.0	
	-1.660	60.2	5.565	10.846	1341.1	387.2	127.01	0.0	0.0	
	-2.160	65.1	6.093	10.279	1527.0	355.8	144.61	0.0	0.0	
	-2.660	70.1	6.591	9.643	1696.5	322.0	160.66	0.0	0.0	
	-3.160	70.1	7.056	8.943	1848.8	286.9	175.08	0.0	0.0	
	-3.160	70.1	7.056	8.943	1848.8	286.9	175.08	0.0	0.0	
	-4.160	70.1	7.874	7.380	2100.6	216.8	198.93	0.0	0.0	
	-4.660	70.1	8.222	6.531	2200.3	181.8	208.37	0.0	0.0	
	-5.160	70.1	8.526	5.646	2282.4	146.7	216.15	0.0	0.0	
	-6.160	70.1	8.999	3.796	2394.1	76.6	226.72	0.0	0.0	
	-6.276	70.0	9.042	3.576	2402.5	68.5	227.52	0.0	0.0	
	-7.160	72.1	9.284	1.885	2435.5	5.7	230.64	0.0	0.0	
	-8.060	74.3	9.376	0.161	2411.1	-60.2	228.33	0.0	0.0	
	-8.160	74.6	9.376	-0.029	2404.7	-67.7	227.72	0.0	0.0	
	-9.160	77.0	9.279	-1.891	2299.3	-143.5	217.75	0.0	0.0	
	-10.160	79.4	9.002	-3.638	2116.9	-221.7	200.48	0.0	0.0	
	-11.160	81.9	8.558	-5.211	1855.1	-302.3	175.68	0.0	0.0	
	-12.060	84.0	8.032	-6.424	1549.6	-377.0	146.75	0.0	0.0	
	-12.160	84.3	7.968	-6.545	1511.5	-385.4	143.14	0.0	0.0	
	-12.160	84.3	7.968	-6.545	1511.5	-385.4	125.88	0.0	0.0	
	-13.060	86.5	7.340	-7.373	1135.7	-462.3	94.58	0.0	0.0	
22.1										
	-13.060	86.5	7.340	-7.373	1135.7	-440.2	94.58	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
	-13.160	86.7	7.265	-7.450	1090.2	-448.8	90.79	0.0	0.0	
	-14.160	89.1	6.488	-8.038	593.1	-536.8	49.39	0.0	0.0	
	-14.350	86.7	6.335	-8.109	489.5	-553.7	40.77	0.0	0.0	
	-14.560	87.1	6.164	-8.172	371.3	-572.0	30.92	0.0	0.0	
	-14.560	73.0	6.164	-8.172	371.3	-572.0	30.92	137.5	137.5	*
	-15.160	71.5	5.670	-8.257	40.9	-527.5	3.41	155.4	155.4	*
	-16.060	69.3	4.930	-8.142	-395.9	-438.9	32.97	182.1	182.1	*
	-16.160	69.1	4.849	-8.113	-439.3	-427.5	36.58	185.1	185.1	*
	-16.350	68.6	4.695	-8.050	-518.3	-404.9	43.17	190.8	190.8	*
	-16.977	67.1	4.199	-7.773	-746.8	-322.0	62.19	209.4	209.4	*
	-16.977	67.1	4.199	-7.773	-746.8	-322.0	62.19	209.9	209.4	
	-17.160	66.6	4.057	-7.674	-803.4	-296.4	66.91	202.8	214.9	
	-18.160	64.2	3.321	-7.028	-1037.6	-177.7	86.41	166.0	244.6	
	-19.160	61.7	2.656	-6.257	-1169.7	-91.6	97.42	132.7	274.3	
	-19.350	29.4	2.539	-6.102	-1185.9	-78.6	98.76	119.6	168.2	
	-20.160	27.1	2.072	-5.423	-1222.2	-13.8	101.79	97.6	171.6	
	-21.160	24.3	1.572	-4.577	-1204.4	46.0	100.30	74.0	175.8	
	-22.160	21.5	1.155	-3.763	-1136.6	86.9	94.65	54.4	180.0	
	-23.160	18.7	0.817	-3.007	-1035.5	113.0	86.24	38.5	184.2	
	-24.160	15.9	0.551	-2.330	-914.4	127.6	76.15	26.0	188.4	
	-25.160	13.1	0.348	-1.741	-783.0	134.1	65.21	16.4	192.6	
	-26.160	10.3	0.200	-1.244	-648.0	135.1	53.97	9.4	196.8	
	-27.160	7.5	0.096	-0.841	-513.7	133.1	42.78	4.5	201.0	
	-27.350	33.9	0.081	-0.775	-488.5	132.5	40.68	7.1	490.0	
	-28.160	31.9	0.029	-0.529	-390.3	109.6	32.51	2.5	512.3	
	-28.160	31.9	0.029	-0.529	-390.3	109.6	36.96	2.5	512.3	
	-28.350	5.2	0.019	-0.472	-370.0	104.0	35.04	0.9	206.8	
	-29.160	2.9	-0.010	-0.262	-287.1	100.8	27.19	0.0	210.2	
	-30.160	0.1	-0.026	-0.075	-187.7	98.4	17.77	0.0	214.4	
	-30.201	0.0	-0.027	-0.069	-183.6	98.3	17.39	0.0	214.6	
	-30.350	25.5	-0.028	-0.048	-169.0	98.1	16.01	0.0	621.2	
	-31.160	22.9	-0.028	0.037	-98.9	75.4	9.36	0.0	644.7	
	-32.160	19.8	-0.021	0.088	-36.1	50.8	3.42	0.0	673.7	
	-33.160	16.6	-0.011	0.100	4.1	30.4	0.39	0.0	702.7	
	-34.160	13.5	-0.002	0.087	26.1	14.5	2.48	0.0	731.8	
	-35.160	10.3	0.006	0.062	34.4	2.8	3.26	0.7	760.8	

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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
	-36.160	7.2	0.010	0.035	33.2	-4.8	3.14	1.4	789.8	
	-36.350	8.0	0.011	0.030	32.1	-5.8	3.04	2.2	859.8	
	-37.160	4.7	0.013	0.011	25.9	-9.0	2.46	2.5	884.4	
	-38.160	0.7	0.013	-0.006	16.5	-9.1	1.56	2.6	914.9	
	-38.325	0.0	0.013	-0.008	15.0	-8.8	1.42	2.6	919.9	
	-39.160	0.0	0.012	-0.015	8.6	-6.7	0.81	2.4	945.4	
	-39.574	0.0	0.011	-0.018	6.0	-5.7	0.57	2.2	958.0	
	-40.160	0.0	0.010	-0.020	3.0	-4.5	0.29	2.0	975.8	
	-41.160	0.0	0.008	-0.021	-0.5	-2.7	0.05	1.6	1006.3	
	-42.160	0.0	0.006	-0.019	-2.4	-1.3	0.23	1.2	1036.7	
	-43.160	0.0	0.004	-0.017	-3.2	-0.3	0.30	0.8	1067.2	
	-44.160	0.0	0.003	-0.015	-3.1	0.4	0.30	0.5	1097.6	
	-45.160	0.0	0.001	-0.012	-2.5	0.7	0.24	0.2	1128.1	
	-46.160	0.0	0.000	-0.011	-1.7	0.9	0.16	0.0	1158.5	
	-46.350	0.0	0.000	-0.010	-1.6	0.9	0.15	0.0	659.2	
	-47.160	0.0	-0.001	-0.010	-0.9	0.8	0.08	0.0	666.5	
	-48.160	0.0	-0.002	-0.009	-0.3	0.5	0.02	0.0	675.5	
	-49.160	0.0	-0.003	-0.009	0.0	0.0	0.00	0.0	684.5	

*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	-2.435	12.618	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.173	12.618	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.089	12.619	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.351	12.631	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.983	12.645	-46.1	-45.7	4.37	0.0	0.0	
550.2										
	+1.340	30.2	1.983	12.645	-46.1	504.5	4.37	0.0	0.0	
	+0.840	35.2	2.615	12.614	202.1	488.2	19.14	0.0	0.0	
	-0.160	45.2	3.862	12.267	671.0	448.0	63.55	0.0	0.0	
	-1.160	55.2	5.057	11.567	1094.7	397.8	103.67	0.0	0.0	
	-1.660	60.2	5.623	11.097	1286.5	369.0	121.84	0.0	0.0	
80.3										
	-1.660	60.2	5.623	11.097	1286.5	449.2	121.84	0.0	0.0	
	-2.160	65.1	6.165	10.546	1503.4	417.9	142.38	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-4.160	85.1	7.996	7.587	2195.7	267.7	207.93	0.0	0.0	
	-4.660	90.1	8.354	6.696	2318.6	223.9	219.58	0.0	0.0	
	-5.160	95.1	8.665	5.760	2419.1	177.6	229.09	0.0	0.0	
	-6.160	105.1	9.144	3.794	2547.5	77.5	241.25	0.0	0.0	
	-6.276	106.2	9.186	3.560	2555.7	65.2	242.03	0.0	0.0	
	-7.160	117.1	9.422	1.767	2570.5	-33.5	243.43	0.0	0.0	
	-8.060	128.3	9.499	-0.037	2491.4	-143.9	235.94	0.0	0.0	
	-8.160	129.6	9.498	-0.233	2476.4	-156.8	234.52	0.0	0.0	
	-9.160	142.0	9.379	-2.108	2252.7	-292.6	213.33	0.0	0.0	
	-10.160	154.4	9.084	-3.751	1887.0	-440.8	178.70	0.0	0.0	
	-11.160	166.9	8.641	-5.045	1366.9	-601.5	129.44	0.0	0.0	
	-12.060	178.0	8.149	-5.808	756.4	-756.7	71.63	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	64.65	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	56.86	0.0	0.0	
	-13.060	190.5	7.551	-6.056	190.9	-941.0	15.90	0.0	0.0	
1129.1										

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
	-13.060	190.5	7.551	-6.056	190.9	188.2	15.90	0.0	0.0	
	-13.160	191.7	7.490	-6.050	155.1	169.1	12.92	0.0	0.0	
	-14.160	204.1	6.886	-6.035	-2.4	-28.9	0.20	0.0	0.0	
	-14.350	203.6	6.772	-6.035	-11.5	-67.9	0.96	0.0	0.0	
	-14.560	206.1	6.645	-6.032	-30.3	-110.9	2.52	0.0	0.0	
	-14.560	192.0	6.645	-6.032	-30.3	-110.9	2.52	137.5	137.5	*
	-15.160	190.5	6.284	-6.004	-105.5	-137.8	8.78	155.4	155.4	*
	-16.060	188.3	5.748	-5.897	-239.8	-156.3	19.97	182.1	182.1	*
	-16.160	188.1	5.689	-5.880	-255.4	-156.8	21.27	185.1	185.1	*
	-16.350	187.6	5.577	-5.844	-285.3	-156.8	23.76	190.8	190.8	*
	-17.160	185.6	5.112	-5.649	-408.4	-143.7	34.01	214.9	214.9	*
	-17.867	183.9	4.720	-5.425	-500.7	-115.0	41.70	235.9	235.9	*
	-17.867	183.9	4.720	-5.425	-500.7	-115.0	41.70	235.9	235.9	
	-18.160	183.2	4.562	-5.320	-532.3	-100.8	44.33	228.0	244.6	
	-19.160	180.7	4.050	-4.920	-614.6	-67.7	51.18	202.4	274.3	
	-19.350	180.3	3.957	-4.838	-627.1	-63.9	52.22	197.8	280.0	
	-19.350	100.8	3.957	-4.838	-627.1	-63.9	52.22	120.6	120.6	*
	-20.160	98.5	3.580	-4.472	-671.7	-45.6	55.94	124.0	124.0	*
	-21.160	95.7	3.157	-3.993	-703.4	-16.6	58.58	128.2	128.2	*
	-22.091	93.1	2.806	-3.537	-703.8	16.7	58.61	132.1	132.1	*
	-22.091	93.1	2.806	-3.537	-703.8	16.7	58.61	132.2	132.1	
	-22.160	92.9	2.782	-3.503	-702.5	19.4	58.51	131.0	132.4	
	-23.160	90.1	2.455	-3.027	-666.3	51.0	55.49	115.7	136.6	
	-24.160	87.3	2.175	-2.585	-604.3	71.2	50.33	102.5	140.8	
	-25.160	84.5	1.937	-2.191	-527.0	82.0	43.89	91.2	145.0	
	-26.160	81.7	1.735	-1.855	-442.8	85.3	36.88	81.7	149.2	
	-27.160	78.9	1.564	-1.577	-358.4	82.6	29.85	73.7	153.4	
	-27.350	152.9	1.535	-1.531	-342.8	81.5	28.55	134.2	490.0	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	23.64	124.0	512.3	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	26.88	124.0	512.3	
	-28.350	76.6	1.393	-1.313	-272.4	57.7	25.80	65.6	159.2	
	-29.160	74.3	1.293	-1.153	-229.6	47.8	21.74	60.9	162.6	
	-30.160	71.5	1.186	-0.989	-188.9	33.2	17.89	55.9	166.8	
	-30.350	144.5	1.167	-0.961	-182.9	30.1	17.32	157.1	621.2	
	-31.160	141.9	1.094	-0.853	-155.2	37.3	14.70	147.2	644.7	
	-32.160	138.8	1.014	-0.746	-116.5	38.7	11.04	136.5	673.7	

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
	-33.160	135.6	0.944	-0.668	-80.1	33.2	7.58	127.0	702.7	
	-34.160	132.5	0.880	-0.617	-52.1	21.8	4.94	118.4	731.8	
	-35.160	129.3	0.820	-0.582	-38.2	5.2	3.62	110.3	760.8	
	-36.160	126.2	0.763	-0.552	-43.2	-16.0	4.09	102.7	789.8	
	-36.350	127.0	0.753	-0.545	-46.7	-20.5	4.42	151.9	859.8	
	-37.160	123.7	0.710	-0.511	-55.8	-2.6	5.28	143.3	884.4	
	-38.160	119.7	0.661	-0.469	-49.5	14.0	4.69	133.4	914.9	
	-39.160	115.6	0.616	-0.437	-29.5	25.2	2.79	124.3	945.4	
	-40.160	111.6	0.573	-0.425	-0.8	31.5	0.07	115.6	975.8	
	-41.160	107.5	0.530	-0.437	32.1	33.4	3.04	107.0	1006.3	
	-42.160	103.5	0.485	-0.475	64.4	30.4	6.09	97.8	1036.7	
	-43.160	99.4	0.434	-0.537	90.9	21.8	8.61	87.7	1067.2	
	-44.160	95.3	0.377	-0.615	105.6	6.4	10.00	76.0	1097.6	
	-45.160	91.3	0.311	-0.699	100.9	-17.4	9.56	62.8	1128.1	
	-46.160	87.2	0.238	-0.767	67.5	-51.2	6.40	47.9	1158.5	
	-46.350	8.9	0.223	-0.777	57.1	-58.8	5.41	45.0	569.6	
	-47.160	0.8	0.159	-0.800	20.7	-31.6	1.96	32.1	568.8	
	-47.241	0.0	0.152	-0.802	18.3	-29.1	1.73	30.8	568.7	
	-48.160	0.0	0.078	-0.808	2.5	-7.7	0.23	15.8	567.8	
	-48.240	0.0	0.072	-0.808	1.9	-6.4	0.18	14.5	567.7	
	-49.160	0.0	-0.003	-0.808	0.0	0.0	0.00	0.0	566.7	

*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	-2.435	12.618	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.173	12.618	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.089	12.619	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.351	12.631	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.983	12.645	-46.1	-45.7	4.37	0.0	0.0	
550.2										
	+1.340	30.2	1.983	12.645	-46.1	504.5	4.37	0.0	0.0	
	+0.840	35.2	2.615	12.614	202.1	488.2	19.14	0.0	0.0	
	-0.160	45.2	3.862	12.267	671.0	448.0	63.55	0.0	0.0	
	-1.160	55.2	5.057	11.567	1094.7	397.8	103.67	0.0	0.0	
	-1.660	60.2	5.623	11.097	1286.5	369.0	121.84	0.0	0.0	
80.3										
	-1.660	60.2	5.623	11.097	1286.5	449.2	121.84	0.0	0.0	
	-2.160	65.1	6.165	10.546	1503.4	417.9	142.38	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-4.160	85.1	7.996	7.587	2195.7	267.7	207.93	0.0	0.0	
	-4.660	90.1	8.354	6.696	2318.6	223.9	219.58	0.0	0.0	
0.0										
	-4.660	90.1	8.354	6.696	2318.6	223.9	219.58	0.0	0.0	
	-5.160	95.1	8.665	5.760	2419.1	177.6	229.09	0.0	0.0	
	-6.160	105.1	9.144	3.794	2547.5	77.5	241.25	0.0	0.0	
	-6.276	106.2	9.186	3.560	2555.7	65.2	242.03	0.0	0.0	
	-7.160	117.1	9.422	1.767	2570.5	-33.5	243.43	0.0	0.0	
	-8.060	128.3	9.499	-0.037	2491.4	-143.9	235.94	0.0	0.0	
	-8.160	129.6	9.498	-0.233	2476.4	-156.8	234.52	0.0	0.0	
	-9.160	142.0	9.379	-2.108	2252.7	-292.6	213.33	0.0	0.0	
	-10.160	154.4	9.084	-3.751	1887.0	-440.8	178.70	0.0	0.0	
	-11.160	166.9	8.641	-5.045	1366.9	-601.5	129.44	0.0	0.0	
	-12.060	178.0	8.149	-5.808	756.4	-756.7	71.63	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	64.65	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	56.86	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
	-13.060	190.5	7.551	-6.056	190.9	-941.0	15.90	0.0	0.0	
1129.1										
	-13.060	190.5	7.551	-6.056	190.9	188.2	15.90	0.0	0.0	
	-13.160	191.7	7.490	-6.050	155.1	169.1	12.92	0.0	0.0	
	-14.160	204.1	6.886	-6.035	-2.4	-28.9	0.20	0.0	0.0	
	-14.350	203.6	6.772	-6.035	-11.5	-67.9	0.96	0.0	0.0	
	-14.560	206.1	6.645	-6.032	-30.3	-110.9	2.52	0.0	0.0	
	-14.560	192.0	6.645	-6.032	-30.3	-110.9	2.52	137.5	137.5	*
	-15.160	190.5	6.284	-6.004	-105.5	-137.8	8.78	155.4	155.4	*
	-16.060	188.3	5.748	-5.897	-239.8	-156.3	19.97	182.1	182.1	*
	-16.160	188.1	5.689	-5.880	-255.4	-156.8	21.27	185.1	185.1	*
	-16.350	187.6	5.577	-5.844	-285.3	-156.8	23.76	190.8	190.8	*
	-17.160	185.6	5.112	-5.649	-408.4	-143.7	34.01	214.9	214.9	*
	-17.871	183.9	4.718	-5.423	-501.2	-114.7	41.74	236.0	236.0	*
	-17.871	183.9	4.718	-5.423	-501.2	-114.7	41.74	235.8	236.0	
	-18.160	183.2	4.562	-5.320	-532.3	-100.8	44.33	228.0	244.6	
	-19.160	180.7	4.050	-4.920	-614.6	-67.7	51.18	202.4	274.3	
	-19.350	180.3	3.957	-4.838	-627.1	-63.9	52.22	197.8	280.0	
	-19.350	100.8	3.957	-4.838	-627.1	-63.9	52.22	120.6	120.6	*
	-20.160	98.5	3.580	-4.472	-671.7	-45.6	55.94	124.0	124.0	*
	-21.160	95.7	3.157	-3.993	-703.4	-16.6	58.58	128.2	128.2	*
	-22.089	93.1	2.807	-3.538	-703.8	16.7	58.61	132.1	132.1	*
	-22.089	93.1	2.807	-3.538	-703.8	16.7	58.61	132.2	132.1	
	-22.160	92.9	2.782	-3.503	-702.5	19.4	58.51	131.0	132.4	
	-23.160	90.1	2.455	-3.027	-666.3	51.0	55.49	115.7	136.6	
	-24.160	87.3	2.175	-2.585	-604.3	71.2	50.33	102.5	140.8	
	-25.160	84.5	1.937	-2.191	-527.0	82.0	43.89	91.2	145.0	
	-26.160	81.7	1.735	-1.855	-442.8	85.3	36.88	81.7	149.2	
	-27.160	78.9	1.564	-1.577	-358.4	82.6	29.85	73.7	153.4	
	-27.350	152.9	1.535	-1.531	-342.8	81.5	28.55	134.2	490.0	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	23.64	124.0	512.3	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	26.88	124.0	512.3	
	-28.350	76.6	1.393	-1.313	-272.4	57.7	25.80	65.6	159.2	
	-29.160	74.3	1.293	-1.153	-229.6	47.8	21.74	60.9	162.6	
	-30.160	71.5	1.186	-0.989	-188.9	33.2	17.89	55.9	166.8	
	-30.350	144.5	1.167	-0.961	-182.9	30.1	17.32	157.1	621.2	

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
	-31.160	141.9	1.094	-0.853	-155.2	37.3	14.70	147.2	644.7	
	-32.160	138.8	1.014	-0.746	-116.5	38.7	11.04	136.5	673.7	
	-33.160	135.6	0.944	-0.668	-80.1	33.2	7.58	127.0	702.7	
	-34.160	132.5	0.880	-0.617	-52.1	21.8	4.94	118.4	731.8	
	-35.160	129.3	0.820	-0.582	-38.2	5.2	3.62	110.3	760.8	
	-36.160	126.2	0.763	-0.552	-43.2	-16.0	4.09	102.7	789.8	
	-36.350	127.0	0.753	-0.545	-46.7	-20.5	4.42	151.9	859.8	
	-37.160	123.7	0.710	-0.511	-55.8	-2.6	5.28	143.3	884.4	
	-38.160	119.7	0.661	-0.469	-49.5	14.0	4.69	133.4	914.9	
	-39.160	115.6	0.616	-0.437	-29.5	25.2	2.79	124.3	945.4	
	-40.160	111.6	0.573	-0.425	-0.8	31.5	0.07	115.6	975.8	
	-41.160	107.5	0.530	-0.437	32.1	33.4	3.04	107.0	1006.3	
	-42.160	103.5	0.485	-0.475	64.4	30.4	6.09	97.8	1036.7	
	-43.160	99.4	0.434	-0.537	90.9	21.8	8.61	87.7	1067.2	
	-44.160	95.3	0.377	-0.615	105.6	6.4	10.00	76.0	1097.6	
	-45.160	91.3	0.311	-0.699	100.9	-17.4	9.56	62.8	1128.1	
	-46.160	87.2	0.238	-0.767	67.5	-51.2	6.40	47.9	1158.5	
	-46.350	8.9	0.223	-0.777	57.1	-58.8	5.41	45.0	569.6	
	-47.160	0.8	0.159	-0.800	20.7	-31.6	1.96	32.1	568.8	
	-47.241	0.0	0.152	-0.802	18.3	-29.1	1.73	30.8	568.7	
	-48.160	0.0	0.078	-0.808	2.5	-7.7	0.23	15.8	567.8	
	-48.240	0.0	0.072	-0.808	1.9	-6.4	0.18	14.5	567.7	
	-49.160	0.0	-0.003	-0.808	0.0	0.0	0.00	0.0	566.7	

*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	-2.434	12.617	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.803	12.617	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.803	12.617	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.173	12.617	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.089	12.618	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.351	12.630	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.983	12.644	-46.1	-45.7	4.37	0.0	0.0	
551.5										
	+1.340	30.2	1.983	12.644	-46.1	505.8	4.37	0.0	0.0	
	+0.840	35.2	2.615	12.613	202.8	489.4	19.20	0.0	0.0	
	-0.160	45.2	3.862	12.265	673.0	449.3	63.73	0.0	0.0	
	-1.160	55.2	5.056	11.563	1098.0	399.1	103.98	0.0	0.0	
	-1.660	60.2	5.623	11.091	1290.4	370.3	122.20	0.0	0.0	
79.6										
	-1.660	60.2	5.623	11.091	1290.4	449.9	122.20	0.0	0.0	
	-2.160	65.1	6.164	10.538	1507.6	418.5	142.77	0.0	0.0	
	-3.160	75.1	7.153	9.192	1891.9	348.4	179.17	0.0	0.0	
	-3.160	75.1	7.153	9.192	1891.9	348.4	179.17	0.0	0.0	
	-4.160	85.1	7.993	7.572	2201.1	268.3	208.44	0.0	0.0	
	-4.660	90.1	8.350	6.679	2324.3	224.5	220.12	0.0	0.0	
0.0										
	-4.660	90.1	8.350	6.679	2324.3	224.5	220.12	0.0	0.0	
	-5.160	95.1	8.660	5.741	2425.1	178.2	229.66	0.0	0.0	
	-6.160	105.1	9.137	3.769	2554.1	78.1	241.87	0.0	0.0	
	-6.276	106.2	9.179	3.535	2562.4	65.8	242.67	0.0	0.0	
	-7.160	117.1	9.412	1.737	2577.7	-32.9	244.11	0.0	0.0	
	-8.060	950058.6	9.487	-0.072	2499.2	-143.3	236.68	0.0	0.0	
	-8.160	949925.1	9.485	-0.268	2478.0	-280.7	234.67	0.0	0.0	
	-9.160	938089.1	9.365	-2.103	2227.4	-256.3	210.94	0.0	0.0	
	-10.160	908568.8	9.072	-3.717	1882.2	-410.0	178.25	0.0	0.0	
	-11.160	864258.3	8.633	-4.998	1376.3	-546.9	130.34	0.0	0.0	
	-12.060	178.0	8.145	-5.765	768.2	-755.4	72.75	0.0	0.0	
	-12.160	179.3	8.087	-5.823	694.6	-773.3	65.78	0.0	0.0	
	-12.160	179.3	8.087	-5.823	694.6	-773.3	57.85	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
	-13.060	190.5	7.550	-6.022	203.3	-939.7	16.93	0.0	0.0	
1126.4										
	-13.060	190.5	7.550	-6.022	203.3	186.7	16.93	0.0	0.0	
	-13.160	191.7	7.490	-6.017	167.5	167.6	13.95	0.0	0.0	
	-14.160	204.1	6.889	-6.011	9.0	-30.4	0.75	0.0	0.0	
	-14.350	203.6	6.775	-6.012	-0.4	-69.4	0.04	0.0	0.0	
	-14.560	206.1	6.649	-6.010	-19.5	-112.4	1.63	0.0	0.0	
	-14.560	192.0	6.649	-6.010	-19.5	-112.4	1.63	137.5	137.5	*
	-15.160	190.5	6.289	-5.987	-95.6	-139.3	7.96	155.4	155.4	*
	-16.060	188.3	5.754	-5.886	-231.3	-157.9	19.26	182.1	182.1	*
	-16.160	188.1	5.695	-5.869	-247.1	-158.3	20.58	185.1	185.1	*
	-16.350	187.6	5.584	-5.834	-277.2	-158.3	23.09	190.8	190.8	*
	-17.160	185.6	5.118	-5.643	-401.5	-145.2	33.44	214.9	214.9	*
	-17.868	183.9	4.726	-5.422	-495.1	-116.4	41.23	235.9	235.9	*
	-17.868	183.9	4.726	-5.422	-495.1	-116.4	41.23	236.2	235.9	
	-18.160	183.2	4.570	-5.318	-527.0	-102.2	43.89	228.4	244.6	
	-19.160	180.7	4.057	-4.922	-610.5	-68.7	50.84	202.8	274.3	
	-19.350	180.3	3.964	-4.841	-623.2	-64.9	51.90	198.1	280.0	
	-19.350	100.8	3.964	-4.841	-623.2	-64.9	51.90	120.6	120.6	*
	-20.160	98.5	3.587	-4.477	-668.6	-46.6	55.68	124.0	124.0	*
	-21.160	95.7	3.163	-4.000	-701.3	-17.6	58.40	128.2	128.2	*
	-22.105	93.1	2.807	-3.538	-702.4	16.3	58.50	132.2	132.2	*
	-22.105	93.1	2.807	-3.538	-702.4	16.3	58.50	132.2	132.2	
	-22.160	92.9	2.787	-3.511	-701.4	18.4	58.42	131.3	132.4	
	-23.160	90.1	2.460	-3.034	-666.0	50.3	55.47	115.9	136.6	
	-24.160	87.3	2.179	-2.592	-604.7	70.7	50.36	102.6	140.8	
	-25.160	84.5	1.940	-2.199	-527.8	81.7	43.95	91.4	145.0	
	-26.160	81.7	1.738	-1.861	-443.9	85.0	36.97	81.8	149.2	
	-27.160	78.9	1.566	-1.583	-359.7	82.5	29.95	73.8	153.4	
	-27.350	152.9	1.536	-1.536	-344.1	81.4	28.66	134.4	490.0	
	-28.160	150.9	1.419	-1.360	-285.2	63.0	23.75	124.1	512.3	
	-28.160	150.9	1.419	-1.360	-285.2	63.0	27.01	124.1	512.3	
	-28.350	76.6	1.394	-1.318	-273.7	57.7	25.92	65.6	159.2	
	-29.160	74.3	1.294	-1.157	-230.8	47.8	21.86	60.9	162.6	
	-30.160	71.5	1.186	-0.992	-190.1	33.3	18.00	55.9	166.8	
	-30.350	144.5	1.168	-0.964	-184.0	30.3	17.43	157.2	621.2	

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
	-31.160	141.9	1.094	-0.855	-156.2	37.5	14.79	147.3	644.7	
	-32.160	138.8	1.014	-0.747	-117.4	38.9	11.12	136.5	673.7	
	-33.160	135.6	0.944	-0.669	-80.7	33.4	7.65	127.0	702.7	
	-34.160	132.5	0.880	-0.618	-52.6	22.0	4.98	118.4	731.8	
	-35.160	129.3	0.820	-0.583	-38.5	5.4	3.65	110.3	760.8	
	-36.160	126.2	0.763	-0.552	-43.4	-15.9	4.11	102.7	789.8	
	-36.350	127.0	0.753	-0.545	-46.9	-20.4	4.44	151.9	859.8	
	-37.160	123.7	0.710	-0.511	-55.9	-2.5	5.29	143.3	884.4	
	-38.160	119.7	0.661	-0.469	-49.6	14.1	4.69	133.4	914.9	
	-39.160	115.6	0.616	-0.437	-29.5	25.2	2.79	124.3	945.4	
	-40.160	111.6	0.573	-0.424	-0.7	31.6	0.07	115.6	975.8	
	-41.160	107.5	0.530	-0.437	32.1	33.4	3.04	107.0	1006.3	
	-42.160	103.5	0.485	-0.475	64.4	30.3	6.10	97.8	1036.7	
	-43.160	99.4	0.434	-0.537	91.0	21.8	8.62	87.7	1067.2	
	-44.160	95.3	0.377	-0.615	105.7	6.4	10.01	76.0	1097.6	
	-45.160	91.3	0.311	-0.698	100.9	-17.4	9.56	62.8	1128.1	
	-46.160	87.2	0.238	-0.767	67.5	-51.2	6.40	47.9	1158.5	
	-46.350	8.9	0.223	-0.777	57.1	-58.9	5.41	45.0	569.6	
	-47.160	0.8	0.159	-0.800	20.7	-31.6	1.96	32.1	568.8	
	-47.241	0.0	0.152	-0.801	18.3	-29.1	1.73	30.8	568.7	
	-48.160	0.0	0.078	-0.808	2.5	-7.7	0.23	15.8	567.8	
	-48.240	0.0	0.072	-0.808	1.9	-6.4	0.18	14.5	567.7	
	-49.160	0.0	-0.002	-0.808	0.0	0.0	0.00	0.0	566.7	

*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/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.181	6.133	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.126	6.133	0.0	0.0	0.00	0.0	0.0	
232.6										
	+4.340	0.3	0.126	6.133	0.0	232.6	0.00	0.0	0.0	
	+3.840	5.3	0.432	6.110	116.0	231.2	10.99	0.0	0.0	
	+2.840	15.2	1.035	5.929	342.9	220.9	32.48	0.0	0.0	
	+1.840	25.2	1.612	5.573	554.6	200.7	52.52	0.0	0.0	
	+1.340	30.2	1.885	5.335	651.6	186.8	61.71	0.0	0.0	
	+0.840	35.2	2.145	5.060	741.0	170.5	70.18	0.0	0.0	
	+0.340	40.2	2.390	4.751	821.7	151.6	77.81	0.0	0.0	
	-0.160	40.2	2.620	4.413	892.5	131.6	84.52	0.0	0.0	
	-1.160	40.2	3.024	3.662	1003.9	91.4	95.07	0.0	0.0	
	-1.660	40.2	3.197	3.257	1044.6	71.3	98.92	0.0	0.0	
	-2.160	40.1	3.349	2.839	1075.2	51.2	101.83	0.0	0.0	
	-3.160	40.1	3.590	1.975	1106.4	11.1	104.77	0.0	0.0	
	-3.160	40.1	3.590	1.975	1106.4	11.1	104.77	0.0	0.0	
	-4.160	40.1	3.744	1.103	1097.4	-29.0	103.92	0.0	0.0	
	-4.660	40.1	3.789	0.674	1077.9	-49.1	102.08	0.0	0.0	
	-5.160	40.1	3.812	0.254	1048.3	-69.1	99.28	0.0	0.0	
	-6.160	40.1	3.797	-0.541	959.1	-109.2	90.83	0.0	0.0	
	-6.276	40.1	3.790	-0.628	946.2	-113.9	89.61	0.0	0.0	
	-6.276	40.0	3.790	-0.628	946.2	-113.9	89.61	0.0	0.0	*
	-7.160	38.7	3.706	-1.250	832.7	-139.6	78.86	20.4	20.4	*
	-8.060	37.3	3.569	-1.796	702.6	-146.2	66.54	41.1	41.1	*
	-8.060	37.3	3.569	-1.796	702.6	-146.2	66.54	41.2	41.1	
	-8.160	37.2	3.550	-1.850	688.0	-145.8	65.16	40.9	43.4	
	-9.160	35.7	3.340	-2.336	544.0	-142.5	51.51	38.5	66.5	
	-10.160	34.2	3.087	-2.710	402.7	-140.4	38.13	35.6	89.5	
	-11.160	32.7	2.802	-2.972	262.7	-139.9	24.88	32.3	112.5	
	-12.060	31.4	2.527	-3.114	136.4	-141.0	12.92	29.1	133.3	
	-12.160	31.3	2.496	-3.124	122.3	-141.3	11.58	28.8	135.6	
	-12.160	31.3	2.496	-3.124	122.3	-141.3	10.19	28.8	135.6	
	-13.060	29.9	2.213	-3.161	-6.1	-144.4	0.51	25.5	156.3	
	-13.160	29.8	2.181	-3.160	-20.6	-144.8	1.71	25.2	158.6	
	-14.160	28.3	1.868	-3.095	-168.0	-150.5	14.00	21.5	181.7	

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
	-14.350	28.7	1.809	-3.071	-196.8	-151.8	16.39	90.4	248.6	
	-15.160	26.9	1.566	-2.929	-300.6	-106.1	25.04	78.2	272.7	
	-16.060	24.8	1.311	-2.716	-376.8	-64.7	31.38	65.5	299.6	
	-16.160	24.5	1.284	-2.689	-383.0	-60.6	31.90	64.2	302.6	
	-16.350	24.1	1.234	-2.638	-393.8	-53.3	32.80	61.7	308.3	
	-17.160	22.2	1.029	-2.407	-425.6	-26.3	35.45	51.4	332.5	
	-18.160	19.9	0.804	-2.105	-438.9	-1.8	36.56	40.2	362.4	
	-19.160	17.6	0.608	-1.802	-431.9	14.6	35.97	30.4	392.2	
	-19.350	13.3	0.575	-1.745	-428.9	16.9	35.72	27.1	188.7	
	-20.160	11.2	0.443	-1.509	-411.1	26.3	34.24	20.9	192.3	
	-21.160	8.7	0.306	-1.234	-380.7	33.9	31.70	14.4	196.8	
	-22.160	6.2	0.195	-0.982	-344.5	38.1	28.69	9.2	201.2	
	-23.160	3.7	0.109	-0.756	-305.2	40.2	25.42	5.1	205.7	
	-23.647	2.5	0.074	-0.656	-285.4	40.8	23.77	3.5	207.9	
	-24.160	1.2	0.043	-0.558	-264.4	41.3	22.02	2.0	210.2	
	-24.624	0.0	0.019	-0.476	-245.2	41.7	20.42	0.9	212.3	
	-25.160	0.0	-0.004	-0.389	-222.7	41.9	18.55	0.0	216.0	
	-26.160	0.0	-0.036	-0.249	-181.2	40.9	15.09	0.0	223.0	
	-27.160	0.0	-0.055	-0.137	-141.4	38.7	11.77	0.0	230.0	
	-27.350	0.0	-0.057	-0.119	-134.1	38.2	11.16	0.0	601.3	
	-28.160	0.0	-0.064	-0.052	-104.8	33.9	8.73	0.0	623.8	
	-28.160	0.0	-0.064	-0.052	-104.8	33.9	9.93	0.0	623.8	
	-28.350	0.0	-0.065	-0.037	-98.5	32.8	9.33	0.0	238.2	
	-29.160	0.0	-0.066	0.018	-72.9	30.3	6.91	0.0	243.8	
	-30.160	0.0	-0.061	0.064	-44.2	27.3	4.18	0.0	250.8	
	-30.350	0.0	-0.060	0.070	-39.0	26.7	3.70	0.0	741.4	
	-31.160	0.0	-0.054	0.088	-20.0	20.5	1.89	0.0	765.1	
	-32.160	0.0	-0.044	0.097	-2.8	13.9	0.27	0.0	794.3	
	-33.160	0.0	-0.035	0.094	8.3	8.6	0.79	0.0	823.6	
	-34.160	0.0	-0.026	0.085	14.8	4.6	1.40	0.0	852.8	
	-34.444	0.0	-0.023	0.082	16.0	3.6	1.51	0.0	861.1	
	-35.160	0.0	-0.018	0.072	17.9	1.7	1.69	0.0	882.0	
	-36.160	0.0	-0.011	0.058	18.5	-0.3	1.75	0.0	911.3	
	-36.350	0.0	-0.010	0.055	18.4	-0.5	1.74	0.0	990.3	
	-37.065	0.0	-0.007	0.045	17.6	-1.7	1.66	0.0	1012.2	
	-37.160	0.0	-0.006	0.043	17.4	-1.9	1.65	0.0	1015.4	

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	-0.003	0.030	15.0	-2.7	1.43	0.0	1048.8	
	-39.160	0.0	0.000	0.020	12.2	-3.0	1.15	0.0	1082.2	
	-40.160	0.0	0.001	0.011	9.2	-2.8	0.87	0.3	1115.6	
	-41.160	0.0	0.002	0.005	6.6	-2.4	0.62	0.5	1149.0	
	-42.160	0.0	0.003	0.001	4.4	-2.0	0.42	0.5	1182.4	
	-43.160	0.0	0.002	-0.002	2.7	-1.5	0.25	0.5	1215.8	
	-44.160	0.0	0.002	-0.004	1.5	-1.0	0.14	0.4	1249.2	
	-45.160	0.0	0.002	-0.005	0.7	-0.6	0.06	0.3	1282.6	
	-46.160	0.0	0.001	-0.005	0.2	-0.3	0.02	0.3	1316.0	
	-46.350	0.0	0.001	-0.005	0.2	-0.3	0.02	0.2	716.2	
	-47.160	0.0	0.001	-0.005	0.0	-0.1	0.00	0.2	723.5	
	-48.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.1	732.5	
	-49.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.0	741.5	

*showing plastic

(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	-1.577	10.147	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.070	10.147	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.070	10.147	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.563	10.147	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.452	10.148	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.467	10.160	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.976	10.174	-46.1	-45.7	4.37	0.0	0.0	
431.7										
	+1.340	30.2	1.976	10.174	-46.1	386.0	4.37	0.0	0.0	
	+0.840	35.2	2.484	10.155	142.9	369.6	13.53	0.0	0.0	
	+0.340	40.2	2.990	10.063	323.1	350.8	30.60	0.0	0.0	
	-0.160	40.2	3.489	9.901	493.5	330.7	46.73	0.0	0.0	
	-1.160	40.2	4.456	9.387	804.1	290.5	76.14	0.0	0.0	
	-1.660	40.2	4.917	9.041	944.3	270.4	89.43	0.0	0.0	
	-2.160	40.1	5.359	8.643	1074.5	250.4	101.76	0.0	0.0	
	-3.160	40.1	6.178	7.701	1304.8	210.2	123.56	0.0	0.0	
	-3.160	40.1	6.178	7.701	1304.8	210.2	123.56	0.0	0.0	
	-4.160	40.1	6.894	6.594	1494.9	170.1	141.57	0.0	0.0	
	-4.660	40.1	7.208	5.988	1575.0	150.1	149.15	0.0	0.0	
	-5.160	40.1	7.492	5.352	1645.0	130.0	155.78	0.0	0.0	
	-6.160	40.1	7.961	4.008	1754.9	89.9	166.20	0.0	0.0	
	-6.276	40.0	8.006	3.847	1765.1	85.3	167.16	0.0	0.0	
	-7.160	42.1	8.291	2.593	1824.6	49.0	172.79	0.0	0.0	
	-8.060	44.3	8.466	1.285	1851.3	10.1	175.32	0.0	0.0	
	-8.160	44.6	8.478	1.139	1852.1	5.6	175.39	0.0	0.0	
	-9.160	47.0	8.519	-0.319	1835.0	-40.2	173.78	0.0	0.0	
	-10.160	49.4	8.415	-1.745	1770.9	-88.4	167.71	0.0	0.0	
	-11.160	51.9	8.172	-3.101	1657.4	-139.1	156.96	0.0	0.0	
	-12.060	54.0	7.842	-4.228	1510.9	-186.7	143.09	0.0	0.0	
	-12.160	54.3	7.799	-4.347	1492.0	-192.1	141.29	0.0	0.0	
	-12.160	54.3	7.799	-4.347	1492.0	-192.1	124.25	0.0	0.0	
	-13.060	56.5	7.367	-5.220	1296.8	-242.0	108.00	0.0	0.0	
	-13.160	56.7	7.315	-5.309	1272.3	-247.6	105.96	0.0	0.0	
	-14.160	59.1	6.743	-6.100	995.9	-305.6	82.94	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
	-14.350	56.7	6.625	-6.227	936.8	-316.9	78.02	0.0	0.0	
	-14.560	57.1	6.493	-6.359	869.0	-328.8	72.37	0.0	0.0	
	-14.560	57.1	6.493	-6.359	869.0	-328.8	72.37	0.0	0.0	*
	-15.160	55.7	6.102	-6.678	662.6	-357.3	55.18	17.9	17.9	*
	-16.060	53.6	5.485	-6.989	329.7	-378.2	27.45	44.8	44.8	*
	-16.160	53.4	5.415	-7.011	291.8	-379.0	24.30	47.8	47.8	*
	-16.350	53.0	5.282	-7.044	219.7	-379.4	18.30	53.5	53.5	*
	-17.160	51.1	4.708	-7.082	-84.6	-368.5	7.05	77.7	77.7	*
	-18.160	48.8	4.007	-6.899	-434.4	-325.8	36.18	107.5	107.5	*
	-19.160	46.5	3.336	-6.493	-725.5	-251.0	60.42	137.4	137.4	*
	-19.350	46.0	3.214	-6.394	-771.5	-233.1	64.25	143.1	143.1	*
	-19.350	30.9	3.214	-6.394	-771.5	-233.1	64.25	151.3	168.7	
	-20.160	28.8	2.714	-5.914	-923.2	-144.3	76.88	127.8	172.3	
	-21.160	26.3	2.156	-5.234	-1022.1	-57.5	85.12	101.6	176.8	
	-22.160	23.8	1.669	-4.513	-1045.4	7.3	87.07	78.6	181.3	
	-23.160	21.3	1.254	-3.796	-1013.7	53.3	84.42	59.0	185.8	
	-24.160	18.7	0.909	-3.115	-943.9	84.0	78.61	42.8	190.2	
	-25.160	16.2	0.629	-2.491	-849.8	102.5	70.77	29.6	194.7	
	-26.160	13.7	0.408	-1.938	-742.1	111.7	61.80	19.2	199.2	
	-27.160	11.2	0.239	-1.463	-628.6	114.3	52.35	11.2	203.7	
	-27.350	20.9	0.212	-1.381	-606.9	114.2	50.54	18.5	364.5	
	-28.160	19.0	0.113	-1.066	-516.0	109.4	42.97	9.9	386.9	
	-28.160	19.0	0.113	-1.066	-516.0	109.4	48.86	9.9	386.9	
	-28.350	9.1	0.093	-0.990	-495.4	107.5	46.91	4.4	209.8	
	-29.160	7.1	0.025	-0.701	-410.0	103.1	38.83	1.2	213.4	
	-30.160	4.6	-0.030	-0.417	-309.9	97.1	29.34	0.0	217.9	
	-30.350	12.6	-0.038	-0.372	-291.5	95.9	27.61	0.0	486.6	
	-31.160	10.2	-0.061	-0.209	-219.7	81.3	20.81	0.0	510.3	
	-32.160	7.2	-0.074	-0.065	-147.5	63.3	13.97	0.0	539.5	
	-33.160	4.3	-0.076	0.028	-92.4	47.4	8.75	0.0	568.7	
	-33.392	3.6	-0.075	0.044	-81.8	44.1	7.75	0.0	575.5	
	-34.160	1.3	-0.070	0.084	-51.6	34.8	4.89	0.0	598.0	
	-34.616	0.0	-0.065	0.100	-36.8	30.3	3.49	0.0	611.3	
	-35.160	0.0	-0.060	0.112	-21.6	25.7	2.05	0.0	627.2	
	-36.160	0.0	-0.048	0.120	0.4	18.5	0.03	0.0	656.5	
	-36.350	0.0	-0.046	0.120	3.8	17.3	0.36	0.0	715.9	

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
	-37.160	0.0	-0.036	0.114	15.0	10.6	1.42	0.0	740.9	
	-38.160	0.0	-0.025	0.099	22.4	4.5	2.12	0.0	771.6	
	-39.160	0.0	-0.016	0.080	24.6	0.3	2.33	0.0	802.4	
	-40.160	0.0	-0.009	0.061	23.5	-2.3	2.22	0.0	833.1	
	-41.160	0.0	-0.004	0.043	20.4	-3.6	1.93	0.0	863.9	
	-42.160	0.0	-0.001	0.029	16.5	-4.1	1.56	0.0	894.6	
	-43.160	0.0	0.002	0.017	12.5	-4.0	1.18	0.3	925.4	
	-44.160	0.0	0.003	0.009	8.7	-3.5	0.82	0.6	956.2	
	-45.084	0.0	0.003	0.004	5.7	-2.9	0.54	0.7	984.6	
	-45.160	0.0	0.004	0.003	5.5	-2.8	0.52	0.7	986.9	
	-46.160	0.0	0.004	0.000	3.1	-2.1	0.29	0.7	1017.7	
	-46.350	0.0	0.004	0.000	2.7	-2.0	0.25	0.7	658.2	
	-47.160	0.0	0.004	-0.002	1.3	-1.4	0.13	0.7	665.5	
	-48.160	0.0	0.003	-0.002	0.3	-0.7	0.03	0.7	674.5	
	-49.160	0.0	0.003	-0.002	0.0	0.0	0.00	0.6	683.5	

*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/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-2.354	12.449	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.732	12.449	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.732	12.449	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.110	12.449	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.135	12.450	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.381	12.462	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	2.004	12.476	-46.1	-45.7	4.37	0.0	0.0	
568.7										
	+1.340	30.2	2.004	12.476	-46.1	522.9	4.37	0.0	0.0	
	+0.840	35.2	2.628	12.443	211.4	506.6	20.02	0.0	0.0	
	-0.160	45.2	3.857	12.082	698.7	466.4	66.16	0.0	0.0	
	-1.160	55.2	5.032	11.353	1140.8	416.2	108.03	0.0	0.0	
	-1.660	60.2	5.587	10.862	1341.8	387.4	127.07	0.0	0.0	
	-2.160	65.1	6.117	10.296	1527.7	356.0	144.68	0.0	0.0	
	-2.660	70.1	6.616	9.659	1697.4	322.2	160.75	0.0	0.0	
	-3.160	70.1	7.082	8.958	1849.8	287.2	175.18	0.0	0.0	
	-3.160	70.1	7.082	8.958	1849.8	287.2	175.18	0.0	0.0	
	-4.160	70.1	7.901	7.394	2101.9	217.0	199.05	0.0	0.0	
	-4.660	70.1	8.249	6.545	2201.6	182.0	208.50	0.0	0.0	
	-5.160	70.1	8.555	5.659	2283.9	146.9	216.29	0.0	0.0	
	-6.160	70.1	9.029	3.808	2395.8	76.9	226.88	0.0	0.0	
	-6.276	70.0	9.072	3.588	2404.2	68.7	227.68	0.0	0.0	
	-7.160	72.1	9.314	1.896	2437.3	5.9	230.82	0.0	0.0	
	-8.060	74.3	9.407	0.170	2413.2	-60.0	228.53	0.0	0.0	
	-8.160	74.6	9.408	-0.020	2406.8	-67.5	227.93	0.0	0.0	
	-9.160	77.0	9.312	-1.883	2301.6	-143.2	217.97	0.0	0.0	
	-10.160	79.4	9.035	-3.632	2119.5	-221.5	200.72	0.0	0.0	
	-11.160	81.9	8.591	-5.207	1857.9	-302.1	175.95	0.0	0.0	
	-12.060	84.0	8.066	-6.422	1552.6	-376.8	147.03	0.0	0.0	
	-12.160	84.3	8.002	-6.543	1514.5	-385.2	143.43	0.0	0.0	
	-12.160	84.3	8.002	-6.543	1514.5	-385.2	126.13	0.0	0.0	
	-13.060	86.5	7.374	-7.374	1138.4	-462.0	94.80	0.0	0.0	
20.1										
	-13.060	86.5	7.374	-7.374	1138.4	-442.0	94.80	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
	-13.160	86.7	7.299	-7.451	1092.8	-450.6	91.01	0.0	0.0	
	-14.160	89.1	6.522	-8.040	594.3	-538.6	49.50	0.0	0.0	
	-14.350	86.7	6.369	-8.112	490.4	-555.5	40.84	0.0	0.0	
	-14.560	87.1	6.198	-8.175	371.8	-573.8	30.97	0.0	0.0	
	-14.560	73.0	6.198	-8.175	371.8	-573.8	30.97	137.5	137.5	*
	-15.160	71.6	5.704	-8.259	40.3	-529.2	3.36	155.5	155.5	*
	-16.060	69.5	4.964	-8.144	-398.1	-440.7	33.15	182.3	182.3	*
	-16.160	69.3	4.882	-8.114	-441.6	-429.3	36.78	185.3	185.3	*
	-16.350	68.8	4.729	-8.051	-521.0	-406.7	43.39	191.0	191.0	*
	-17.003	67.3	4.212	-7.759	-758.9	-320.1	63.21	210.5	210.5	*
	-17.003	67.3	4.212	-7.759	-758.9	-320.1	63.21	210.5	210.5	
	-17.160	67.0	4.091	-7.673	-807.6	-298.0	67.25	204.5	215.2	
	-18.160	64.7	3.355	-7.024	-1042.7	-178.0	86.84	167.7	245.1	
	-19.160	62.4	2.690	-6.250	-1174.5	-90.8	97.82	134.4	275.0	
	-19.350	30.3	2.573	-6.094	-1190.5	-77.6	99.15	121.2	169.1	
	-20.160	28.2	2.107	-5.412	-1225.8	-12.2	102.09	99.2	172.7	
	-21.160	25.7	1.608	-4.565	-1206.3	47.9	100.46	75.7	177.2	
	-22.160	23.2	1.193	-3.750	-1136.3	89.1	94.63	56.2	181.7	
	-23.160	20.7	0.856	-2.995	-1033.1	115.2	86.03	40.3	186.2	
	-24.160	18.1	0.591	-2.320	-909.9	129.6	75.77	27.8	190.6	
	-25.160	15.6	0.389	-1.735	-776.7	135.5	64.69	18.3	195.1	
	-26.160	13.1	0.241	-1.243	-640.7	135.8	53.36	11.3	199.6	
	-27.160	10.6	0.137	-0.845	-506.2	132.7	42.16	6.5	204.1	
	-27.350	36.4	0.122	-0.780	-481.1	131.9	40.07	10.7	492.5	
	-28.160	34.5	0.069	-0.538	-383.0	109.9	31.90	6.0	514.9	
	-28.160	34.5	0.069	-0.538	-383.0	109.9	36.27	6.0	514.9	
	-28.350	8.5	0.059	-0.482	-362.7	104.4	34.35	2.8	210.2	
	-29.160	6.5	0.029	-0.277	-279.9	100.0	26.51	1.4	213.8	
	-30.160	4.0	0.011	-0.095	-182.3	95.6	17.27	0.5	218.3	
	-30.201	3.9	0.010	-0.089	-178.4	95.4	16.89	0.5	218.5	
	-30.350	28.4	0.009	-0.069	-164.2	95.0	15.55	1.3	624.1	
	-31.160	26.1	0.007	0.014	-96.0	73.7	9.09	1.0	647.8	
	-32.160	23.1	0.012	0.063	-34.3	50.4	3.24	1.6	677.1	
	-33.160	20.2	0.019	0.073	6.0	30.7	0.56	2.5	706.3	
	-34.160	17.2	0.025	0.059	28.5	15.0	2.70	3.4	735.5	
	-35.160	14.3	0.030	0.032	37.3	3.0	3.53	4.0	764.8	

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	11.3	0.032	0.003	35.7	-5.6	3.38	4.3	794.0	
	-36.350	12.1	0.032	-0.003	34.5	-6.9	3.27	6.4	863.9	
	-37.160	9.1	0.031	-0.023	27.4	-10.3	2.60	6.2	888.8	
	-38.160	5.3	0.027	-0.040	16.2	-11.6	1.54	5.5	919.5	
	-38.325	4.7	0.027	-0.042	14.3	-11.5	1.36	5.4	924.6	
	-39.160	1.6	0.023	-0.048	5.2	-9.9	0.50	4.6	950.3	
	-39.574	0.0	0.021	-0.049	1.4	-8.4	0.14	4.2	963.0	
	-40.160	0.0	0.018	-0.049	-2.8	-6.1	0.26	3.6	981.0	
	-41.160	0.0	0.013	-0.045	-7.2	-2.9	0.68	2.7	1011.8	
	-42.160	0.0	0.009	-0.038	-8.9	-0.7	0.85	1.8	1042.6	
	-43.160	0.0	0.006	-0.031	-8.8	0.8	0.83	1.1	1073.3	
	-44.160	0.0	0.003	-0.025	-7.5	1.7	0.71	0.6	1104.1	
	-45.160	0.0	0.001	-0.020	-5.6	2.0	0.53	0.1	1134.8	
	-46.160	0.0	-0.001	-0.016	-3.6	2.0	0.34	0.0	1165.6	
	-46.350	0.0	-0.001	-0.016	-3.2	1.9	0.30	0.0	659.2	
	-47.160	0.0	-0.003	-0.014	-1.8	1.6	0.17	0.0	666.5	
	-48.160	0.0	-0.004	-0.013	-0.5	0.9	0.05	0.0	675.5	
	-49.160	0.0	-0.005	-0.013	0.0	0.0	0.00	0.0	684.5	

*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	-2.445	12.692	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.176	12.692	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.093	12.694	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.363	12.705	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.998	12.719	-46.1	-45.7	4.37	0.0	0.0	
540.9										
	+1.340	30.2	1.998	12.719	-46.1	495.1	4.37	0.0	0.0	
	+0.840	35.2	2.634	12.689	197.5	478.8	18.70	0.0	0.0	
	-0.160	45.2	3.889	12.350	657.0	438.6	62.22	0.0	0.0	
	-1.160	55.2	5.092	11.664	1071.3	388.4	101.46	0.0	0.0	
	-1.660	60.2	5.664	11.204	1258.4	359.6	119.18	0.0	0.0	
97.0										
	-1.660	60.2	5.664	11.204	1258.4	456.5	119.18	0.0	0.0	
	-2.160	65.1	6.212	10.664	1479.0	425.2	140.06	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-4.160	85.1	8.070	7.732	2185.8	275.0	207.00	0.0	0.0	
	-4.660	90.1	8.434	6.844	2312.5	231.2	218.99	0.0	0.0	
	-5.160	95.1	8.753	5.910	2416.6	184.9	228.85	0.0	0.0	
	-6.160	105.1	9.247	3.943	2552.2	84.8	241.70	0.0	0.0	
	-6.276	106.2	9.291	3.709	2561.4	72.5	242.57	0.0	0.0	
	-7.160	117.1	9.540	1.909	2582.6	-26.2	244.57	0.0	0.0	
	-8.060	128.3	9.629	0.095	2510.1	-136.6	237.71	0.0	0.0	
	-8.160	129.6	9.629	-0.103	2495.8	-149.5	236.35	0.0	0.0	
	-9.160	142.0	9.523	-1.996	2279.4	-285.3	215.86	0.0	0.0	
	-10.160	154.4	9.238	-3.663	1921.0	-433.5	181.92	0.0	0.0	
	-11.160	166.9	8.802	-4.987	1408.2	-594.2	133.35	0.0	0.0	
	-12.060	178.0	8.314	-5.781	804.3	-749.4	76.17	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	69.25	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	60.90	0.0	0.0	
	-13.060	190.5	7.716	-6.066	241.7	-933.7	20.13	0.0	0.0	
1111.4										

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
	-13.060	190.5	7.716	-6.066	241.7	177.8	20.13	0.0	0.0	
	-13.160	191.7	7.656	-6.064	205.7	158.7	17.13	0.0	0.0	
	-14.160	204.1	7.049	-6.083	41.3	-39.3	3.44	0.0	0.0	
	-14.350	203.6	6.933	-6.088	30.2	-78.3	2.51	0.0	0.0	
	-14.560	206.1	6.805	-6.091	9.2	-121.3	0.77	0.0	0.0	
	-14.560	192.0	6.805	-6.091	9.2	-121.3	0.77	137.5	137.5	*
	-15.160	190.6	6.440	-6.078	-72.2	-148.2	6.01	155.5	155.5	*
	-16.060	188.5	5.896	-5.989	-215.9	-166.8	17.98	182.3	182.3	*
	-16.160	188.3	5.837	-5.974	-232.6	-167.2	19.37	185.3	185.3	*
	-16.350	187.8	5.723	-5.941	-264.4	-167.2	22.02	191.0	191.0	*
	-17.160	186.0	5.249	-5.755	-395.9	-154.1	32.97	215.2	215.2	*
	-17.972	184.1	4.792	-5.499	-508.5	-119.7	42.35	239.5	239.5	*
	-17.972	184.1	4.792	-5.499	-508.5	-119.7	42.35	239.5	239.5	
	-18.160	183.7	4.689	-5.431	-530.1	-109.8	44.14	234.4	245.1	
	-19.160	181.4	4.166	-5.030	-618.6	-71.2	51.51	208.2	275.0	
	-19.350	180.9	4.071	-4.948	-631.6	-66.5	52.60	203.5	280.6	
	-19.350	101.7	4.071	-4.948	-631.6	-66.5	52.60	121.5	121.5	*
	-20.160	99.6	3.685	-4.579	-678.3	-48.1	56.49	125.1	125.1	*
	-21.160	97.1	3.251	-4.094	-712.5	-19.1	59.34	129.6	129.6	*
	-22.160	94.6	2.866	-3.597	-714.2	16.9	59.48	134.1	134.1	*
	-22.201	94.5	2.852	-3.577	-713.5	18.5	59.42	134.3	134.3	*
	-22.201	94.5	2.852	-3.577	-713.5	18.5	59.42	134.3	134.3	
	-23.160	92.1	2.531	-3.112	-679.5	50.5	56.59	119.2	138.6	
	-24.160	89.5	2.243	-2.660	-617.4	71.9	51.41	105.6	143.0	
	-25.160	87.0	1.997	-2.258	-539.0	83.3	44.89	94.1	147.5	
	-26.160	84.5	1.789	-1.914	-453.4	86.6	37.76	84.3	152.0	
	-27.160	82.0	1.613	-1.629	-368.0	83.3	30.65	75.9	156.5	
	-27.350	155.4	1.582	-1.582	-352.2	82.1	29.34	138.4	492.5	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	24.34	127.8	514.9	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	27.68	127.8	514.9	
	-28.350	79.9	1.435	-1.358	-280.5	59.7	26.56	67.6	162.6	
	-29.160	77.9	1.332	-1.193	-236.5	48.5	22.39	62.7	166.2	
	-30.160	75.4	1.222	-1.024	-196.0	32.0	18.56	57.5	170.7	
	-30.350	147.4	1.202	-0.995	-190.2	28.5	18.01	161.8	624.1	
	-31.160	145.1	1.127	-0.882	-163.3	36.9	15.46	151.6	647.8	
	-32.160	142.1	1.044	-0.768	-124.5	39.3	11.79	140.5	677.1	

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
	-33.160	139.2	0.972	-0.685	-87.2	34.2	8.26	130.8	706.3	
	-34.160	136.2	0.907	-0.628	-58.3	22.8	5.52	122.0	735.5	
	-35.160	133.3	0.846	-0.589	-43.5	5.9	4.12	113.8	764.8	
	-36.160	130.3	0.789	-0.554	-48.1	-16.0	4.56	106.1	794.0	
	-36.350	131.1	0.778	-0.547	-51.6	-20.7	4.89	157.1	863.9	
	-37.160	128.1	0.735	-0.510	-60.5	-2.0	5.73	148.4	888.8	
	-38.160	124.3	0.687	-0.464	-53.3	15.3	5.05	138.6	919.5	
	-39.160	120.6	0.642	-0.430	-31.8	26.9	3.01	129.6	950.3	
	-40.160	116.8	0.600	-0.416	-1.2	33.5	0.11	121.1	981.0	
	-41.160	113.1	0.558	-0.429	33.8	35.5	3.20	112.6	1011.8	
	-42.160	109.3	0.513	-0.470	68.2	32.5	6.46	103.6	1042.6	
	-43.160	105.5	0.463	-0.535	96.8	23.7	9.17	93.5	1073.3	
	-44.160	101.8	0.406	-0.619	113.3	7.9	10.73	81.9	1104.1	
	-45.160	98.0	0.339	-0.709	109.6	-16.7	10.38	68.5	1134.8	
	-46.160	94.3	0.264	-0.784	76.3	-51.9	7.22	53.3	1165.6	
	-46.350	17.0	0.249	-0.795	65.7	-59.9	6.22	50.3	577.7	
	-47.160	9.7	0.184	-0.824	27.4	-35.3	2.60	37.1	577.7	
	-47.241	9.0	0.177	-0.825	24.7	-33.1	2.34	35.7	577.7	
	-48.160	0.7	0.100	-0.835	4.5	-11.8	0.43	20.3	577.7	
	-48.240	0.0	0.094	-0.835	3.6	-10.3	0.34	18.9	577.7	
	-49.160	0.0	0.017	-0.836	0.0	0.0	0.00	3.4	577.7	

*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	-2.445	12.692	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.176	12.692	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.093	12.694	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.363	12.705	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.998	12.719	-46.1	-45.7	4.37	0.0	0.0	
540.9										
	+1.340	30.2	1.998	12.719	-46.1	495.1	4.37	0.0	0.0	
	+0.840	35.2	2.634	12.689	197.5	478.8	18.70	0.0	0.0	
	-0.160	45.2	3.889	12.350	657.0	438.6	62.22	0.0	0.0	
	-1.160	55.2	5.092	11.664	1071.3	388.4	101.46	0.0	0.0	
	-1.660	60.2	5.664	11.204	1258.4	359.6	119.18	0.0	0.0	
97.0										
	-1.660	60.2	5.664	11.204	1258.4	456.5	119.18	0.0	0.0	
	-2.160	65.1	6.212	10.664	1479.0	425.2	140.06	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-4.160	85.1	8.070	7.732	2185.8	275.0	207.00	0.0	0.0	
	-4.660	90.1	8.434	6.844	2312.5	231.2	218.99	0.0	0.0	
0.0										
	-4.660	90.1	8.434	6.844	2312.5	231.2	218.99	0.0	0.0	
	-5.160	95.1	8.753	5.910	2416.6	184.9	228.85	0.0	0.0	
	-6.160	105.1	9.247	3.943	2552.2	84.8	241.70	0.0	0.0	
	-6.276	106.2	9.291	3.709	2561.4	72.5	242.57	0.0	0.0	
	-7.160	117.1	9.540	1.909	2582.6	-26.2	244.57	0.0	0.0	
	-8.060	128.3	9.629	0.095	2510.1	-136.6	237.71	0.0	0.0	
	-8.160	129.6	9.629	-0.103	2495.8	-149.5	236.35	0.0	0.0	
	-9.160	142.0	9.523	-1.996	2279.4	-285.3	215.86	0.0	0.0	
	-10.160	154.4	9.238	-3.663	1921.0	-433.5	181.92	0.0	0.0	
	-11.160	166.9	8.802	-4.987	1408.2	-594.2	133.35	0.0	0.0	
	-12.060	178.0	8.314	-5.781	804.3	-749.4	76.17	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	69.25	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	60.90	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
	-13.060	190.5	7.716	-6.066	241.7	-933.7	20.13	0.0	0.0	
1111.4										
	-13.060	190.5	7.716	-6.066	241.7	177.8	20.13	0.0	0.0	
	-13.160	191.7	7.656	-6.064	205.7	158.7	17.13	0.0	0.0	
	-14.160	204.1	7.049	-6.083	41.3	-39.3	3.44	0.0	0.0	
	-14.350	203.6	6.933	-6.088	30.2	-78.3	2.51	0.0	0.0	
	-14.560	206.1	6.805	-6.091	9.2	-121.3	0.77	0.0	0.0	
	-14.560	192.0	6.805	-6.091	9.2	-121.3	0.77	137.5	137.5	*
	-15.160	190.6	6.440	-6.078	-72.2	-148.2	6.01	155.5	155.5	*
	-16.060	188.5	5.896	-5.989	-215.9	-166.8	17.98	182.3	182.3	*
	-16.160	188.3	5.837	-5.974	-232.6	-167.2	19.37	185.3	185.3	*
	-16.350	187.8	5.723	-5.941	-264.4	-167.2	22.02	191.0	191.0	*
	-17.160	186.0	5.249	-5.755	-395.9	-154.1	32.97	215.2	215.2	*
	-17.975	184.1	4.790	-5.497	-508.9	-119.5	42.38	239.6	239.6	*
	-17.975	184.1	4.790	-5.497	-508.9	-119.5	42.38	239.4	239.6	
	-18.160	183.7	4.689	-5.431	-530.1	-109.8	44.14	234.4	245.1	
	-19.160	181.4	4.166	-5.030	-618.6	-71.2	51.51	208.2	275.0	
	-19.350	180.9	4.071	-4.948	-631.6	-66.5	52.60	203.5	280.6	
	-19.350	101.7	4.071	-4.948	-631.6	-66.5	52.60	121.5	121.5	*
	-20.160	99.6	3.685	-4.579	-678.3	-48.1	56.49	125.1	125.1	*
	-21.160	97.1	3.251	-4.094	-712.5	-19.1	59.34	129.6	129.6	*
	-22.160	94.6	2.866	-3.597	-714.2	16.9	59.48	134.1	134.1	*
	-22.196	94.5	2.854	-3.579	-713.6	18.3	59.43	134.2	134.2	*
	-22.196	94.5	2.854	-3.579	-713.6	18.3	59.43	134.4	134.2	
	-23.160	92.1	2.531	-3.112	-679.5	50.5	56.59	119.2	138.6	
	-24.160	89.5	2.243	-2.660	-617.4	71.9	51.41	105.6	143.0	
	-25.160	87.0	1.997	-2.258	-539.0	83.3	44.89	94.1	147.5	
	-26.160	84.5	1.789	-1.914	-453.4	86.6	37.76	84.3	152.0	
	-27.160	82.0	1.613	-1.629	-368.0	83.3	30.65	75.9	156.5	
	-27.350	155.4	1.582	-1.582	-352.2	82.1	29.34	138.4	492.5	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	24.34	127.8	514.9	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	27.68	127.8	514.9	
	-28.350	79.9	1.435	-1.358	-280.5	59.7	26.56	67.6	162.6	
	-29.160	77.9	1.332	-1.193	-236.5	48.5	22.39	62.7	166.2	
	-30.160	75.4	1.222	-1.024	-196.0	32.0	18.56	57.5	170.7	
	-30.350	147.4	1.202	-0.995	-190.2	28.5	18.01	161.8	624.1	

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
	-31.160	145.1	1.127	-0.882	-163.3	36.9	15.46	151.6	647.8	
	-32.160	142.1	1.044	-0.768	-124.5	39.3	11.79	140.5	677.1	
	-33.160	139.2	0.972	-0.685	-87.2	34.2	8.26	130.8	706.3	
	-34.160	136.2	0.907	-0.628	-58.3	22.8	5.52	122.0	735.5	
	-35.160	133.3	0.846	-0.589	-43.5	5.9	4.12	113.8	764.8	
	-36.160	130.3	0.789	-0.554	-48.1	-16.0	4.56	106.1	794.0	
	-36.350	131.1	0.778	-0.547	-51.6	-20.7	4.89	157.1	863.9	
	-37.160	128.1	0.735	-0.510	-60.5	-2.0	5.73	148.4	888.8	
	-38.160	124.3	0.687	-0.464	-53.3	15.3	5.05	138.6	919.5	
	-39.160	120.6	0.642	-0.430	-31.8	26.9	3.01	129.6	950.3	
	-40.160	116.8	0.600	-0.416	-1.2	33.5	0.11	121.1	981.0	
	-41.160	113.1	0.558	-0.429	33.8	35.5	3.20	112.6	1011.8	
	-42.160	109.3	0.513	-0.470	68.2	32.5	6.46	103.6	1042.6	
	-43.160	105.5	0.463	-0.535	96.8	23.7	9.17	93.5	1073.3	
	-44.160	101.8	0.406	-0.619	113.3	7.9	10.73	81.9	1104.1	
	-45.160	98.0	0.339	-0.709	109.6	-16.7	10.38	68.5	1134.8	
	-46.160	94.3	0.264	-0.784	76.3	-51.9	7.22	53.3	1165.6	
	-46.350	17.0	0.249	-0.795	65.7	-59.9	6.22	50.3	577.7	
	-47.160	9.7	0.184	-0.824	27.4	-35.3	2.60	37.1	577.7	
	-47.241	9.0	0.177	-0.825	24.7	-33.1	2.34	35.7	577.7	
	-48.160	0.7	0.100	-0.835	4.5	-11.8	0.43	20.3	577.7	
	-48.240	0.0	0.094	-0.835	3.6	-10.3	0.34	18.9	577.7	
	-49.160	0.0	0.017	-0.836	0.0	0.0	0.00	3.4	577.7	

*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	-2.445	12.691	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.810	12.691	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.810	12.691	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.176	12.691	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.093	12.693	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.363	12.704	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.999	12.718	-46.1	-45.7	4.37	0.0	0.0	
542.2										
	+1.340	30.2	1.999	12.718	-46.1	496.4	4.37	0.0	0.0	
	+0.840	35.2	2.634	12.688	198.1	480.1	18.76	0.0	0.0	
	-0.160	45.2	3.889	12.347	658.9	439.9	62.40	0.0	0.0	
	-1.160	55.2	5.092	11.660	1074.5	389.7	101.76	0.0	0.0	
	-1.660	60.2	5.664	11.199	1262.3	360.9	119.54	0.0	0.0	
96.3										
	-1.660	60.2	5.664	11.199	1262.3	457.2	119.54	0.0	0.0	
	-2.160	65.1	6.211	10.656	1483.2	425.9	140.46	0.0	0.0	
	-3.160	75.1	7.212	9.327	1874.8	355.7	177.55	0.0	0.0	
	-3.160	75.1	7.212	9.327	1874.8	355.7	177.55	0.0	0.0	
	-4.160	85.1	8.067	7.717	2191.3	275.6	207.52	0.0	0.0	
	-4.660	90.1	8.431	6.827	2318.3	231.8	219.55	0.0	0.0	
0.0										
	-4.660	90.1	8.431	6.827	2318.3	231.8	219.55	0.0	0.0	
	-5.160	95.1	8.749	5.890	2422.7	185.5	229.44	0.0	0.0	
	-6.160	105.1	9.240	3.918	2559.1	85.5	242.35	0.0	0.0	
	-6.276	106.2	9.284	3.683	2568.3	73.2	243.22	0.0	0.0	
	-7.160	117.1	9.530	1.879	2590.1	-25.5	245.28	0.0	0.0	
	-8.060	963066.6	9.617	0.059	2518.1	-136.0	238.47	0.0	0.0	
	-8.160	963063.7	9.616	-0.139	2497.7	-274.4	236.53	0.0	0.0	
	-9.160	952440.0	9.508	-1.992	2254.2	-249.3	213.47	0.0	0.0	
	-10.160	923921.4	9.225	-3.630	1916.3	-403.2	181.47	0.0	0.0	
	-11.160	880344.3	8.793	-4.940	1417.7	-539.1	134.26	0.0	0.0	
	-12.060	178.0	8.309	-5.739	816.2	-748.4	77.30	0.0	0.0	
	-12.160	179.3	8.252	-5.800	743.2	-766.3	70.39	0.0	0.0	
	-12.160	179.3	8.252	-5.800	743.2	-766.3	61.90	0.0	0.0	

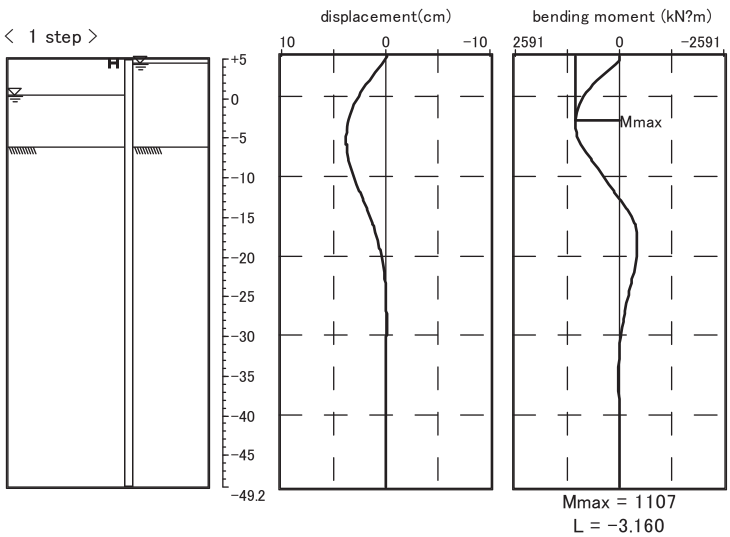
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-13.060	190.5	7.716	-6.032	253.9	-932.7	21.15	0.0	0.0	
1109.0										
	-13.060	190.5	7.716	-6.032	253.9	176.3	21.15	0.0	0.0	
	-13.160	191.7	7.655	-6.031	217.9	157.2	18.15	0.0	0.0	
	-14.160	204.1	7.051	-6.058	52.6	-40.8	4.38	0.0	0.0	
	-14.350	203.6	6.936	-6.065	41.2	-79.8	3.43	0.0	0.0	
	-14.560	206.1	6.809	-6.069	19.9	-122.8	1.66	0.0	0.0	
	-14.560	192.0	6.809	-6.069	19.9	-122.8	1.66	137.5	137.5	*
	-15.160	190.6	6.445	-6.061	-62.4	-149.7	5.20	155.5	155.5	*
	-16.060	188.5	5.902	-5.977	-207.4	-168.2	17.27	182.3	182.3	*
	-16.160	188.3	5.842	-5.963	-224.3	-168.7	18.68	185.3	185.3	*
	-16.350	187.8	5.729	-5.931	-256.3	-168.7	21.35	191.0	191.0	*
	-17.160	186.0	5.256	-5.749	-389.1	-155.6	32.40	215.2	215.2	*
	-17.971	184.1	4.800	-5.497	-502.7	-121.3	41.87	239.4	239.4	*
	-17.971	184.1	4.800	-5.497	-502.7	-121.3	41.87	239.9	239.4	
	-18.160	183.7	4.696	-5.429	-524.7	-111.2	43.70	234.7	245.1	
	-19.160	181.4	4.173	-5.032	-614.4	-72.2	51.17	208.5	275.0	
	-19.350	180.9	4.078	-4.950	-627.7	-67.5	52.27	203.8	280.6	
	-19.350	101.7	4.078	-4.950	-627.7	-67.5	52.27	121.5	121.5	*
	-20.160	99.6	3.692	-4.583	-675.2	-49.1	56.23	125.1	125.1	*
	-21.160	97.1	3.257	-4.100	-710.4	-20.1	59.16	129.6	129.6	*
	-22.160	94.6	2.872	-3.604	-713.0	15.9	59.38	134.1	134.1	*
	-22.215	94.4	2.852	-3.577	-712.1	18.1	59.30	134.3	134.3	*
	-22.215	94.4	2.852	-3.577	-712.1	18.1	59.30	134.3	134.3	
	-23.160	92.1	2.536	-3.119	-679.1	49.7	56.56	119.4	138.6	
	-24.160	89.5	2.247	-2.668	-617.7	71.4	51.44	105.8	143.0	
	-25.160	87.0	2.001	-2.266	-539.7	83.0	44.95	94.2	147.5	
	-26.160	84.5	1.792	-1.921	-454.5	86.4	37.85	84.4	152.0	
	-27.160	82.0	1.615	-1.635	-369.2	83.2	30.75	76.0	156.5	
	-27.350	155.4	1.584	-1.587	-353.5	82.0	29.44	138.5	492.5	
	-28.160	153.5	1.463	-1.406	-293.6	64.8	24.45	128.0	514.9	
	-28.160	153.5	1.463	-1.406	-293.6	64.8	27.80	128.0	514.9	
	-28.350	79.9	1.437	-1.363	-281.7	59.8	26.68	67.7	162.6	
	-29.160	77.9	1.333	-1.198	-237.7	48.6	22.51	62.8	166.2	
	-30.160	75.4	1.222	-1.027	-197.1	32.1	18.67	57.6	170.7	
	-30.350	147.4	1.203	-0.998	-191.3	28.7	18.12	161.9	624.1	

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
	-31.160	145.1	1.127	-0.884	-164.3	37.1	15.56	151.6	647.8	
	-32.160	142.1	1.044	-0.769	-125.4	39.4	11.87	140.5	677.1	
	-33.160	139.2	0.972	-0.686	-87.9	34.4	8.33	130.8	706.3	
	-34.160	136.2	0.906	-0.628	-58.8	23.0	5.57	122.0	735.5	
	-35.160	133.3	0.846	-0.589	-43.8	6.0	4.15	113.8	764.8	
	-36.160	130.3	0.788	-0.554	-48.4	-15.9	4.58	106.1	794.0	
	-36.350	131.1	0.778	-0.547	-51.8	-20.6	4.91	157.0	863.9	
	-37.160	128.1	0.735	-0.510	-60.6	-1.9	5.74	148.4	888.8	
	-38.160	124.3	0.687	-0.464	-53.3	15.3	5.05	138.6	919.5	
	-39.160	120.6	0.642	-0.430	-31.8	26.9	3.01	129.6	950.3	
	-40.160	116.8	0.600	-0.416	-1.1	33.6	0.11	121.1	981.0	
	-41.160	113.1	0.558	-0.429	33.8	35.5	3.20	112.6	1011.8	
	-42.160	109.3	0.513	-0.469	68.2	32.5	6.46	103.6	1042.6	
	-43.160	105.5	0.463	-0.535	96.9	23.7	9.17	93.5	1073.3	
	-44.160	101.8	0.406	-0.619	113.3	7.9	10.73	81.9	1104.1	
	-45.160	98.0	0.339	-0.709	109.7	-16.8	10.38	68.5	1134.8	
	-46.160	94.3	0.264	-0.784	76.3	-51.9	7.22	53.3	1165.6	
	-46.350	17.0	0.249	-0.795	65.7	-59.9	6.22	50.3	577.7	
	-47.160	9.7	0.184	-0.824	27.4	-35.3	2.60	37.1	577.7	
	-47.241	9.0	0.177	-0.825	24.7	-33.1	2.34	35.7	577.7	
	-48.160	0.7	0.101	-0.835	4.5	-11.8	0.43	20.3	577.7	
	-48.240	0.0	0.094	-0.835	3.6	-10.3	0.34	18.9	577.7	
	-49.160	0.0	0.017	-0.836	0.0	0.0	0.00	3.4	577.7	

*showing plastic
bending moment at support of footing concrete is reduced value

2.11 displacement / member force diagram

bridge axis direction



- 195 -

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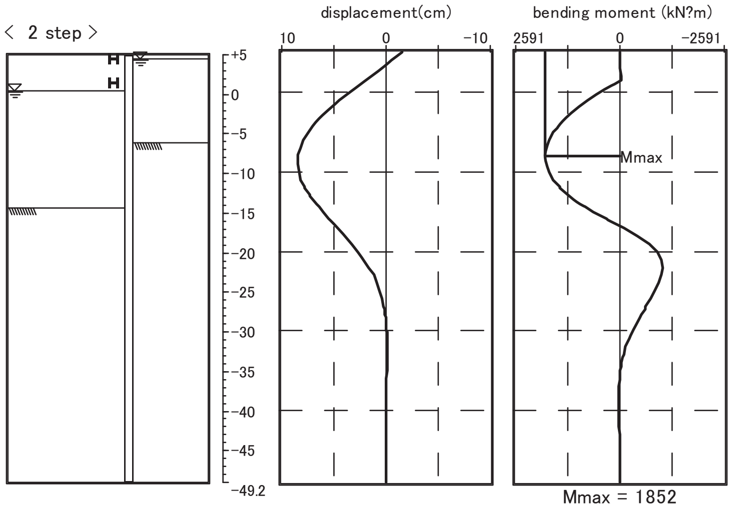

Mmax = 1852
L = −8.160

- 196 -

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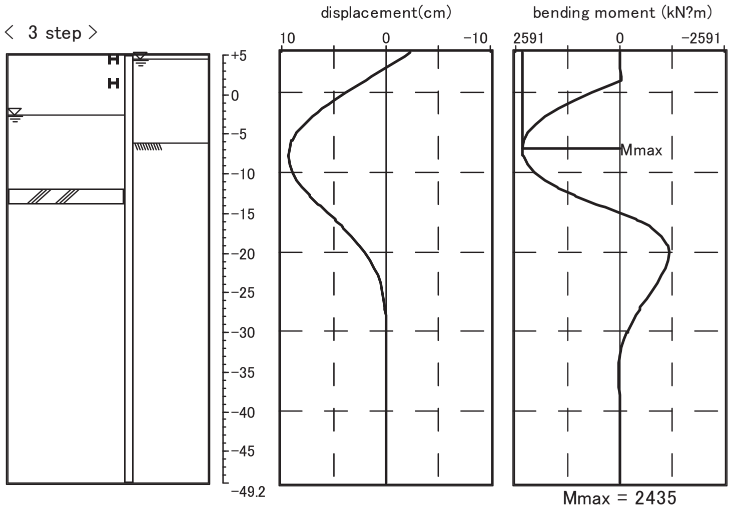
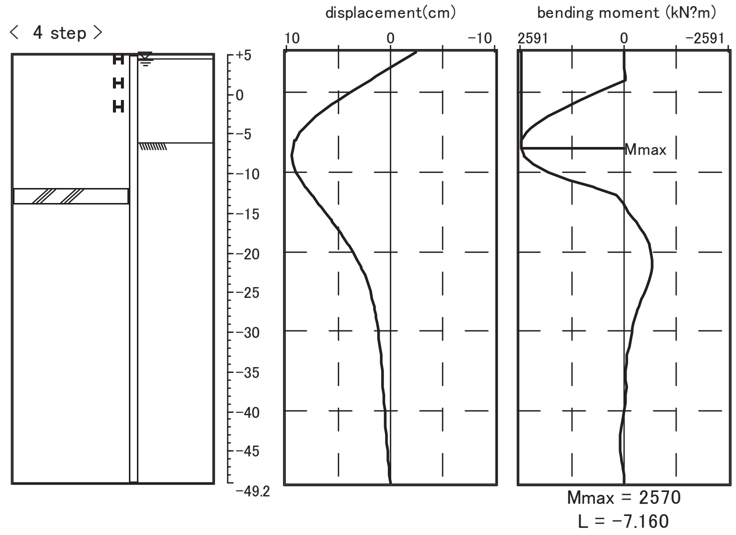
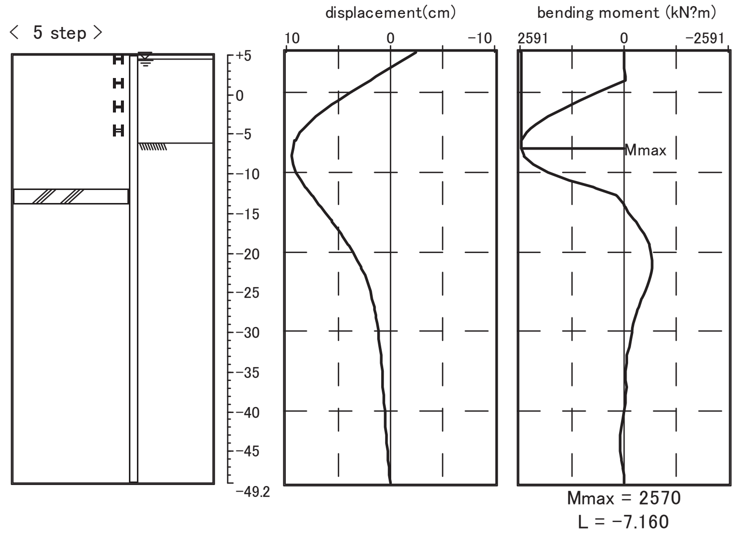


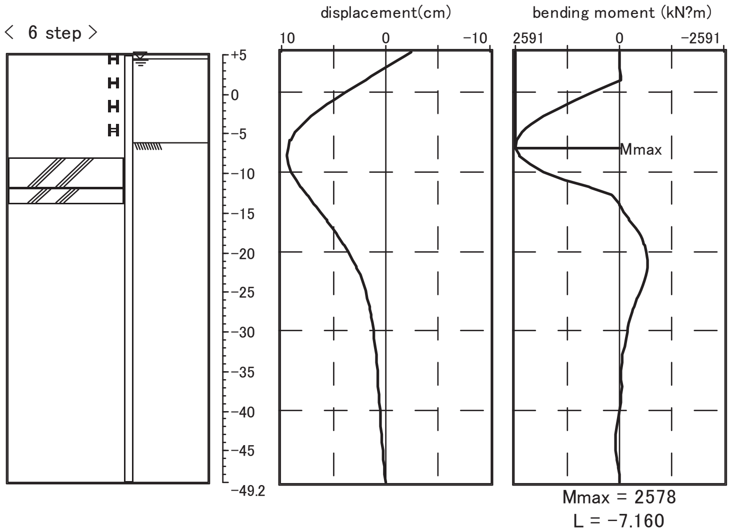
Mmax = 2435
L = −7.160



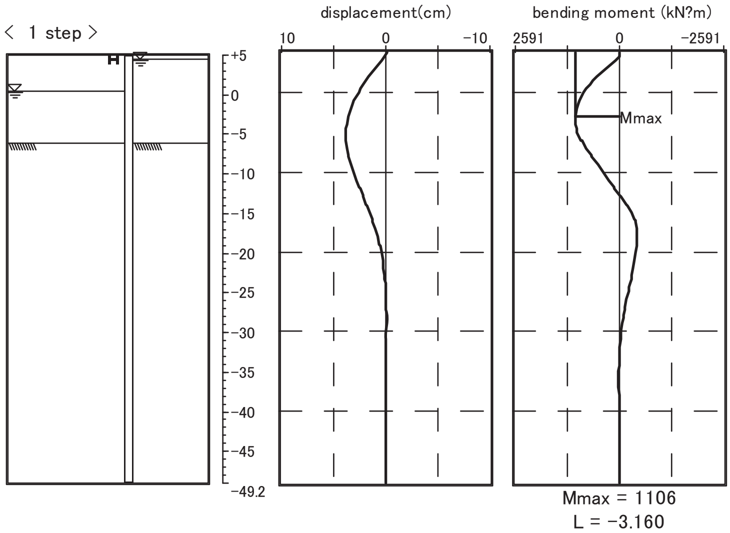
< 4 step >
displacement(cm)
10
0
−10
bending moment (kN?m)
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2570
L = −7.160

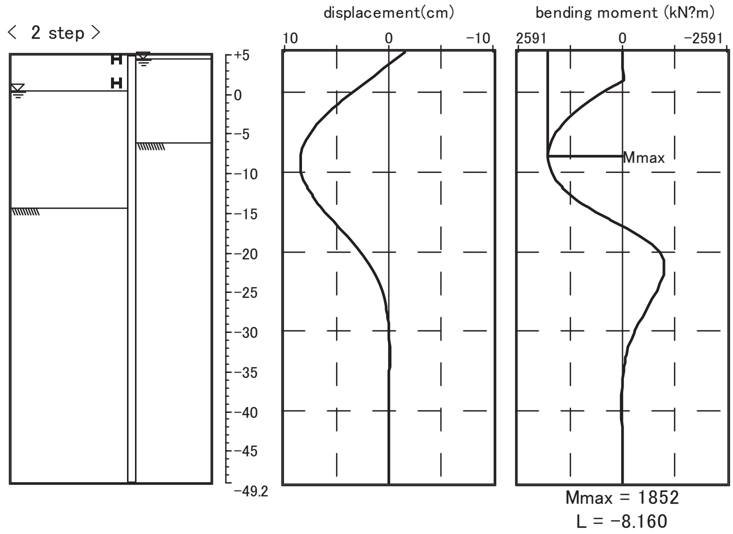


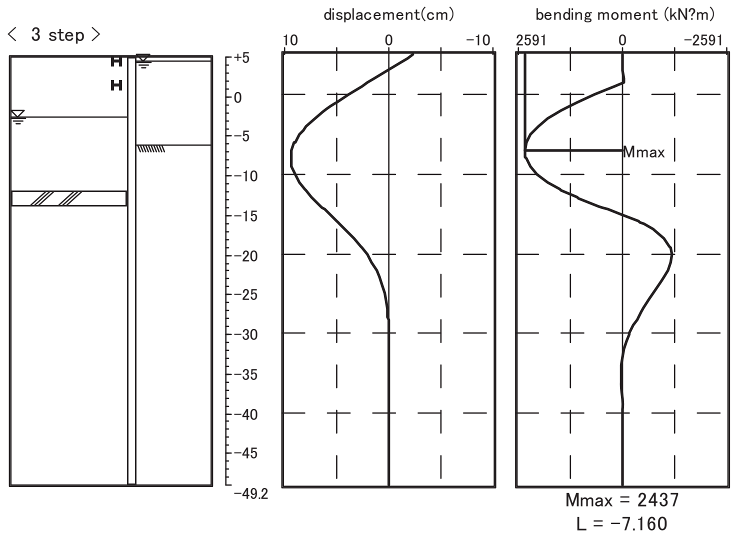
< 5 step >
displacement(cm)
10
0
−10
bending moment (kN?m)
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2570
L = −7.160



perpendicular direction




< 2 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 1852
L = −8.160


< 3 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
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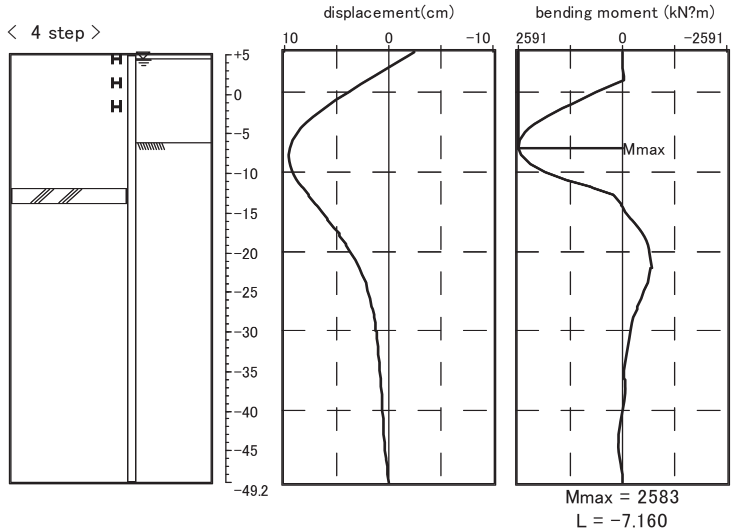
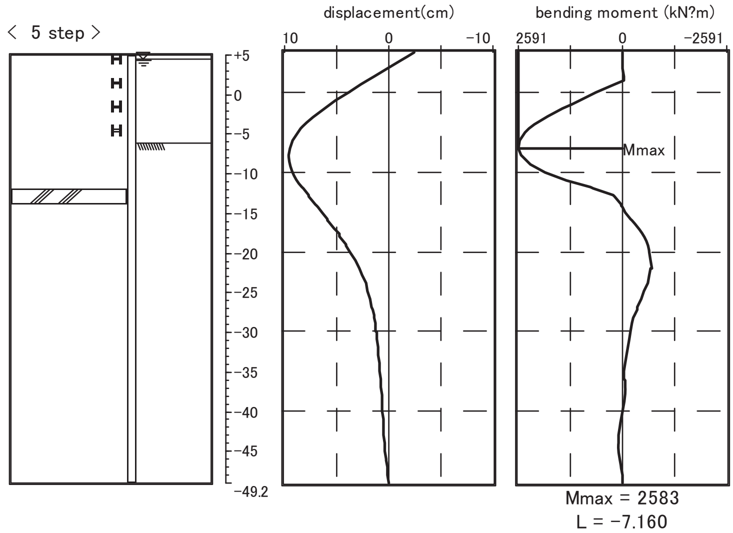
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2437
L = −7.160



< 4 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2583
L = −7.160



< 5 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
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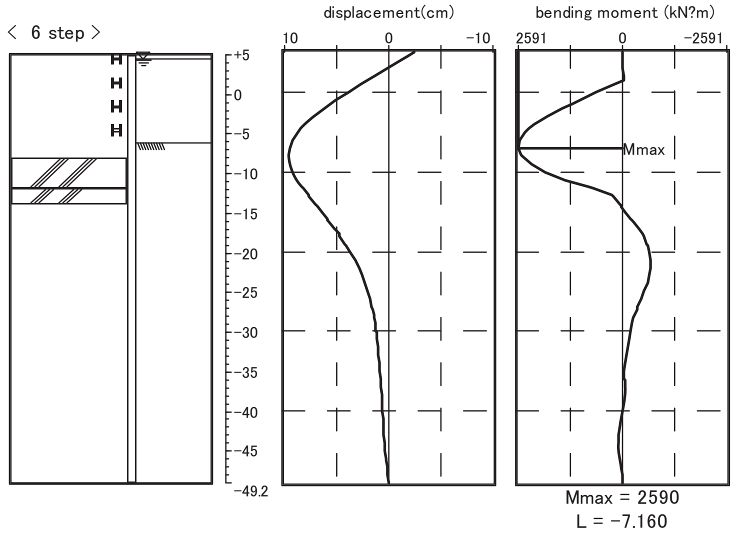
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2583
L = −7.160



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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	232.62	H-350*350*12*19	232.57
2	2H-400*400*13*21	284.21	2H-400*400*13*21	284.33

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
3	H-300*300*10*15	80.29	H-300*300*10*15	96.95
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	431.16	39800	1986.21	232.57	OK
2	2H-400*400*13*21	428.66	66600	3382.15	284.33	OK
3	H-300*300*10*15	433.66	20200	990.74	96.95	OK
4	H-300*300*10*15	433.66	20200	990.74	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	232.57	232.62	431.16
2	2H-400*400*13*21	218.70	3330	284.33	284.21	428.66
3	H-300*300*10*15	118.40	1350	96.95	80.29	433.66
4	H-300*300*10*15	118.40	1350	0.00	0.00	433.66

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	1002.8	86.5	141.3	158.24	210.00	OK
2	2.700	1218.8	104.5	172.7	138.96	210.00	OK
3	2.700	420.4	36.5	48.8	98.65	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/mm²)

Sig.bcy : bending compressive stress by bending moment about strong axis (N/mm²)

Sig.caz : about weak axis allowable axial direction compressive stress (N/mm²)

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

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

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

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/mm²)

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

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

L2 : distance between fixed flange (mm)

b : compressive flange width (mm)

Sig.cal : allowable stress for local buckling of protrusion under compressive force (N/mm²)

(= 210.0 (N/mm²))

Sig.eay : Euler buckling stress about strong axis(N/mm²) = $\frac{1,200,000}{\left(\frac{L4}{ry}\right)^2}$

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 (cm²)	Z (cm³)	r (cm)	L (m)	L' (m)	L1 (m)	L2 (m)	L4 (m)	L5 (m)
1	H-350*350*12*19	171.90	2280	431.16	4.000	1.300	2.700	2.700	2.700	2.700
2	2H-400*400*13*21	218.70	3330	428.66	4.000	1.300	2.700	2.700	2.700	2.700
3	H-300*300*10*15	118.40	1350	433.66	4.000	1.300	2.700	2.700	2.700	2.700
4	H-300*300*10*15	118.40	1350	433.66	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	26.73	199.26	6.75	201.90	15.43	5041.15
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	232.57	232.62	1152.76	211.98	67.06	92.97
2	284.33	284.21	1368.80	258.99	62.59	77.78
3	96.95	80.29	570.45	73.16	48.18	54.19
4	0.00	0.00	150.00	0.00	12.67	0.00

row	Alp.	Beta	Alp.+Beta	judgement
1	0.344	0.477	0.821	OK
2	0.314	0.390	0.704	OK
3	0.256	0.284	0.541	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	67.06	92.97	3803.13	94.64	161.70	210.00	OK
2	62.59	77.78	5041.15	78.75	141.34	210.00	OK
3	48.18	54.19	2824.86	55.13	103.31	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	232.62	2.700	314.04	37.44	83.88	120.00	OK
2	284.21	2.700	383.69	46.54	82.44	120.00	OK
3	80.29	2.700	108.39	27.00	40.14	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	5.673	8.273	8.273	5.673
2	2H-400*400*13*21	218.70	3330	4.000	5.573	8.173	8.173	5.573
3	H-300*300*10*15	118.40	1350	4.000	5.773	8.373	8.373	5.773
4	H-300*300*10*15	118.40	1350	4.000	5.773	8.373	8.373	5.773

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	63.81	153.65	16.21	167.85	54.43	405.08
2	55.18	164.27	13.93	176.04	46.70	550.17

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
3	76.46	138.09	19.24	156.92	63.92	293.74
4	76.46	138.09	19.24	156.92	63.92	293.74

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	232.57	232.62	1080.50	42.78	62.86	18.76
2	284.33	284.21	1286.86	41.75	58.84	12.54
3	96.95	80.29	471.15	43.82	39.79	32.46
4	0.00	0.00	150.00	43.82	12.67	32.46

row	Alp.	Beta	Alp.+Beta	judgement
1	0.409	0.132	0.541	OK
2	0.358	0.080	0.438	OK
3	0.288	0.239	0.527	OK
4	0.092	0.216	0.308	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	62.86	18.76	405.08	22.21	85.06	210.00	OK
2	58.84	12.54	550.17	14.04	72.88	210.00	OK
3	39.79	32.46	293.74	37.54	77.34	210.00	OK
4	12.67	32.46	293.74	33.92	46.59	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	8.273	20.68	37.44	5.52	120.00	OK
2	8.173	20.43	46.54	4.39	120.00	OK
3	8.373	20.93	27.00	7.75	120.00	OK
4	8.373	20.93	27.00	7.75	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-400*400*13*21	218.70	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	232.62	444.12	25.84	206.70	OK
2	18.20	284.21	542.62	24.81	209.75	OK
3	24.35	80.29	153.28	12.95	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 -6.276 (m)
riverside water table elevation +4.340 (m)
steel pipe sheet pile length 54.000 (m)

(1)final excavation time (5 step)
observing strut elevation = -4.660 (m)
coffered landside excavation area elevation = -14.560 (m)
coffered landside water table elevation = -14.560 (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 -6.276	1.616	------- -------	0.00 0.00	90.00 106.16
2	-6.276 -14.350	8.074	------- -------	0.00 22.41	106.16 186.90
3	-14.350 -14.560	0.210	------- -------	19.04 19.54	186.90 189.00
4	-14.560 -16.350	1.790	0.00 48.58	19.54 23.76	189.00 0.00
5	-16.350 -19.350	3.000	48.58 129.99	23.76 30.83	0.00 0.00
6	-19.350 -27.350	8.000	122.32 182.32	20.59 80.59	0.00 0.00
7	-27.350 -28.350	1.000	319.99 346.03	50.57 53.03	0.00 0.00
8	-28.350 -30.350	2.000	190.32 205.32	88.59 103.59	0.00 0.00
9	-30.350 -30.571	0.221	411.53 417.52	55.30 55.82	0.00 0.00

active earth pressure /water pressure Pa = 3770.2 (kN/m)
ya = 12.474 (m)
Ma = 47028 (kN.m/m)
passive earth pressure Pp = 2350.0 (kN/m)
yp = 20.012 (m)
Mp = 47028 (kN.m/m)

balanced depth Z = 16.011 (m) (elevation = -30.571 (m))
embedment length D = 19.213 (m) (elevation = -33.773 (m))
required sheet pile length L = 38.613 (m)

(2)before installation of the lower strut (4 step)
observing strut elevation = -1.660 (m)
coffered landside excavation area elevation = -14.560 (m)
coffered landside water table elevation = -14.560 (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 -6.276	4.616	------- -------	0.00 0.00	60.00 106.16
2	-6.276 -14.350	8.074	------- -------	0.00 22.41	106.16 186.90
3	-14.350 -14.560	0.210	------- -------	19.04 19.54	186.90 189.00
4	-14.560 -16.350	1.790	0.00 48.58	19.54 23.76	189.00 0.54
5	-16.350 -19.350	3.000	48.58 129.99	23.76 30.83	0.54 0.43
6	-19.350 -27.350	8.000	122.32 182.32	20.59 80.59	0.43 0.14
7	-27.350 -28.350	1.000	319.99 346.03	50.57 53.03	0.14 0.10
8	-28.350 -30.350	2.000	190.32 205.32	88.59 103.59	0.10 0.03
9	-30.350 -31.114	0.764	411.53 432.26	55.30 57.10	0.03 0.00

active earth pressure /water pressure Pa = 4077.2 (kN/m)
ya = 14.915 (m)
Ma = 60813 (kN.m/m)
passive earth pressure Pp = 2580.7 (kN/m)
yp = 23.564 (m)
Mp = 60813 (kN.m/m)
balanced depth Z = 16.554 (m) (elevation = -31.114 (m))
embedment length D = 19.864 (m) (elevation = -34.424 (m))

required sheet pile length L = 39.264 (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)	-22.089	34.63	58.61	93.24	140.00
2	Oridinary(low tide)	-22.089	35.86	58.61	94.48	140.00
3	Ord+Temp(high tide)	-21.160	69.15	58.58	127.73	161.00
4	Ord+Temp(low tide)	-21.160	70.39	58.58	128.96	161.00
5	Wind+Temp	-21.160	69.36	58.58	127.93	189.00
6	Ord+Collision	-21.160	50.92	58.58	109.50	210.00
7	Earthquake	-21.160	121.69	58.58	180.27	210.00

2) material :SKY490

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)	-12.060	39.38	71.63	111.02	185.00
2	Oridinary(low tide)	-12.060	40.79	71.63	112.42	185.00
3	Ord+Temp(high tide)	-12.060	79.05	71.63	150.69	212.75
4	Ord+Temp(low tide)	-12.060	80.46	71.63	152.09	212.75
5	Wind+Temp	-12.060	79.22	71.63	150.86	249.75
6	Ord+Collision	-12.060	56.10	71.63	127.73	277.50
7	Earthquake	-12.060	123.12	71.63	194.75	277.50

(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)	-12.160	34.63	60.90	95.53	140.00
2	Oridinary(low tide)	-12.160	35.86	60.90	96.76	140.00
3	Wind	-12.160	41.97	60.90	102.87	175.00
4	Ord+Collision	-21.160	67.47	59.34	126.81	210.00
5	Earthquake	-21.160	124.27	59.34	183.62	210.00

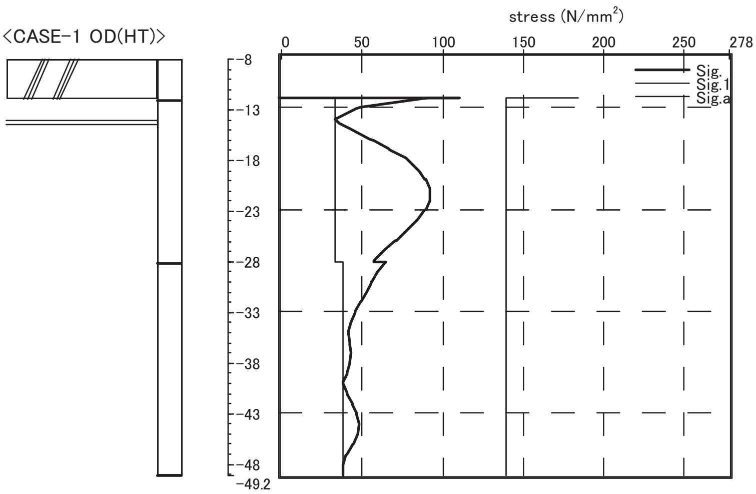
2) material :SKY490

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)	-12.060	39.38	76.17	115.55	185.00
2	Oridinary(low tide)	-12.060	40.79	76.17	116.95	185.00
3	Wind	-12.060	47.85	76.17	124.02	231.25
4	Ord+Collision	-12.060	70.59	76.17	146.76	277.50
5	Earthquake	-12.060	124.07	76.17	200.24	277.50

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



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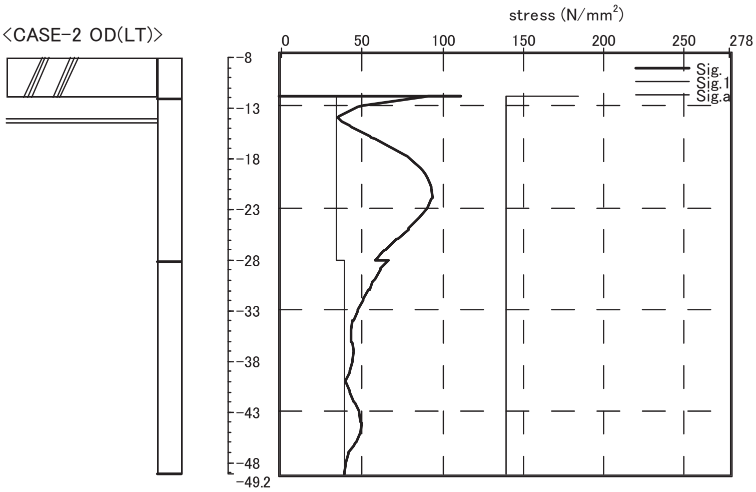

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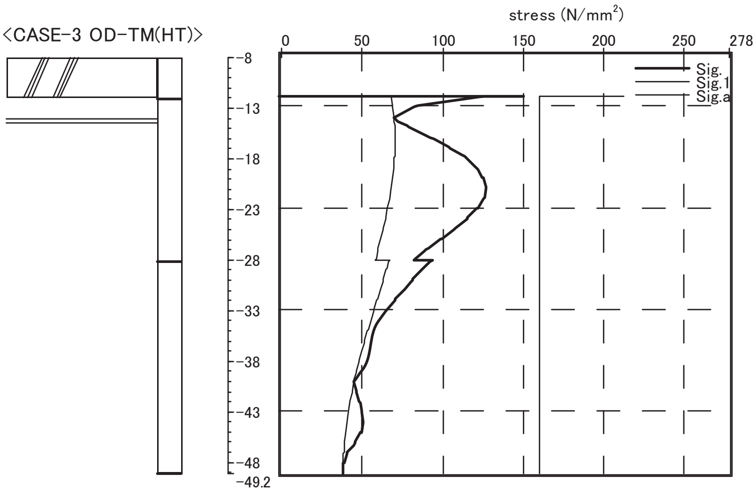

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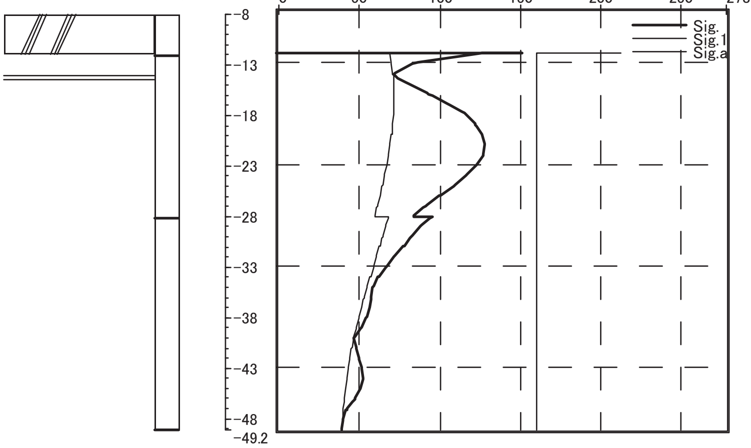

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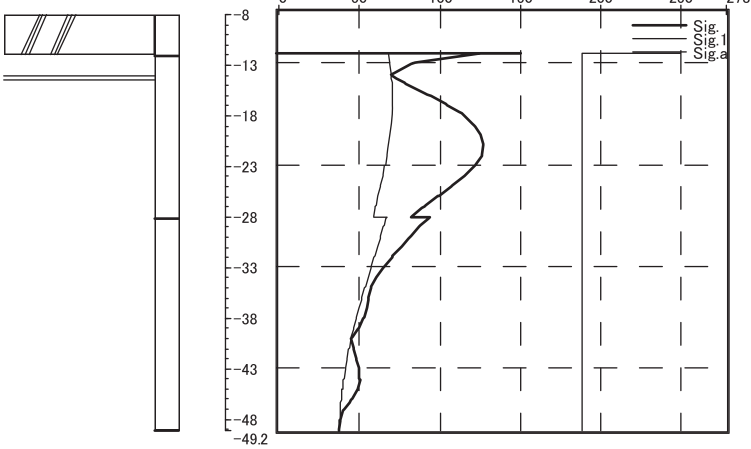

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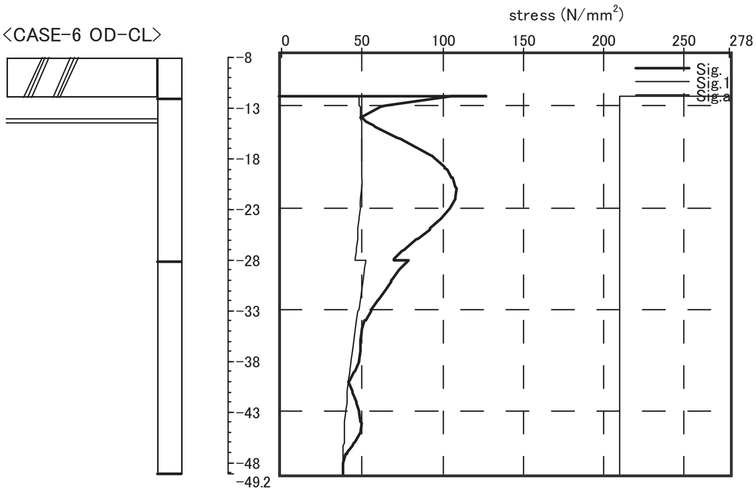
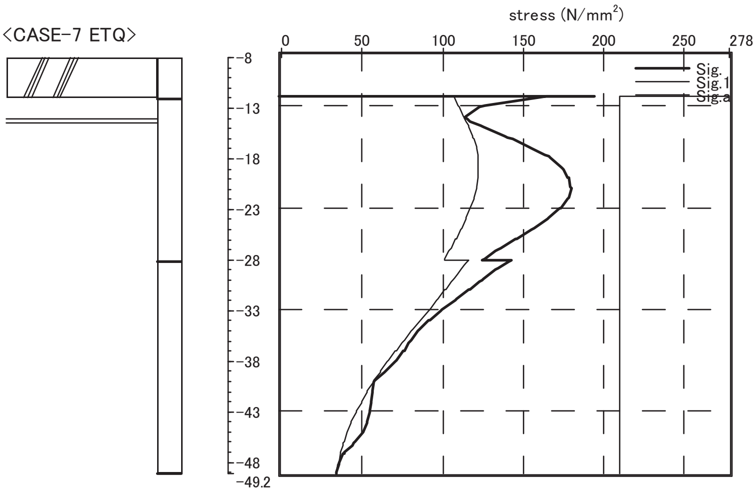
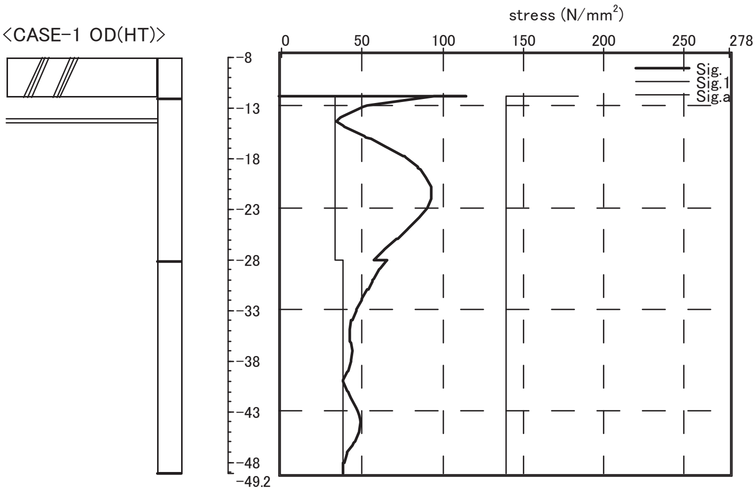


<CASE-7 ETQ>



(2)perpendicular direction

<CASE-1 OD(HT)>



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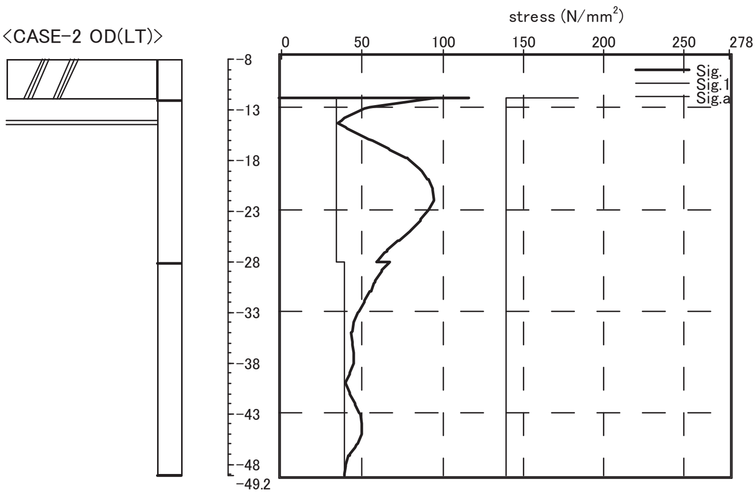

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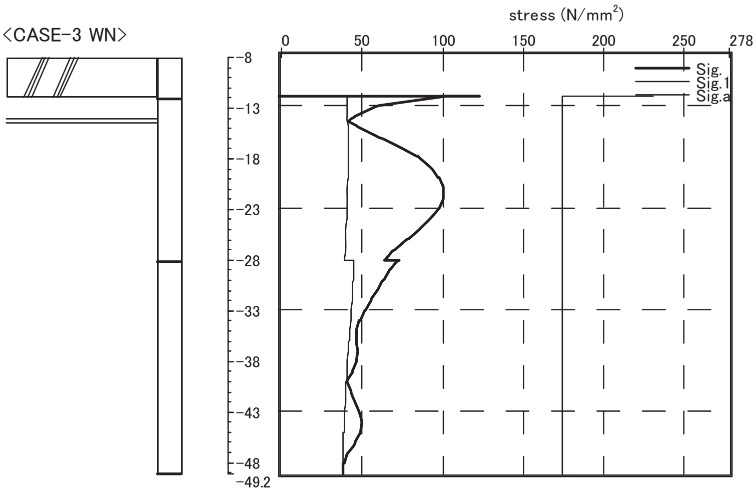

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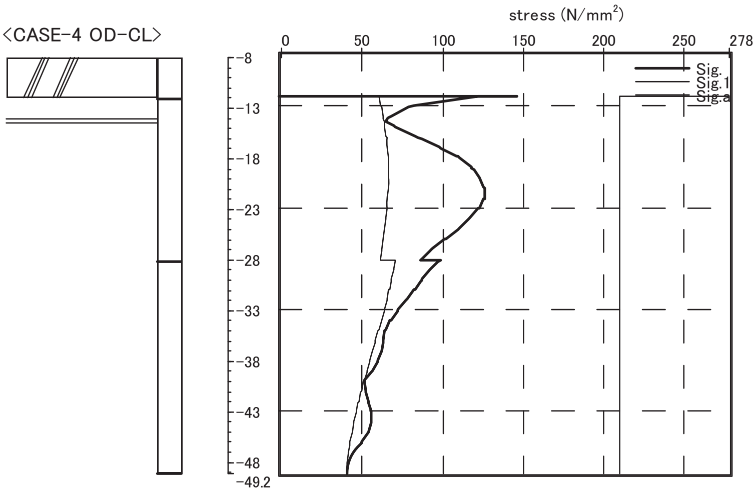

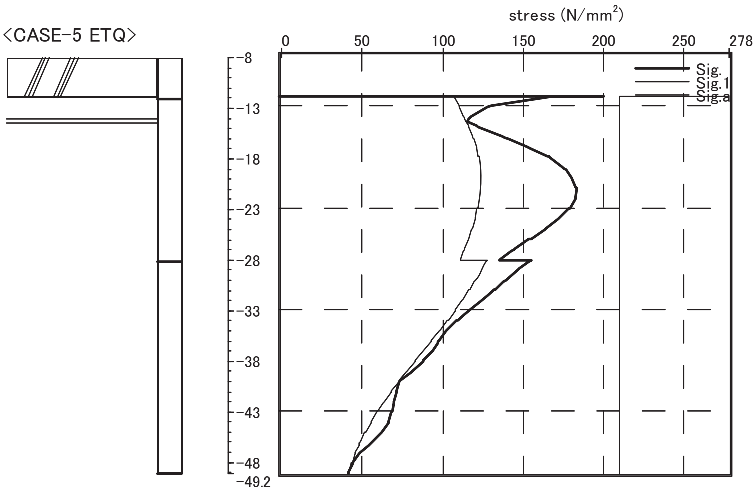

3.3 detail output

(1)bridge axis direction

1)Oridinary(high tide)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	39.38	71.63	111.02	
-12.160	39.38	64.65	104.03	
-12.160	34.63	56.86	91.48	
-13.060	34.63	15.90	50.53	
-13.160	34.63	12.92	47.55	
-14.060	34.63	1.47	36.10	
-14.160	34.63	0.20	34.82	
-14.350	34.63	0.96	35.59	
-14.560	34.63	2.52	37.15	
-15.060	34.63	7.74	42.37	
-15.160	34.63	8.78	43.41	
-16.060	34.63	19.97	54.60	
-16.160	34.63	21.27	55.90	
-16.350	34.63	23.76	58.38	
-17.060	34.63	32.74	67.37	
-17.160	34.63	34.01	68.64	
-17.871	34.63	41.74	76.37	
-18.060	34.63	43.43	78.06	
-18.160	34.63	44.33	78.96	
-19.060	34.63	50.50	85.12	
-19.160	34.63	51.18	85.81	
-19.350	34.63	52.22	86.85	
-20.060	34.63	55.48	90.11	
-20.160	34.63	55.94	90.57	
-21.060	34.63	58.31	92.94	
-21.160	34.63	58.58	93.21	
-22.060	34.63	58.61	93.24	
-22.089	34.63	58.61	93.24	**
-22.160	34.63	58.51	93.14	
-23.060	34.63	55.79	90.42	
-23.160	34.63	55.49	90.12	
-24.060	34.63	50.84	85.47	
-24.160	34.63	50.33	84.95	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.060	34.63	44.53	79.16	
-25.160	34.63	43.89	78.52	
-26.060	34.63	37.58	72.21	
-26.160	34.63	36.88	71.50	
-27.060	34.63	30.55	65.18	
-27.160	34.63	29.85	64.48	
-27.350	34.63	28.55	63.18	
-28.060	34.63	24.25	58.88	
-28.160	34.63	23.64	58.27	
-28.160	39.38	26.88	66.27	
-28.350	39.38	25.80	65.18	
-29.060	39.38	22.24	61.62	
-29.160	39.38	21.74	61.12	
-30.060	39.38	18.28	57.66	
-30.160	39.38	17.89	57.27	
-30.350	39.38	17.32	56.70	
-31.060	39.38	15.02	54.40	
-31.160	39.38	14.70	54.08	
-32.060	39.38	11.40	50.78	
-32.160	39.38	11.04	50.42	
-33.060	39.38	7.93	47.31	
-33.160	39.38	7.58	46.96	
-34.060	39.38	5.20	44.58	
-34.160	39.38	4.94	44.32	
-35.060	39.38	3.75	43.13	
-35.160	39.38	3.62	43.00	
-36.060	39.38	4.05	43.43	
-36.160	39.38	4.09	43.47	
-36.350	39.38	4.42	43.80	
-37.060	39.38	5.17	44.55	
-37.160	39.38	5.28	44.66	
-38.060	39.38	4.75	44.13	
-38.160	39.38	4.69	44.07	
-39.060	39.38	2.98	42.36	
-39.160	39.38	2.79	42.17	
-40.060	39.38	0.34	39.72	
-40.160	39.38	0.07	39.45	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-41.060	39.38	2.74	42.12	
-41.160	39.38	3.04	42.42	
-42.060	39.38	5.79	45.17	
-42.160	39.38	6.09	45.48	
-43.060	39.38	8.36	47.74	
-43.160	39.38	8.61	47.99	
-44.060	39.38	9.86	49.25	
-44.160	39.38	10.00	49.38	
-45.060	39.38	9.60	48.98	
-45.160	39.38	9.56	48.94	
-46.060	39.38	6.71	46.09	
-46.160	39.38	6.40	45.78	
-46.350	39.38	5.41	44.79	
-47.060	39.38	2.39	41.77	
-47.160	39.38	1.96	41.34	
-47.241	39.38	1.73	41.11	
-48.060	39.38	0.40	39.78	
-48.160	39.38	0.23	39.61	
-48.240	39.38	0.18	39.56	
-49.060	39.38	0.02	39.40	
-49.160	39.38	0.00	39.38	

*   :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)	
-12.060	40.79	71.63	112.42	
-12.160	40.79	64.65	105.44	
-12.160	35.86	56.86	92.72	
-13.060	35.86	15.90	51.76	
-13.160	35.86	12.92	48.79	
-14.060	35.86	1.47	37.33	
-14.160	35.86	0.20	36.06	
-14.350	35.86	0.96	36.83	
-14.560	35.86	2.52	38.39	
-15.060	35.86	7.74	43.61	
-15.160	35.86	8.78	44.65	
-16.060	35.86	19.97	55.83	
-16.160	35.86	21.27	57.14	
-16.350	35.86	23.76	59.62	
-17.060	35.86	32.74	68.61	
-17.160	35.86	34.01	69.87	
-17.871	35.86	41.74	77.60	
-18.060	35.86	43.43	79.30	
-18.160	35.86	44.33	80.19	
-19.060	35.86	50.50	86.36	
-19.160	35.86	51.18	87.05	
-19.350	35.86	52.22	88.09	
-20.060	35.86	55.48	91.35	
-20.160	35.86	55.94	91.81	
-21.060	35.86	58.31	94.18	
-21.160	35.86	58.58	94.44	
-22.060	35.86	58.61	94.48	
-22.089	35.86	58.61	94.48	**
-22.160	35.86	58.51	94.37	
-23.060	35.86	55.79	91.65	
-23.160	35.86	55.49	91.35	
-24.060	35.86	50.84	86.71	
-24.160	35.86	50.33	86.19	
-25.060	35.86	44.53	80.40	
-25.160	35.86	43.89	79.75	
-26.060	35.86	37.58	73.44	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	35.86	36.88	72.74	
-27.060	35.86	30.55	66.42	
-27.160	35.86	29.85	65.72	
-27.350	35.86	28.55	64.42	
-28.060	35.86	24.25	60.11	
-28.160	35.86	23.64	59.51	
-28.160	40.79	26.88	67.67	
-28.350	40.79	25.80	66.59	
-29.060	40.79	22.24	63.03	
-29.160	40.79	21.74	62.53	
-30.060	40.79	18.28	59.06	
-30.160	40.79	17.89	58.68	
-30.350	40.79	17.32	58.11	
-31.060	40.79	15.02	55.81	
-31.160	40.79	14.70	55.48	
-32.060	40.79	11.40	52.19	
-32.160	40.79	11.04	51.82	
-33.060	40.79	7.93	48.71	
-33.160	40.79	7.58	48.37	
-34.060	40.79	5.20	45.99	
-34.160	40.79	4.94	45.72	
-35.060	40.79	3.75	44.54	
-35.160	40.79	3.62	44.40	
-36.060	40.79	4.05	44.83	
-36.160	40.79	4.09	44.88	
-36.350	40.79	4.42	45.21	
-37.060	40.79	5.17	45.96	
-37.160	40.79	5.28	46.07	
-38.060	40.79	4.75	45.54	
-38.160	40.79	4.69	45.48	
-39.060	40.79	2.98	43.77	
-39.160	40.79	2.79	43.58	
-40.060	40.79	0.34	41.13	
-40.160	40.79	0.07	40.86	
-41.060	40.79	2.74	43.53	
-41.160	40.79	3.04	43.82	
-42.060	40.79	5.79	46.58	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	40.79	6.09	46.88	
-43.060	40.79	8.36	49.15	
-43.160	40.79	8.61	49.40	
-44.060	40.79	9.86	50.65	
-44.160	40.79	10.00	50.79	
-45.060	40.79	9.60	50.39	
-45.160	40.79	9.56	50.34	
-46.060	40.79	6.71	47.50	
-46.160	40.79	6.40	47.18	
-46.350	40.79	5.41	46.19	
-47.060	40.79	2.39	43.18	
-47.160	40.79	1.96	42.75	
-47.241	40.79	1.73	42.52	
-48.060	40.79	0.40	41.18	
-48.160	40.79	0.23	41.02	
-48.240	40.79	0.18	40.97	
-49.060	40.79	0.02	40.81	
-49.160	40.79	0.00	40.79	

* :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)	
-12.060	79.05	71.63	150.69	
-12.160	79.15	64.65	143.80	
-12.160	69.29	56.86	126.14	
-13.060	70.04	15.90	85.94	
-13.160	70.11	12.92	83.04	
-14.060	70.79	1.47	72.26	
-14.160	70.86	0.20	71.05	
-14.350	70.99	0.96	71.95	
-14.560	71.13	2.52	73.65	
-15.060	71.39	7.74	79.13	
-15.160	71.42	8.78	80.20	
-16.060	71.67	19.97	91.64	
-16.160	71.68	21.27	92.95	
-16.350	71.69	23.76	95.45	
-17.060	71.65	32.74	104.40	
-17.160	71.63	34.01	105.63	
-17.871	71.43	41.74	113.17	
-18.060	71.38	43.43	114.81	
-18.160	71.32	44.33	115.65	
-19.060	70.86	50.50	121.36	
-19.160	70.80	51.18	121.98	
-19.350	70.67	52.22	122.89	
-20.060	70.14	55.48	125.63	
-20.160	70.05	55.94	126.00	
-21.060	69.25	58.31	127.57	
-21.160	69.15	58.58	127.73	**
-22.060	68.21	58.61	126.83	
-22.089	68.18	58.61	126.79	
-22.160	68.10	58.51	126.60	
-23.060	67.04	55.79	122.83	
-23.160	66.92	55.49	122.40	
-24.060	65.77	50.84	116.61	
-24.160	65.63	50.33	115.96	
-25.060	64.40	44.53	108.93	
-25.160	64.25	43.89	108.14	
-26.060	62.95	37.58	100.53	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	62.80	36.88	99.68	
-27.060	61.44	30.55	92.00	
-27.160	61.29	29.85	91.14	
-27.350	61.00	28.55	89.55	
-28.060	59.88	24.25	84.13	
-28.160	59.72	23.64	83.36	
-28.160	68.17	26.88	95.06	
-28.350	67.82	25.80	93.62	
-29.060	66.50	22.24	88.74	
-29.160	66.31	21.74	88.05	
-30.060	64.60	18.28	82.88	
-30.160	64.41	17.89	82.30	
-30.350	64.05	17.32	81.37	
-31.060	62.68	15.02	77.70	
-31.160	62.49	14.70	77.19	
-32.060	60.74	11.40	72.14	
-32.160	60.55	11.04	71.58	
-33.060	58.80	7.93	66.72	
-33.160	58.60	7.58	66.18	
-34.060	56.86	5.20	62.07	
-34.160	56.68	4.94	61.61	
-35.060	54.97	3.75	58.72	
-35.160	54.78	3.62	58.40	
-36.060	53.12	4.05	57.16	
-36.160	52.93	4.09	57.03	
-36.350	52.59	4.42	57.01	
-37.060	51.33	5.17	56.50	
-37.160	51.16	5.28	56.44	
-38.060	49.64	4.75	54.39	
-38.160	49.48	4.69	54.17	
-39.060	48.06	2.98	51.05	
-39.160	47.92	2.79	50.71	
-40.060	46.60	0.34	46.95	
-40.160	46.47	0.07	46.54	
-41.060	45.27	2.74	48.01	
-41.160	45.15	3.04	48.18	
-42.060	44.06	5.79	49.85	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	43.95	6.09	50.05	
-43.060	42.99	8.36	51.34	
-43.160	42.89	8.61	51.50	
-44.060	42.04	9.86	51.91	
-44.160	41.96	10.00	51.97	
-45.060	41.24	9.60	50.84	
-45.160	41.17	9.56	50.73	
-46.060	40.57	6.71	47.28	
-46.160	40.51	6.40	46.90	
-46.350	40.40	5.41	45.80	
-47.060	40.03	2.39	42.42	
-47.160	39.99	1.96	41.95	
-47.241	39.96	1.73	41.69	
-48.060	39.63	0.40	40.02	
-48.160	39.60	0.23	39.84	
-48.240	39.59	0.18	39.77	
-49.060	39.40	0.02	39.42	
-49.160	39.42	0.00	39.42	

*   :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)	
-12.060	80.46	71.63	152.09	
-12.160	80.56	64.65	145.21	
-12.160	70.52	56.86	127.38	
-13.060	71.28	15.90	87.18	
-13.160	71.35	12.92	84.27	
-14.060	72.03	1.47	73.49	
-14.160	72.09	0.20	72.29	
-14.350	72.23	0.96	73.19	
-14.560	72.36	2.52	74.89	
-15.060	72.62	7.74	80.36	
-15.160	72.65	8.78	81.44	
-16.060	72.91	19.97	92.87	
-16.160	72.91	21.27	94.19	
-16.350	72.93	23.76	96.69	
-17.060	72.89	32.74	105.63	
-17.160	72.86	34.01	106.87	
-17.871	72.66	41.74	114.40	
-18.060	72.61	43.43	116.04	
-18.160	72.56	44.33	116.89	
-19.060	72.10	50.50	122.59	
-19.160	72.03	51.18	123.21	
-19.350	71.91	52.22	124.13	
-20.060	71.38	55.48	126.86	
-20.160	71.29	55.94	127.23	
-21.060	70.49	58.31	128.80	
-21.160	70.39	58.58	128.96	**
-22.060	69.45	58.61	128.06	
-22.089	69.42	58.61	128.03	
-22.160	69.33	58.51	127.84	
-23.060	68.28	55.79	124.07	
-23.160	68.15	55.49	123.64	
-24.060	67.00	50.84	117.85	
-24.160	66.87	50.33	117.19	
-25.060	65.63	44.53	110.16	
-25.160	65.49	43.89	109.38	
-26.060	64.19	37.58	101.76	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	64.04	36.88	100.91	
-27.060	62.68	30.55	93.23	
-27.160	62.53	29.85	92.38	
-27.350	62.23	28.55	90.79	
-28.060	61.12	24.25	85.37	
-28.160	60.96	23.64	84.60	
-28.160	69.58	26.88	96.46	
-28.350	69.23	25.80	95.03	
-29.060	67.90	22.24	90.14	
-29.160	67.71	21.74	89.45	
-30.060	66.01	18.28	84.28	
-30.160	65.82	17.89	83.71	
-30.350	65.46	17.32	82.78	
-31.060	64.09	15.02	79.11	
-31.160	63.90	14.70	78.59	
-32.060	62.15	11.40	73.55	
-32.160	61.95	11.04	72.99	
-33.060	60.20	7.93	68.13	
-33.160	60.01	7.58	67.59	
-34.060	58.27	5.20	63.47	
-34.160	58.08	4.94	63.02	
-35.060	56.37	3.75	60.12	
-35.160	56.19	3.62	59.81	
-36.060	54.52	4.05	58.57	
-36.160	54.34	4.09	58.43	
-36.350	54.00	4.42	58.42	
-37.060	52.74	5.17	57.91	
-37.160	52.57	5.28	57.85	
-38.060	51.05	4.75	55.80	
-38.160	50.89	4.69	55.58	
-39.060	49.47	2.98	52.45	
-39.160	49.32	2.79	52.12	
-40.060	48.01	0.34	48.35	
-40.160	47.88	0.07	47.95	
-41.060	46.67	2.74	49.41	
-41.160	46.55	3.04	49.59	
-42.060	45.47	5.79	51.26	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	45.36	6.09	51.45	
-43.060	44.39	8.36	52.75	
-43.160	44.30	8.61	52.91	
-44.060	43.45	9.86	53.31	
-44.160	43.37	10.00	53.37	
-45.060	42.64	9.60	52.24	
-45.160	42.58	9.56	52.13	
-46.060	41.97	6.71	48.68	
-46.160	41.91	6.40	48.31	
-46.350	41.80	5.41	47.21	
-47.060	41.43	2.39	43.82	
-47.160	41.39	1.96	43.36	
-47.241	41.36	1.73	43.09	
-48.060	41.03	0.40	41.43	
-48.160	41.01	0.23	41.24	
-48.240	40.99	0.18	41.17	
-49.060	40.81	0.02	40.83	
-49.160	40.83	0.00	40.83	

* :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)	
-12.060	79.22	71.63	150.86	
-12.160	79.33	64.65	143.98	
-12.160	69.43	56.86	126.29	
-13.060	70.20	15.90	86.10	
-13.160	70.28	12.92	83.20	
-14.060	70.97	1.47	72.44	
-14.160	71.04	0.20	71.24	
-14.350	71.18	0.96	72.14	
-14.560	71.32	2.52	73.84	
-15.060	71.59	7.74	79.33	
-15.160	71.61	8.78	80.40	
-16.060	71.88	19.97	91.85	
-16.160	71.89	21.27	93.16	
-16.350	71.91	23.76	95.66	
-17.060	71.87	32.74	104.61	
-17.160	71.84	34.01	105.85	
-17.871	71.65	41.74	113.39	
-18.060	71.60	43.43	115.03	
-18.160	71.54	44.33	115.87	
-19.060	71.08	50.50	121.58	
-19.160	71.02	51.18	122.20	
-19.350	70.89	52.22	123.11	
-20.060	70.36	55.48	125.84	
-20.160	70.27	55.94	126.21	
-21.060	69.46	58.31	127.78	
-21.160	69.36	58.58	127.93	**
-22.060	68.41	58.61	127.03	
-22.089	68.38	58.61	126.99	
-22.160	68.29	58.51	126.80	
-23.060	67.23	55.79	123.02	
-23.160	67.10	55.49	122.59	
-24.060	65.94	50.84	116.78	
-24.160	65.80	50.33	116.13	
-25.060	64.55	44.53	109.09	
-25.160	64.41	43.89	108.30	
-26.060	63.09	37.58	100.67	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	62.94	36.88	99.82	
-27.060	61.57	30.55	92.12	
-27.160	61.41	29.85	91.26	
-27.350	61.11	28.55	89.67	
-28.060	59.98	24.25	84.23	
-28.160	59.82	23.64	83.46	
-28.160	68.29	26.88	95.18	
-28.350	67.94	25.80	93.73	
-29.060	66.59	22.24	88.83	
-29.160	66.40	21.74	88.14	
-30.060	64.67	18.28	82.95	
-30.160	64.48	17.89	82.37	
-30.350	64.11	17.32	81.43	
-31.060	62.73	15.02	77.75	
-31.160	62.53	14.70	77.22	
-32.060	60.75	11.40	72.15	
-32.160	60.55	11.04	71.59	
-33.060	58.77	7.93	66.70	
-33.160	58.58	7.58	66.16	
-34.060	56.81	5.20	62.01	
-34.160	56.62	4.94	61.55	
-35.060	54.88	3.75	58.63	
-35.160	54.69	3.62	58.31	
-36.060	52.99	4.05	57.04	
-36.160	52.81	4.09	56.90	
-36.350	52.46	4.42	56.88	
-37.060	51.17	5.17	56.35	
-37.160	51.00	5.28	56.28	
-38.060	49.45	4.75	54.20	
-38.160	49.29	4.69	53.98	
-39.060	47.84	2.98	50.82	
-39.160	47.69	2.79	50.49	
-40.060	46.35	0.34	46.69	
-40.160	46.21	0.07	46.28	
-41.060	44.98	2.74	47.72	
-41.160	44.86	3.04	47.90	
-42.060	43.75	5.79	49.54	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	43.64	6.09	49.73	
-43.060	42.65	8.36	51.01	
-43.160	42.55	8.61	51.16	
-44.060	41.68	9.86	51.54	
-44.160	41.60	10.00	51.60	
-45.060	40.85	9.60	50.45	
-45.160	40.78	9.56	50.34	
-46.060	40.16	6.71	46.87	
-46.160	40.10	6.40	46.50	
-46.350	39.99	5.41	45.39	
-47.060	39.61	2.39	42.00	
-47.160	39.57	1.96	41.53	
-47.241	39.53	1.73	41.26	
-48.060	39.19	0.40	39.59	
-48.160	39.17	0.23	39.40	
-48.240	39.15	0.18	39.33	
-49.060	38.93	0.02	38.95	
-49.160	38.95	0.00	38.95	

*   :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)	
-12.060	56.10	71.63	127.73	
-12.160	56.17	64.65	120.83	
-12.160	49.26	56.86	106.12	
-13.060	49.85	15.90	65.75	
-13.160	49.91	12.92	62.83	
-14.060	50.46	1.47	51.93	
-14.160	50.51	0.20	50.71	
-14.350	50.62	0.96	51.59	
-14.560	50.74	2.52	53.26	
-15.060	50.98	7.74	58.72	
-15.160	51.02	8.78	59.80	
-16.060	51.33	19.97	71.30	
-16.160	51.35	21.27	72.63	
-16.350	51.40	23.76	75.16	
-17.060	51.52	32.74	84.26	
-17.160	51.52	34.01	85.53	
-17.871	51.55	41.74	93.29	
-18.060	51.56	43.43	94.99	
-18.160	51.55	44.33	95.88	
-19.060	51.47	50.50	101.96	
-19.160	51.45	51.18	102.63	
-19.350	51.42	52.22	103.64	
-20.060	51.26	55.48	106.74	
-20.160	51.23	55.94	107.17	
-21.060	50.96	58.31	109.27	
-21.160	50.92	58.58	109.50	**
-22.060	50.57	58.61	109.18	
-22.089	50.55	58.61	109.17	
-22.160	50.52	58.51	109.03	
-23.060	50.10	55.79	105.89	
-23.160	50.05	55.49	105.54	
-24.060	49.58	50.84	100.42	
-24.160	49.52	50.33	99.85	
-25.060	49.00	44.53	93.53	
-25.160	48.93	43.89	92.82	
-26.060	48.37	37.58	85.95	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	48.30	36.88	85.18	
-27.060	47.71	30.55	78.26	
-27.160	47.64	29.85	77.49	
-27.350	47.51	28.55	76.06	
-28.060	47.01	24.25	71.25	
-28.160	46.93	23.64	70.58	
-28.160	53.50	26.88	80.39	
-28.350	53.34	25.80	79.14	
-29.060	52.74	22.24	74.98	
-29.160	52.65	21.74	74.39	
-30.060	51.87	18.28	70.14	
-30.160	51.78	17.89	69.67	
-30.350	51.61	17.32	68.93	
-31.060	50.98	15.02	66.00	
-31.160	50.89	14.70	65.58	
-32.060	50.06	11.40	61.47	
-32.160	49.97	11.04	61.01	
-33.060	49.14	7.93	57.06	
-33.160	49.04	7.58	56.63	
-34.060	48.21	5.20	53.41	
-34.160	48.11	4.94	53.05	
-35.060	47.28	3.75	51.03	
-35.160	47.19	3.62	50.81	
-36.060	46.38	4.05	50.42	
-36.160	46.29	4.09	50.38	
-36.350	46.12	4.42	50.54	
-37.060	45.50	5.17	50.67	
-37.160	45.41	5.28	50.69	
-38.060	44.66	4.75	49.41	
-38.160	44.58	4.69	49.27	
-39.060	43.87	2.98	46.85	
-39.160	43.80	2.79	46.59	
-40.060	43.13	0.34	43.48	
-40.160	43.07	0.07	43.14	
-41.060	42.46	2.74	45.20	
-41.160	42.40	3.04	45.43	
-42.060	41.84	5.79	47.63	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	41.79	6.09	47.88	
-43.060	41.29	8.36	49.65	
-43.160	41.24	8.61	49.85	
-44.060	40.81	9.86	50.67	
-44.160	40.77	10.00	50.77	
-45.060	40.39	9.60	49.99	
-45.160	40.36	9.56	49.91	
-46.060	40.04	6.71	46.75	
-46.160	40.01	6.40	46.41	
-46.350	39.96	5.41	45.36	
-47.060	39.76	2.39	42.15	
-47.160	39.74	1.96	41.71	
-47.241	39.73	1.73	41.46	
-48.060	39.56	0.40	39.95	
-48.160	39.54	0.23	39.78	
-48.240	39.53	0.18	39.71	
-49.060	39.42	0.02	39.44	
-49.160	39.41	0.00	39.41	

*   :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)	
-12.060	123.12	71.63	194.75	
-12.160	123.50	64.65	188.15	
-12.160	107.90	56.86	164.76	
-13.060	110.86	15.90	126.76	
-13.160	111.18	12.92	124.10	
-14.060	114.04	1.47	115.51	
-14.160	114.35	0.20	114.55	
-14.350	114.94	0.96	115.90	
-14.560	115.59	2.52	118.11	
-15.060	117.04	7.74	124.78	
-15.160	117.31	8.78	126.09	
-16.060	119.67	19.97	139.64	
-16.160	119.91	21.27	141.19	
-16.350	120.37	23.76	144.13	
-17.060	121.79	32.74	154.53	
-17.160	121.91	34.01	155.91	
-17.871	122.75	41.74	164.49	
-18.060	122.98	43.43	166.41	
-18.160	123.01	44.33	167.34	
-19.060	123.32	50.50	173.81	
-19.160	123.30	51.18	174.48	
-19.350	123.27	52.22	175.49	
-20.060	122.90	55.48	178.39	
-20.160	122.80	55.94	178.74	
-21.060	121.86	58.31	180.17	
-21.160	121.69	58.58	180.27	**
-22.060	120.25	58.61	178.86	
-22.089	120.19	58.61	178.80	
-22.160	120.04	58.51	178.54	
-23.060	118.15	55.79	173.94	
-23.160	117.90	55.49	173.39	
-24.060	115.63	50.84	166.47	
-24.160	115.34	50.33	165.67	
-25.060	112.75	44.53	157.28	
-25.160	112.43	43.89	156.32	
-26.060	109.56	37.58	147.14	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	109.22	36.88	146.09	
-27.060	106.12	30.55	136.67	
-27.160	105.76	29.85	135.61	
-27.350	105.08	28.55	133.63	
-28.060	102.43	24.25	126.68	
-28.160	102.04	23.64	125.68	
-28.160	116.77	26.88	143.66	
-28.350	115.92	25.80	141.72	
-29.060	112.67	22.24	134.91	
-29.160	112.20	21.74	133.94	
-30.060	107.98	18.28	126.25	
-30.160	107.50	17.89	125.39	
-30.350	106.59	17.32	123.92	
-31.060	103.13	15.02	118.15	
-31.160	102.63	14.70	117.33	
-32.060	98.09	11.40	109.49	
-32.160	97.57	11.04	108.61	
-33.060	92.92	7.93	100.85	
-33.160	92.40	7.58	99.98	
-34.060	87.70	5.20	92.90	
-34.160	87.18	4.94	92.12	
-35.060	82.49	3.75	86.24	
-35.160	81.98	3.62	85.60	
-36.060	77.35	4.05	81.39	
-36.160	76.84	4.09	80.93	
-36.350	75.87	4.42	80.29	
-37.060	72.32	5.17	77.50	
-37.160	71.84	5.28	77.12	
-38.060	67.51	4.75	72.26	
-38.160	67.05	4.69	71.74	
-39.060	62.95	2.98	65.93	
-39.160	62.52	2.79	65.31	
-40.060	58.67	0.34	59.02	
-40.160	58.28	0.07	58.35	
-41.060	54.71	2.74	57.46	
-41.160	54.35	3.04	57.39	
-42.060	51.09	5.79	56.88	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	50.76	6.09	56.85	
-43.060	47.81	8.36	56.17	
-43.160	47.52	8.61	56.13	
-44.060	44.89	9.86	54.75	
-44.160	44.63	10.00	54.63	
-45.060	42.32	9.60	51.93	
-45.160	42.11	9.56	51.66	
-46.060	40.13	6.71	46.84	
-46.160	39.93	6.40	46.33	
-46.350	39.56	5.41	44.97	
-47.060	38.30	2.39	40.69	
-47.160	38.16	1.96	40.12	
-47.241	38.04	1.73	39.77	
-48.060	36.85	0.40	37.24	
-48.160	36.74	0.23	36.97	
-48.240	36.65	0.18	36.83	
-49.060	35.75	0.02	35.77	
-49.160	35.84	0.00	35.84	

*   :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)	
-12.060	39.38	76.17	115.55	
-12.160	39.38	69.25	108.63	
-12.160	34.63	60.90	95.53	**
-13.060	34.63	20.13	54.75	
-13.160	34.63	17.13	51.76	
-14.060	34.63	4.81	39.44	
-14.160	34.63	3.44	38.07	
-14.350	34.63	2.51	37.14	
-14.560	34.63	0.77	35.40	
-15.060	34.63	5.14	39.77	
-15.160	34.63	6.01	40.64	
-16.060	34.63	17.98	52.61	
-16.160	34.63	19.37	54.00	
-16.350	34.63	22.02	56.64	
-17.060	34.63	31.62	66.25	
-17.160	34.63	32.97	67.60	
-17.975	34.63	42.38	77.01	
-18.060	34.63	43.19	77.82	
-18.160	34.63	44.14	78.77	
-19.060	34.63	50.78	85.40	
-19.160	34.63	51.51	86.14	
-19.350	34.63	52.60	87.23	
-20.060	34.63	56.01	90.64	
-20.160	34.63	56.49	91.12	
-21.060	34.63	59.06	93.68	
-21.160	34.63	59.34	93.97	
-22.060	34.63	59.47	94.10	
-22.160	34.63	59.48	94.11	
-22.196	34.63	59.43	94.06	
-23.060	34.63	56.88	91.51	
-23.160	34.63	56.59	91.21	
-24.060	34.63	51.93	86.56	
-24.160	34.63	51.41	86.04	
-25.060	34.63	45.54	80.17	
-25.160	34.63	44.89	79.52	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.060	34.63	38.47	73.10	
-26.160	34.63	37.76	72.39	
-27.060	34.63	31.36	65.98	
-27.160	34.63	30.65	65.27	
-27.350	34.63	29.34	63.96	
-28.060	34.63	24.96	59.59	
-28.160	34.63	24.34	58.97	
-28.160	39.38	27.68	67.06	
-28.350	39.38	26.56	65.94	
-29.060	39.38	22.91	62.29	
-29.160	39.38	22.39	61.77	
-30.060	39.38	18.94	58.32	
-30.160	39.38	18.56	57.94	
-30.350	39.38	18.01	57.39	
-31.060	39.38	15.78	55.16	
-31.160	39.38	15.46	54.84	
-32.060	39.38	12.16	51.54	
-32.160	39.38	11.79	51.17	
-33.060	39.38	8.61	47.99	
-33.160	39.38	8.26	47.64	
-34.060	39.38	5.79	45.17	
-34.160	39.38	5.52	44.90	
-35.060	39.38	4.26	43.64	
-35.160	39.38	4.12	43.50	
-36.060	39.38	4.51	43.89	
-36.160	39.38	4.56	43.94	
-36.350	39.38	4.89	44.27	
-37.060	39.38	5.62	45.00	
-37.160	39.38	5.73	45.11	
-38.060	39.38	5.11	44.50	
-38.160	39.38	5.05	44.43	
-39.060	39.38	3.21	42.59	
-39.160	39.38	3.01	42.39	
-40.060	39.38	0.40	39.78	
-40.160	39.38	0.11	39.49	
-41.060	39.38	2.89	42.27	
-41.160	39.38	3.20	42.58	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.060	39.38	6.13	45.51	
-42.160	39.38	6.46	45.84	
-43.060	39.38	8.90	48.28	
-43.160	39.38	9.17	48.55	
-44.060	39.38	10.57	49.95	
-44.160	39.38	10.73	50.11	
-45.060	39.38	10.42	49.80	
-45.160	39.38	10.38	49.76	
-46.060	39.38	7.54	46.92	
-46.160	39.38	7.22	46.60	
-46.350	39.38	6.22	45.60	
-47.060	39.38	3.04	42.43	
-47.160	39.38	2.60	41.98	
-47.241	39.38	2.34	41.72	
-48.060	39.38	0.64	40.02	
-48.160	39.38	0.43	39.81	
-48.240	39.38	0.34	39.73	
-49.060	39.38	0.04	39.42	
-49.160	39.38	0.00	39.38	

*   :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)	
-12.060	40.79	76.17	116.95	
-12.160	40.79	69.25	110.04	
-12.160	35.86	60.90	96.76	**
-13.060	35.86	20.13	55.99	
-13.160	35.86	17.13	52.99	
-14.060	35.86	4.81	40.68	
-14.160	35.86	3.44	39.31	
-14.350	35.86	2.51	38.38	
-14.560	35.86	0.77	36.63	
-15.060	35.86	5.14	41.00	
-15.160	35.86	6.01	41.88	
-16.060	35.86	17.98	53.84	
-16.160	35.86	19.37	55.23	
-16.350	35.86	22.02	57.88	
-17.060	35.86	31.62	67.48	
-17.160	35.86	32.97	68.84	
-17.975	35.86	42.38	78.25	
-18.060	35.86	43.19	79.06	
-18.160	35.86	44.14	80.01	
-19.060	35.86	50.78	86.64	
-19.160	35.86	51.51	87.38	
-19.350	35.86	52.60	88.47	
-20.060	35.86	56.01	91.88	
-20.160	35.86	56.49	92.36	
-21.060	35.86	59.06	94.92	
-21.160	35.86	59.34	95.21	
-22.060	35.86	59.47	95.33	
-22.160	35.86	59.48	95.35	
-22.196	35.86	59.43	95.29	
-23.060	35.86	56.88	92.75	
-23.160	35.86	56.59	92.45	
-24.060	35.86	51.93	87.80	
-24.160	35.86	51.41	87.28	
-25.060	35.86	45.54	81.40	
-25.160	35.86	44.89	80.75	
-26.060	35.86	38.47	74.34	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	35.86	37.76	73.63	
-27.060	35.86	31.36	67.22	
-27.160	35.86	30.65	66.51	
-27.350	35.86	29.34	65.20	
-28.060	35.86	24.96	60.82	
-28.160	35.86	24.34	60.21	
-28.160	40.79	27.68	68.47	
-28.350	40.79	26.56	67.35	
-29.060	40.79	22.91	63.69	
-29.160	40.79	22.39	63.18	
-30.060	40.79	18.94	59.73	
-30.160	40.79	18.56	59.35	
-30.350	40.79	18.01	58.80	
-31.060	40.79	15.78	56.56	
-31.160	40.79	15.46	56.25	
-32.060	40.79	12.16	52.95	
-32.160	40.79	11.79	52.58	
-33.060	40.79	8.61	49.40	
-33.160	40.79	8.26	49.05	
-34.060	40.79	5.79	46.58	
-34.160	40.79	5.52	46.30	
-35.060	40.79	4.26	45.04	
-35.160	40.79	4.12	44.90	
-36.060	40.79	4.51	45.30	
-36.160	40.79	4.56	45.34	
-36.350	40.79	4.89	45.67	
-37.060	40.79	5.62	46.41	
-37.160	40.79	5.73	46.51	
-38.060	40.79	5.11	45.90	
-38.160	40.79	5.05	45.83	
-39.060	40.79	3.21	44.00	
-39.160	40.79	3.01	43.80	
-40.060	40.79	0.40	41.19	
-40.160	40.79	0.11	40.90	
-41.060	40.79	2.89	43.68	
-41.160	40.79	3.20	43.98	
-42.060	40.79	6.13	46.92	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	40.79	6.46	47.24	
-43.060	40.79	8.90	49.68	
-43.160	40.79	9.17	49.96	
-44.060	40.79	10.57	51.36	
-44.160	40.79	10.73	51.51	
-45.060	40.79	10.42	51.20	
-45.160	40.79	10.38	51.17	
-46.060	40.79	7.54	48.33	
-46.160	40.79	7.22	48.01	
-46.350	40.79	6.22	47.00	
-47.060	40.79	3.04	43.83	
-47.160	40.79	2.60	43.38	
-47.241	40.79	2.34	43.12	
-48.060	40.79	0.64	41.42	
-48.160	40.79	0.43	41.21	
-48.240	40.79	0.34	41.13	
-49.060	40.79	0.04	40.82	
-49.160	40.79	0.00	40.79	

* :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)	
-12.060	47.85	76.17	124.02	
-12.160	47.87	69.25	117.12	
-12.160	41.97	60.90	102.87	**
-13.060	42.15	20.13	62.28	
-13.160	42.17	17.13	59.30	
-14.060	42.33	4.81	47.15	
-14.160	42.35	3.44	45.80	
-14.350	42.39	2.51	44.90	
-14.560	42.42	0.77	43.19	
-15.060	42.49	5.14	47.63	
-15.160	42.50	6.01	48.51	
-16.060	42.59	17.98	60.57	
-16.160	42.60	19.37	61.97	
-16.350	42.61	22.02	64.63	
-17.060	42.64	31.62	74.26	
-17.160	42.64	32.97	75.61	
-17.975	42.64	42.38	85.02	
-18.060	42.64	43.19	85.83	
-18.160	42.63	44.14	86.78	
-19.060	42.59	50.78	93.37	
-19.160	42.58	51.51	94.10	
-19.350	42.57	52.60	95.17	
-20.060	42.51	56.01	98.52	
-20.160	42.49	56.49	98.99	
-21.060	42.38	59.06	101.44	
-21.160	42.37	59.34	101.71	
-22.060	42.23	59.47	101.70	
-22.160	42.21	59.48	101.70	
-22.196	42.21	59.43	101.64	
-23.060	42.05	56.88	98.93	
-23.160	42.03	56.59	98.62	
-24.060	41.84	51.93	93.77	
-24.160	41.82	51.41	93.23	
-25.060	41.61	45.54	87.15	
-25.160	41.59	44.89	86.48	
-26.060	41.37	38.47	79.84	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	41.34	37.76	79.10	
-27.060	41.10	31.36	72.46	
-27.160	41.07	30.65	71.72	
-27.350	41.02	29.34	70.36	
-28.060	40.82	24.96	65.78	
-28.160	40.79	24.34	65.13	
-28.160	46.50	27.68	74.18	
-28.350	46.44	26.56	73.00	
-29.060	46.19	22.91	69.09	
-29.160	46.15	22.39	68.54	
-30.060	45.82	18.94	64.77	
-30.160	45.79	18.56	64.35	
-30.350	45.72	18.01	63.73	
-31.060	45.45	15.78	61.23	
-31.160	45.41	15.46	60.87	
-32.060	45.05	12.16	57.21	
-32.160	45.01	11.79	56.80	
-33.060	44.64	8.61	53.25	
-33.160	44.59	8.26	52.85	
-34.060	44.21	5.79	50.00	
-34.160	44.17	5.52	49.68	
-35.060	43.78	4.26	48.04	
-35.160	43.73	4.12	47.85	
-36.060	43.34	4.51	47.86	
-36.160	43.30	4.56	47.86	
-36.350	43.22	4.89	48.10	
-37.060	42.91	5.62	48.53	
-37.160	42.86	5.73	48.59	
-38.060	42.48	5.11	47.59	
-38.160	42.44	5.05	47.48	
-39.060	42.06	3.21	45.27	
-39.160	42.02	3.01	45.03	
-40.060	41.66	0.40	42.06	
-40.160	41.62	0.11	41.73	
-41.060	41.28	2.89	44.17	
-41.160	41.24	3.20	44.44	
-42.060	40.92	6.13	47.05	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	40.88	6.46	47.34	
-43.060	40.58	8.90	49.48	
-43.160	40.55	9.17	49.72	
-44.060	40.28	10.57	50.85	
-44.160	40.25	10.73	50.98	
-45.060	40.01	10.42	50.43	
-45.160	39.99	10.38	50.37	
-46.060	39.78	7.54	47.31	
-46.160	39.76	7.22	46.98	
-46.350	39.72	6.22	45.93	
-47.060	39.58	3.04	42.62	
-47.160	39.56	2.60	42.16	
-47.241	39.55	2.34	41.89	
-48.060	39.42	0.64	40.06	
-48.160	39.41	0.43	39.84	
-48.240	39.40	0.34	39.75	
-49.060	39.31	0.04	39.35	
-49.160	39.30	0.00	39.30	

*   :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)	
-12.060	70.59	76.17	146.76	
-12.160	70.75	69.25	140.00	
-12.160	61.79	60.90	122.69	
-13.060	63.00	20.13	83.13	
-13.160	63.13	17.13	80.26	
-14.060	64.28	4.81	69.09	
-14.160	64.40	3.44	67.84	
-14.350	64.64	2.51	67.15	
-14.560	64.89	0.77	65.66	
-15.060	65.43	5.14	70.57	
-15.160	65.52	6.01	71.54	
-16.060	66.33	17.98	84.31	
-16.160	66.41	19.37	85.78	
-16.350	66.55	22.02	88.56	
-17.060	66.99	31.62	98.61	
-17.160	67.03	32.97	100.00	
-17.975	67.37	42.38	109.76	
-18.060	67.41	43.19	110.60	
-18.160	67.43	44.14	111.58	
-19.060	67.62	50.78	118.40	
-19.160	67.63	51.51	119.14	
-19.350	67.65	52.60	120.25	
-20.060	67.64	56.01	123.66	
-20.160	67.63	56.49	124.12	
-21.060	67.50	59.06	126.55	
-21.160	67.47	59.34	126.81	**
-22.060	67.20	59.47	126.66	
-22.160	67.15	59.48	126.63	
-22.196	67.14	59.43	126.57	
-23.060	66.76	56.88	123.64	
-23.160	66.70	56.59	123.29	
-24.060	66.19	51.93	118.12	
-24.160	66.13	51.41	117.54	
-25.060	65.52	45.54	111.06	
-25.160	65.44	44.89	110.33	
-26.060	64.74	38.47	103.22	

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elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-26.160	64.66	37.76	102.42	
-27.060	63.88	31.36	95.24	
-27.160	63.79	30.65	94.43	
-27.350	63.61	29.34	92.95	
-28.060	62.92	24.96	87.88	
-28.160	62.82	24.34	87.16	
-28.160	71.94	27.68	99.62	
-28.350	71.71	26.56	98.27	
-29.060	70.83	22.91	93.74	
-29.160	70.70	22.39	93.09	
-30.060	69.53	18.94	88.47	
-30.160	69.39	18.56	87.95	
-30.350	69.14	18.01	87.15	
-31.060	68.15	15.78	83.92	
-31.160	68.00	15.46	83.46	
-32.060	66.64	12.16	78.80	
-32.160	66.48	11.79	78.27	
-33.060	65.02	8.61	73.64	
-33.160	64.85	8.26	73.11	
-34.060	63.32	5.79	69.12	
-34.160	63.15	5.52	68.67	
-35.060	61.56	4.26	65.82	
-35.160	61.38	4.12	65.50	
-36.060	59.77	4.51	64.28	
-36.160	59.58	4.56	64.14	
-36.350	59.24	4.89	64.13	
-37.060	57.94	5.62	63.57	
-37.160	57.76	5.73	63.49	
-38.060	56.12	5.11	61.23	
-38.160	55.94	5.05	60.98	
-39.060	54.31	3.21	57.52	
-39.160	54.14	3.01	57.14	
-40.060	52.55	0.40	52.95	
-40.160	52.38	0.11	52.49	
-41.060	50.85	2.89	53.74	
-41.160	50.69	3.20	53.88	
-42.060	49.23	6.13	55.37	

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elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-42.160	49.08	6.46	55.54	
-43.060	47.72	8.90	56.62	
-43.160	47.58	9.17	56.75	
-44.060	46.33	10.57	56.90	
-44.160	46.20	10.73	56.93	
-45.060	45.08	10.42	55.49	
-45.160	44.97	10.38	55.35	
-46.060	43.98	7.54	51.51	
-46.160	43.88	7.22	51.10	
-46.350	43.69	6.22	49.91	
-47.060	43.05	3.04	46.09	
-47.160	42.97	2.60	45.57	
-47.241	42.91	2.34	45.25	
-48.060	42.30	0.64	42.94	
-48.160	42.25	0.43	42.68	
-48.240	42.20	0.34	42.55	
-49.060	41.76	0.04	41.80	
-49.160	41.71	0.00	41.71	

* :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)	
-12.060	124.07	76.17	200.24	
-12.160	124.43	69.25	193.68	
-12.160	108.22	60.90	169.12	
-13.060	111.01	20.13	131.13	
-13.160	111.31	17.13	128.44	
-14.060	114.03	4.81	118.85	
-14.160	114.33	3.44	117.77	
-14.350	114.90	2.51	117.41	
-14.560	115.51	0.77	116.28	
-15.060	116.93	5.14	122.07	
-15.160	117.20	6.01	123.21	
-16.060	119.56	17.98	137.54	
-16.160	119.81	19.37	139.18	
-16.350	120.28	22.02	142.29	
-17.060	121.81	31.62	153.43	
-17.160	121.97	32.97	154.94	
-17.975	123.23	42.38	165.61	
-18.060	123.36	43.19	166.55	
-18.160	123.45	44.14	167.60	
-19.060	124.26	50.78	175.03	
-19.160	124.31	51.51	175.82	
-19.350	124.40	52.60	177.00	
-20.060	124.56	56.01	180.57	
-20.160	124.54	56.49	181.03	
-21.060	124.34	59.06	183.40	
-21.160	124.27	59.34	183.62	**
-22.060	123.66	59.47	183.13	
-22.160	123.55	59.48	183.03	
-22.196	123.51	59.43	182.94	
-23.060	122.55	56.88	179.43	
-23.160	122.40	56.59	178.99	
-24.060	121.07	51.93	173.00	
-24.160	120.88	51.41	172.30	
-25.060	119.24	45.54	164.78	
-25.160	119.03	44.89	163.92	
-26.060	117.12	38.47	155.59	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	116.88	37.76	154.64	
-27.060	114.73	31.36	146.09	
-27.160	114.47	30.65	145.12	
-27.350	113.99	29.34	143.33	
-28.060	112.07	24.96	137.03	
-28.160	111.78	24.34	136.12	
-28.160	128.55	27.68	156.23	
-28.350	127.91	26.56	154.47	
-29.060	125.43	22.91	148.34	
-29.160	125.07	22.39	147.46	
-30.060	121.79	18.94	140.73	
-30.160	121.42	18.56	139.97	
-30.350	120.70	18.01	138.72	
-31.060	117.92	15.78	133.70	
-31.160	117.50	15.46	132.96	
-32.060	113.68	12.16	125.84	
-32.160	113.23	11.79	125.02	
-33.060	109.15	8.61	117.77	
-33.160	108.68	8.26	116.94	
-34.060	104.39	5.79	110.18	
-34.160	103.90	5.52	109.42	
-35.060	99.47	4.26	103.72	
-35.160	98.96	4.12	103.08	
-36.060	94.44	4.51	98.95	
-36.160	93.93	4.56	98.49	
-36.350	92.97	4.89	97.86	
-37.060	89.36	5.62	94.98	
-37.160	88.85	5.73	94.58	
-38.060	84.27	5.11	89.39	
-38.160	83.77	5.05	88.82	
-39.060	79.25	3.21	82.46	
-39.160	78.76	3.01	81.76	
-40.060	74.34	0.40	74.74	
-40.160	73.87	0.11	73.98	
-41.060	69.61	2.89	72.50	
-41.160	69.16	3.20	72.36	
-42.060	65.10	6.13	71.23	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	64.68	6.46	71.14	
-43.060	60.86	8.90	69.76	
-43.160	60.47	9.17	69.64	
-44.060	56.93	10.57	67.50	
-44.160	56.57	10.73	67.30	
-45.060	53.34	10.42	63.76	
-45.160	53.02	10.38	63.40	
-46.060	50.14	7.54	57.68	
-46.160	49.84	7.22	57.07	
-46.350	49.28	6.22	55.50	
-47.060	47.35	3.04	50.39	
-47.160	47.11	2.60	49.71	
-47.241	46.92	2.34	49.26	
-48.060	45.00	0.64	45.64	
-48.160	44.81	0.43	45.24	
-48.240	44.66	0.34	45.01	
-49.060	43.13	0.04	43.16	
-49.160	42.97	0.00	42.97	

* :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)
1.4478 (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	OD(HT)	-6.276	3.180	72.27
2	OD(LT)	-6.276	-2.390	72.27
3	OD-TM(HT)	-6.276	3.180	72.27
4	OD-TM(LT)	-6.276	-2.390	72.27
5	WN-TM	-6.276	4.990	72.27
6	OD-CL	-6.276	3.180	72.27
7	ETQ	-6.276	0.290	72.27

2)perpendicular direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m²)
1	OD(HT)	-6.276	3.180	72.27
2	OD(LT)	-6.276	-2.390	72.27
3	WN	-6.276	4.990	72.27
4	OD-CL	-6.276	3.180	72.27
5	ETQ	-6.276	0.290	72.27

note: backfilling soil height , water table height is shown in elevation(crest of pile cap elevation = -8.060m)

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

$= 8.973^2*Pai/4 + 8.973*(14.764- 8.973) = 115.205\ (m^2)$

(2)area of backfilling soil

$A2 = A1 - Ap = 74.635\ (m^2)$

where, Ap:leg column cross sectional area = 40.57 (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)	55500.0	0.0	0.0	0.0	0.0
2	OD(LT)	55500.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	55500.0	5400.0	118300.0	21600.0	139900.0
4	OD-TM(LT)	55500.0	5400.0	118300.0	21600.0	139900.0
5	WN-TM	55500.0	5500.0	120100.0	22000.0	142100.0
6	OD-CL	55500.0	3700.0	44600.0	14800.0	59400.0
7	ETQ	48500.0	15300.0	242600.0	61200.0	303800.0

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)	55500.0	0.0	0.0	0.0	0.0
2	OD(LT)	55500.0	0.0	0.0	0.0	0.0
3	WN	55500.0	1200.0	28500.0	4800.0	33300.0
4	OD-CL	55500.0	7300.0	87900.0	29200.0	117100.0
5	ETQ	48500.0	14800.0	266800.0	59200.0	326000.0

(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) = 17.0 (kN/m^3)

Gam.sat: unit weight of backfilling soil(saturated) = 18.0 (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)	11.240	1.784	6681.88	1065.19	4560.07	3187.01
2	OD(LT)	5.670	1.784	6681.88	1065.19	2300.32	5446.75
3	OD-TM(HT)	11.240	1.784	6681.88	1065.19	4560.07	3187.01
4	OD-TM(LT)	5.670	1.784	6681.88	1065.19	2300.32	5446.75
5	WN-TM	13.050	1.784	6681.88	1065.19	5294.39	2452.69
6	OD-CL	11.240	1.784	6681.88	1065.19	4560.07	3187.01
7	ETQ	8.350	1.784	6681.88	1065.19	3387.60	4359.48

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)	11.240	1.784	6681.88	1065.19	4560.07	3187.01
2	OD(LT)	5.670	1.784	6681.88	1065.19	2300.32	5446.75
3	WN	13.050	1.784	6681.88	1065.19	5294.39	2452.69
4	OD-CL	11.240	1.784	6681.88	1065.19	4560.07	3187.01
5	ETQ	8.350	1.784	6681.88	1065.19	3387.60	4359.48

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	58687.0	0.0	0.0
2	OD(LT)	0.0	60946.8	0.0	0.0
3	OD-TM(HT)	0.0	58687.0	5400.0	139900.0
4	OD-TM(LT)	0.0	60946.8	5400.0	139900.0
5	WN-TM	0.0	57952.7	5500.0	142100.0
6	OD-CL	0.0	58687.0	3700.0	59400.0
7	ETQ	0.0	52859.5	15300.0	303800.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	58687.0	0.0	0.0
2	OD(LT)	0.0	60946.8	0.0	0.0
3	WN	0.0	57952.7	1200.0	33300.0
4	OD-CL	0.0	58687.0	7300.0	117100.0
5	ETQ	0.0	52859.5	14800.0	326000.0

(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)	30	0.04464	491.60	903.99
separation wall sheet pile(2)	6	0.04464	36.96	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)	1630	1630	1.00
2	OD(LT)	1693	1693	1.00
3	OD-TM(HT)	2977	284	1.15
4	OD-TM(LT)	3039	347	1.15
5	WN-TM	2977	242	1.35
6	OD-CL	2202	1059	1.50
7	ETQ	4392	-1455	1.50

2)perpendicular direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	OD(HT)	1630	1630	1.00
2	OD(LT)	1693	1693	1.00
3	WN	1902	1318	1.25
4	OD-CL	2657	603	1.50
5	ETQ	4328	-1392	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 = 11.3732 (m) (bridge axis direction)

Bx = 17.1644 (m) (perpendicular direction)

periphery steel pipe pile body diameter Do = 1.2000 (m)

leg column shape : oval

leg column dimension : 4.000 (m) (bridge axis direction)

11.000 (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 = 30 (number)

n2 : number of separation wall steel pipe sheet pile = 6 (number)

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

Ao1 : pure cross sectional area of periphery steel pipe sheet pile = 0.04464 (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	491.60	903.99
separation wall steel pipe sheet pile	IB2	36.96	0.00
intermediate driven single pile	IB3	0.00	0.00

1)bridge axis direction

1. check location

X1 = 5.0866 (m)

X2 = -5.0866 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Oridinary(high tide)	58687.0	0.0	1.00
2	Oridinary(low tide)	60946.8	0.0	1.00
3	Ord+Temp(high tide)	58687.0	139900.0	1.15
4	Ord+Temp(low tide)	60946.8	139900.0	1.15
5	Wind+Temp	57952.7	142100.0	1.35
6	Ord+Collision	58687.0	59400.0	1.50
7	Earthquake	52859.5	303800.0	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	5.0866	-5.0866
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Oridinary(high tide)	1630.2	1630.2
2	Oridinary(low tide)	1693.0	1693.0
3	Ord+Temp(high tide)	2976.5	283.9
4	Ord+Temp(low tide)	3039.3	346.6
5	Wind+Temp	2977.3	242.3
6	Ord+Collision	2201.8	1058.6
7	Earthquake	4391.9	-1455.3

4.separation wall steel pipe sheet pile reaction

coordinated system of center of figure		
pile No	number	Xi (m)
1	1	3.6333
2	1	2.1800

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	1630.2	1630.2	1693.0	1693.0	2591.9	668.5	2654.6	731.3
2	1630.2	1630.2	1693.0	1693.0	2207.2	1053.2	2270.0	1116.0

abbreviation	[5] WN-TM		[6] OD-CL		[7] ETQ	
pile No	R1	R2	R1	R2	R1	R2
1	2586.6	633.0	2038.5	1221.9	3556.6	-620.0
2	2195.9	1023.7	1875.2	1385.2	2721.3	215.3

2)perpendicular direction

1. check location

Y1 = 7.9822 (m)

Y2 = -7.9822 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Oridinary(high tide)	58687.0	0.0	1.00
2	Oridinary(low tide)	60946.8	0.0	1.00
3	Wind	57952.7	33300.0	1.25
4	Ord+Collision	58687.0	117100.0	1.50
5	Earthquake	52859.5	326000.0	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	7.9822	-7.9822
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Oridinary(high tide)	1630.2	1630.2
2	Oridinary(low tide)	1693.0	1693.0
3	Wind	1903.8	1315.8
4	Ord+Collision	2664.2	596.2
5	Earthquake	4346.9	-1410.3

(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 = 2.4866 (m)(bridge axis direction)
= 2.2822 (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)
= 1.4478 (m) (perpendicular direction)

d : effective height of pile cap = 3.6245 (m) (bridge axis direction)
= 3.7023 (m) (perpendicular direction)

ai : Do + d

		bridge axis direction	perpendicular direction
separation wall steel pipe sheet pile	ai	4.8245	4.9023

(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)	3865	3865	1126	1091
2	Oridinary(low tide)	4022	4022	1169	1134
3	Ord+Temp(high tide)	7082	647	2056	2021
4	Ord+Temp(low tide)	7240	805	2099	2064
5	Wind+Temp	7082	546	2056	2021
6	Ord+Collision	5231	2499	1521	1486
7	Earthquake	10445	-3528	3034	2998

2)perpendicular direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
1	Oridinary(high tide)	3057	3057	1126	1106
2	Oridinary(low tide)	3182	3182	1169	1149
3	Wind	3602	2431	1315	1295
4	Ord+Collision	5116	999	1840	1820
5	Earthquake	8465	-2996	3002	2982

4.1.4 stress calculation

(1)bridge axis direction

b = 100.0 (cm)   h = 400.0 (cm)

rebar in use

lower tensile (As = 177.884 (cm^2))

1 row	cover 300 (mm)	D51 @ 183
2 row	cover 500 (mm)	D51 @ 302

upper tensile (As = 61.092 (cm^2))

1 row	cover 150 (mm)	D32 @ 260
2 row	cover 300 (mm)	D32 @ 260

			unit	OD(HT)	OD(LT)	OD-TM(HT)
bottom side ten sile	bending moment	MA	kN.m	3865.0	4022.0	7082.0
	required rebar amount	Asr	cm^2	73.716	76.835	119.874
	neutral axis	x	cm	114.9	114.9	114.9
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.07 69.00	2.16 71.81	3.80 126.44
	tensile resultant force required rebar amount	T As	kN cm^2	1717.7 107.353	1787.6 111.726	3147.6 171.065
top side ten sile	bending moment	MA'	kN.m	3865.0	4022.0	647.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	13.1	13.1	13.1
	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	9.20 184.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1126.0 0.31 1.01	1169.0 0.32 1.01	2056.0 0.57 1.16
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1091.0 0.30 1.01	1134.0 0.31 1.01	2021.0 0.56 1.16
shear force to share by concrete		SC a	kN	3656.0	3656.0	4204.0
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	----	0.274	0.274	0.274
	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 = 0.669 : effective height   d = 362.45 (cm)

2) correction coefficient about tensile rebar percentage   Cpt = 1.191 : tensile rebar percentage   pt = 0.491 (%)

3) for shear span ratio increment coefficient   Cdc = 5.507 : shear span   a = 2.487 (m)

			unit	OD-TM(LT)	WN-TM	OD-CL
bottom side ten sile	bending moment	MA	kN.m	7240.0	7082.0	5231.0
	required rebar amount	Asr	cm^2	122.655	101.336	52.583
	neutral axis	x	cm	114.9	114.9	114.9
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	3.88 129.25	3.80 126.43	2.80 93.39
	tensile resultant force required rebar amount	T As	kN cm^2	3217.6 174.867	3147.3 145.710	2324.8 77.493
top side ten sile	bending moment	MA'	kN.m	805.0	546.0	2499.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	13.1	13.1	13.1
	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	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	2099.0 0.58 1.16	2056.0 0.57 1.36	1521.0 0.42 1.53
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2064.0 0.57 1.16	2021.0 0.56 1.36	1486.0 0.41 1.53
shear force to share by concrete		SC a	kN	4204.0	4936.0	5563.0
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	----	0.274	0.274	0.274
	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 = 0.669 : effective height d = 362.45 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.191 : tensile rebar percentage pt = 0.491 (%)
3) for shear span ratio increment coefficient Cdc = 5.507 : shear span a = 2.487 (m)

			unit	ETQ
bottom side ten sile	bending moment	MA	kN.m	10445.0
	required rebar amount	Asr	cm^2	107.907
	neutral axis	x	cm	114.9
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	5.60 186.49
	tensile resultant force required rebar amount	T As	kN cm^2	4642.4 154.747
top side ten sile	bending moment	MA'	kN.m	-3528.0
	required rebar amount	Asr	cm^2	33.550
	neutral axis	x	cm	74.6
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.69 167.69
	tensile resultant force required rebar amount	T As	kN cm^2	1568.0 52.265
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	3034.0 0.84 1.53
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2998.0 0.83 1.53
shear force to share by concrete		SC a	kN	5563.0
rebar	shear force to share	Sh'	kN	0.0
	member axial direction spacing	s	cm	100.0
	reduction coefficient	Cds	----	0.274
	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 = 0.669 : effective height d = 362.45 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.191 : tensile rebar percentage pt = 0.491 (%)
3) for shear span ratio increment coefficient Cdc = 5.507 : shear span a = 2.487 (m)

(2)perpendicular direction

b = 100.0 (cm)   h = 400.0 (cm)

rebar in use

lower tensile (As = 146.667 (cm^2))

1 row	cover	230 (mm)	D51 @ 209
2 row	cover	430 (mm)	D51 @ 408

upper tensile (As = 57.466 (cm^2))

1 row	cover	118 (mm)	D32 @ 209
2 row	cover	268 (mm)	D32 @ 408

			unit	OD(HT)	OD(LT)	WN
bottom side ten sile	bending moment	MA	kN.m	3057.0	3182.0	3602.0
	required rebar amount	Asr	cm^2	56.341	58.726	52.996
	neutral axis	x	cm	107.5	107.5	107.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.70 63.89	1.77 66.50	2.00 75.27
	tensile resultant force required rebar amount	T As	kN cm^2	1358.7 84.919	1414.2 88.391	1600.8 80.041
top side ten sile	bending moment	MA'	kN.m	3057.0	3182.0	2431.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	10.5	10.5	10.5
	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	1126.0 0.30 0.98	1169.0 0.32 0.98	1315.0 0.36 1.22
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1106.0 0.30 0.98	1149.0 0.31 0.98	1295.0 0.35 1.22
shear force to share by concrete		SC a	kN	3625.0	3625.0	4531.0
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	----	0.247	0.247	0.247
	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 = 370.23 (cm)

2) correction coefficient about tensile rebar percentage   Cpt = 1.096 : tensile rebar percentage   pt = 0.396 (%)

3) for shear span ratio increment coefficient   Cdc = 5.841 : shear span   a = 2.282 (m)

			unit	OD-CL	ETQ
bottom side tensile	bending moment	MA	kN.m	5116.0	8465.0
	required rebar amount	Asr	cm^2	50.094	84.427
	neutral axis	x	cm	107.5	107.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.84 106.90	4.70 176.91
	tensile resultant force required rebar amount	T As	kN cm^2	2273.6 75.786	3762.4 125.413
top side tensile	bending moment	MA'	kN.m	999.0	-2996.0
	required rebar amount	Asr	cm^2	0.000	27.718
	neutral axis	x	cm	10.5	73.1
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	2.28 147.63
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	1331.4 44.381
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	1840.0 0.50 1.49	3002.0 0.81 1.49
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1820.0 0.49 1.49	2982.0 0.81 1.49
shear force to share by concrete		SC a	kN	5516.0	5516.0
rebar	shear force to share	Sh'	kN	0.0	0.0
	member axial direction spacing	s	cm	100.0	100.0
	reduction coefficient	Cds	----	0.247	0.247
	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 = 370.23 (cm)

2) correction coefficient about tensile rebar percentage Cpt = 1.096 : tensile rebar percentage pt = 0.396 (%)

3) for shear span ratio increment coefficient Cdc = 5.841 : shear span a = 2.282 (m)

(3) required thickness of pile cap

$$h >= 1.94 * \sqrt[3]{\frac{kp*Lambda^4}{E}} = 1.236 \text{ (m)}$$

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) = 2.7740E+005

Kv2(separation wall steel pipe sheet pile) = 2.7740E+005

Kv3(intermediate driven single pile) = 0.0000E+000

n1 : number of periphery steel pipe sheet pile = 30

n2 : number of separation wall steel pipe sheet pile = 6

n3 : number of intermediate driven single pile = 0

A : area of pile cap (m^2) = 140.2

E : Young's modulus of pile cap (kN/m^2) = $2.50 * 10^7$

Lambda : protrusion length of pile cap (m) = 3.09

(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	21295	5103	17757	17788	OK
	upper tensile	7845	5103	5997	6109	OK
perpendicular direction	lower tensile	18089	5103	14391	14667	OK
	upper tensile	7497	5103	5093	5747	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 :SKY490
(5) diameter of steel material main body :D = 1200.0 (mm)
(6) section coefficient of steel pipe pile body :Z = 13081.0 (cm³)
(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)	1630	0	1.00
2	Oridinary(low tide)	1693	0	1.00
3	Ord+Temp(high tide)	2977	180	1.15
4	Ord+Temp(low tide)	3039	180	1.15
5	Wind+Temp	2977	183	1.35
6	Ord+Collision	2202	123	1.50
7	Earthquake	4392	510	1.50

(2)perpendicular direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Oridinary(high tide)	1630	0	1.00
2	Oridinary(low tide)	1693	0	1.00
3	Wind	1902	40	1.25
4	Ord+Collision	2657	243	1.50
5	Earthquake	4328	493	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/m²) = 185.00 (N/mm²)
Zo : section coefficient of steel pipe pile body (m³) = 13081.0 (cm³)

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) = 2600.00
Sig.s1: moment rebar tensile stress (N/mm²)
nb : number of moment rebar (number/ row) = 20
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 = 76

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)	1630.0	978	2420	2420	930.8	0.0
2	OD(LT)	1693.0	1016	2420	2420	930.8	0.0
3	OD-TM(HT)	2977.0	1786	2783	2783	1070.4	180.0
4	OD-TM(LT)	3039.0	1823	2783	2783	1070.4	180.0
5	WN-TM	2977.0	1786	3267	3267	1256.5	183.0
6	OD-CL	2202.0	1321	3630	3630	1396.1	123.0
7	ETQ	4392.0	2635	3630	3630	1396.1	510.0

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	120.22	0.00	120.22	160.00	20 >= 16	55.41	96.00	76 >= 44
2	120.22	0.00	120.22	160.00	20 >= 16	57.55	96.00	76 >= 46
3	138.26	11.62	149.88	184.00	20 >= 17	101.19	110.40	76 >= 70
4	138.26	11.62	149.88	184.00	20 >= 17	103.30	110.40	76 >= 72
5	162.30	11.82	174.12	216.00	20 >= 17	101.19	129.60	76 >= 60
6	180.33	7.94	188.28	300.00	20 >= 13	74.85	180.00	76 >= 32
7	180.33	32.94	213.27	300.00	20 >= 15	149.29	180.00	76 >= 64

perpendicular direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	OD(HT)	1630.0	978	2420	2420	930.8	0.0
2	OD(LT)	1693.0	1016	2420	2420	930.8	0.0
3	WN	1902.0	1141	3025	3025	1163.5	40.0
4	OD-CL	2657.0	1594	3630	3630	1396.1	243.0
5	ETQ	4328.0	2597	3630	3630	1396.1	493.0

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	120.22	0.00	120.22	160.00	20 >= 16	55.41	96.00	76 >= 44
2	120.22	0.00	120.22	160.00	20 >= 16	57.55	96.00	76 >= 46
3	150.28	2.58	152.86	200.00	20 >= 16	64.65	120.00	76 >= 41
4	180.33	15.69	196.03	300.00	20 >= 14	90.31	180.00	76 >= 39
5	180.33	31.84	212.17	300.00	20 >= 15	147.11	180.00	76 >= 63

4.3 calculation of pile head joint part

4.3.1 design condition

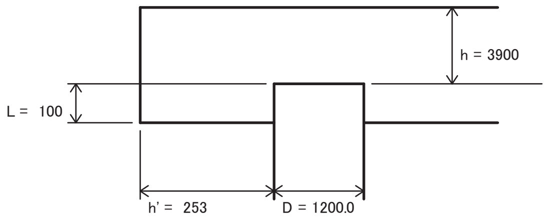
(1) design condition

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	Oridinary(high tide)	1.00	1630	1630	0	0
2	Oridinary(low tide)	1.00	1693	1693	0	0
3	Ord+Temp(high tide)	1.15	2592	669	150	155
4	Ord+Temp(low tide)	1.15	2655	731	150	155
5	Wind+Temp	1.35	2587	633	153	158
6	Ord+Collision	1.50	2039	1222	103	66
7	Earthquake	1.50	3557	-620	425	338

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	1630	1630	0	0
2	Oridinary(low tide)	1.00	1693	1693	0	0
3	Wind	1.25	1610	1610	33	37
4	Ord+Collision	1.50	1630	1630	203	130
5	Earthquake	1.50	1468	1468	411	362

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)

= 8.973^2*Pai/4 + 8.973*(14.764- 8.973) = 115.205 (m^2)

(2)area of backfilling soil

A2 = A1 - Ap = 74.635 (m^2)

where, Ap:leg column cross sectional area = 40.57 (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)	55500.0	0.0	0.0	0.0	0.0
2	OD(LT)	55500.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	55500.0	5400.0	118300.0	21600.0	139900.0
4	OD-TM(LT)	55500.0	5400.0	118300.0	21600.0	139900.0
5	WN-TM	55500.0	5500.0	120100.0	22000.0	142100.0
6	OD-CL	55500.0	3700.0	44600.0	14800.0	59400.0
7	ETQ	48500.0	15300.0	242600.0	61200.0	303800.0

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)	55500.0	0.0	0.0	0.0	0.0
2	OD(LT)	55500.0	0.0	0.0	0.0	0.0
3	WN	55500.0	1200.0	28500.0	4800.0	33300.0
4	OD-CL	55500.0	7300.0	87900.0	29200.0	117100.0
5	ETQ	48500.0	14800.0	266800.0	59200.0	326000.0

(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) = 17.0 (kN/m³)
Gam.sat: unit weight of backfilling soil(saturated) = 18.0 (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)	11.240	1.784	6681.88	1065.19	4560.07	3187.01
2	OD(LT)	5.670	1.784	6681.88	1065.19	2300.32	5446.75

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
3	OD-TM(HT)	11.240	1.784	6681.88	1065.19	4560.07	3187.01
4	OD-TM(LT)	5.670	1.784	6681.88	1065.19	2300.32	5446.75
5	WN-TM	13.050	1.784	6681.88	1065.19	5294.39	2452.69
6	OD-CL	11.240	1.784	6681.88	1065.19	4560.07	3187.01
7	ETQ	8.350	1.784	6681.88	1065.19	3387.60	4359.48

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)	11.240	1.784	6681.88	1065.19	4560.07	3187.01
2	OD(LT)	5.670	1.784	6681.88	1065.19	2300.32	5446.75
3	WN	13.050	1.784	6681.88	1065.19	5294.39	2452.69
4	OD-CL	11.240	1.784	6681.88	1065.19	4560.07	3187.01
5	ETQ	8.350	1.784	6681.88	1065.19	3387.60	4359.48

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	58687.0	0.0	0.0
2	OD(LT)	0.0	60946.8	0.0	0.0
3	OD-TM(HT)	0.0	58687.0	5400.0	139900.0
4	OD-TM(LT)	0.0	60946.8	5400.0	139900.0
5	WN-TM	0.0	57952.7	5500.0	142100.0
6	OD-CL	0.0	58687.0	3700.0	59400.0
7	ETQ	0.0	52859.5	15300.0	303800.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	58687.0	0.0	0.0
2	OD(LT)	0.0	60946.8	0.0	0.0
3	WN	0.0	57952.7	1200.0	33300.0
4	OD-CL	0.0	58687.0	7300.0	117100.0
5	ETQ	0.0	52859.5	14800.0	326000.0

(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)	30	0.04464	491.60	903.99
separation wall sheet pile(2)	6	0.04464	36.96	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)	1630	1630	0	1.00
2	OD(LT)	1693	1693	0	1.00
3	OD-TM(HT)	2592	669	150	1.15
4	OD-TM(LT)	2655	731	150	1.15
5	WN-TM	2587	633	153	1.35
6	OD-CL	2039	1222	103	1.50
7	ETQ	3557	-620	425	1.50

2)perpendicular direction

No	abbreviation	max vertical force (kN)	min vertical force (kN)	horizontal force(kN)	increment coefficient
1	OD(HT)	1630	1630	0	1.00
2	OD(LT)	1693	1693	0	1.00
3	WN	1610	1610	33	1.25
4	OD-CL	1630	1630	203	1.50
5	ETQ	1468	1468	411	1.50

4.3.3 pile head joint part stress calculation

(1) pile cap concrete vertical bearing stress

$$Sig.cv = \frac{PNmax}{Pai*D^2/4} <= Sig.ca$$

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)	1630	1.44	7.20	0.026	0.900
2	Oridinary(low tide)	1693	1.50	7.20	0.027	0.900
3	Ord+Temp(high tide)	2592	2.29	8.28	0.041	0.900
4	Ord+Temp(low tide)	2655	2.35	8.28	0.042	0.900
5	Wind+Temp	2587	2.29	9.72	0.041	0.900
6	Ord+Collision	2039	1.80	10.80	0.033	0.900
7	Earthquake	3557	3.15	10.80	0.057	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)	1630	1.44	7.20	0.026	0.900
2	Oridinary(low tide)	1693	1.50	7.20	0.027	0.900
3	Wind	1610	1.42	9.00	0.026	0.900
4	Ord+Collision	1630	1.44	10.80	0.026	0.900
5	Earthquake	1468	1.30	10.80	0.023	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)	150	1.250	8.280
4	Ord+Temp(low tide)	150	1.250	8.280
5	Wind+Temp	153	1.275	9.720
6	Ord+Collision	103	0.858	10.800
7	Earthquake	425	3.542	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	33	0.275	9.000
4	Ord+Collision	203	1.692	10.800
5	Earthquake	411	3.425	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(cm²)
1row	160.00	26.0	D29 - 12 (@283)	77.088

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	OD(HT)	0.0	1630.0	0.000	0.00	0.77	8.00	-11.50	160.00
		0.0	1630.0	0.000	0.00	0.77	8.00	-11.50	160.00
2	OD(LT)	0.0	1693.0	0.000	0.00	0.80	8.00	-11.94	160.00
		0.0	1693.0	0.000	0.00	0.80	8.00	-11.94	160.00
3	OD-TM(HT)	155.0	2592.0	0.000	346.27	1.59	9.20	-14.58	184.00
		155.0	669.0	0.000	148.13	0.68	9.20	-0.98	184.00
4	OD-TM(LT)	155.0	2655.0	0.000	352.74	1.61	9.20	-15.02	184.00
		155.0	731.0	0.000	155.00	0.71	9.20	-1.44	184.00
5	WN-TM	158.0	2587.0	0.000	340.71	1.59	10.80	-14.47	216.00
		158.0	633.0	0.000	142.19	0.68	10.80	-0.58	216.00
6	OD-CL	66.0	2039.0	0.000	571.92	1.11	12.00	-12.81	300.00
		66.0	1222.0	0.000	374.81	0.73	12.00	-7.04	300.00
7	ETQ	338.0	3557.0	0.000	247.57	2.47	12.00	-17.01	300.00
		338.0	-620.0	51.566	22.40	2.72	12.00	203.23	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	OD(HT)	0.0	1630.0	0.000	0.00	0.77	8.00	-11.50	160.00
		0.0	1630.0	0.000	0.00	0.77	8.00	-11.50	160.00
2	OD(LT)	0.0	1693.0	0.000	0.00	0.80	8.00	-11.94	160.00
		0.0	1693.0	0.000	0.00	0.80	8.00	-11.94	160.00

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)
3	WN	37.0	1610.0	0.000	772.86	0.84	10.00	-10.47	200.00
		37.0	1610.0	0.000	772.86	0.84	10.00	-10.47	200.00
4	OD-CL	130.0	1630.0	0.000	279.65	1.07	12.00	-8.39	300.00
		130.0	1630.0	0.000	279.65	1.07	12.00	-8.39	300.00
5	ETQ	362.0	1468.0	0.000	143.13	1.56	12.00	-1.49	300.00
		362.0	1468.0	0.000	143.13	1.56	12.00	-1.49	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

(2) pile head reinforcing rebar anchor length

$$Lo = \frac{Sig.sa}{4*Tau.oa} Phi = 906 \text{ (mm)}$$

Lo : rebaranchor length (mm)
Sig.sa : rebar allowable tensile stress = 200.00 (N/mm²)
Tau.oa : allowable rebar bond stress = 1.600 (N/mm²)
Phi. : pile head reinforcing rebar diameter = 29 (mm)

embedment length L >= Lo + 10 * Phi. = 1196 (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 = 6.424 (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)	21.2	18.2	15.9	14.2

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	sandy	6.290	3.0	4800	9600	44339	0.50
2	sandy	2.000	13.0	20800	41600	117855	0.50
3	sandy	3.000	13.0	20800	41600	117855	0.50
4	clay	8.000	7.0	19600	39200	125458	0.50
5	sandy	1.000	13.0	36400	72800	117855	0.50
6	clay	2.000	7.0	19600	39200	125458	0.50
7	sandy	6.000	20.0	56000	112000	157052	0.50
8	sandy	10.000	30.0	84000	168000	205805	0.50
9	clay	2.810	30.0	84000	168000	301510	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	355333	106600
separation wall sheet pile	355333	106600
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 = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	1283	385	1114	557
2	-12.060 - -14.350	1283	385	1114	557
3	-14.350 - -16.350	5562	1669	4828	2414
4	-16.350 - -19.350	5562	1669	4828	2414
5	-19.350 - -27.350	5241	1572	4550	2275
6	-27.350 - -28.350	9733	2920	8450	4225
7	-28.350 - -30.350	5241	1572	4550	2275
8	-30.350 - -36.350	14974	4492	12999	6500
9	-36.350 - -42.378	22461	6738	19499	9749
10	-42.378 - -46.350	22461	13476	19499	19499
11	-46.350 - -49.160	22461	13476	19499	19499

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	1857	557	770	385
2	-12.060 - -14.350	1857	557	770	385
3	-14.350 - -16.350	8047	2414	3337	1669
4	-16.350 - -19.350	8047	2414	3337	1669
5	-19.350 - -27.350	7583	2275	3145	1572
6	-27.350 - -28.350	14083	4225	5840	2920
7	-28.350 - -30.350	7583	2275	3145	1572
8	-30.350 - -36.350	21666	6500	8984	4492
9	-36.350 - -42.378	32498	9749	13476	6738
10	-42.378 - -46.350	32498	19499	13476	13476
11	-46.350 - -49.160	32498	19499	13476	13476

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -42.378(m) evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

earthquake time

1.bridge axis direction(Be = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	855	256	742	371
2	-12.060 - -14.350	855	256	742	371
3	-14.350 - -16.350	3704	1111	3216	1608
4	-16.350 - -19.350	11123	3337	9657	4828
5	-19.350 - -27.350	10482	3145	9100	4550
6	-27.350 - -28.350	19466	5840	16899	8450
7	-28.350 - -30.350	10482	3145	9100	4550
8	-30.350 - -36.350	29948	8984	25999	12999
9	-36.350 - -42.378	44921	13476	38998	19499
10	-42.378 - -46.350	44921	26953	38998	38998

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
11	-46.350 - -49.160	44921	26953	38998	38998

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	1237	371	513	256
2	-12.060 - -14.350	1237	371	513	256
3	-14.350 - -16.350	5359	1608	2222	1111
4	-16.350 - -19.350	16094	4828	6674	3337
5	-19.350 - -27.350	15166	4550	6289	3145
6	-27.350 - -28.350	28165	8450	11680	5840
7	-28.350 - -30.350	15166	4550	6289	3145
8	-30.350 - -36.350	43331	12999	17969	8984
9	-36.350 - -42.378	64997	19499	26953	13476
10	-42.378 - -46.350	64997	38998	26953	26953
11	-46.350 - -49.160	64997	38998	26953	26953

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -42.378(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 = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	11856	3557	10292	5146
2	-12.060 - -14.350	11856	3557	10292	5146
3	-14.350 - -16.350	31513	9454	27358	13679
4	-16.350 - -19.350	31513	9454	27358	13679
5	-19.350 - -27.350	33546	10064	29123	14561

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
6	-27.350 - -28.350	31513	9454	27358	13679
7	-28.350 - -30.350	33546	10064	29123	14561
8	-30.350 - -36.350	41994	12598	36457	18228
9	-36.350 - -42.378	55030	16509	47774	23887
10	-42.378 - -46.350	55030	33018	47774	47774
11	-46.350 - -49.160	80621	48372	69990	69990

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	17154	5146	7113	3557
2	-12.060 - -14.350	17154	5146	7113	3557
3	-14.350 - -16.350	45596	13679	18908	9454
4	-16.350 - -19.350	45596	13679	18908	9454
5	-19.350 - -27.350	48538	14561	20128	10064
6	-27.350 - -28.350	45596	13679	18908	9454
7	-28.350 - -30.350	48538	14561	20128	10064
8	-30.350 - -36.350	60761	18228	25196	12598
9	-36.350 - -42.378	79623	23887	33018	16509
10	-42.378 - -46.350	79623	47774	33018	33018
11	-46.350 - -49.160	116649	69990	48372	48372

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -42.378(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

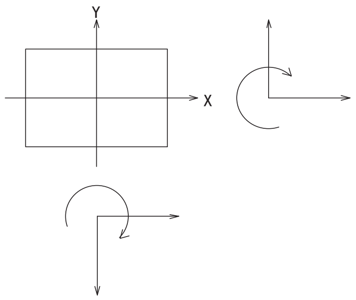
item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.0671E-001	8.6740E-002
ThetaoH	mrad	4.7441E-003	3.1862E-003
Del.oM	mm	4.7441E-002	3.1862E-002
ThetaoM	mrad	4.0983E-003	2.6594E-003
Ass	kN/m	1.9306E+006	2.0591E+006
Asr	kN/rad	-2.2348E+007	-2.4670E+007
Ars	kN.m/m	-2.2348E+007	-2.4670E+007
Arr	kN.m/rad	5.0269E+008	6.7160E+008

earthquake time

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	9.6392E-002	7.6136E-002
ThetaoH	mrad	4.5479E-003	2.9296E-003
Del.oM	mm	4.5479E-002	2.9296E-002
ThetaoM	mrad	4.0061E-003	2.5205E-003
Ass	kN/m	2.2340E+006	2.3761E+006
Asr	kN/rad	-2.5361E+007	-2.7617E+007
Ars	kN.m/m	-2.5361E+007	-2.7617E+007
Arr	kN.m/rad	5.3752E+008	7.1773E+008

to estimate natural period

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	2.8183E-002	2.2889E-002
ThetaoH	mrad	1.8523E-003	1.2275E-003
Del.oM	mm	1.8523E-002	1.2275E-002
ThetaoM	mrad	2.3542E-003	1.5142E-003
Ass	kN/m	7.3479E+006	7.7287E+006
Asr	kN/rad	-5.7814E+007	-6.2651E+007
Ars	kN.m/m	-5.7814E+007	-6.2651E+007
Arr	kN.m/rad	8.7966E+008	1.1683E+009

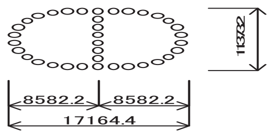


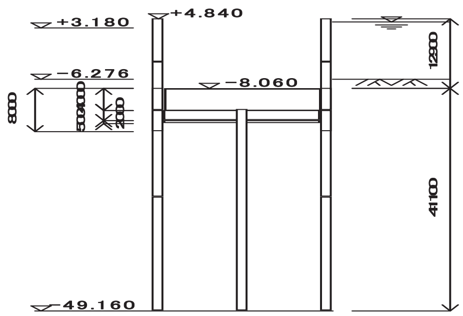
Y direction: bridge axis direction
X direction:perpendicular direction

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 = 54.000(m)
number = 30(number)

steel pipe thickness (mm)	length (m)	material
14.0	8.000	SKY400
14.0	9.000	SKY490
16.0	16.000	SKY400
14.0	21.000	SKY400

2)separation wall sheet pile

external diameter = 1200.0(mm)
pile length = 37.200(m)
number = 6(number)

steel pipe thickness (mm)	length (m)	material
14.0	37.200	SKY400

1.3 ground condition

No	soil	layer thick ness (m)	ave rage 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	sand	8.074	3.0	17.0	8.0	0.0	29.00	4800	9600	0.333	0.333	0.333
2	sand	2.000	13.0	17.0	8.0	0.0	33.00	20800	41600	0.333	0.333	0.333
3	sand	3.000	13.0	17.0	8.0	0.0	33.00	20800	41600	1.000	1.000	1.000
4	chsv	8.000	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
5	sand	1.000	13.0	17.0	8.0	0.0	32.00	36400	72800	1.000	1.000	1.000
6	chsv	2.000	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
7	sand	6.000	20.0	17.0	8.0	0.0	33.00	56000	112000	1.000	1.000	1.000
8	sand	10.000	30.0	17.0	8.0	0.0	34.00	84000	168000	1.000	1.000	1.000

No	soil	layer thick ness (m)	ave rage 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
9	chsv	6.000	30.0	18.0	8.0	180.0	0.00	84000	168000	1.000	1.000	1.000
10	sand	5.400	50.0	19.0	10.0	0.0	34.00	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 =   30

to(mm)	L(m)	Ao(cm²)	Io(cm⁴)	Zo(cm³)	material
14.0	4.100	446.4	782242	13081	SKY490
16.0	16.000	519.9	908031	15184	SKY400
14.0	21.000	446.4	782242	13081	SKY400

2)separation wall sheet pile Do =   1200(mm) number =   6

to(mm)	L(m)	Ao(cm²)	Io(cm⁴)	Zo(cm³)	material
14.0	37.100	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	491.60	903.99
separation wall sheet pile	36.96	0.00

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

bridge axis direction I = SumIoi + Mu * Sum(Aoi * Yi²)

perpendicular direction I = SumIoi + Mu * Sum(Aoi * Xi²)

Mu : composite efficiency - 0.75

No	L(m)	bridge axis direction	perpendicular direction
1	4.100	17.976138	30.544184
2	16.000	20.724262	35.565970
3	21.000	17.976138	30.544184

foundation length = 41.100 (m)

(4)coordinates of cetroid of steel pipe sheet pile

1) periphery sheet pile

No	Y(m)	X(m)	number
1	5.0866	0.0000	2
2	5.0866	1.4478	4
3	5.0866	2.8956	4
4	0.7239	7.9304	4
5	2.1131	7.5225	4
6	3.3310	6.7398	4
7	4.2791	5.6456	4
8	4.8806	4.3287	4

2) separation wall sheet pile

No	Y(m)	X(m)	number
1	3.6333	0.0000	2
2	2.1800	0.0000	2
3	0.7267	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	0.790	------	0.790	------	----
1	5.500	4800	5.500	9600	0.333
2	2.000	20800	2.000	41600	0.333
3	3.000	20800	3.000	41600	1.000
4	8.000	19600	8.000	39200	1.000
5	1.000	36400	1.000	72800	1.000
6	2.000	19600	2.000	39200	1.000
7	6.000	56000	6.000	112000	1.000
8	10.000	84000	10.000	168000	1.000
9	2.810	84000	2.810	168000	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/m³)

Alp.*Eo: ground modulus of elasticity (kN/m²)

usual time = 84000

earthquake time = 168000

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	98995	197990
separation wall sheet pile	1200.0	98995	197990

(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)	1.7976E+009		3.0544E+009	
D (cm)	1716.44		1137.32	
Beta(cm^{-1})	0.000429	0.000429	0.000368	0.000368
1/Beta(cm)	2330.4	2330.4	2717.2	2717.2
average Alp.*Eo (N/cm^2)	1990.4	1990.4	2504.1	2504.1
BH, $\sqrt{De*Le}$ (cm)	2000.0 < 2630.4	2000.0 < 2630.4	1757.9 < 2141.2	1757.9 < 2141.2

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	0.790	0.790	------	------	------	------	------	------
1	5.500	5.500	4800	9600	1372	913	1511	1006
2	2.000	2.000	20800	41600	5943	3958	6547	4360
3	3.000	3.000	20800	41600	5943	11887	6547	13095
4	8.000	8.000	19600	39200	5601	11201	6170	12339
5	1.000	1.000	36400	72800	10401	20802	11458	22916
6	2.000	2.000	19600	39200	5601	11201	6170	12339
7	6.000	6.000	56000	112000	16002	32003	17627	35255
8	10.000	10.000	84000	168000	24002	48005	26441	52882
9	2.810	2.810	84000	168000	24002	48005	26441	52882

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	0.790	0.790	------	------	------	------
1	5.500	5.500	1372	913	1511	1006
2	2.000	2.000	5943	3958	6547	4360
3	3.000	3.000	5943	11887	6547	13095
4	8.000	8.000	5601	11201	6170	12339
5	1.000	1.000	10401	20802	11458	22916
6	2.000	2.000	5601	11201	6170	12339
7	6.000	6.000	16002	32003	17627	35255
8	10.000	10.000	24002	48005	26441	52882
9	2.810	2.810	24002	48005	26441	52882

(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	29698	59397
separation wall sheet pile	29698	59397

(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 (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	30	1.1310	6	0.0000	0	4.0306E+006	8.0612E+006

2) shear spring constant

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

usual time	in quakes
1.2092E+006	2.4184E+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 (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	491.60	36.96	5.9178E+007	1.1836E+008
perpendicular direction	903.99	0.00	1.0121E+008	2.0242E+008

spring constant at bottom of celler(using value)

		usual time	in quakes
vertical spring Kv (kN/m)		4.0306E+006	8.0612E+006
shear spring Ks (kN/m)		1.2092E+006	2.4184E+006
rotational spring Kr (kN.m/rad)	bridge axis direction	5.9178E+007	1.1836E+008
	perpendicular direction	1.0121E+008	2.0242E+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)

$$\frac{\text{equivalent embedment depth to bearing strata}}{\text{pile diameter}} = \frac{2.810}{1.2000} = 2.34$$

qd / $\bar{N}$ = 140

$\bar{N}$:design N value in steel pipe sheet pile tip ground $\bar{N}$ = 30.0

qd = 140 * 30.0 = 4215 (kN/m^2)

n1 : celler part periphery steel pipe sheet pile number (number) n1 = 30

n2 : number of steel pipe sheet pile in separation wall part (number) n2 = 6

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

U1 : enveloping celler part periphery length (m) U1 = 47.312 (m)

U2 : enveloping celler part and separation wall part periphery length
and sum of perimeter of intermediate driven single pile U2 = 55.319 (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 = 6.782 (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	sandy	3.0	0.790	0.0	0.0	0.333	0.0	0.0
2	sandy	3.0	5.500	0.0	0.0	0.333	0.0	0.0
3	sandy	13.0	2.000	26.0	26.0	0.333	52.0	17.3
4	sandy	13.0	3.000	26.0	26.0	1.000	78.0	78.0
5	cohesv	7.0	8.000	70.0	70.0	1.000	560.0	560.0
6	sandy	13.0	1.000	26.0	26.0	1.000	26.0	26.0
7	cohesv	7.0	2.000	70.0	70.0	1.000	140.0	140.0
8	sandy	20.0	6.000	40.0	40.0	1.000	240.0	240.0
9	sandy	30.0	10.000	60.0	60.0	1.000	600.0	600.0
10	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5
Sum			41.100				2117.5	2082.8

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
9	sandy	30.0	3.972	60.0	60.0	1.000	238.3	238.3
10	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5
Sum			6.782				659.8	659.8

DE: reduction coefficient in earthquake time

ultimate bearing capacity

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

= 4767 + 3797 = 8564 (kN/number) (usual time)

= 4767 + 3751 = 8518 (kN/number) (earthquake time)

allowable compressive bearing capacity

usual time Ra = (1 / 3) * 8564 = 2855 (kN/number)

earthquake Ra = (1 / 2) * 8518 = 4259 (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) =	130.8	130.8
joint weight	w2 (kN) =	0.0	0.0
soil weight inside of pipe	w3 (kN) =	279.6	279.6
filling concrete weight	w4 (kN) =	0.0	0.0
	W (kN) =	410.4	410.4

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	sandy	3.0	0.790	0.0	0.0	0.333	0.0	0.0
2	sandy	3.0	5.500	0.0	0.0	0.333	0.0	0.0
3	sandy	13.0	2.000	26.0	26.0	0.333	52.0	17.3
4	sandy	13.0	3.000	26.0	26.0	1.000	78.0	78.0
5	cohesv	7.0	8.000	70.0	70.0	1.000	560.0	560.0
6	sandy	13.0	1.000	26.0	26.0	1.000	26.0	26.0
7	cohesv	7.0	2.000	70.0	70.0	1.000	140.0	140.0
8	sandy	20.0	6.000	40.0	40.0	1.000	240.0	240.0
9	sandy	30.0	10.000	60.0	60.0	1.000	600.0	600.0
10	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5

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
Sum			41.100				2117.5	2082.8

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
9	sandy	30.0	3.972	60.0	60.0	1.000	238.3	238.3
10	cohesv	30.0	2.810	150.0	150.0	1.000	421.5	421.5
Sum			6.782				659.8	659.8

DE: reduction coefficient in earthquake time

ultimate uplifting force
Pu = 3797 (kN/number) (usual time time)
Pu = 3751 (kN/number) (earthquake time)

allowable uplifting force
usual time Pa - (1 / 6) * 3797 + 410 - 1043 (kN/number)
earthquake Pa - (1 / 3) * 3751 + 410 - 1661 (kN/number)

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

allowable compressive bearing capacity	usual time	2855
	in quakes	4259
allowable uplifting force bearing capacity	usual time	1043
	in quakes	1661

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 : 11.3732 (m)  *  17.1644 (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    =  30
filling  concrete cast height               h2    =   8.000 (m)
leg column cross sectional area             Ap    =  40.570 (m2)
                              shape      :   oval
                              dimension  : a    =  11.000 (m)      perpendicular direction
                                         : b    =   4.000 (m)      bridge axis direction
unit weight : backfilling soil(wet)        Gam.t  = 17.0  (kN/m3)
              backfilling soil(saturated)  Gam.sat = 18.0  (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                  =  0.790 (m) ( depth from crest of  )
```

1)bridge axis direction

No	load name	backfilling soil height (m)	water table height (m)
1	Wind+Temp	-8.060	4.990
2	Ord+Collision(scour)	-8.060	3.180
3	Earthquake(scour)	-8.060	0.290

2)perpendicular direction

No	load name	backfilling soil height (m)	water table height (m)
1	Wind	-8.060	4.990
2	Ord+Collision(scour)	-8.060	3.180
3	Earthquake(scour)	-8.060	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	55500.0	5500.0	120100.0
2	Ord+Collision(scour)	55500.0	3700.0	44600.0
3	Earthquake(scour)	48500.0	16200.0	244000.0

2)perpendicular direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Wind	55500.0	1200.0	28500.0
2	Ord+Collision(scour)	55500.0	7300.0	87900.0
3	Earthquake(scour)	48500.0	15100.0	267500.0

(3) pile cap area

oval

$$A1 = \frac{Pai}{4}*(B-D)^2 + (B-D)*(L-B) - \frac{Pai}{4}*D^2*\frac{n}{2} = 123.235\ (m^2)$$

filling concrete area

$$A2 = \frac{Pai}{4}*D^2*n = 33.929\ (m^2)$$

backfilling soil area

$$A3 = A1 + A2 - Ap = 116.594\ (m^2)$$

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	13.050	0.000	7147.6	3528.6	0.0	5294.4	5381.9
2	OD-CL(SC)	11.240	0.000	7147.6	3528.6	0.0	4560.1	6116.2
3	ETQ(SC)	8.350	0.000	7147.6	3528.6	0.0	3387.6	7288.7

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	13.050	0.000	7147.6	3528.6	0.0	5294.4	5381.9
2	OD-CL(SC)	11.240	0.000	7147.6	3528.6	0.0	4560.1	6116.2
3	ETQ(SC)	8.350	0.000	7147.6	3528.6	0.0	3387.6	7288.7

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 0.790 m)
1)bridge axis direction
w = A1*Gam.c1*kh = 905.78 (kN/m)
H = w* 0.790 = 715.56 (kN)
2)perpendicular direction
w = A1*Gam.c1*kh = 905.78 (kN/m)
H = w* 0.790 = 715.56 (kN)

filling concrete (working height 0.790 m)
1)bridge axis direction
w = A2*Gam.c2*kh = 234.11 (kN/m)
H = w* 0.790 = 184.95 (kN)
2)perpendicular direction
w = A2*Gam.c2*kh = 234.11 (kN/m)
H = w* 0.790 = 184.95 (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	60881.9	5500.0	120100.0	1.35	usual time	usual time
2	Ord+Collision(scour)	61616.2	3700.0	44600.0	1.50	usual time	usual time
3	Earthquake(scour)	55788.7	16200.0	244000.0	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	60881.9	1200.0	28500.0	1.25	usual time	usual time
2	Ord+Collision(scour)	61616.2	7300.0	87900.0	1.50	usual time	usual time
3	Earthquake(scour)	55788.7	15100.0	267500.0	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	60881.9	5500.0	120100.0	1.35	usual time	usual time
2	Ord+Collision(scour)	61616.2	3700.0	44600.0	1.50	usual time	usual time
3	Earthquake(scour)	55788.7	16200.0	244000.0	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	60881.9	1200.0	28500.0	1.25	usual time	usual time
2	Ord+Collision(scour)	61616.2	7300.0	87900.0	1.50	usual time	usual time
3	Earthquake(scour)	55788.7	15100.0	267500.0	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	60881.9	61616.2	55788.7
		Ho	kN	5500.0	3700.0	16200.0
		Mo	kN.m	120100.0	44600.0	244000.0
foundation crest	displacement	Del.1	cm	1.187	0.583	3.484
	deflexion angle	Theta.1	mrad	-0.908	-0.419	-2.414
design ground surface	displacement	Del.2	cm	1.116	0.550	3.296
	deflexion angle	Theta.2	mrad	-0.881	-0.409	-2.359
celler part maximum bending moment		Mmax	kN.m	-150817.0	-68177.0	-383293.0
Mmax accrue location		Lm	m	-16.350	-18.060	-19.350
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	71.68	52.92	128.03
		Lm	m	-16.350	-28.160	-19.350
	periphery sheet pile(SKY490)	Sigmax	N/mm²	78.72	55.37	125.37
		Lm	m	-12.160	-12.160	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	70.45	51.92	108.38
		Lm	m	-12.160	-12.160	-19.350
	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	119.0	-126.0	-347.0
vertical reaction	maximum	Rmax	kN/num	1692	1713	1553
	minimum	Rmin	kN/num	1690	1710	1546
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2855	2855	4259
	uplifting force	Pa	kN/num	-1043	-1043	-1661
	stress(SKY400)	Sig.a	N/mm²	189.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	249.75	277.50	277.50

note)Lm is elevation

2)perpendicular direction

item			unit	WN	OD-CL(SC)	ETQ(SC)
working force		Vo	kN	60881.9	61616.2	55788.7
		Ho	kN	1200.0	7300.0	15100.0
		Mo	kN.m	28500.0	87900.0	267500.0
foundation crest	displacement	Del.1	cm	0.249	1.162	3.126
	deflexion angle	Theta.1	mrad	-0.157	-0.662	-1.834
design ground surface	displacement	Del.2	cm	0.237	1.110	2.983
	deflexion angle	Theta.2	mrad	-0.153	-0.651	-1.799
celler part maximum bending moment		Mmax	kN.m	-36058.0	-141871.0	-408780.0
Mmax accrue location		Lm	m	-18.060	-20.060	-20.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	45.63	71.56	132.15
		Lm	m	-28.160	-28.160	-28.160
	periphery sheet pile(SKY490)	Sigmax	N/mm²	46.91	70.02	125.15
		Lm	m	-12.160	-12.160	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	40.69	48.65	64.96
		Lm	m	-12.160	-28.160	-28.160
	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	-1446.0	-8571.0	-28632.0
vertical reaction	maximum	Rmax	kN/num	1704	1787	1801
	minimum	Rmin	kN/num	1678	1636	1299
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2855	2855	4259
	uplifting force	Pa	kN/num	-1043	-1043	-1661
	stress(SKY400)	Sig.a	N/mm²	175.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	231.25	277.50	277.50

note)Lm is elevation

1.10 detail output

(1)bridge axis direction

1)Wind+Temp

working force	vertical force	Vo	kN	60881.9
	horizontal force	Ho	kN	5500.0
	moment	Mo	kN.m	120100.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.124
	calculation displacement	Del.	cm	1.116

convergence rate (Del.1 - Del.) / Del.1 = 0.68 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1372	2894
2	5943	12535
3	5943	12535
4	5601	11814
5	10401	21938
6	5601	11814
7	16002	33751
8	24002	50625
9	24002	50625

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	1.187	-0.908	-5500.0	-120100.0	72.95	65.85	
-8.850	1.116	-0.881	-5500.0	-124445.0	74.22	66.86	
-9.060	1.098	-0.874	-5384.5	-125587.8	74.55	67.12	
-10.060	1.012	-0.838	-4860.6	-130706.9	76.04	68.31	
-11.060	0.930	-0.801	-4378.3	-135322.9	77.39	69.39	
-12.060	0.852	-0.763	-3935.9	-139476.8	78.60	70.36	
-12.160	0.844	-0.759	-3893.7	-139868.3	78.72	70.45	
-12.160	0.844	-0.759	-3893.7	-139868.3	68.90	61.72	
-13.060	0.777	-0.729	-3531.3	-143207.3	69.75	62.40	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-14.060	0.706	-0.694	-3163.0	-146551.5	70.60	63.08	
-14.350	0.686	-0.683	-3062.7	-147454.2	70.83	63.26	
-14.560	0.672	-0.676	-2755.8	-148065.0	70.98	63.39	
-15.060	0.639	-0.658	-2050.8	-149265.1	71.29	63.63	
-16.060	0.575	-0.622	-746.0	-150652.0	71.64	63.91	
-16.350	0.557	-0.611	-393.0	-150816.9	71.68	63.95	*
-17.060	0.514	-0.585	425.1	-150801.7	71.68	63.94	
-18.060	0.458	-0.549	1470.2	-149843.9	71.43	63.75	
-19.060	0.405	-0.513	2397.2	-147900.7	70.94	63.36	
-19.350	0.390	-0.503	2645.0	-147169.4	70.75	63.21	
-20.060	0.355	-0.478	3181.0	-145098.2	70.23	62.79	
-21.060	0.309	-0.443	3853.7	-141573.0	69.33	62.07	
-22.060	0.266	-0.409	4436.6	-137420.7	68.27	61.23	
-23.060	0.227	-0.377	4936.4	-132727.6	67.08	60.27	
-24.060	0.191	-0.345	5359.7	-127573.4	65.77	59.23	
-25.060	0.158	-0.315	5713.0	-122031.5	64.36	58.10	
-26.060	0.128	-0.287	6002.3	-116168.7	62.87	56.91	
-27.060	0.101	-0.259	6233.5	-110046.2	61.31	55.67	
-27.350	0.093	-0.252	6290.5	-108230.1	60.85	55.30	
-28.060	0.076	-0.234	6516.3	-103680.9	59.69	54.37	
-28.160	0.074	-0.231	6544.5	-103027.9	59.52	54.24	
-28.160	0.074	-0.231	6544.5	-103027.9	67.96	61.87	
-28.350	0.069	-0.226	6595.6	-101779.5	67.60	61.58	
-29.060	0.054	-0.206	6684.2	-97063.9	66.22	60.48	
-30.060	0.035	-0.180	6773.7	-90331.6	64.26	58.92	
-30.350	0.030	-0.173	6792.6	-88364.4	63.68	58.46	
-31.060	0.018	-0.156	6890.0	-83504.2	62.26	57.33	
-32.060	0.004	-0.133	6951.1	-76576.7	60.24	55.71	
-33.060	-0.009	-0.113	6934.8	-69627.7	58.21	54.10	
-34.060	-0.019	-0.095	6852.9	-62728.9	56.20	52.49	
-35.060	-0.028	-0.078	6716.0	-55940.3	54.22	50.91	
-36.060	-0.035	-0.064	6533.7	-49312.1	52.28	49.37	
-36.350	-0.037	-0.060	6473.5	-47425.9	51.73	48.93	
-37.060	-0.041	-0.051	6234.9	-42913.0	50.42	47.88	
-38.060	-0.045	-0.040	5861.8	-36861.4	48.65	46.47	
-39.060	-0.049	-0.030	5454.1	-31201.0	47.00	45.15	
-40.060	-0.051	-0.022	5020.0	-25962.0	45.47	43.93	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-41.060	-0.053	-0.016	4566.5	-21167.4	44.07	42.82	
-42.060	-0.054	-0.010	4099.2	-16833.6	42.80	41.81	
-43.060	-0.055	-0.006	3622.7	-12972.0	41.67	40.91	
-44.060	-0.056	-0.003	3140.7	-9590.0	40.69	40.12	
-45.060	-0.056	-0.001	2655.8	-6691.6	39.84	39.45	
-46.060	-0.056	0.001	2170.0	-4278.7	39.14	38.88	
-46.350	-0.056	0.001	2029.1	-3669.9	38.96	38.74	
-47.060	-0.056	0.001	1684.6	-2351.5	38.57	38.44	
-48.060	-0.056	0.002	1200.5	-909.1	38.15	38.10	
-49.060	-0.055	0.002	718.1	50.1	37.90	37.90	
-49.160	-0.055	0.002	669.9	119.5	37.92	37.92	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.850	1.116	-0.881	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	71.68	-16.350
periphery sheet pile (SKY490)	78.72	-12.160
separation wall sheet pile (SKY400)	70.45	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 119.5 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)

periphery	n1 = 30 (number)	IB1 = 491.60 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (number)	IB1 = 36.96 (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 = 5.087
maximum Rmax = 1692 (kN/number)
minimum Rmin = 1690 (kN/number)

2)Ord+Collision(scour)

working force	vertical force	Vo	kN	61616.2
	horizontal force	Ho	kN	3700.0
	moment	Mo	kN.m	44600.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.550

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

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1372	3068
2	5943	13289
3	5943	13289
4	5601	12524
5	10401	23257
6	5601	12524
7	16002	35782
8	24002	53670
9	24002	53670

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	0.583	-0.419	-3700.0	-44600.0	51.36	48.73	
-8.850	0.550	-0.409	-3700.0	-47523.0	52.22	49.41	
-9.060	0.541	-0.406	-3639.7	-48293.6	52.44	49.59	
-10.060	0.501	-0.393	-3365.2	-51794.3	53.46	50.40	
-11.060	0.463	-0.378	-3111.4	-55031.0	54.41	51.16	
-12.060	0.426	-0.362	-2877.5	-58023.9	55.28	51.85	
-12.160	0.422	-0.360	-2855.2	-58310.5	55.37	51.92	
-12.160	0.422	-0.360	-2855.2	-58310.5	48.55	45.56	
-13.060	0.390	-0.347	-2662.7	-60792.4	49.18	46.06	
-14.060	0.356	-0.332	-2466.2	-63355.4	49.83	46.59	
-14.350	0.347	-0.328	-2412.5	-64062.7	50.01	46.73	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-14.560	0.340	-0.325	-2248.0	-64552.0	50.14	46.83	
-15.060	0.324	-0.317	-1869.5	-65580.6	50.40	47.04	
-16.060	0.293	-0.301	-1166.2	-67092.6	50.79	47.34	
-16.350	0.284	-0.296	-975.3	-67403.0	50.86	47.41	
-17.060	0.264	-0.285	-531.5	-67935.9	51.00	47.52	
-18.060	0.236	-0.268	38.2	-68177.3	51.06	47.56	*
-19.060	0.210	-0.252	546.9	-67879.8	50.99	47.50	
-19.350	0.203	-0.247	683.5	-67701.3	50.94	47.47	
-20.060	0.186	-0.235	980.0	-67109.2	50.79	47.35	
-21.060	0.163	-0.219	1354.7	-65937.8	50.49	47.11	
-22.060	0.142	-0.204	1682.2	-64415.6	50.10	46.80	
-23.060	0.122	-0.188	1965.9	-62588.0	49.64	46.43	
-24.060	0.104	-0.173	2209.2	-60497.2	49.11	46.00	
-25.060	0.088	-0.159	2415.2	-58182.0	48.52	45.53	
-26.060	0.072	-0.145	2587.0	-55678.2	47.88	45.03	
-27.060	0.059	-0.132	2727.5	-53018.5	47.20	44.49	
-27.350	0.055	-0.129	2762.8	-52222.3	47.00	44.32	
-28.060	0.046	-0.120	2905.4	-50208.6	46.49	43.92	
-28.160	0.045	-0.119	2923.5	-49917.2	46.42	43.86	
-28.160	0.045	-0.119	2923.5	-49917.2	52.92	49.96	
-28.350	0.043	-0.116	2956.6	-49358.5	52.75	49.83	
-29.060	0.035	-0.106	3015.4	-47237.7	52.13	49.34	
-30.060	0.025	-0.094	3078.9	-44188.8	51.24	48.63	
-30.350	0.022	-0.090	3093.5	-43293.7	50.98	48.42	
-31.060	0.016	-0.082	3175.8	-41066.6	50.33	47.90	
-32.060	0.008	-0.071	3249.3	-37850.1	49.39	47.16	
-33.060	0.002	-0.061	3279.3	-34582.4	48.44	46.40	
-34.060	-0.004	-0.052	3272.0	-31303.9	47.48	45.63	
-35.060	-0.009	-0.043	3232.9	-28049.1	46.53	44.87	
-36.060	-0.013	-0.036	3167.1	-24847.1	45.60	44.13	
-36.350	-0.014	-0.034	3143.7	-23932.0	45.33	43.92	
-37.060	-0.016	-0.030	3046.9	-21733.4	44.69	43.40	
-38.060	-0.019	-0.024	2887.8	-18764.1	43.82	42.71	
-39.060	-0.021	-0.019	2706.5	-15965.3	43.01	42.06	
-40.060	-0.022	-0.015	2507.7	-13356.8	42.24	41.45	
-41.060	-0.024	-0.012	2295.0	-10954.5	41.54	40.90	
-42.060	-0.025	-0.009	2071.6	-8770.4	40.91	40.39	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-43.060	-0.026	-0.007	1839.9	-6814.0	40.33	39.93	
-44.060	-0.026	-0.005	1602.0	-5092.6	39.83	39.53	
-45.060	-0.027	-0.004	1359.5	-3611.5	39.40	39.19	
-46.060	-0.027	-0.003	1113.3	-2374.9	39.04	38.90	
-46.350	-0.027	-0.003	1041.4	-2062.4	38.95	38.83	
-47.060	-0.027	-0.003	864.3	-1385.9	38.75	38.67	
-48.060	-0.027	-0.002	613.0	-647.0	38.53	38.50	
-49.060	-0.028	-0.002	359.6	-160.6	38.39	38.38	
-49.160	-0.028	-0.002	334.2	-125.9	38.38	38.37	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.850	0.550	-0.409	5.000

maximum stress

	Sig.(N/mm^2)	elevation(m)
periphery sheet pile (SKY400)	52.92	-28.160
periphery sheet pile (SKY490)	55.37	-12.160
separation wall sheet pile (SKY400)	51.92	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -125.9 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)

periphery	n1 = 30 (number)	IB1 =	491.60 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (number)	IB1 =	36.96 (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 = 5.087
maximum Rmax = 1713 (kN/number)
minimum Rmin = 1710 (kN/number)

3)Earthquake(scour)

working force	vertical force	Vo	kN	55788.7
	horizontal force	Ho	kN	16200.0
	moment	Mo	kN.m	244000.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	3.314
	calculation displacement	Del.	cm	3.296

convergence rate (Del.1 - Del.) / Del.1 = 0.53 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	913	1122
2	3958	4862
3	11887	14602
4	11201	13759
5	20802	25553
6	11201	13759
7	32003	39312
8	48005	58969
9	48005	58969

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	3.484	-2.414	-16200.0	-244000.0	105.95	91.52	
-8.850	3.296	-2.359	-17100.5	-257153.7	109.79	94.58	
-9.060	3.247	-2.344	-16968.3	-260730.9	110.83	95.41	
-10.060	3.016	-2.269	-16365.6	-277394.2	115.69	99.29	
-11.060	2.793	-2.190	-15806.7	-293476.7	120.39	103.03	
-12.060	2.578	-2.106	-15289.8	-309021.5	124.93	106.65	
-12.160	2.557	-2.097	-15240.4	-310548.0	125.37	107.01	
-12.160	2.557	-2.097	-15240.4	-310548.0	109.53	93.60	
-13.060	2.371	-2.028	-14813.6	-324069.9	112.97	96.35	
-14.060	2.173	-1.948	-14376.3	-338661.7	116.68	99.31	
-14.350	2.116	-1.924	-14256.6	-342813.4	117.74	100.16	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-14.560	2.076	-1.907	-13889.3	-345768.6	118.49	100.76	
-15.060	1.982	-1.865	-13042.7	-352499.9	120.20	102.12	
-16.060	1.800	-1.778	-11465.4	-364741.3	123.31	104.61	
-16.350	1.748	-1.753	-11036.1	-368003.8	124.14	105.27	
-17.060	1.626	-1.689	-8034.1	-374760.8	125.86	106.64	
-18.060	1.462	-1.598	-4166.0	-380826.6	127.41	107.88	
-19.060	1.307	-1.506	-698.3	-383226.3	128.02	108.36	
-19.350	1.263	-1.479	235.7	-383292.7	128.03	108.38	*
-20.060	1.161	-1.413	2267.5	-382393.8	127.80	108.20	
-21.060	1.024	-1.321	4845.8	-378810.3	126.89	107.47	
-22.060	0.897	-1.231	7111.9	-372806.3	125.37	106.25	
-23.060	0.778	-1.142	9087.4	-364683.3	123.30	104.60	
-24.060	0.668	-1.055	10793.3	-354721.4	120.77	102.57	
-25.060	0.567	-0.971	12250.0	-343179.9	117.83	100.23	
-26.060	0.474	-0.889	13477.4	-330297.9	114.55	97.61	
-27.060	0.389	-0.811	14494.8	-316295.1	110.99	94.77	
-27.350	0.366	-0.789	14753.2	-312053.7	109.91	93.91	
-28.060	0.312	-0.737	15806.7	-301195.0	107.15	91.70	
-28.160	0.304	-0.729	15941.8	-299607.6	106.75	91.38	
-28.160	0.304	-0.729	15941.8	-299607.6	122.18	104.46	
-28.350	0.291	-0.714	16189.6	-296554.9	121.29	103.75	
-29.060	0.242	-0.656	16635.4	-284897.2	117.89	101.04	
-30.060	0.180	-0.579	17132.2	-268001.3	112.95	97.10	
-30.350	0.164	-0.558	17249.9	-263015.6	111.50	95.94	
-31.060	0.126	-0.507	17942.0	-250511.7	107.85	93.03	
-32.060	0.079	-0.440	18627.8	-232200.2	102.50	88.77	
-33.060	0.038	-0.378	19016.3	-213355.2	97.00	84.38	
-34.060	0.003	-0.321	19149.4	-194252.7	91.42	79.94	
-35.060	-0.027	-0.270	19065.2	-175128.7	85.84	75.49	
-36.060	-0.051	-0.224	18798.5	-156183.0	80.31	71.08	
-36.350	-0.058	-0.212	18691.6	-150746.6	78.72	69.81	
-37.060	-0.072	-0.183	18224.8	-137635.3	74.90	66.76	
-38.060	-0.088	-0.147	17411.7	-119803.2	69.69	62.61	
-39.060	-0.101	-0.116	16449.1	-102861.7	64.75	58.66	
-40.060	-0.112	-0.090	15368.2	-86944.4	60.10	54.96	
-41.060	-0.120	-0.068	14195.8	-72155.7	55.78	51.52	
-42.060	-0.125	-0.050	12954.2	-58575.8	51.82	48.35	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.060	-0.130	-0.035	11661.9	-46264.2	48.22	45.49	
-44.060	-0.133	-0.024	10333.7	-35263.9	45.01	42.93	
-45.060	-0.135	-0.016	8980.9	-25604.9	42.19	40.68	
-46.060	-0.136	-0.010	7612.3	-17307.3	39.77	38.75	
-46.350	-0.136	-0.008	7213.3	-15157.5	39.14	38.25	
-47.060	-0.137	-0.006	6233.7	-10383.6	37.75	37.14	
-48.060	-0.137	-0.004	4849.2	-4841.8	36.13	35.85	
-49.060	-0.137	-0.003	3460.8	-686.6	34.92	34.88	
-49.160	-0.137	-0.003	3321.7	-347.5	34.82	34.80	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.850	3.296	-2.359	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	128.03	-19.350
periphery sheet pile (SKY490)	125.37	-12.160
separation wall sheet pile (SKY400)	108.38	-19.350
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -347.5 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)

periphery	n1 = 30 (number)	IB1 = 491.60 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (number)	IB1 = 36.96 (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 = 5.087
maximum Rmax = 1553 (kN/number)
minimum Rmin = 1546 (kN/number)

(2)perpendicular direction

1)Wind

working force	vertical force	Vo	kN	60881.9
	horizontal force	Ho	kN	1200.0
	moment	Mo	kN.m	28500.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.237

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

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1511	3379
2	6547	14640
3	6547	14640
4	6170	13796
5	11458	25620
6	6170	13796
7	17627	39416
8	26441	59124
9	26441	59124

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	0.249	-0.157	-1200.0	-28500.0	45.69	40.31	
-8.850	0.237	-0.153	-1200.0	-29448.0	45.95	40.39	
-9.060	0.234	-0.152	-1181.0	-29698.0	46.01	40.41	
-10.060	0.219	-0.147	-1094.0	-30835.0	46.33	40.51	
-11.060	0.205	-0.142	-1012.6	-31887.9	46.61	40.60	
-12.060	0.191	-0.136	-936.7	-32862.1	46.88	40.68	
-12.160	0.189	-0.136	-929.4	-32955.4	46.91	40.69	
-12.160	0.189	-0.136	-929.4	-32955.4	41.12	35.78	
-13.060	0.177	-0.132	-866.1	-33763.1	41.31	35.84	
-14.060	0.164	-0.127	-800.5	-34595.9	41.51	35.91	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-14.350	0.161	-0.126	-782.4	-34825.4	41.57	35.92	
-14.560	0.158	-0.124	-726.6	-34983.8	41.60	35.94	
-15.060	0.152	-0.122	-597.7	-35314.7	41.68	35.96	
-16.060	0.140	-0.117	-354.8	-35789.3	41.79	36.00	
-16.350	0.137	-0.116	-288.1	-35882.5	41.82	36.00	
-17.060	0.128	-0.112	-131.5	-36030.9	41.85	36.01	
-18.060	0.118	-0.107	73.2	-36058.5	41.86	36.02	*
-19.060	0.107	-0.102	260.1	-35890.4	41.82	36.00	
-19.350	0.104	-0.100	311.1	-35807.5	41.80	36.00	
-20.060	0.097	-0.097	423.2	-35546.4	41.74	35.98	
-21.060	0.088	-0.092	568.2	-35049.4	41.62	35.94	
-22.060	0.079	-0.087	698.7	-34414.8	41.47	35.89	
-23.060	0.070	-0.082	815.6	-33656.6	41.29	35.84	
-24.060	0.062	-0.077	919.6	-32787.9	41.08	35.77	
-25.060	0.055	-0.073	1011.5	-31821.4	40.85	35.70	
-26.060	0.048	-0.069	1091.9	-30768.8	40.60	35.62	
-27.060	0.041	-0.064	1161.5	-29641.2	40.34	35.54	
-27.350	0.039	-0.063	1179.8	-29301.7	40.26	35.51	
-28.060	0.035	-0.060	1256.4	-28436.3	40.05	35.45	
-28.160	0.034	-0.060	1266.5	-28310.1	40.02	35.44	
-28.160	0.034	-0.060	1266.5	-28310.1	45.63	40.29	
-28.350	0.033	-0.059	1285.2	-28067.7	45.57	40.27	
-29.060	0.029	-0.056	1319.8	-27142.7	45.31	40.19	
-30.060	0.024	-0.051	1361.2	-25801.5	44.95	40.08	
-30.350	0.022	-0.050	1371.6	-25405.2	44.84	40.05	
-31.060	0.019	-0.047	1436.9	-24407.5	44.57	39.96	
-32.060	0.014	-0.043	1510.8	-22932.0	44.16	39.84	
-33.060	0.010	-0.040	1565.3	-21392.4	43.74	39.71	
-34.060	0.006	-0.036	1601.9	-19807.4	43.31	39.57	
-35.060	0.003	-0.033	1622.1	-18194.1	42.87	39.43	
-36.060	0.000	-0.030	1627.5	-16568.1	42.42	39.30	
-36.350	-0.001	-0.030	1626.4	-16096.3	42.29	39.26	
-37.060	-0.003	-0.028	1615.5	-14944.8	41.98	39.16	
-38.060	-0.006	-0.026	1584.2	-13343.5	41.54	39.02	
-39.060	-0.008	-0.024	1535.7	-11782.1	41.11	38.89	
-40.060	-0.011	-0.022	1471.4	-10277.3	40.70	38.76	
-41.060	-0.013	-0.020	1392.5	-8844.1	40.31	38.64	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-42.060	-0.015	-0.019	1300.1	-7496.7	39.94	38.52	
-43.060	-0.017	-0.018	1194.9	-6248.2	39.60	38.42	
-44.060	-0.018	-0.017	1077.9	-5110.8	39.29	38.32	
-45.060	-0.020	-0.016	949.6	-4096.1	39.01	38.24	
-46.060	-0.021	-0.015	810.6	-3215.1	38.77	38.16	
-46.350	-0.022	-0.015	768.3	-2986.2	38.71	38.14	
-47.060	-0.023	-0.015	661.1	-2478.4	38.57	38.10	
-48.060	-0.024	-0.015	501.6	-1896.2	38.41	38.05	
-49.060	-0.026	-0.014	332.3	-1478.4	38.29	38.01	
-49.160	-0.026	-0.014	314.9	-1446.1	38.28	38.01	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.850	0.237	-0.153	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	45.63	-28.160
periphery sheet pile (SKY490)	46.91	-12.160
separation wall sheet pile (SKY400)	40.69	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -1446.1 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 40.350 (m^4)

periphery	n1 = 30 (number)	IB1 =	903.99 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (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 = 7.930
maximum Rmax = 1704 (kN/number)
minimum Rmin = 1678 (kN/number)

2)Ord+Collision(scour)

working force	vertical force	Vo	kN	61616.2
	horizontal force	Ho	kN	7300.0
	moment	Mo	kN.m	87900.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.115
	calculation displacement	Del.	cm	1.110

convergence rate (Del.1 - Del.) / Del.1 = 0.37 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1511	3200
2	6547	13868
3	6547	13868
4	6170	13068
5	11458	24269
6	6170	13068
7	17627	37336
8	26441	56004
9	26441	56004

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	1.162	-0.662	-7300.0	-87900.0	62.40	45.81	
-8.850	1.110	-0.651	-7300.0	-93667.0	63.97	46.30	
-9.060	1.097	-0.647	-7215.6	-95191.1	64.39	46.43	
-10.060	1.033	-0.631	-6828.1	-102211.1	66.31	47.03	
-11.060	0.971	-0.614	-6463.6	-108855.0	68.13	47.59	
-12.060	0.910	-0.596	-6121.4	-115145.7	69.85	48.13	
-12.160	0.904	-0.594	-6088.4	-115756.2	70.02	48.18	
-12.160	0.904	-0.594	-6088.4	-115756.2	61.14	42.39	
-13.060	0.851	-0.579	-5800.9	-121105.0	62.41	42.79	
-14.060	0.794	-0.561	-5501.4	-126754.4	63.75	43.21	
-14.350	0.778	-0.556	-5418.4	-128337.8	64.12	43.33	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-14.560	0.767	-0.552	-5162.6	-129448.7	64.38	43.41	
-15.060	0.739	-0.543	-4568.9	-131880.7	64.96	43.60	
-16.060	0.686	-0.524	-3445.5	-135880.9	65.91	43.90	
-16.350	0.671	-0.519	-3135.3	-136835.0	66.13	43.97	
-17.060	0.634	-0.505	-2404.7	-138799.3	66.60	44.11	
-18.060	0.585	-0.485	-1443.6	-140716.9	67.05	44.26	
-19.060	0.537	-0.465	-559.0	-141712.0	67.29	44.33	
-19.350	0.524	-0.460	-316.4	-141838.8	67.32	44.34	
-20.060	0.492	-0.446	219.3	-141871.3	67.33	44.34	*
-21.060	0.448	-0.426	917.5	-141297.5	67.19	44.30	
-22.060	0.407	-0.406	1552.4	-140057.4	66.90	44.21	
-23.060	0.367	-0.386	2127.0	-138212.8	66.46	44.07	
-24.060	0.329	-0.367	2644.1	-135822.6	65.89	43.89	
-25.060	0.294	-0.348	3106.8	-132942.8	65.21	43.68	
-26.060	0.260	-0.330	3517.6	-129626.4	64.43	43.43	
-27.060	0.228	-0.312	3879.5	-125923.8	63.55	43.15	
-27.350	0.219	-0.307	3975.7	-124784.7	63.28	43.06	
-28.060	0.197	-0.294	4383.2	-121814.8	62.58	42.84	
-28.160	0.194	-0.293	4437.2	-121373.8	62.47	42.81	
-28.160	0.194	-0.293	4437.2	-121373.8	71.56	48.65	
-28.350	0.189	-0.289	4537.7	-120521.1	71.32	48.58	
-29.060	0.169	-0.275	4726.4	-117231.1	70.42	48.30	
-30.060	0.142	-0.256	4957.4	-112386.0	69.10	47.89	
-30.350	0.135	-0.251	5017.1	-110939.6	68.70	47.77	
-31.060	0.118	-0.238	5397.6	-107239.3	67.69	47.45	
-32.060	0.095	-0.221	5847.7	-101608.5	66.15	46.98	
-33.060	0.073	-0.205	6203.8	-95575.2	64.50	46.46	
-34.060	0.054	-0.190	6472.9	-89229.8	62.76	45.92	
-35.060	0.035	-0.176	6661.4	-82656.2	60.96	45.37	
-36.060	0.018	-0.163	6775.2	-75931.9	59.12	44.79	
-36.350	0.014	-0.159	6795.0	-73964.1	58.58	44.63	
-37.060	0.003	-0.151	6832.3	-69123.4	57.26	44.22	
-38.060	-0.012	-0.140	6803.1	-62298.0	55.39	43.64	
-39.060	-0.025	-0.130	6684.7	-55546.9	53.54	43.06	
-40.060	-0.038	-0.122	6483.0	-48956.4	51.74	42.50	
-41.060	-0.050	-0.114	6203.7	-42606.8	50.00	41.96	
-42.060	-0.061	-0.108	5851.4	-36573.3	48.35	41.45	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.060	-0.071	-0.102	5430.4	-30926.8	46.81	40.97	
-44.060	-0.081	-0.098	4944.0	-25734.4	45.39	40.53	
-45.060	-0.091	-0.094	4395.3	-21059.7	44.11	40.13	
-46.060	-0.100	-0.091	3786.7	-16963.8	42.99	39.79	
-46.350	-0.103	-0.090	3599.3	-15892.7	42.69	39.69	
-47.060	-0.109	-0.088	3120.1	-13505.6	42.04	39.49	
-48.060	-0.118	-0.086	2397.3	-10742.3	41.28	39.26	
-49.060	-0.126	-0.085	1619.4	-8729.4	40.73	39.09	
-49.160	-0.127	-0.085	1538.6	-8571.5	40.69	39.07	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.850	1.110	-0.651	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	71.56	-28.160
periphery sheet pile (SKY490)	70.02	-12.160
separation wall sheet pile (SKY400)	48.65	-28.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -8571.5 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 40.350 (m^4)

periphery	n1 =	30 (number)	IB1 =	903.99 (m^2)	Ao1 =	0.0446 (m^2/number)
separation wall	n1 =	6 (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 = 7.930
maximum Rmax = 1787 (kN/number)
minimum Rmin = 1636 (kN/number)

3)Earthquake(scour)

working force	vertical force	Vo	kN	55788.7
	horizontal force	Ho	kN	15100.0
	moment	Mo	kN.m	267500.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	3.007
	calculation displacement	Del.	cm	2.983

convergence rate (Del.1 - Del.) / Del.1 = 0.80 (%) < 1.00 (%)

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1006	1298
2	4360	5623
3	13095	16886
4	12339	15912
5	22916	29551
6	12339	15912
7	35255	45463
8	52882	68195
9	52882	68195

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	3.126	-1.834	-15100.0	-267500.0	107.91	57.44	
-8.850	2.983	-1.799	-16000.5	-279784.7	111.27	58.48	
-9.060	2.945	-1.789	-15908.7	-283135.2	112.19	58.77	
-10.060	2.769	-1.742	-15487.1	-298830.8	116.48	60.10	
-11.060	2.597	-1.691	-15091.2	-314117.9	120.67	61.40	
-12.060	2.430	-1.639	-14720.3	-329021.6	124.75	62.67	
-12.160	2.414	-1.633	-14684.6	-330491.9	125.15	62.79	
-12.160	2.414	-1.633	-14684.6	-330491.9	108.82	55.28	
-13.060	2.269	-1.591	-14373.6	-343566.7	111.92	56.26	
-14.060	2.112	-1.541	-14050.4	-357776.8	115.29	57.33	
-14.350	2.068	-1.527	-13961.0	-361838.3	116.25	57.63	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-14.560	2.036	-1.516	-13685.4	-364741.2	116.94	57.85	
-15.060	1.961	-1.490	-13046.5	-371423.1	118.52	58.35	
-16.060	1.814	-1.437	-11839.7	-383858.4	121.47	59.28	
-16.350	1.773	-1.421	-11507.1	-387243.5	122.27	59.53	
-17.060	1.673	-1.382	-9157.9	-394571.5	124.00	60.08	
-18.060	1.538	-1.326	-6075.3	-402166.5	125.80	60.65	
-19.060	1.408	-1.269	-3247.4	-406807.1	126.90	61.00	
-19.350	1.371	-1.253	-2473.4	-407636.1	127.10	61.06	
-20.060	1.284	-1.212	-767.8	-408780.1	127.37	61.15	*
-21.060	1.166	-1.155	1447.9	-408422.2	127.28	61.12	
-22.060	1.053	-1.097	3454.7	-405953.9	126.70	60.94	
-23.060	0.946	-1.040	5262.8	-401579.1	125.66	60.61	
-24.060	0.845	-0.984	6882.7	-395491.1	124.22	60.15	
-25.060	0.749	-0.929	8324.3	-387873.2	122.42	59.58	
-26.060	0.659	-0.875	9597.8	-378898.5	120.29	58.91	
-27.060	0.574	-0.823	10712.8	-368730.4	117.88	58.15	
-27.350	0.550	-0.808	11007.9	-365580.6	117.14	57.91	
-28.060	0.494	-0.772	12254.0	-357314.7	115.18	57.29	
-28.160	0.487	-0.767	12418.9	-356081.1	114.89	57.20	
-28.160	0.487	-0.767	12418.9	-356081.1	132.15	64.96	
-28.350	0.472	-0.756	12725.0	-353692.2	131.50	64.76	
-29.060	0.420	-0.715	13297.9	-344450.1	128.97	63.98	
-30.060	0.351	-0.660	13995.0	-330793.3	125.23	62.82	
-30.350	0.332	-0.644	14174.4	-326708.4	124.11	62.47	
-31.060	0.288	-0.607	15312.2	-316231.0	121.25	61.58	
-32.060	0.230	-0.556	16648.6	-300225.6	116.87	60.22	
-33.060	0.177	-0.509	17697.2	-283029.7	112.16	58.76	
-34.060	0.128	-0.464	18482.5	-264918.9	107.21	57.22	
-35.060	0.084	-0.422	19027.9	-246144.6	102.07	55.63	
-36.060	0.043	-0.383	19355.0	-226935.8	96.81	53.99	
-36.350	0.032	-0.373	19411.9	-221314.3	95.27	53.52	
-37.060	0.007	-0.348	19519.6	-207485.2	91.49	52.34	
-38.060	-0.026	-0.315	19442.8	-187982.6	86.15	50.69	
-39.060	-0.056	-0.286	19121.1	-168681.3	80.87	49.05	
-40.060	-0.084	-0.260	18577.3	-149814.4	75.71	47.44	
-41.060	-0.108	-0.237	17831.6	-131593.9	70.73	45.90	
-42.060	-0.131	-0.217	16901.7	-114212.6	65.97	44.42	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-43.060	-0.152	-0.200	15803.4	-97846.6	61.49	43.03	
-44.060	-0.171	-0.185	14550.0	-82657.5	57.34	41.74	
-45.060	-0.189	-0.173	13153.1	-68794.4	53.54	40.56	
-46.060	-0.206	-0.162	11622.3	-56395.8	50.15	39.51	
-46.350	-0.210	-0.160	11154.5	-53093.0	49.25	39.23	
-47.060	-0.221	-0.154	9965.4	-45591.8	47.19	38.59	
-48.060	-0.237	-0.147	8189.1	-36504.8	44.71	37.82	
-49.060	-0.251	-0.142	6298.4	-29251.8	42.72	37.20	
-49.160	-0.252	-0.141	6103.2	-28631.7	42.55	37.15	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.850	2.983	-1.799	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	132.15	-28.160
periphery sheet pile (SKY490)	125.15	-12.160
separation wall sheet pile (SKY400)	64.96	-28.160
separation wall sheet pile (SKY490)	------	--------

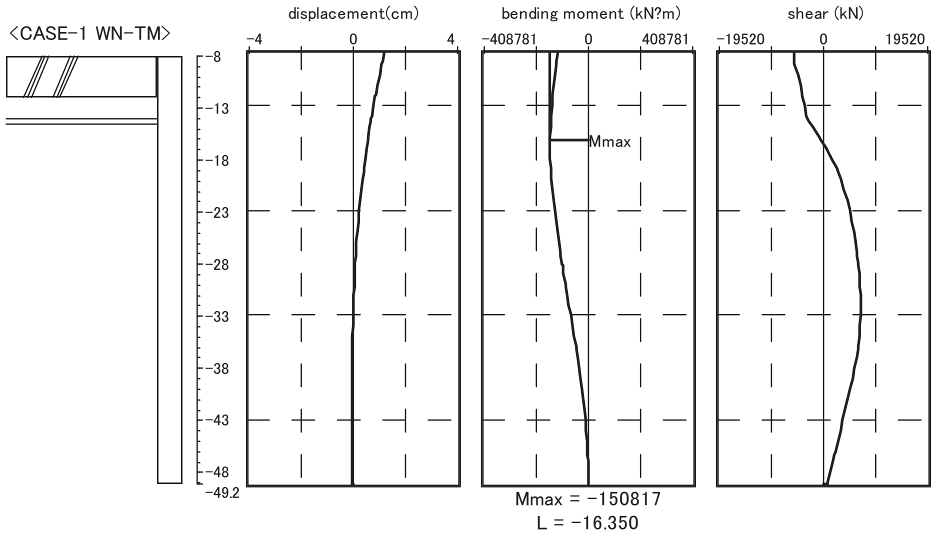
vertical reaction

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

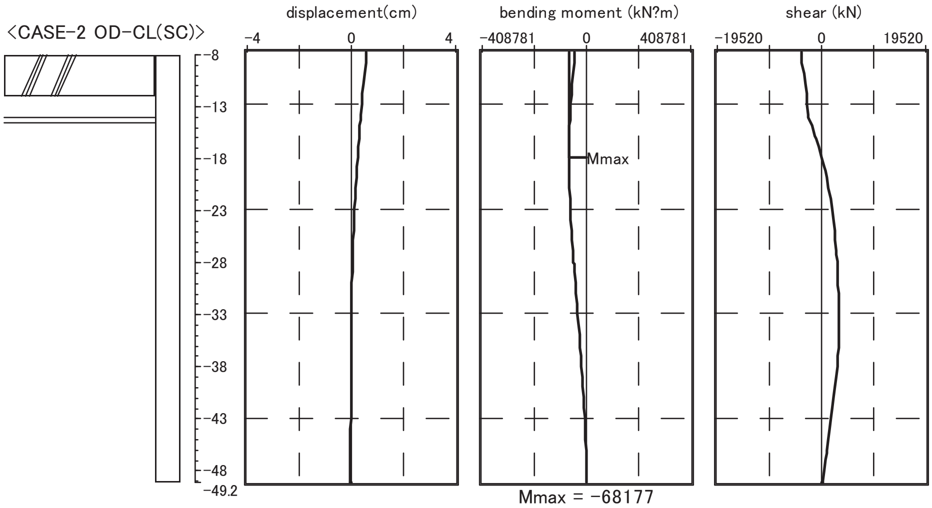
```
MB             =    -28631.7 (kN.m)
Sum(ni*Aoi)  =       1.607 (m²)
Sum(IBi*Aoi) =      40.350 (m⁴)
      periphery          n1  =  30 (number)   IB1 =        903.99 (m²)   Ao1 =  0.0446 (m²/number)
      separation wall    n1  =   6 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0446 (m²/number)
      intermediate drive n1  =   0 (number)   IB1 =          0.00 (m²)   Ao1 =  0.0000 (m²/number)
      x =   7.930
 maximum   Rmax =   1801 (kN/number)
 minimum   Rmin =   1299 (kN/number)
```


1.11 displacement / member force diagram

bridge axis direction

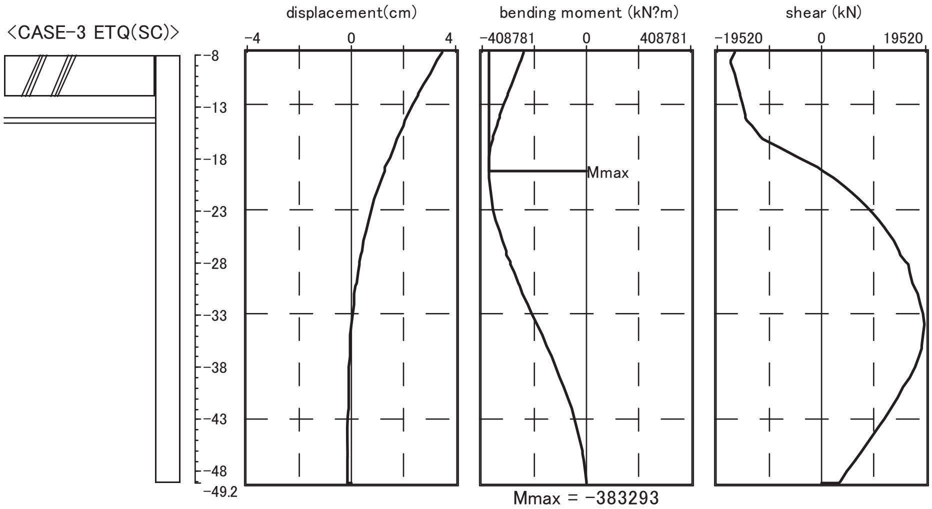


<CASE-2 OD-CL(SC)>



Mmax = -68177
L = -18.060

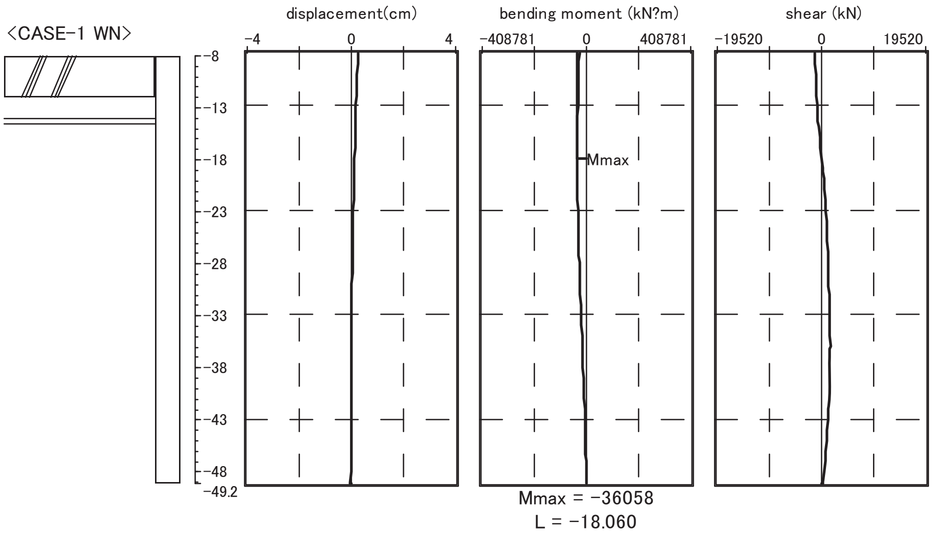
<CASE-3 ETQ(SC)>



Mmax = -383293
L = -19.350

perpendicular direction

<CASE-1 WN>



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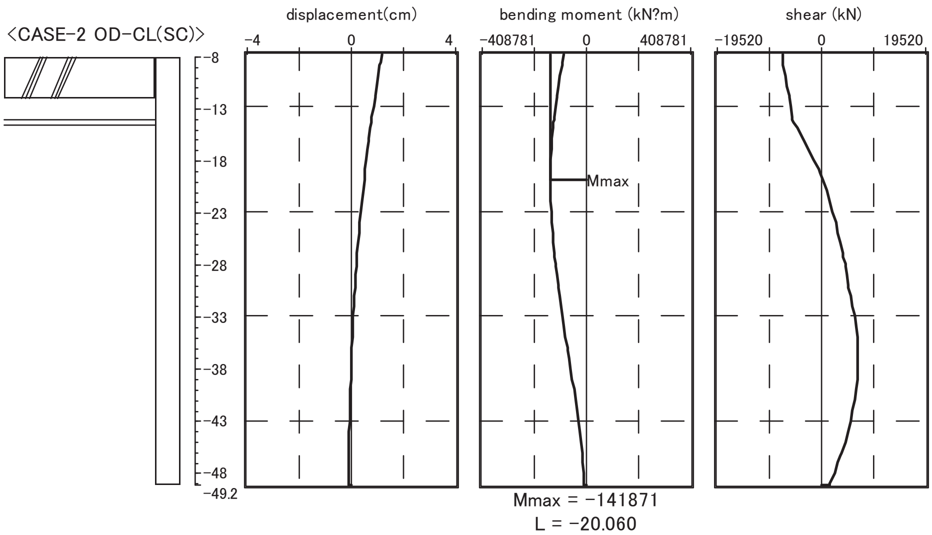
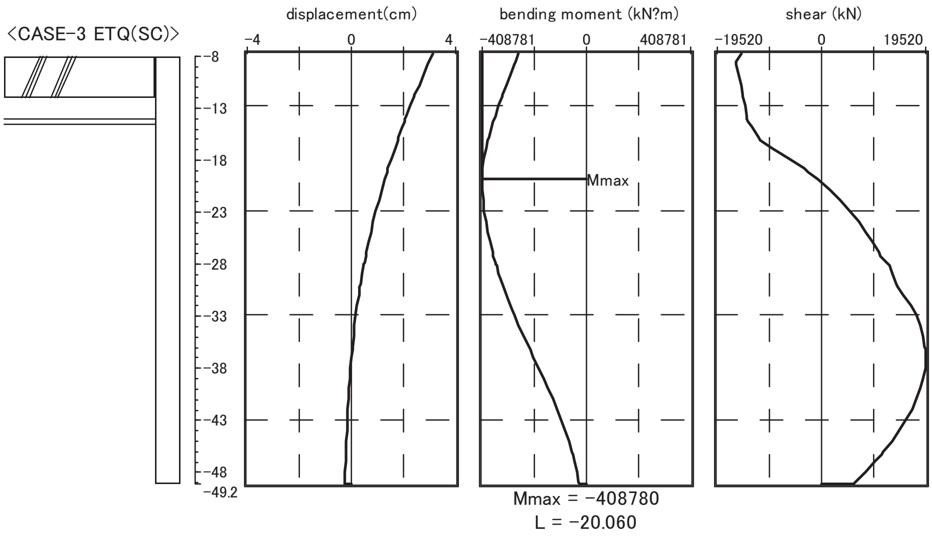
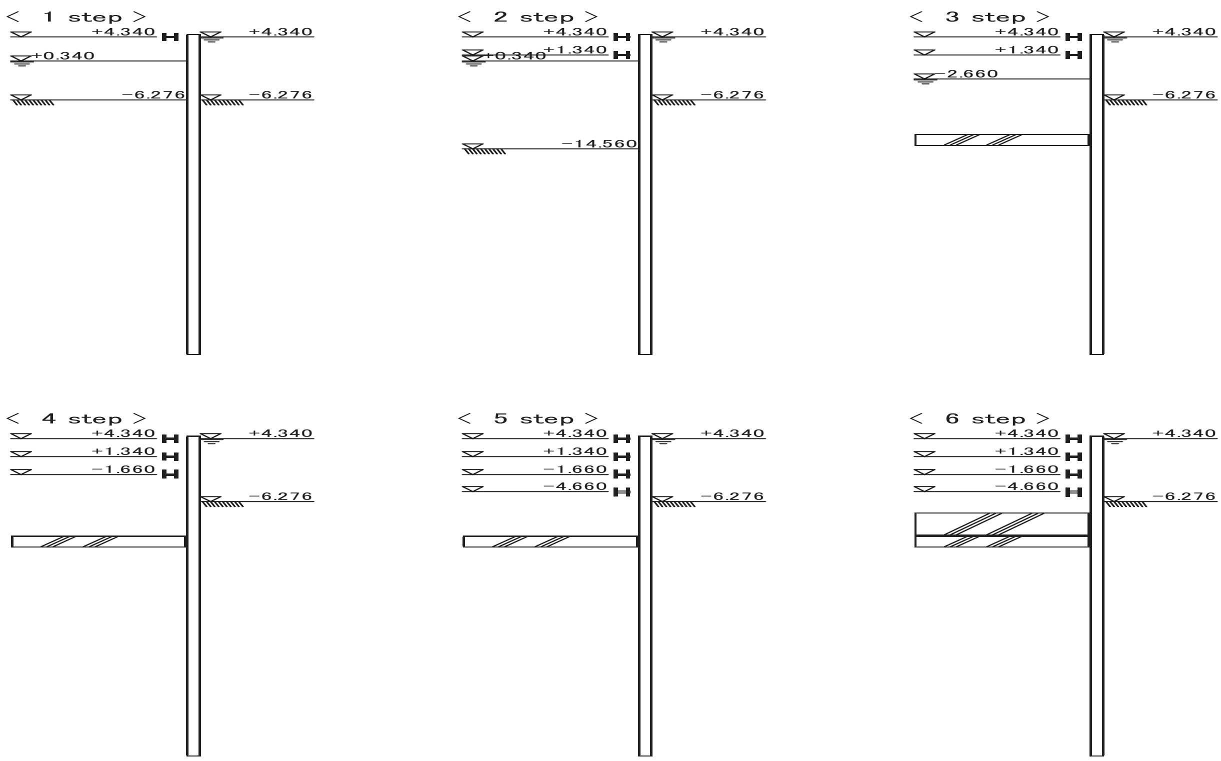




2 coffering calculation

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	8.000	633569.6	10559.5	633569.6	10559.5	SKY400
2	9.000	633569.6	10559.5	633569.6	10559.5	SKY490
3	16.000	720452.4	12007.5	720452.4	12007.5	SKY400
4	21.000	633569.6	10559.5	633569.6	10559.5	SKY400
						Sig.= 54.000 (m)

2.3 soil condition

current ground surface elevation -6.276 (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	sandy	8.074	3.0	17.0	8.0	0.0	29.0	0
2	sandy	2.000	13.0	17.0	8.0	0.0	33.0	0
3	sandy	3.000	13.0	17.0	8.0	0.0	33.0	0
4	cohesv	8.000	7.0	17.5	7.5	42.0	0.0	0
5	sandy	1.000	13.0	17.0	8.0	0.0	32.0	0
6	cohesv	2.000	7.0	17.5	7.5	42.0	0.0	0
7	sandy	6.000	20.0	17.0	8.0	0.0	33.0	0
8	sandy	10.000	30.0	17.0	8.0	0.0	34.0	0
9	cohesv	2.810	30.0	18.0	8.0	180.0	0.0	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	1153	1153	1153	1153	0
2	4998	4998	4998	4998	0
3	4998	4998	4998	4998	0
4	4710	4710	4710	4710	0
5	8746	8746	8746	8746	0
6	4710	4710	4710	4710	0
7	13456	13456	13456	13456	0
8	20184	20184	20184	20184	0
9	20184	20184	20184	20184	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-400*400*13*21	2H-400*400*13*21	2H-400*400*13*21
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
3	30.0	30.0	118.40	27.00	20200	1350	13.10	7.55

row	H (cm)	B (cm)	A (cm^2)	Aw (cm^2)	Iy (cm^4)	Zy (cm^3)	ry (cm)	rz (cm)
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	-6.276	+0.340
2	-14.560	+0.340
3	-14.560	-2.660
4	-14.560	-14.560
5	-14.560	-14.560
6	-14.560	-14.560

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	10.616	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

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

linear part

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

Here, E : Young's modulus of timbering = 2.00 * 10^8(kN/m²)

A1 : sectional area of wailing(m²)

A2 : sectional area of strut (m²)

r : timbering radius in arc part (m)

L1 : strut length (m)

L2 : strut spacing (m)

1)bridge axis direction

linear part

row	A2 (cm²)	L1 (m)	L2 (m)	K (kN/m/m)
1	171.90	8.623	4.000	1.9935E+005
2	437.40	8.573	4.000	5.1019E+005
3	118.40	8.673	4.000	1.3651E+005
4	118.40	8.673	4.000	1.3651E+005

arc part

row	A1 (cm²)	r (m)	K (kN/m/m)
1	171.90	4.312	1.8494E+005
2	437.40	4.287	4.7608E+005
3	118.40	4.337	1.2592E+005
4	118.40	4.337	1.2592E+005

(2)footing concrete spring constant

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

where, Alp. : reduction coefficient of spring = 0.050

Ec : Young's modulus of concrete at bottom = 2.35 * 10^7(kN/m²)

Ac : sectional area per unit width of footing concrete = 2.000 (m²/m)

B : footing concrete width (m)

bridge axis direction B = 8.973

perpendicular direction B = 14.764

1)bridge axis direction

K = 5.2378E+005 (kN/m/m)

2)perpendicular direction

K = 3.1833E+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	1.9935E+005	1.8494E+005
timbering 2row	invld	5.1019E+005	4.7608E+005
timbering 3row	invld	1.3651E+005	1.2592E+005
timbering 4row	invld	1.3651E+005	1.2592E+005
footing concrete	invld	5.2378E+005	3.1833E+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)

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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 = 54.000 (m)
design water tableelevation +4.340 (m)
design ground elevation -6.276 (m)

(4)sum up
1) 1 step
excavation area elevation = -6.276 (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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	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	-6.276 -14.350	8.074	106.16 206.51	66.16 364.56	66.16 178.80	40.00 27.71	0.00 185.76
4	-14.350 -16.350	2.000	203.56 227.69	423.39 511.88	175.09 204.11	28.47 23.58	248.30 307.77
5	-16.350 -19.350	3.000	227.69 263.88	511.88 644.62	204.11 247.63	23.58 16.25	307.77 396.99
6	-19.350 -23.647	4.297	197.05 242.17	372.42 447.62	184.98 242.17	12.07 0.00	187.44 205.45
7	-23.647 -24.624	0.977	242.17 252.42	447.62 464.71	242.17 252.42	0.00 0.00	205.45 212.29
8	-24.624 -27.350	2.726	252.42 281.05	464.71 512.42	252.42 281.05	0.00 0.00	212.29 231.37
9	-27.350 -28.350	1.000	363.46 375.61	973.66 1015.85	375.08 389.73	0.00 0.00	598.58 626.12
10	-28.350 -30.350	2.000	291.25 312.25	529.42 564.42	291.25 312.25	0.00 0.00	238.17 252.17
11	-30.350 -34.444	4.094	398.05 447.43	1155.77 1336.89	417.60 479.90	0.00 0.00	738.17 856.99
12	-34.444 -36.350	1.906	447.43 470.43	1336.89 1421.24	479.90 505.04	0.00 0.00	856.99 916.20
13	-36.350 -37.065	0.715	467.83 476.39	1490.27 1523.50	501.90 511.25	0.00 0.00	988.37 1012.25
14	-37.065 -46.350	9.285	476.39 587.62	1523.50 1955.14	511.25 632.76	0.00 0.00	1012.25 1322.38
15	-46.350 -49.160	2.810	396.21 421.50	1112.42 1163.00	396.21 421.50	0.00 0.00	716.21 741.50

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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	40.00 40.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	66.16 364.56	66.16 178.51	40.00 28.00	0.00 186.05

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
4	-14.350 -16.350	2.000	203.56 227.69	423.39 511.88	174.84 203.58	28.72 24.11	248.55 308.30
5	-16.350 -19.350	3.000	227.69 263.88	511.88 644.62	203.58 246.70	24.11 17.18	308.30 397.92
6	-19.350 -23.647	4.297	197.05 242.17	372.42 447.62	183.76 239.71	13.29 2.46	188.66 207.91
7	-23.647 -24.624	0.977	242.17 252.42	447.62 464.71	239.71 252.42	2.46 0.00	207.91 212.29
8	-24.624 -27.350	2.726	252.42 281.05	464.71 512.42	252.42 281.05	0.00 0.00	212.29 231.37
9	-27.350 -28.350	1.000	363.46 375.61	973.66 1015.85	372.31 386.82	0.00 0.00	601.35 629.03
10	-28.350 -30.350	2.000	291.25 312.25	529.42 564.42	291.25 312.25	0.00 0.00	238.17 252.17
11	-30.350 -34.444	4.094	398.05 447.43	1155.77 1336.89	414.35 475.79	0.00 0.00	741.42 861.10
12	-34.444 -36.350	1.906	447.43 470.43	1336.89 1421.24	475.79 504.40	0.00 0.00	861.10 916.84
13	-36.350 -37.065	0.715	467.83 476.39	1490.27 1523.50	500.01 511.25	0.00 0.00	990.26 1012.25
14	-37.065 -46.350	9.285	476.39 587.62	1523.50 1955.14	511.25 632.76	0.00 0.00	1012.25 1322.38
15	-46.350 -49.160	2.810	396.21 421.50	1112.42 1163.00	396.21 421.50	0.00 0.00	716.21 741.50

2) 2 step

excavation area elevation = -14.560 (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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	40.00 40.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	66.16 146.90	66.16 146.90	40.00 59.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	146.90 149.00	146.90 149.00	56.66 57.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	149.00 228.20	149.00 174.97	57.09 52.72	0.00 53.23
6	-16.350 -19.350	3.000	227.69 263.88	228.20 360.93	174.97 218.49	52.72 45.39	53.23 142.44
7	-19.350 -27.350	8.000	176.59 260.59	314.43 454.43	146.59 253.05	30.00 7.54	167.84 201.38
8	-27.350 -28.350	1.000	363.46 375.61	707.00 749.19	344.99 359.65	18.46 15.96	362.01 389.54
9	-28.350 -30.350	2.000	270.79 291.79	471.43 506.43	264.99 291.61	5.80 0.18	206.44 214.82
10	-30.350 -33.392	3.042	398.05 434.75	872.08 1006.66	388.46 434.75	9.59 0.00	483.62 571.91
11	-33.392 -34.616	1.225	434.75 449.52	1006.66 1060.84	434.75 453.38	0.00 0.00	571.91 607.46
12	-34.616 -36.350	1.734	449.52 470.43	1060.84 1137.55	453.38 479.77	0.00 0.00	607.46 657.79
13	-36.350 -45.084	8.734	467.83 572.46	1188.01 1594.04	476.16 616.19	0.00 0.00	711.86 977.85
14	-45.084 -46.350	1.266	572.46 587.62	1594.04 1652.88	616.19 632.76	0.00 0.00	977.85 1020.13
15	-46.350 -49.160	2.810	375.75 401.04	1054.43 1105.01	396.21 421.50	0.00 0.00	658.22 683.51

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 -6.276	6.616	40.00 106.16	0.00 66.16	0.00 66.16	40.00 40.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	66.16 146.90	66.16 146.90	40.00 59.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	146.90 149.00	146.90 149.00	56.66 57.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	149.00 228.20	149.00 174.72	57.09 52.96	0.00 53.47
6	-16.350 -19.350	3.000	227.69 263.88	228.20 360.93	174.72 217.84	52.96 46.04	53.47 143.09
7	-19.350 -27.350	8.000	176.59 260.59	314.43 454.43	145.73 249.89	30.86 10.70	168.70 204.54
8	-27.350 -28.350	1.000	363.46 375.61	707.00 749.19	342.52 357.03	20.94 18.58	364.48 392.16
9	-28.350 -30.350	2.000	270.79 291.79	471.43 506.43	261.65 287.69	9.14 4.10	209.78 218.74
10	-30.350 -33.392	3.042	398.05 434.75	872.08 1006.66	385.49 431.14	12.57 3.61	486.60 575.52
11	-33.392 -34.616	1.225	434.75 449.52	1006.66 1060.84	431.14 449.52	3.61 0.00	575.52 611.32
12	-34.616 -36.350	1.734	449.52 470.43	1060.84 1137.55	449.52 475.54	0.00 0.00	611.32 662.01
13	-36.350 -45.084	8.734	467.83 572.46	1188.01 1594.04	472.07 609.46	0.00 0.00	715.94 984.58
14	-45.084 -46.350	1.266	572.46 587.62	1594.04 1652.88	609.46 629.37	0.00 0.00	984.58 1023.51
15	-46.350 -49.160	2.810	375.75 401.04	1054.43 1105.01	396.21 421.50	0.00 0.00	658.22 683.51

3) 3 step
excavation area elevation = -14.560 (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/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						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 -6.276	3.616	70.00 106.16	0.00 36.16	0.00 36.16	70.00 70.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	36.16 116.90	36.16 116.90	70.00 89.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	116.90 119.00	116.90 119.00	86.66 87.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	270.66 349.85	133.12 159.08	72.98 68.61	137.54 190.77
6	-16.350 -19.350	3.000	227.69 263.88	349.85 482.59	159.08 202.60	68.61 61.28	190.77 279.98
7	-19.350 -27.350	8.000	176.59 260.59	315.43 455.43	147.19 253.65	29.40 6.94	168.24 201.78
8	-27.350 -28.350	1.000	363.46 375.61	819.55 861.74	329.57 344.22	33.89 31.39	489.99 517.52
9	-28.350 -30.201	1.851	270.79 290.23	472.43 504.83	265.59 290.23	5.20 0.00	206.84 214.60
10	-30.201 -30.350	0.149	290.23 291.79	504.83 507.43	290.23 292.21	0.00 0.00	214.60 215.22
11	-30.350 -36.350	6.000	398.05 470.43	993.74 1259.21	372.58 463.88	25.48 6.55	621.16 795.33
12	-36.350 -38.325	1.975	467.83 491.49	1319.60 1411.42	459.82 491.49	8.01 0.00	859.78 919.93
13	-38.325 -39.574	1.249	491.49 506.45	1411.42 1469.48	491.49 511.52	0.00 0.00	919.93 957.97
14	-39.574 -46.350	6.776	506.45 587.62	1469.48 1784.47	511.52 620.15	0.00 0.00	957.97 1164.32
15	-46.350 -49.160	2.810	375.75 401.04	1055.43 1106.01	396.21 421.50	0.00 0.00	659.22 684.51

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 -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 -6.276	3.616	70.00 106.16	0.00 36.16	0.00 36.16	70.00 70.00	0.00 0.00
3	-6.276 -14.350	8.074	106.16 206.51	36.16 116.90	36.16 116.90	70.00 89.61	0.00 0.00
4	-14.350 -14.560	0.210	203.56 206.09	116.90 119.00	116.90 119.00	86.66 87.09	0.00 0.00
5	-14.560 -16.350	1.790	206.09 227.69	270.66 349.85	133.12 158.84	72.98 68.85	137.54 191.01
6	-16.350 -19.350	3.000	227.69 263.88	349.85 482.59	158.84 201.96	68.85 61.92	191.01 280.63
7	-19.350 -27.350	8.000	176.59 260.59	315.43 455.43	146.33 250.49	30.26 10.10	169.10 204.94
8	-27.350 -28.350	1.000	363.46 375.61	819.55 861.74	327.09 341.60	36.37 34.01	492.46 520.14
9	-28.350 -30.201	1.851	270.79 290.23	472.43 504.83	262.25 286.36	8.54 3.87	210.18 218.47
10	-30.201 -30.350	0.149	290.23 291.79	504.83 507.43	286.36 288.29	3.87 3.50	218.47 219.14
11	-30.350 -36.350	6.000	398.05 470.43	993.74 1259.21	369.60 459.66	28.45 10.78	624.14 799.55
12	-36.350 -38.325	1.975	467.83 491.49	1319.60 1411.42	455.73 486.80	12.10 4.69	863.87 924.61
13	-38.325 -39.574	1.249	491.49 506.45	1411.42 1469.48	486.80 506.45	4.69 0.00	924.61 963.03
14	-39.574 -46.350	6.776	506.45 587.62	1469.48 1784.47	506.45 613.04	0.00 0.00	963.03 1171.43
15	-46.350 -49.160	2.810	375.75 401.04	1055.43 1106.01	396.21 421.50	0.00 0.00	659.22 684.51

4) 4 step

excavation area elevation = -14.560 (m)

landside water table elevation = -14.560 (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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 40.08	191.98 187.61	137.54 190.77
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	40.08 83.60	187.61 180.28	190.77 279.98
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	75.79 182.25	100.80 78.34	120.64 154.18
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	210.57 225.22	152.89 150.39	489.99 517.52
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	194.19 220.81	76.60 70.98	159.24 167.62
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	253.58 344.88	144.48 125.55	621.16 795.33
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	340.82 501.15	127.01 86.47	859.78 1164.32
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	366.81 383.77	8.94 0.00	569.62 568.70
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	383.77 402.77	0.00 0.00	568.70 567.67
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	402.77 420.29	0.00 0.00	567.67 566.72

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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 39.84	191.98 187.85	137.54 191.01
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	39.84 82.96	187.85 180.92	191.01 280.63
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	74.93 179.09	101.66 81.50	121.50 157.34
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	208.09 222.60	155.37 153.01	492.46 520.14
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	190.85 216.89	79.94 74.90	162.58 171.54
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	250.60 340.66	147.45 129.78	624.14 799.55
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	336.73 494.04	131.10 93.58	863.87 1171.43
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	358.74 374.78	17.01 8.99	577.69 577.69
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	374.78 392.75	8.99 0.00	577.69 577.69
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	392.75 409.32	0.00 0.00	577.69 577.69

5) 5 step

excavation area elevation   = -14.560 (m)

landside water table elevation = -14.560 (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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 40.08	191.98 187.61	137.54 190.77
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	40.08 83.60	187.61 180.28	190.77 279.98
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	75.79 182.25	100.80 78.34	120.64 154.18
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	210.57 225.22	152.89 150.39	489.99 517.52
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	194.19 220.81	76.60 70.98	159.24 167.62
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	253.58 344.88	144.48 125.55	621.16 795.33
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	340.82 501.15	127.01 86.47	859.78 1164.32
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	366.81 383.77	8.94 0.00	569.62 568.70
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	383.77 402.77	0.00 0.00	568.70 567.67
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	402.77 420.29	0.00 0.00	567.67 566.72

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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 39.84	191.98 187.85	137.54 191.01
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	39.84 82.96	187.85 180.92	191.01 280.63
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	74.93 179.09	101.66 81.50	121.50 157.34
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	208.09 222.60	155.37 153.01	492.46 520.14
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	190.85 216.89	79.94 74.90	162.58 171.54
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	250.60 340.66	147.45 129.78	624.14 799.55
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	336.73 494.04	131.10 93.58	863.87 1171.43
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	358.74 374.78	17.01 8.99	577.69 577.69
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	374.78 392.75	8.99 0.00	577.69 577.69
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	392.75 409.32	0.00 0.00	577.69 577.69

6) 6 step
excavation area elevation = -14.560 (m)
landside water table elevation = -14.560 (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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 40.08	191.98 187.61	137.54 190.77
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	40.08 83.60	187.61 180.28	190.77 279.98
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	75.79 182.25	100.80 78.34	120.64 154.18
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	210.57 225.22	152.89 150.39	489.99 517.52
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	194.19 220.81	76.60 70.98	159.24 167.62
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	253.58 344.88	144.48 125.55	621.16 795.33
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	340.82 501.15	127.01 86.47	859.78 1164.32
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	366.81 383.77	8.94 0.00	569.62 568.70
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	383.77 402.77	0.00 0.00	568.70 567.67
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	402.77 420.29	0.00 0.00	567.67 566.72

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 -6.276	10.616	0.00 106.16	0.00 0.00	0.00 0.00	0.00 106.16	0.00 0.00
2	-6.276 -14.350	8.074	106.16 206.51	0.00 0.00	0.00 0.00	106.16 206.51	0.00 0.00
3	-14.350 -14.560	0.210	203.56 206.09	0.00 0.00	0.00 0.00	203.56 206.09	0.00 0.00
4	-14.560 -16.350	1.790	206.09 227.69	151.66 230.85	14.12 39.84	191.98 187.85	137.54 191.01
5	-16.350 -19.350	3.000	227.69 263.88	230.85 363.59	39.84 82.96	187.85 180.92	191.01 280.63
6	-19.350 -27.350	8.000	176.59 260.59	196.43 336.43	74.93 179.09	101.66 81.50	121.50 157.34
7	-27.350 -28.350	1.000	363.46 375.61	700.55 742.74	208.09 222.60	155.37 153.01	492.46 520.14
8	-28.350 -30.350	2.000	270.79 291.79	353.43 388.43	190.85 216.89	79.94 74.90	162.58 171.54
9	-30.350 -36.350	6.000	398.05 470.43	874.74 1140.21	250.60 340.66	147.45 129.78	624.14 799.55
10	-36.350 -46.350	10.000	467.83 587.62	1200.60 1665.47	336.73 494.04	131.10 93.58	863.87 1171.43
11	-46.350 -47.241	0.891	375.75 383.77	936.43 952.47	358.74 374.78	17.01 8.99	577.69 577.69
12	-47.241 -48.240	0.999	383.77 392.75	952.47 970.44	374.78 392.75	8.99 0.00	577.69 577.69
13	-48.240 -49.160	0.920	392.75 401.04	970.44 987.01	392.75 409.32	0.00 0.00	577.69 577.69

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 -6.276	6.616	----	----	----	----
3	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
4	sandy	-14.350 -16.350	2.000	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -23.647	4.297	17.5	42.0	0.00	7.0
7	cohesv	-23.647 -24.625	0.978	17.5	42.0	0.00	7.0
8	cohesv	-24.625 -27.350	2.725	17.5	42.0	0.00	7.0
9	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
10	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
11	sandy	-30.350 -34.445	4.095	17.0	0.0	33.00	20.0
12	sandy	-34.445 -36.350	1.905	17.0	0.0	33.00	20.0
13	sandy	-36.350 -37.066	0.716	17.0	0.0	34.00	30.0
14	sandy	-37.066 -46.350	9.284	17.0	0.0	34.00	30.0
15	cohesv	-46.350 -49.160	2.810	18.0	180.0	0.00	30.0

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 -6.276	6.616	0.00 0.00	-------- --------	40.00 106.16	------- -------	------- -------	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	0.000 0.000	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51
4	sandy	-14.350 -16.350	2.000	243.42 277.42	0.000 0.000	186.90 206.90	0.2948 0.2948	------- -------	16.66 20.79	203.56 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -23.647	4.297	328.42 403.62	222.258 297.460	-------- --------	0.6000 0.6000	0.6000 0.6000	197.05 242.17	197.05 242.17
7	cohesv	-23.647 -24.625	0.978	403.62 420.73	297.460 314.573	-------- --------	0.6000 0.6000	0.6000 0.6000	242.17 252.44	242.17 252.44
8	cohesv	-24.625 -27.350	2.725	420.73 468.42	314.573 362.258	-------- --------	0.6000 0.6000	0.6000 0.6000	252.44 281.05	252.44 281.05
9	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
10	cohesv	-28.350 -30.350	2.000	485.42 520.42	379.258 414.258	-------- --------	0.6000 0.6000	0.6000 0.6000	291.25 312.25	291.25 312.25
11	sandy	-30.350 -34.445	4.095	520.42 590.03	0.000 0.000	346.90 387.85	0.2948 0.2948	------- -------	51.15 59.60	398.05 447.45
12	sandy	-34.445 -36.350	1.905	590.03 622.42	0.000 0.000	387.85 406.90	0.2948 0.2948	------- -------	59.60 63.53	447.45 470.43
13	sandy	-36.350 -37.066	0.716	622.42 634.60	0.000 0.000	406.90 414.06	0.2827 0.2827	------- -------	60.93 62.35	467.83 476.41
14	sandy	-37.066 -46.350	9.284	634.60 792.42	0.000 0.000	414.06 506.90	0.2827 0.2827	------- -------	62.35 80.72	476.41 587.62
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	686.258 736.838	-------- --------	0.5000 0.5000	0.5000 0.5000	396.21 421.50	396.21 421.50

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	6.616	0.00 0.00	0.00 66.16	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	66.16 203.42	66.16 146.90	3.8511 3.8511	0.00 217.66	66.16 364.56
4	sandy	-14.350 -16.350	2.000	203.42 237.42	146.90 166.90	4.8921 4.8921	276.49 344.98	423.39 511.88
5	sandy	-16.350 -19.350	3.000	237.42 288.42	166.90 196.90	4.8921 4.8921	344.98 447.72	511.88 644.62
6	cohesv	-19.350 -23.647	4.297	288.42 363.62	-------- --------	1.0000 1.0000	372.42 447.62	372.42 447.62
7	cohesv	-23.647 -24.625	0.978	363.62 380.73	-------- --------	1.0000 1.0000	447.62 464.73	447.62 464.73
8	cohesv	-24.625 -27.350	2.725	380.73 428.42	-------- --------	1.0000 1.0000	464.73 512.42	464.73 512.42
9	sandy	-27.350 -28.350	1.000	428.42 445.42	276.90 286.90	4.5985 4.5985	696.76 728.95	973.66 1015.85
10	cohesv	-28.350 -30.350	2.000	445.42 480.42	-------- --------	1.0000 1.0000	529.42 564.42	529.42 564.42
11	sandy	-30.350 -34.445	4.095	480.42 550.03	306.90 347.85	4.8921 4.8921	848.87 989.09	1155.77 1336.93
12	sandy	-34.445 -36.350	1.905	550.03 582.42	347.85 366.90	4.8921 4.8921	989.09 1054.34	1336.93 1421.24
13	sandy	-36.350 -37.066	0.716	582.42 594.60	366.90 374.06	5.2124 5.2124	1123.37 1149.51	1490.27 1523.57
14	sandy	-37.066 -46.350	9.284	594.60 752.42	374.06 466.90	5.2124 5.2124	1149.51 1488.24	1523.57 1955.14
15	cohesv	-46.350 -49.160	2.810	752.42 803.00	-------- --------	1.0000 1.0000	1112.42 1163.00	1112.42 1163.00

$Pp1 = Kp * \{ Sum.((Gam.*h)) + q - pw2 \} + 2*c*\sqrt{Kp}$ (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
2	-------	+0.340 -6.276	6.616	0.00 0.00	40.00 106.16	0.0000 0.0000	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
4	sandy	-14.350 -16.350	2.000	243.42 277.42	186.90 206.90	0.4554 0.4554	25.74 32.11	212.64 239.01
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -23.647	4.297	328.42 403.62	-------- --------	0.6000 0.6000	197.05 242.17	197.05 242.17
7	cohesv	-23.647 -24.625	0.978	403.62 420.73	-------- --------	0.6000 0.6000	242.17 252.44	242.17 252.44
8	cohesv	-24.625 -27.350	2.725	420.73 468.42	-------- --------	0.6000 0.6000	252.44 281.05	252.44 281.05
9	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
10	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
11	sandy	-30.350 -34.445	4.095	520.42 590.03	346.90 387.85	0.4554 0.4554	79.01 92.07	425.91 479.91
12	sandy	-34.445 -36.350	1.905	590.03 622.42	387.85 406.90	0.4554 0.4554	92.07 98.14	479.91 505.04
13	sandy	-36.350 -37.066	0.716	622.42 634.60	406.90 414.06	0.4408 0.4408	95.00 97.21	501.90 511.28
14	sandy	-37.066 -46.350	9.284	634.60 792.42	414.06 506.90	0.4408 0.4408	97.21 125.86	511.28 632.76
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	-------- --------	0.5000 0.5000	396.21 421.50	396.21 421.50

$Po1 = Ko * \{ Sum.(Gam.*h) + q - pw1 \}$ (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	4.000	0.00	0.00	-------	--------	0.0000	0.00	0.00
		+0.340		0.00	0.00		--------	0.0000	0.00	0.00
2	-------	+0.340	6.616	0.00	0.00	-------	--------	0.0000	0.00	0.00
		-6.276		0.00	66.16		--------	0.0000	0.00	66.16
3	sandy	-6.276	8.074	66.16	66.16	3.00	0.00	0.5152	0.00	66.16
		-14.350		203.42	146.90		24.22	0.5152	31.90	178.80
4	sandy	-14.350	2.000	203.42	146.90	13.00	24.22	0.4554	28.19	175.09
		-16.350		237.42	166.90		50.22	0.4554	37.21	204.11
5	sandy	-16.350	3.000	237.42	166.90	13.00	50.22	0.4554	37.21	204.11
		-19.350		288.42	196.90		89.22	0.4554	50.73	247.63
6	cohesv	-19.350	4.297	288.42	--------	21.00	89.22	0.6000	184.98	184.98
		-23.647		363.62	--------		179.46	0.6000	242.17	242.17
7	cohesv	-23.647	0.978	363.62	--------	21.00	179.46	0.6000	242.17	242.17
		-24.625		380.73	--------		200.00	0.6000	255.19	255.19
8	cohesv	-24.625	2.725	380.73	--------	21.00	200.00	0.6000	255.19	255.19
		-27.350		428.42	--------		257.22	0.6000	291.45	291.45
9	sandy	-27.350	1.000	428.42	276.90	13.00	257.22	0.4701	98.18	375.08
		-28.350		445.42	286.90		270.22	0.4701	102.83	389.73
10	cohesv	-28.350	2.000	445.42	--------	21.00	270.22	0.6000	303.39	303.39
		-30.350		480.42	--------		312.22	0.6000	330.00	330.00
11	sandy	-30.350	4.095	480.42	306.90	20.00	312.22	0.4554	110.70	417.60
		-34.445		550.03	347.85		394.11	0.4554	132.07	479.91
12	sandy	-34.445	1.905	550.03	347.85	20.00	394.11	0.4554	132.07	479.91
		-36.350		582.42	366.90		432.22	0.4554	142.01	508.91
13	sandy	-36.350	0.716	582.42	366.90	30.00	432.22	0.4408	137.47	504.37
		-37.066		594.60	374.06		453.71	0.4408	141.79	515.85
14	sandy	-37.066	9.284	594.60	374.06	30.00	453.71	0.4408	141.79	515.85
		-46.350		752.42	466.90		732.22	0.4408	197.80	664.70

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	cohesv	-46.350	2.810	752.42	--------	90.00	732.22	0.5000	457.81	457.81
		-49.160		803.00	--------		985.12	0.5000	511.28	511.28

friction force B7027influence range B = 4.487 (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	4.000	0.00	0.00	-------	--------	0.0000	0.00	0.00
		+0.340		0.00	0.00		--------	0.0000	0.00	0.00
2	-------	+0.340	6.616	0.00	0.00	-------	--------	0.0000	0.00	0.00
		-6.276		0.00	66.16		--------	0.0000	0.00	66.16
3	sandy	-6.276	8.074	66.16	66.16	3.00	0.00	0.5152	0.00	66.16
		-14.350		203.42	146.90		24.22	0.5152	31.61	178.51
4	sandy	-14.350	2.000	203.42	146.90	13.00	24.22	0.4554	27.94	174.84
		-16.350		237.42	166.90		50.22	0.4554	36.68	203.58
5	sandy	-16.350	3.000	237.42	166.90	13.00	50.22	0.4554	36.68	203.58
		-19.350		288.42	196.90		89.22	0.4554	49.80	246.70
6	cohesv	-19.350	4.297	288.42	--------	21.00	89.22	0.6000	183.76	183.76
		-23.647		363.62	--------		179.46	0.6000	239.71	239.71
7	cohesv	-23.647	0.978	363.62	--------	21.00	179.46	0.6000	239.71	239.71
		-24.625		380.73	--------		200.00	0.6000	252.44	252.44
8	cohesv	-24.625	2.725	380.73	--------	21.00	200.00	0.6000	252.44	252.44
		-27.350		428.42	--------		257.22	0.6000	287.92	287.92
9	sandy	-27.350	1.000	428.42	276.90	13.00	257.22	0.4701	95.41	372.31
		-28.350		445.42	286.90		270.22	0.4701	99.92	386.82
10	cohesv	-28.350	2.000	445.42	--------	21.00	270.22	0.6000	299.68	299.68
		-30.350		480.42	--------		312.22	0.6000	325.72	325.72
11	sandy	-30.350	4.095	480.42	306.90	20.00	312.22	0.4554	107.45	414.35
		-34.445		550.03	347.85		394.11	0.4554	127.96	475.80

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	sandy	-34.445 -36.350	1.905	550.03 582.42	347.85 366.90	20.00	394.11 432.22	0.4554 0.4554	127.96 137.50	475.80 504.40
13	sandy	-36.350 -37.066	0.716	582.42 594.60	366.90 374.06	30.00	432.22 453.71	0.4408 0.4408	133.11 137.21	500.01 511.28
14	sandy	-37.066 -46.350	9.284	594.60 752.42	374.06 466.90	30.00	453.71 732.22	0.4408 0.4408	137.21 190.41	511.28 657.31
15	cohesv	-46.350 -49.160	2.810	752.42 803.00	-------- --------	90.00	732.22 985.12	0.5000 0.5000	449.43 500.01	449.43 500.01

friction force B7027influence range B = 5.000 (m)

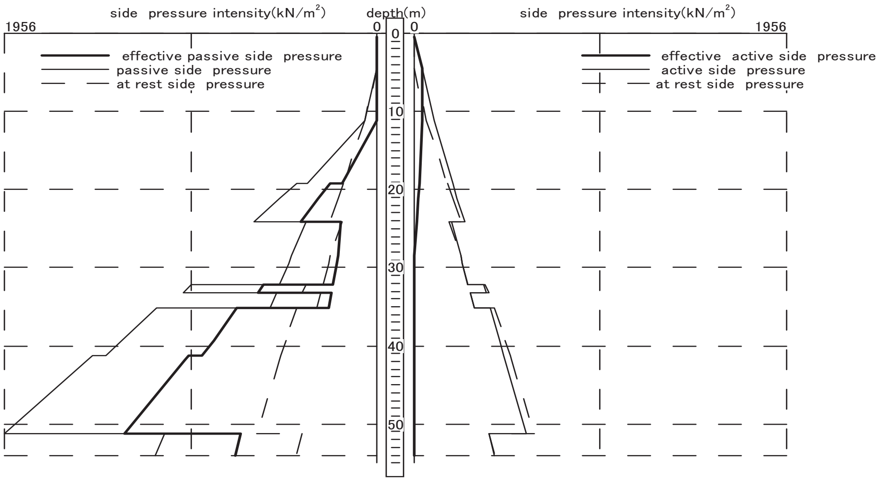
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

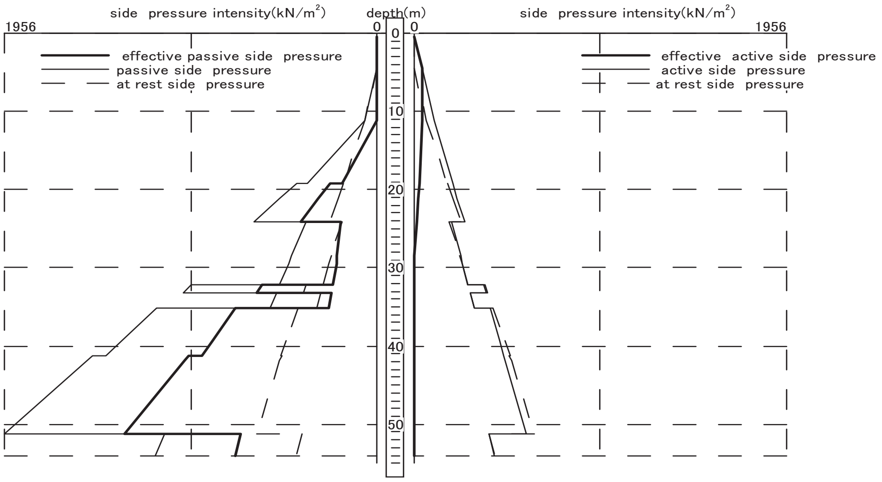
bridge axis direction

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 -6.276	6.616	----	----	----	----
3	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
4	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
5	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
6	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
7	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
8	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
9	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
10	sandy	-30.350 -33.392	3.042	17.0	0.0	33.00	20.0
11	sandy	-33.392 -34.616	1.225	17.0	0.0	33.00	20.0
12	sandy	-34.616 -36.350	1.734	17.0	0.0	33.00	20.0
13	sandy	-36.350 -45.084	8.734	17.0	0.0	34.00	30.0
14	sandy	-45.084 -46.350	1.266	17.0	0.0	34.00	30.0
15	cohesv	-46.350 -49.160	2.810	18.0	180.0	0.00	30.0

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 -6.276	6.616	0.00 0.00	-------- --------	40.00 106.16	------- -------	------- -------	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51
4	sandy	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
5	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
6	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
8	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
9	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
10	sandy	-30.350 -33.392	3.042	520.42 572.12	0.000 0.000	346.90 377.32	0.2948 0.2948	------- -------	51.15 57.43	398.05 434.75
11	sandy	-33.392 -34.616	1.225	572.12 592.94	0.000 0.000	377.32 389.56	0.2948 0.2948	------- -------	57.43 59.96	434.75 449.52
12	sandy	-34.616 -36.350	1.734	592.94 622.42	0.000 0.000	389.56 406.90	0.2948 0.2948	------- -------	59.96 63.53	449.52 470.43
13	sandy	-36.350 -45.084	8.734	622.42 770.90	0.000 0.000	406.90 494.24	0.2827 0.2827	------- -------	60.93 78.22	467.83 572.46
14	sandy	-45.084 -46.350	1.266	770.90 792.42	0.000 0.000	494.24 506.90	0.2827 0.2827	------- -------	78.22 80.72	572.46 587.62
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	545.430 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 401.04	375.75 401.04

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	6.616	0.00 0.00	0.00 66.16	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	66.16 146.90	0.0000 0.0000	0.00 0.00	66.16 146.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	146.90 149.00	0.0000 0.0000	0.00 0.00	146.90 149.00
5	sandy	-14.560 -16.350	1.790	149.00 179.43	149.00 166.90	4.8921 4.8921	0.00 61.30	149.00 228.20
6	sandy	-16.350 -19.350	3.000	179.43 230.43	166.90 196.90	4.8921 4.8921	61.30 164.03	228.20 360.93
7	cohesv	-19.350 -27.350	8.000	230.43 370.43	-------- --------	1.0000 1.0000	314.43 454.43	314.43 454.43
8	sandy	-27.350 -28.350	1.000	370.43 387.43	276.90 286.90	4.5985 4.5985	430.10 462.29	707.00 749.19
9	cohesv	-28.350 -30.350	2.000	387.43 422.43	-------- --------	1.0000 1.0000	471.43 506.43	471.43 506.43
10	sandy	-30.350 -33.392	3.042	422.43 474.14	306.90 337.32	4.8921 4.8921	565.18 669.34	872.08 1006.66
11	sandy	-33.392 -34.616	1.225	474.14 494.95	337.32 349.56	4.8921 4.8921	669.34 711.28	1006.66 1060.84
12	sandy	-34.616 -36.350	1.734	494.95 524.43	349.56 366.90	4.8921 4.8921	711.28 770.65	1060.84 1137.55
13	sandy	-36.350 -45.084	8.734	524.43 672.91	366.90 454.24	5.2124 5.2124	821.11 1139.80	1188.01 1594.04
14	sandy	-45.084 -46.350	1.266	672.91 694.43	454.24 466.90	5.2124 5.2124	1139.80 1185.98	1594.04 1652.88
15	cohesv	-46.350 -49.160	2.810	694.43 745.01	-------- --------	1.0000 1.0000	1054.43 1105.01	1054.43 1105.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -6.276	6.616	0.00 0.00	40.00 106.16	0.0000 0.0000	0.00 0.00	40.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
4	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
5	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01
6	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
8	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
9	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
10	sandy	-30.350 -33.392	3.042	520.42 572.12	346.90 377.32	0.4554 0.4554	79.01 88.71	425.91 466.02
11	sandy	-33.392 -34.616	1.225	572.12 592.94	377.32 389.56	0.4554 0.4554	88.71 92.61	466.02 482.17
12	sandy	-34.616 -36.350	1.734	592.94 622.42	389.56 406.90	0.4554 0.4554	92.61 98.14	482.17 505.04
13	sandy	-36.350 -45.084	8.734	622.42 770.90	406.90 494.24	0.4408 0.4408	95.00 121.95	501.90 616.19
14	sandy	-45.084 -46.350	1.266	770.90 792.42	494.24 506.90	0.4408 0.4408	121.95 125.86	616.19 632.76
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	-------- --------	0.5000 0.5000	396.21 421.50	396.21 421.50

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 -6.276	6.616	0.00 0.00	0.00 66.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	66.16 146.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	66.16 146.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	146.90 149.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	146.90 149.00
5	sandy	-14.560 -16.350	1.790	149.00 179.43	149.00 166.90	13.00	0.00 23.27	0.4554 0.4554	0.00 8.07	149.00 174.97
6	sandy	-16.350 -19.350	3.000	179.43 230.43	166.90 196.90	13.00	23.27 62.27	0.4554 0.4554	8.07 21.59	174.97 218.49
7	cohesv	-19.350 -27.350	8.000	230.43 370.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	146.59 253.05	146.59 253.05
8	sandy	-27.350 -28.350	1.000	370.43 387.43	276.90 286.90	13.00	230.27 243.27	0.4701 0.4701	68.09 72.75	344.99 359.65
9	cohesv	-28.350 -30.350	2.000	387.43 422.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	264.99 291.61	264.99 291.61
10	sandy	-30.350 -33.392	3.042	422.43 474.14	306.90 337.32	20.00	285.27 346.10	0.4554 0.4554	81.56 97.43	388.46 434.75
11	sandy	-33.392 -34.616	1.225	474.14 494.95	337.32 349.56	20.00	346.10 370.59	0.4554 0.4554	97.43 103.82	434.75 453.38
12	sandy	-34.616 -36.350	1.734	494.95 524.43	349.56 366.90	20.00	370.59 405.27	0.4554 0.4554	103.82 112.87	453.38 479.77
13	sandy	-36.350 -45.084	8.734	524.43 672.91	366.90 454.24	30.00	405.27 667.30	0.4408 0.4408	109.26 161.95	476.16 616.19
14	sandy	-45.084 -46.350	1.266	672.91 694.43	454.24 466.90	30.00	667.30 705.27	0.4408 0.4408	161.95 169.59	616.19 636.49

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	cohesv	-46.350 -49.160	2.810	694.43 745.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	425.81 479.29	425.81 479.29

friction force B7027influence range B = 4.487 (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 -6.276	6.616	0.00 0.00	0.00 66.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 66.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	66.16 146.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	66.16 146.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	146.90 149.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	146.90 149.00
5	sandy	-14.560 -16.350	1.790	149.00 179.43	149.00 166.90	13.00	0.00 23.27	0.4554 0.4554	0.00 7.82	149.00 174.72
6	sandy	-16.350 -19.350	3.000	179.43 230.43	166.90 196.90	13.00	23.27 62.27	0.4554 0.4554	7.82 20.94	174.72 217.84
7	cohesv	-19.350 -27.350	8.000	230.43 370.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	145.73 249.89	145.73 249.89
8	sandy	-27.350 -28.350	1.000	370.43 387.43	276.90 286.90	13.00	230.27 243.27	0.4701 0.4701	65.62 70.13	342.52 357.03
9	cohesv	-28.350 -30.350	2.000	387.43 422.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	261.65 287.69	261.65 287.69
10	sandy	-30.350 -33.392	3.042	422.43 474.14	306.90 337.32	20.00	285.27 346.10	0.4554 0.4554	78.59 93.82	385.49 431.14
11	sandy	-33.392 -34.616	1.225	474.14 494.95	337.32 349.56	20.00	346.10 370.59	0.4554 0.4554	93.82 99.96	431.14 449.52

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	sandy	-34.616 -36.350	1.734	494.95 524.43	349.56 366.90	20.00	370.59 405.27	0.4554 0.4554	99.96 108.64	449.52 475.54
13	sandy	-36.350 -45.084	8.734	524.43 672.91	366.90 454.24	30.00	405.27 667.30	0.4408 0.4408	105.17 155.22	472.07 609.46
14	sandy	-45.084 -46.350	1.266	672.91 694.43	454.24 466.90	30.00	667.30 705.27	0.4408 0.4408	155.22 162.47	609.46 629.37
15	cohesv	-46.350 -49.160	2.810	694.43 745.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	417.74 468.32	417.74 468.32

friction force B7027influence range B = 5.000 (m)

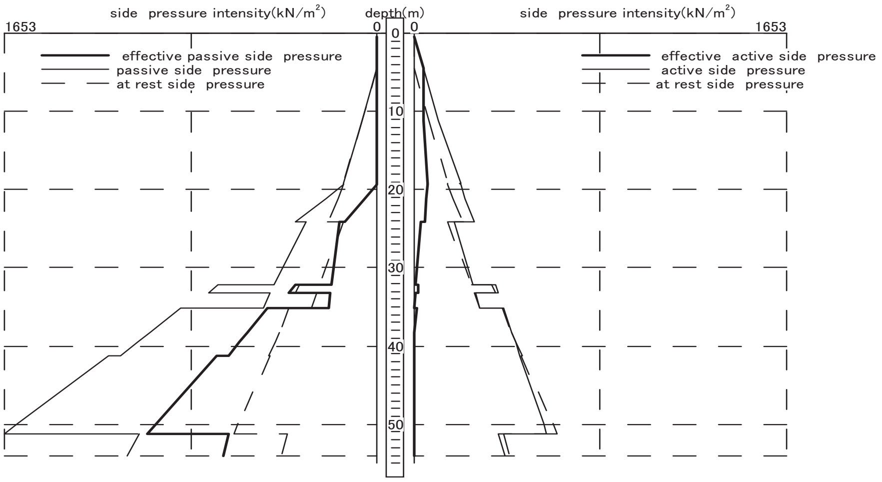
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

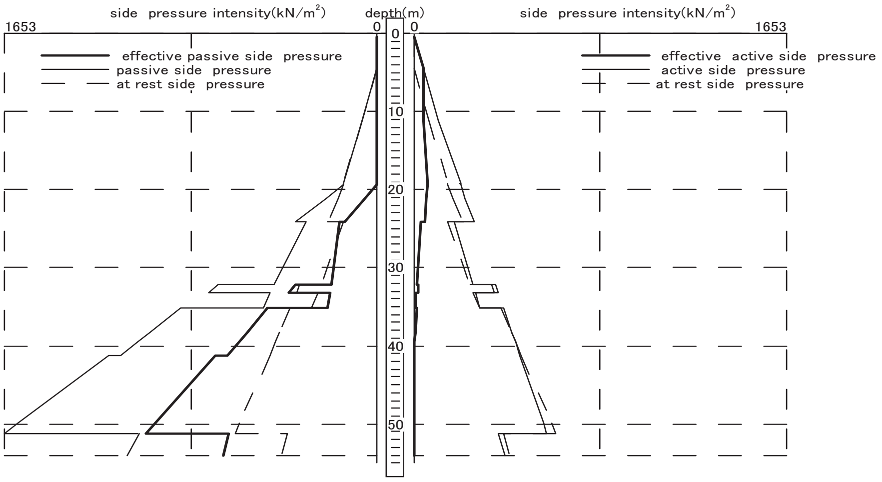
bridge axis direction

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 -6.276	3.616	----	----	----	----
3	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
4	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
5	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
6	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
7	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
8	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
9	cohesv	-28.350 -30.201	1.851	17.5	42.0	0.00	7.0
10	cohesv	-30.201 -30.350	0.149	17.5	42.0	0.00	7.0
11	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
12	sandy	-36.350 -38.325	1.975	17.0	0.0	34.00	30.0
13	sandy	-38.325 -39.574	1.249	17.0	0.0	34.00	30.0
14	sandy	-39.574 -46.350	6.776	17.0	0.0	34.00	30.0
15	cohesv	-46.350 -49.160	2.810	18.0	180.0	0.00	30.0

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
2	----	-2.660 -6.276	3.616	0.00 0.00	-------- --------	70.00 106.16	------- -------	------- -------	0.00 0.00	70.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51
4	sandy	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
5	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
6	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
8	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
9	cohesv	-28.350 -30.201	1.851	485.42 517.82	238.430 270.830	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 290.23	270.79 290.23
10	cohesv	-30.201 -30.350	0.149	517.82 520.42	270.830 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	290.23 291.79	290.23 291.79
11	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
12	sandy	-36.350 -38.325	1.975	622.42 655.99	0.000 0.000	406.90 426.65	0.2827 0.2827	------- -------	60.93 64.84	467.83 491.49
13	sandy	-38.325 -39.574	1.249	655.99 677.23	0.000 0.000	426.65 439.14	0.2827 0.2827	------- -------	64.84 67.31	491.49 506.45
14	sandy	-39.574 -46.350	6.776	677.23 792.42	0.000 0.000	439.14 506.90	0.2827 0.2827	------- -------	67.31 80.72	506.45 587.62
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	545.430 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 401.04	375.75 401.04

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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
2	----	-2.660 -6.276	3.616	0.00 0.00	0.00 36.16	0.0000 0.0000	0.00 0.00	0.00 36.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	36.16 116.90	0.0000 0.0000	0.00 0.00	36.16 116.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	116.90 119.00	0.0000 0.0000	0.00 0.00	116.90 119.00
5	sandy	-14.560 -16.350	1.790	150.00 180.43	119.00 136.90	4.8921 4.8921	151.66 212.95	270.66 349.85
6	sandy	-16.350 -19.350	3.000	180.43 231.43	136.90 166.90	4.8921 4.8921	212.95 315.69	349.85 482.59
7	cohesv	-19.350 -27.350	8.000	231.43 371.43	-------- --------	1.0000 1.0000	315.43 455.43	315.43 455.43
8	sandy	-27.350 -28.350	1.000	371.43 388.43	246.90 256.90	4.5985 4.5985	572.65 604.84	819.55 861.74
9	cohesv	-28.350 -30.201	1.851	388.43 420.83	-------- --------	1.0000 1.0000	472.43 504.83	472.43 504.83
10	cohesv	-30.201 -30.350	0.149	420.83 423.43	-------- --------	1.0000 1.0000	504.83 507.43	504.83 507.43
11	sandy	-30.350 -36.350	6.000	423.43 525.43	276.90 336.90	4.8921 4.8921	716.84 922.31	993.74 1259.21
12	sandy	-36.350 -38.325	1.975	525.43 559.01	336.90 356.65	5.2124 5.2124	982.70 1054.76	1319.60 1411.42
13	sandy	-38.325 -39.574	1.249	559.01 580.24	356.65 369.14	5.2124 5.2124	1054.76 1100.34	1411.42 1469.48
14	sandy	-39.574 -46.350	6.776	580.24 695.43	369.14 436.90	5.2124 5.2124	1100.34 1347.57	1469.48 1784.47
15	cohesv	-46.350 -49.160	2.810	695.43 746.01	-------- --------	1.0000 1.0000	1055.43 1106.01	1055.43 1106.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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
2	-------	-2.660 -6.276	3.616	0.00 0.00	70.00 106.16	0.0000 0.0000	0.00 0.00	70.00 106.16
3	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
4	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
5	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01
6	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
7	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
8	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
9	cohesv	-28.350 -30.201	1.851	485.42 517.82	-------- --------	0.6000 0.6000	291.25 310.69	291.25 310.69
10	cohesv	-30.201 -30.350	0.149	517.82 520.42	-------- --------	0.6000 0.6000	310.69 312.25	310.69 312.25
11	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
12	sandy	-36.350 -38.325	1.975	622.42 655.99	406.90 426.65	0.4408 0.4408	95.00 101.10	501.90 527.75
13	sandy	-38.325 -39.574	1.249	655.99 677.23	426.65 439.14	0.4408 0.4408	101.10 104.95	527.75 544.09
14	sandy	-39.574 -46.350	6.776	677.23 792.42	439.14 506.90	0.4408 0.4408	104.95 125.86	544.09 632.76
15	cohesv	-46.350 -49.160	2.810	792.42 843.00	-------- --------	0.5000 0.5000	396.21 421.50	396.21 421.50

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (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 -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 -6.276	3.616	0.00 0.00	0.00 36.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 36.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	36.16 116.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	36.16 116.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	116.90 119.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	116.90 119.00
5	sandy	-14.560 -16.350	1.790	150.00 180.43	119.00 136.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	133.12 159.08
6	sandy	-16.350 -19.350	3.000	180.43 231.43	136.90 166.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	159.08 202.60
7	cohesv	-19.350 -27.350	8.000	231.43 371.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	147.19 253.65	147.19 253.65
8	sandy	-27.350 -28.350	1.000	371.43 388.43	246.90 256.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	329.57 344.22
9	cohesv	-28.350 -30.201	1.851	388.43 420.83	-------- --------	21.00	243.27 282.15	0.6000 0.6000	265.59 290.23	265.59 290.23
10	cohesv	-30.201 -30.350	0.149	420.83 423.43	-------- --------	21.00	282.15 285.27	0.6000 0.6000	290.23 292.21	290.23 292.21
11	sandy	-30.350 -36.350	6.000	423.43 525.43	276.90 336.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	372.58 463.88
12	sandy	-36.350 -38.325	1.975	525.43 559.01	336.90 356.65	30.00	405.27 464.52	0.4408 0.4408	122.92 134.84	459.82 491.49
13	sandy	-38.325 -39.574	1.249	559.01 580.24	356.65 369.14	30.00	464.52 502.00	0.4408 0.4408	134.84 142.38	491.49 511.52
14	sandy	-39.574 -46.350	6.776	580.24 695.43	369.14 436.90	30.00	502.00 705.27	0.4408 0.4408	142.38 183.25	511.52 620.15

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	cohesv	-46.350 -49.160	2.810	695.43 746.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	426.31 479.79	426.31 479.79

friction force B7027influence range B = 4.487 (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 -6.276	3.616	0.00 0.00	0.00 36.16	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 36.16
3	sandy	-6.276 -14.350	8.074	0.00 0.00	36.16 116.90	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	36.16 116.90
4	sandy	-14.350 -14.560	0.210	0.00 0.00	116.90 119.00	13.00	0.00 0.00	0.0000 0.0000	0.00 0.00	116.90 119.00
5	sandy	-14.560 -16.350	1.790	150.00 180.43	119.00 136.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	133.12 158.84
6	sandy	-16.350 -19.350	3.000	180.43 231.43	136.90 166.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	158.84 201.96
7	cohesv	-19.350 -27.350	8.000	231.43 371.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	146.33 250.49	146.33 250.49
8	sandy	-27.350 -28.350	1.000	371.43 388.43	246.90 256.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	327.09 341.60
9	cohesv	-28.350 -30.201	1.851	388.43 420.83	-------- --------	21.00	243.27 282.15	0.6000 0.6000	262.25 286.36	262.25 286.36
10	cohesv	-30.201 -30.350	0.149	420.83 423.43	-------- --------	21.00	282.15 285.27	0.6000 0.6000	286.36 288.29	286.36 288.29
11	sandy	-30.350 -36.350	6.000	423.43 525.43	276.90 336.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	369.60 459.66

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	sandy	-36.350 -38.325	1.975	525.43 559.01	336.90 356.65	30.00	405.27 464.52	0.4408 0.4408	118.83 130.15	455.73 486.80
13	sandy	-38.325 -39.574	1.249	559.01 580.24	356.65 369.14	30.00	464.52 502.00	0.4408 0.4408	130.15 137.31	486.80 506.45
14	sandy	-39.574 -46.350	6.776	580.24 695.43	369.14 436.90	30.00	502.00 705.27	0.4408 0.4408	137.31 176.14	506.45 613.04
15	cohesv	-46.350 -49.160	2.810	695.43 746.01	-------- --------	90.00	705.27 958.17	0.5000 0.5000	418.24 468.82	418.24 468.82

friction force B7027influence range B = 5.000 (m)

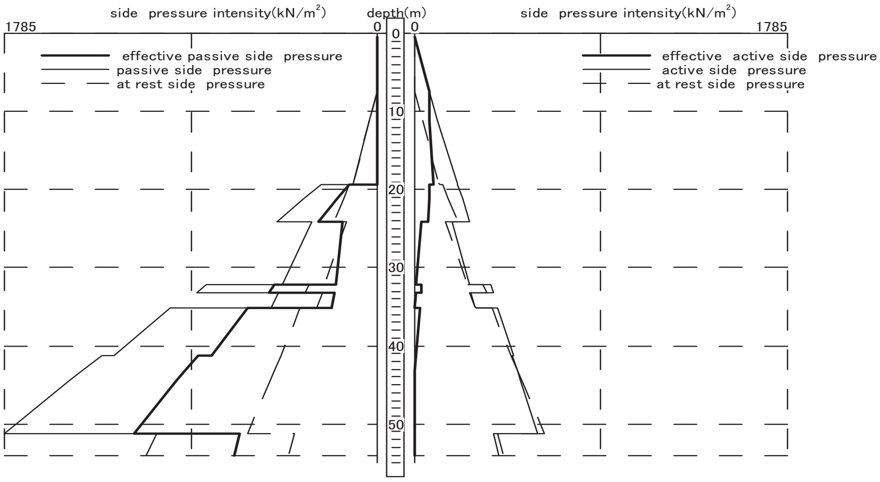
Po1'= Ko * $\{$ Sum.(Gam.*h) + q - pw2 $\}$ + Ko * $\{$ Sum.(f*h)—B $\}$ (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

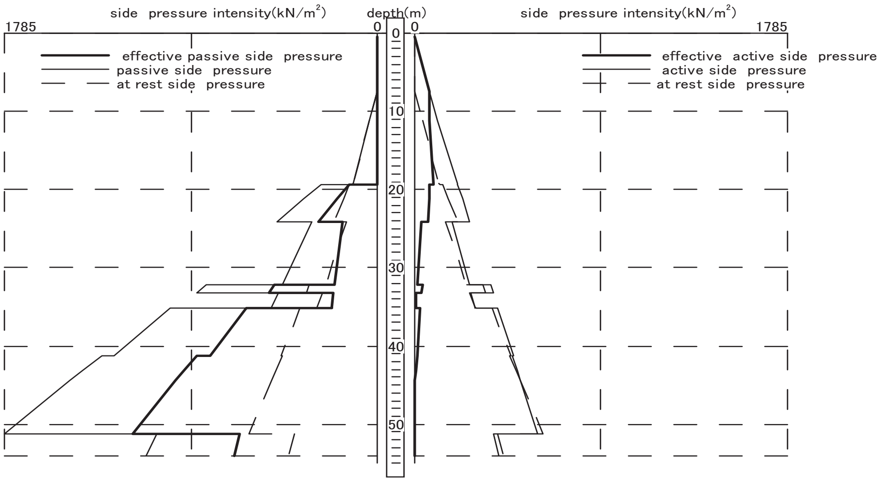
bridge axis direction

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 -6.276	10.616	----	----	----	----
2	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
3	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
4	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
7	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
8	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
9	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
10	sandy	-36.350 -46.350	10.000	17.0	0.0	34.00	30.0
11	cohesv	-46.350 -47.241	0.891	18.0	180.0	0.00	30.0
12	cohesv	-47.241 -48.240	0.999	18.0	180.0	0.00	30.0
13	cohesv	-48.240 -49.160	0.920	18.0	180.0	0.00	30.0

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 -6.276	10.616	0.00 0.00	-------- --------	0.00 106.16	------- -------	------- -------	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51

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	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
4	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
7	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
9	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
10	sandy	-36.350 -46.350	10.000	622.42 792.42	0.000 0.000	406.90 506.90	0.2827 0.2827	------- -------	60.93 80.72	467.83 587.62
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	545.430 561.467	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 383.77	375.75 383.77
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	561.467 579.443	-------- --------	0.4172 0.4172	0.5000 0.5000	383.77 392.75	383.77 392.75
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	579.443 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	392.75 401.04	392.75 401.04

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	10.616	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.350 -14.560	0.210	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	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	4.8921 4.8921	151.66 212.95	151.66 230.85
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	4.8921 4.8921	212.95 315.69	230.85 363.59
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	1.0000 1.0000	196.43 336.43	196.43 336.43
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	4.5985 4.5985	572.65 604.84	700.55 742.74
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	1.0000 1.0000	353.43 388.43	353.43 388.43
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	4.8921 4.8921	716.84 922.31	874.74 1140.21
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	5.2124 5.2124	982.70 1347.57	1200.60 1665.47
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	1.0000 1.0000	936.43 952.47	936.43 952.47
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	1.0000 1.0000	952.47 970.44	952.47 970.44
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	1.0000 1.0000	970.44 987.01	970.44 987.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -6.276	10.616	0.00 0.00	0.00 106.16	0.0000 0.0000	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
3	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
4	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
7	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
9	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
10	sandy	-36.350 -46.350	10.000	622.42 792.42	406.90 506.90	0.4408 0.4408	95.00 125.86	501.90 632.76
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	-------- --------	0.5000 0.5000	396.21 404.23	396.21 404.23
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	-------- --------	0.5000 0.5000	404.23 413.22	404.23 413.22
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	-------- --------	0.5000 0.5000	413.22 421.50	413.22 421.50

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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	14.12 40.08

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	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	40.08 83.60
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	75.79 182.25	75.79 182.25
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	210.57 225.22
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	194.19 220.81	194.19 220.81
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	253.58 344.88
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	122.92 183.25	340.82 501.15
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	366.81 383.77	366.81 383.77
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	383.77 402.77	383.77 402.77
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	402.77 420.29	402.77 420.29

friction force B7027influence range B = 4.487 (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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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)
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	14.12 39.84
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	39.84 82.96
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	74.93 179.09	74.93 179.09
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	208.09 222.60
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	190.85 216.89	190.85 216.89
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	250.60 340.66
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	118.83 176.14	336.73 494.04
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	358.74 374.78	358.74 374.78
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	374.78 392.75	374.78 392.75
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	392.75 409.32	392.75 409.32

friction force B7027influence range B = 5.000 (m)

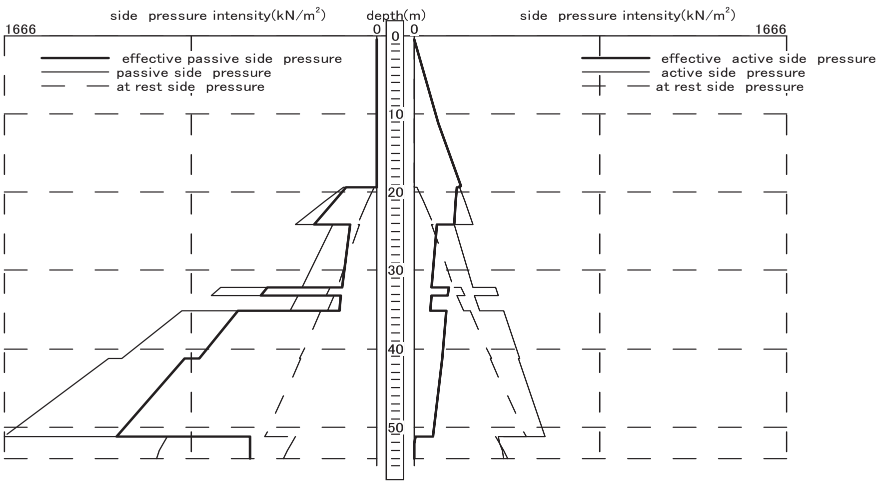
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

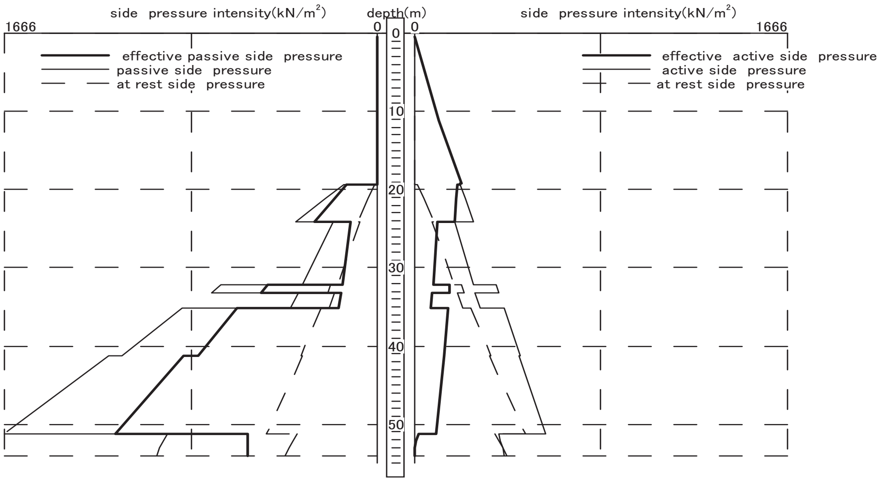
bridge axis direction

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 -6.276	10.616	----	----	----	----
2	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
3	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
4	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
7	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
8	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
9	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
10	sandy	-36.350 -46.350	10.000	17.0	0.0	34.00	30.0
11	cohesv	-46.350 -47.241	0.891	18.0	180.0	0.00	30.0
12	cohesv	-47.241 -48.240	0.999	18.0	180.0	0.00	30.0
13	cohesv	-48.240 -49.160	0.920	18.0	180.0	0.00	30.0

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 -6.276	10.616	0.00 0.00	-------- --------	0.00 106.16	------- -------	------- -------	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51

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	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
4	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
7	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
9	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
10	sandy	-36.350 -46.350	10.000	622.42 792.42	0.000 0.000	406.90 506.90	0.2827 0.2827	------- -------	60.93 80.72	467.83 587.62
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	545.430 561.467	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 383.77	375.75 383.77
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	561.467 579.443	-------- --------	0.4172 0.4172	0.5000 0.5000	383.77 392.75	383.77 392.75
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	579.443 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	392.75 401.04	392.75 401.04

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

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

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

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 -6.276	10.616	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.350 -14.560	0.210	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	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	4.8921 4.8921	151.66 212.95	151.66 230.85
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	4.8921 4.8921	212.95 315.69	230.85 363.59
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	1.0000 1.0000	196.43 336.43	196.43 336.43
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	4.5985 4.5985	572.65 604.84	700.55 742.74
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	1.0000 1.0000	353.43 388.43	353.43 388.43
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	4.8921 4.8921	716.84 922.31	874.74 1140.21
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	5.2124 5.2124	982.70 1347.57	1200.60 1665.47
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	1.0000 1.0000	936.43 952.47	936.43 952.47
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	1.0000 1.0000	952.47 970.44	952.47 970.44
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	1.0000 1.0000	970.44 987.01	970.44 987.01

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

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

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

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 -6.276	10.616	0.00 0.00	0.00 106.16	0.0000 0.0000	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
3	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
4	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
7	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
9	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
10	sandy	-36.350 -46.350	10.000	622.42 792.42	406.90 506.90	0.4408 0.4408	95.00 125.86	501.90 632.76
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	-------- --------	0.5000 0.5000	396.21 404.23	396.21 404.23
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	-------- --------	0.5000 0.5000	404.23 413.22	404.23 413.22
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	-------- --------	0.5000 0.5000	413.22 421.50	413.22 421.50

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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	14.12 40.08

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	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	40.08 83.60
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	75.79 182.25	75.79 182.25
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	210.57 225.22
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	194.19 220.81	194.19 220.81
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	253.58 344.88
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	122.92 183.25	340.82 501.15
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	366.81 383.77	366.81 383.77
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	383.77 402.77	383.77 402.77
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	402.77 420.29	402.77 420.29

friction force B7027influence range B = 4.487 (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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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)
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	14.12 39.84
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	39.84 82.96
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	74.93 179.09	74.93 179.09
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	208.09 222.60
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	190.85 216.89	190.85 216.89
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	250.60 340.66
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	118.83 176.14	336.73 494.04
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	358.74 374.78	358.74 374.78
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	374.78 392.75	374.78 392.75
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	392.75 409.32	392.75 409.32

friction force B7027influence range B = 5.000 (m)

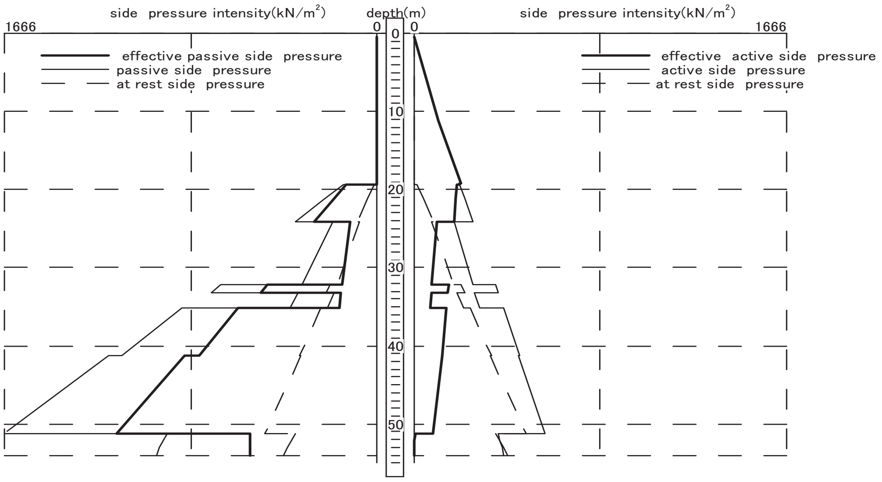
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

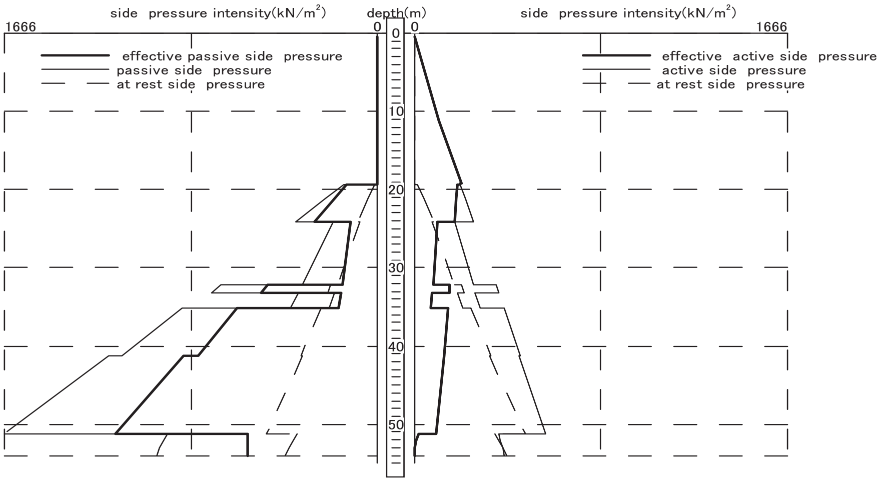
bridge axis direction

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 -6.276	10.616	----	----	----	----
2	sandy	-6.276 -14.350	8.074	17.0	0.0	29.00	3.0
3	sandy	-14.350 -14.560	0.210	17.0	0.0	33.00	13.0
4	sandy	-14.560 -16.350	1.790	17.0	0.0	33.00	13.0
5	sandy	-16.350 -19.350	3.000	17.0	0.0	33.00	13.0
6	cohesv	-19.350 -27.350	8.000	17.5	42.0	0.00	7.0
7	sandy	-27.350 -28.350	1.000	17.0	0.0	32.00	13.0
8	cohesv	-28.350 -30.350	2.000	17.5	42.0	0.00	7.0
9	sandy	-30.350 -36.350	6.000	17.0	0.0	33.00	20.0
10	sandy	-36.350 -46.350	10.000	17.0	0.0	34.00	30.0
11	cohesv	-46.350 -47.241	0.891	18.0	180.0	0.00	30.0
12	cohesv	-47.241 -48.240	0.999	18.0	180.0	0.00	30.0
13	cohesv	-48.240 -49.160	0.920	18.0	180.0	0.00	30.0

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 -6.276	10.616	0.00 0.00	-------- --------	0.00 106.16	------- -------	------- -------	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	-------- --------	106.16 186.90	0.3470 0.3470	------- -------	0.00 19.61	106.16 206.51

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	-14.350 -14.560	0.210	243.42 246.99	-------- --------	186.90 189.00	0.2948 0.2948	------- -------	16.66 17.09	203.56 206.09
4	sandy	-14.560 -16.350	1.790	246.99 277.42	0.000 0.000	189.00 206.90	0.2948 0.2948	------- -------	17.09 20.79	206.09 227.69
5	sandy	-16.350 -19.350	3.000	277.42 328.42	0.000 0.000	206.90 236.90	0.2948 0.2948	------- -------	20.79 26.98	227.69 263.88
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	81.430 221.430	-------- --------	0.5172 0.5172	0.6000 0.6000	176.59 260.59	176.59 260.59
7	sandy	-27.350 -28.350	1.000	468.42 485.42	0.000 0.000	316.90 326.90	0.3073 0.3073	------- -------	46.56 48.71	363.46 375.61
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	238.430 273.430	-------- --------	0.5172 0.5172	0.6000 0.6000	270.79 291.79	270.79 291.79
9	sandy	-30.350 -36.350	6.000	520.42 622.42	0.000 0.000	346.90 406.90	0.2948 0.2948	------- -------	51.15 63.53	398.05 470.43
10	sandy	-36.350 -46.350	10.000	622.42 792.42	0.000 0.000	406.90 506.90	0.2827 0.2827	------- -------	60.93 80.72	467.83 587.62
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	545.430 561.467	-------- --------	0.4172 0.4172	0.5000 0.5000	375.75 383.77	375.75 383.77
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	561.467 579.443	-------- --------	0.4172 0.4172	0.5000 0.5000	383.77 392.75	383.77 392.75
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	579.443 596.010	-------- --------	0.4172 0.4172	0.5000 0.5000	392.75 401.04	392.75 401.04

$Pa1 = Ka1*\left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -6.276	10.616	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.350 -14.560	0.210	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	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	4.8921 4.8921	151.66 212.95	151.66 230.85
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	4.8921 4.8921	212.95 315.69	230.85 363.59
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	1.0000 1.0000	196.43 336.43	196.43 336.43
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	4.5985 4.5985	572.65 604.84	700.55 742.74
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	1.0000 1.0000	353.43 388.43	353.43 388.43
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	4.8921 4.8921	716.84 922.31	874.74 1140.21
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	5.2124 5.2124	982.70 1347.57	1200.60 1665.47
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	1.0000 1.0000	936.43 952.47	936.43 952.47
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	1.0000 1.0000	952.47 970.44	952.47 970.44
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	1.0000 1.0000	970.44 987.01	970.44 987.01

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -6.276	10.616	0.00 0.00	0.00 106.16	0.0000 0.0000	0.00 0.00	0.00 106.16
2	sandy	-6.276 -14.350	8.074	106.16 243.42	106.16 186.90	0.5152 0.5152	0.00 29.12	106.16 216.02
3	sandy	-14.350 -14.560	0.210	243.42 246.99	186.90 189.00	0.4554 0.4554	25.74 26.41	212.64 215.41
4	sandy	-14.560 -16.350	1.790	246.99 277.42	189.00 206.90	0.4554 0.4554	26.41 32.11	215.41 239.01

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
5	sandy	-16.350 -19.350	3.000	277.42 328.42	206.90 236.90	0.4554 0.4554	32.11 41.67	239.01 278.57
6	cohesv	-19.350 -27.350	8.000	328.42 468.42	-------- --------	0.6000 0.6000	197.05 281.05	197.05 281.05
7	sandy	-27.350 -28.350	1.000	468.42 485.42	316.90 326.90	0.4701 0.4701	71.23 74.52	388.13 401.42
8	cohesv	-28.350 -30.350	2.000	485.42 520.42	-------- --------	0.6000 0.6000	291.25 312.25	291.25 312.25
9	sandy	-30.350 -36.350	6.000	520.42 622.42	346.90 406.90	0.4554 0.4554	79.01 98.14	425.91 505.04
10	sandy	-36.350 -46.350	10.000	622.42 792.42	406.90 506.90	0.4408 0.4408	95.00 125.86	501.90 632.76
11	cohesv	-46.350 -47.241	0.891	792.42 808.46	-------- --------	0.5000 0.5000	396.21 404.23	396.21 404.23
12	cohesv	-47.241 -48.240	0.999	808.46 826.43	-------- --------	0.5000 0.5000	404.23 413.22	404.23 413.22
13	cohesv	-48.240 -49.160	0.920	826.43 843.00	-------- --------	0.5000 0.5000	413.22 421.50	413.22 421.50

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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 22.18	14.12 40.08

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	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	22.18 35.70	40.08 83.60
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	75.79 182.25	75.79 182.25
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	82.67 87.32	210.57 225.22
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	194.19 220.81	194.19 220.81
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	95.68 126.98	253.58 344.88
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	122.92 183.25	340.82 501.15
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	366.81 383.77	366.81 383.77
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	383.77 402.77	383.77 402.77
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	402.77 420.29	402.77 420.29

friction force B7027influence range B = 4.487 (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 -6.276	10.616	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-6.276 -14.350	8.074	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
3	sandy	-14.350 -14.560	0.210	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)
4	sandy	-14.560 -16.350	1.790	31.00 61.43	0.00 17.90	13.00	0.00 23.27	0.4554 0.4554	14.12 21.94	14.12 39.84
5	sandy	-16.350 -19.350	3.000	61.43 112.43	17.90 47.90	13.00	23.27 62.27	0.4554 0.4554	21.94 35.06	39.84 82.96
6	cohesv	-19.350 -27.350	8.000	112.43 252.43	-------- --------	21.00	62.27 230.27	0.6000 0.6000	74.93 179.09	74.93 179.09
7	sandy	-27.350 -28.350	1.000	252.43 269.43	127.90 137.90	13.00	230.27 243.27	0.4701 0.4701	80.19 84.70	208.09 222.60
8	cohesv	-28.350 -30.350	2.000	269.43 304.43	-------- --------	21.00	243.27 285.27	0.6000 0.6000	190.85 216.89	190.85 216.89
9	sandy	-30.350 -36.350	6.000	304.43 406.43	157.90 217.90	20.00	285.27 405.27	0.4554 0.4554	92.70 122.76	250.60 340.66
10	sandy	-36.350 -46.350	10.000	406.43 576.43	217.90 317.90	30.00	405.27 705.27	0.4408 0.4408	118.83 176.14	336.73 494.04
11	cohesv	-46.350 -47.241	0.891	576.43 592.47	-------- --------	90.00	705.27 785.46	0.5000 0.5000	358.74 374.78	358.74 374.78
12	cohesv	-47.241 -48.240	0.999	592.47 610.44	-------- --------	90.00	785.46 875.33	0.5000 0.5000	374.78 392.75	374.78 392.75
13	cohesv	-48.240 -49.160	0.920	610.44 627.01	-------- --------	90.00	875.33 958.17	0.5000 0.5000	392.75 409.32	392.75 409.32

friction force B7027influence range B = 5.000 (m)

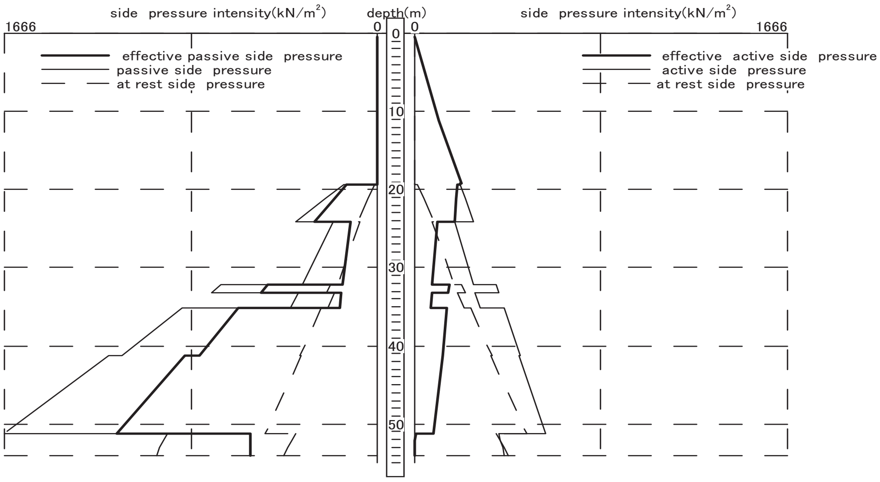
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

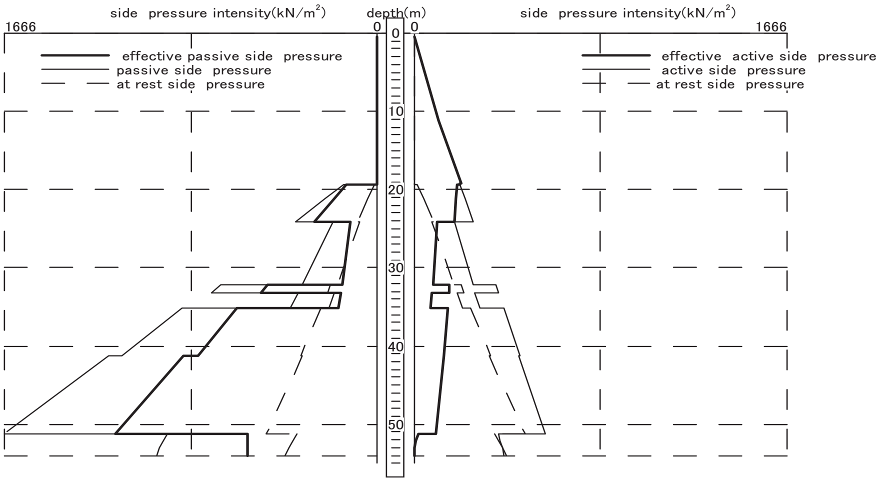
bridge axis direction

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	3.800	8.491	9.376	9.499
	accrue location	Lm	m	-5.160	-9.160	-8.160	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	1107.0	1851.0	2435.0	2570.0
		Sig.	N/mm^2	104.81	175.32	230.64	243.43
		Lm	m	-3.160	-8.060	-7.160	-7.160
	SKY400	M	kN.m	1107.0	1305.0	1849.0	1887.0
		Sig.max	N/mm^2	104.81	123.56	175.08	178.71
		Lm	m	-3.160	-3.160	-3.160	-3.160
	SKY490	M	kN.m	1107.0	1851.0	2435.0	2570.0
		Sig.max	N/mm^2	104.81	175.32	230.64	243.43
		Lm	m	-3.160	-8.060	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	703.0	1852.0	2411.0	2491.0
		Sig.	N/mm^2	66.60	175.39	228.33	235.94
		Lm	m	-8.060	-8.160	-8.060	-8.060
	SKY400	M	kN.m	-442.0	1492.0	1511.0	-704.0
		Sig.max	N/mm^2	36.81	124.25	125.88	58.61
		Lm	m	-18.160	-12.160	-12.160	-22.091
	SKY490	M	kN.m	703.0	1852.0	2411.0	2491.0
		Sig.max	N/mm^2	66.60	175.39	228.33	235.94
		Lm	m	-8.060	-8.160	-8.060	-8.060
(SKY400)		Sig.a	N/mm^2	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm^2	280.00	280.00	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	232.6	0.0	0.0	0.0
		2nd row	kN/m	------	431.7	568.4	550.2
		3rd row	kN/m	------	------	------	80.3
		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	22.1	1129.1

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	9.499	9.487
	accrue location	Lm	m	-8.060	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	2570.0	2578.0
		Sig.	N/mm²	243.43	244.11
		Lm	m	-7.160	-7.160
	SKY400	M	kN.m	1887.0	1892.0
		Sig.max	N/mm²	178.71	179.17
		Lm	m	-3.160	-3.160
	SKY490	M	kN.m	2570.0	2578.0
		Sig.max	N/mm²	243.43	244.11
		Lm	m	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	2491.0	2499.0
		Sig.	N/mm²	235.94	236.68
		Lm	m	-8.060	-8.060
	SKY400	M	kN.m	-704.0	-702.0
		Sig.max	N/mm²	58.61	58.50
		Lm	m	-22.089	-22.105
	SKY490	M	kN.m	2491.0	2499.0
		Sig.max	N/mm²	235.94	236.68
		Lm	m	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	550.2	551.5
		3rd row	kN/m	80.3	79.6
		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	1129.1	1126.4

note)Lm shows elevation

2)perpendicular direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	3.812	8.519	9.408	9.629
	accrue location	Lm	m	-5.160	-9.160	-8.160	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	1106.0	1851.0	2437.0	2583.0
		Sig.	N/mm²	104.77	175.32	230.82	244.57
		Lm	m	-3.160	-8.060	-7.160	-7.160
	SKY400	M	kN.m	1106.0	1305.0	1850.0	1870.0
		Sig.max	N/mm²	104.77	123.56	175.18	177.09
		Lm	m	-3.160	-3.160	-3.160	-3.160
	SKY490	M	kN.m	1106.0	1851.0	2437.0	2583.0
		Sig.max	N/mm²	104.77	175.32	230.82	244.57
		Lm	m	-3.160	-8.060	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	703.0	1852.0	2413.0	2510.0
		Sig.	N/mm²	66.54	175.39	228.53	237.71
		Lm	m	-8.060	-8.160	-8.060	-8.060
	SKY400	M	kN.m	-439.0	1492.0	1515.0	731.0
		Sig.max	N/mm²	36.56	124.25	126.13	60.90
		Lm	m	-18.160	-12.160	-12.160	-12.160
	SKY490	M	kN.m	703.0	1852.0	2413.0	2510.0
		Sig.max	N/mm²	66.54	175.39	228.53	237.71
		Lm	m	-8.060	-8.160	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	232.6	0.0	0.0	0.0
		2nd row	kN/m	------	431.7	568.7	540.9
		3rd row	kN/m	------	------	------	97.0
		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	20.1	1111.4

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	9.629	9.617
	accrue location	Lm	m	-8.060	-8.060
displace coffer displace part	max bending moment	Mmax	kN.m	2583.0	2590.0
		Sig.	N/mm²	244.57	245.28
		Lm	m	-7.160	-7.160
	SKY400	M	kN.m	1870.0	1875.0
		Sig.max	N/mm²	177.09	177.55
		Lm	m	-3.160	-3.160
	SKY490	M	kN.m	2583.0	2590.0
		Sig.max	N/mm²	244.57	245.28
		Lm	m	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	2510.0	2518.0
		Sig.	N/mm²	237.71	238.47
		Lm	m	-8.060	-8.060
	SKY400	M	kN.m	731.0	743.0
		Sig.max	N/mm²	60.90	61.90
		Lm	m	-12.160	-12.160
	SKY490	M	kN.m	2510.0	2518.0
		Sig.max	N/mm²	237.71	238.47
		Lm	m	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	540.9	542.2
		3rd row	kN/m	97.0	96.3
		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	1111.4	1109.0

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	-0.190	6.131	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.117	6.131	0.0	0.0	0.00	0.0	0.0	
232.6										
	+4.340	0.3	0.117	6.131	0.0	232.6	0.00	0.0	0.0	
	+3.840	5.3	0.423	6.108	116.1	231.2	10.99	0.0	0.0	
	+2.840	15.2	1.026	5.927	343.0	221.0	32.48	0.0	0.0	
	+1.840	25.2	1.602	5.571	554.7	200.8	52.53	0.0	0.0	
	+1.340	30.2	1.875	5.333	651.7	186.9	61.72	0.0	0.0	
	+0.840	35.2	2.135	5.058	741.2	170.5	70.19	0.0	0.0	
	+0.340	40.2	2.380	4.749	821.9	151.7	77.83	0.0	0.0	
	-0.160	40.2	2.609	4.410	892.7	131.6	84.54	0.0	0.0	
	-1.160	40.2	3.014	3.659	1004.2	91.4	95.10	0.0	0.0	
	-1.660	40.2	3.187	3.255	1044.9	71.3	98.95	0.0	0.0	
	-2.160	40.1	3.339	2.836	1075.6	51.3	101.86	0.0	0.0	
	-3.160	40.1	3.580	1.972	1106.8	11.1	104.81	0.0	0.0	
	-3.160	40.1	3.580	1.972	1106.8	11.1	104.81	0.0	0.0	
	-4.160	40.1	3.733	1.100	1097.8	-29.0	103.97	0.0	0.0	
	-4.660	40.1	3.777	0.670	1078.3	-49.0	102.12	0.0	0.0	
	-5.160	40.1	3.800	0.250	1048.8	-69.1	99.32	0.0	0.0	
	-6.160	40.1	3.785	-0.545	959.7	-109.2	90.88	0.0	0.0	
	-6.276	40.1	3.778	-0.632	946.7	-113.8	89.66	0.0	0.0	
	-6.276	40.0	3.778	-0.632	946.7	-113.8	89.66	0.0	0.0	*
	-7.160	38.7	3.694	-1.255	833.3	-139.6	78.92	20.3	20.3	*
	-8.060	37.3	3.556	-1.801	703.3	-146.1	66.60	41.0	41.0	*
	-8.060	37.3	3.556	-1.801	703.3	-146.1	66.60	41.0	41.0	
	-8.160	37.1	3.538	-1.856	688.7	-145.8	65.22	40.8	43.3	
	-9.160	35.6	3.327	-2.342	544.6	-142.5	51.58	38.4	66.4	
	-10.160	34.1	3.073	-2.716	403.2	-140.4	38.19	35.4	89.4	
	-11.160	32.6	2.787	-2.979	263.2	-140.0	24.93	32.1	112.4	
	-12.060	31.2	2.512	-3.121	136.8	-141.1	12.96	29.0	133.1	
	-12.160	31.0	2.481	-3.131	122.7	-141.4	11.62	28.6	135.4	
	-12.160	31.0	2.481	-3.131	122.7	-141.4	10.22	28.6	135.4	
	-13.060	29.7	2.197	-3.168	-5.8	-144.4	0.48	25.3	156.1	
	-13.160	29.5	2.165	-3.167	-20.3	-144.9	1.69	25.0	158.4	

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
	-14.160	28.0	1.851	-3.102	-167.8	-150.5	13.97	21.3	181.4	
	-14.350	28.5	1.792	-3.078	-196.5	-151.8	16.36	89.6	248.3	
	-15.160	26.5	1.548	-2.937	-300.5	-106.5	25.03	77.4	272.4	
	-16.060	24.3	1.293	-2.723	-377.2	-65.5	31.41	64.6	299.1	
	-16.160	24.0	1.266	-2.697	-383.6	-61.5	31.94	63.3	302.1	
	-16.350	23.6	1.215	-2.645	-394.6	-54.3	32.86	60.7	307.8	
	-17.160	21.6	1.010	-2.413	-427.3	-27.6	35.58	50.5	331.9	
	-18.160	19.2	0.784	-2.110	-442.0	-3.3	36.81	39.2	361.6	
	-19.160	16.7	0.588	-1.805	-436.5	12.9	36.35	29.4	391.3	
	-19.350	12.1	0.554	-1.747	-433.8	15.2	36.13	26.1	187.4	
	-20.160	9.8	0.423	-1.508	-417.4	24.9	34.76	19.9	190.8	
	-21.160	7.0	0.286	-1.228	-388.0	33.1	32.31	13.5	195.0	
	-22.160	4.2	0.176	-0.971	-352.1	38.3	29.32	8.3	199.2	
	-23.160	1.4	0.091	-0.740	-311.9	41.8	25.98	4.3	203.4	
	-23.647	0.0	0.057	-0.638	-291.2	43.1	24.25	2.7	205.5	
	-24.160	0.0	0.027	-0.538	-268.8	44.1	22.39	1.3	209.0	
	-24.624	0.0	0.004	-0.455	-248.3	44.5	20.68	0.2	212.3	
	-25.160	0.0	-0.018	-0.367	-224.4	44.3	18.69	0.0	216.0	
	-26.160	0.0	-0.047	-0.227	-180.8	42.7	15.06	0.0	223.0	
	-27.160	0.0	-0.064	-0.116	-139.4	40.1	11.61	0.0	230.0	
	-27.350	0.0	-0.066	-0.098	-131.8	39.5	10.98	0.0	598.6	
	-28.160	0.0	-0.071	-0.032	-101.8	34.6	8.48	0.0	620.9	
	-28.160	0.0	-0.071	-0.032	-101.8	34.6	9.64	0.0	620.9	
	-28.350	0.0	-0.072	-0.018	-95.4	33.4	9.03	0.0	238.2	
	-29.160	0.0	-0.071	0.035	-69.4	30.7	6.57	0.0	243.8	
	-30.160	0.0	-0.065	0.078	-40.4	27.4	3.83	0.0	250.8	
	-30.350	0.0	-0.063	0.084	-35.2	26.9	3.34	0.0	738.2	
	-31.160	0.0	-0.056	0.100	-16.2	20.3	1.53	0.0	761.7	
	-32.160	0.0	-0.046	0.106	0.6	13.5	0.06	0.0	790.7	
	-33.160	0.0	-0.035	0.101	11.3	8.1	1.07	0.0	819.7	
	-34.160	0.0	-0.026	0.089	17.3	4.0	1.63	0.0	848.8	
	-34.444	0.0	-0.023	0.085	18.3	3.1	1.73	0.0	857.0	
	-35.160	0.0	-0.017	0.074	19.7	1.1	1.87	0.0	879.2	
	-36.160	0.0	-0.011	0.059	19.8	-0.8	1.88	0.0	910.3	
	-36.350	0.0	-0.010	0.056	19.7	-1.0	1.86	0.0	988.4	
	-37.065	0.0	-0.006	0.045	18.5	-2.2	1.75	0.0	1012.2	

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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
	-37.160	0.0	-0.006	0.043	18.3	-2.3	1.73	0.0	1015.4	
	-38.160	0.0	-0.002	0.030	15.6	-3.0	1.47	0.0	1048.8	
	-39.160	0.0	0.000	0.019	12.4	-3.2	1.17	0.1	1082.2	
	-40.160	0.0	0.002	0.010	9.3	-3.0	0.88	0.4	1115.6	
	-41.160	0.0	0.003	0.004	6.5	-2.5	0.62	0.5	1149.0	
	-42.160	0.0	0.003	0.000	4.3	-2.0	0.40	0.5	1182.4	
	-43.160	0.0	0.003	-0.003	2.6	-1.5	0.24	0.5	1215.8	
	-44.160	0.0	0.002	-0.004	1.3	-1.0	0.13	0.4	1249.2	
	-45.160	0.0	0.002	-0.005	0.6	-0.6	0.06	0.4	1282.6	
	-46.160	0.0	0.001	-0.005	0.2	-0.3	0.02	0.2	1316.0	
	-46.350	0.0	0.001	-0.005	0.1	-0.2	0.01	0.2	716.2	
	-47.160	0.0	0.001	-0.005	0.0	-0.1	0.00	0.1	723.5	
	-48.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.0	732.5	
	-49.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.0	741.5	

*showing plastic

(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	-1.589	10.135	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.082	10.135	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.082	10.135	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.576	10.135	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.438	10.137	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.452	10.149	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.960	10.163	-46.1	-45.7	4.37	0.0	0.0	
431.7										
	+1.340	30.2	1.960	10.163	-46.1	386.0	4.37	0.0	0.0	
	+0.840	35.2	2.468	10.143	142.9	369.6	13.53	0.0	0.0	
	+0.340	40.2	2.973	10.051	323.1	350.8	30.60	0.0	0.0	
	-0.160	40.2	3.472	9.890	493.4	330.7	46.73	0.0	0.0	
	-1.160	40.2	4.437	9.375	804.0	290.5	76.14	0.0	0.0	
	-1.660	40.2	4.897	9.030	944.3	270.4	89.42	0.0	0.0	
	-2.160	40.1	5.339	8.631	1074.5	250.4	101.75	0.0	0.0	
	-3.160	40.1	6.157	7.690	1304.8	210.2	123.56	0.0	0.0	
	-3.160	40.1	6.157	7.690	1304.8	210.2	123.56	0.0	0.0	
	-4.160	40.1	6.872	6.583	1494.9	170.1	141.57	0.0	0.0	
	-4.660	40.1	7.186	5.977	1574.9	150.0	149.15	0.0	0.0	
	-5.160	40.1	7.469	5.341	1645.0	130.0	155.78	0.0	0.0	
	-6.160	40.1	7.936	3.997	1754.9	89.9	166.19	0.0	0.0	
	-6.276	40.0	7.982	3.836	1765.1	85.3	167.15	0.0	0.0	
	-7.160	42.1	8.266	2.582	1824.5	49.0	172.79	0.0	0.0	
	-8.060	44.3	8.439	1.274	1851.2	10.0	175.32	0.0	0.0	
	-8.160	44.6	8.451	1.128	1852.0	5.6	175.39	0.0	0.0	
	-9.160	47.0	8.491	-0.330	1834.9	-40.2	173.77	0.0	0.0	
	-10.160	49.4	8.386	-1.756	1770.8	-88.4	167.70	0.0	0.0	
	-11.160	51.9	8.142	-3.112	1657.3	-139.1	156.95	0.0	0.0	
	-12.060	54.0	7.811	-4.239	1510.9	-186.7	143.08	0.0	0.0	
	-12.160	54.3	7.768	-4.358	1491.9	-192.1	141.29	0.0	0.0	
	-12.160	54.3	7.768	-4.358	1491.9	-192.1	124.25	0.0	0.0	
	-13.060	56.5	7.335	-5.231	1296.7	-242.0	107.99	0.0	0.0	
	-13.160	56.7	7.283	-5.320	1272.2	-247.6	105.95	0.0	0.0	
	-14.160	59.1	6.709	-6.111	995.8	-305.6	82.93	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
	-14.350	56.7	6.592	-6.238	936.7	-316.9	78.01	0.0	0.0	
	-14.560	57.1	6.460	-6.370	868.9	-328.8	72.36	0.0	0.0	
	-14.560	57.1	6.460	-6.370	868.9	-328.8	72.36	0.0	0.0	*
	-15.160	55.6	6.067	-6.689	662.5	-357.3	55.17	17.8	17.8	*
	-16.060	53.4	5.450	-7.000	329.6	-378.2	27.45	44.6	44.6	*
	-16.160	53.2	5.380	-7.022	291.7	-379.0	24.29	47.6	47.6	*
	-16.350	52.7	5.246	-7.055	219.6	-379.4	18.29	53.2	53.2	*
	-17.160	50.7	4.672	-7.093	-84.7	-368.5	7.05	77.3	77.3	*
	-18.160	48.3	3.970	-6.910	-434.5	-325.8	36.19	107.1	107.1	*
	-19.160	45.9	3.297	-6.503	-725.6	-251.0	60.43	136.8	136.8	*
	-19.350	45.4	3.175	-6.405	-771.6	-233.1	64.26	142.4	142.4	*
	-19.350	30.0	3.175	-6.405	-771.6	-233.1	64.26	149.5	167.8	
	-20.160	27.7	2.675	-5.925	-923.6	-145.0	76.92	126.0	171.2	
	-21.160	24.9	2.116	-5.244	-1023.5	-58.8	85.24	99.7	175.4	
	-22.160	22.1	1.627	-4.521	-1048.5	5.6	87.32	76.6	179.6	
	-23.160	19.3	1.211	-3.801	-1018.6	51.4	84.83	57.1	183.8	
	-24.160	16.5	0.866	-3.116	-950.7	82.2	79.17	40.8	188.0	
	-25.160	13.7	0.586	-2.488	-858.2	101.0	71.47	27.6	192.2	
	-26.160	10.9	0.366	-1.928	-751.6	110.9	62.59	17.2	196.4	
	-27.160	8.1	0.198	-1.446	-638.4	114.6	53.17	9.3	200.6	
	-27.350	18.5	0.171	-1.363	-616.6	114.7	51.35	15.0	362.0	
	-28.160	16.4	0.074	-1.042	-525.6	109.1	43.77	6.5	384.3	
	-28.160	16.4	0.074	-1.042	-525.6	109.1	49.77	6.5	384.3	
	-28.350	5.8	0.055	-0.965	-505.0	107.1	47.83	2.6	206.4	
	-29.160	3.5	-0.011	-0.670	-419.4	104.1	39.72	0.0	209.8	
	-30.160	0.7	-0.062	-0.379	-317.3	100.2	30.05	0.0	214.0	
	-30.350	9.6	-0.069	-0.333	-298.3	99.5	28.25	0.0	483.6	
	-31.160	7.0	-0.089	-0.167	-224.0	84.0	21.21	0.0	507.1	
	-32.160	3.9	-0.098	-0.021	-149.2	65.8	14.13	0.0	536.2	
	-33.160	0.7	-0.095	0.073	-91.4	50.4	8.66	0.0	565.2	
	-33.392	0.0	-0.093	0.089	-80.1	47.4	7.58	0.0	571.9	
	-34.160	0.0	-0.085	0.127	-47.3	38.2	4.48	0.0	594.2	
	-34.616	0.0	-0.079	0.141	-31.0	33.2	2.94	0.0	607.5	
	-35.160	0.0	-0.071	0.151	-14.5	27.7	1.37	0.0	623.2	
	-36.160	0.0	-0.055	0.152	8.9	19.3	0.84	0.0	652.3	
	-36.350	0.0	-0.052	0.151	12.4	17.9	1.17	0.0	711.9	

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
	-37.160	0.0	-0.041	0.139	23.7	10.3	2.24	0.0	736.5	
	-38.160	0.0	-0.028	0.117	30.3	3.4	2.87	0.0	767.0	
	-39.160	0.0	-0.017	0.093	31.3	-1.1	2.97	0.0	797.4	
	-40.160	0.0	-0.009	0.069	28.8	-3.7	2.73	0.0	827.9	
	-41.160	0.0	-0.003	0.048	24.4	-4.9	2.31	0.0	858.3	
	-42.160	0.0	0.000	0.030	19.3	-5.2	1.83	0.1	888.8	
	-43.160	0.0	0.003	0.017	14.3	-4.8	1.35	0.6	919.2	
	-44.160	0.0	0.004	0.008	9.8	-4.1	0.93	0.8	949.7	
	-45.084	0.0	0.004	0.002	6.4	-3.3	0.60	0.9	977.8	
	-45.160	0.0	0.004	0.001	6.1	-3.2	0.58	0.9	980.4	
	-46.160	0.0	0.004	-0.002	3.3	-2.3	0.31	0.9	1013.8	
	-46.350	0.0	0.004	-0.003	2.9	-2.2	0.27	0.9	658.2	
	-47.160	0.0	0.004	-0.004	1.4	-1.5	0.13	0.8	665.5	
	-48.160	0.0	0.004	-0.005	0.3	-0.7	0.03	0.7	674.5	
	-49.160	0.0	0.003	-0.005	0.0	0.0	0.00	0.6	683.5	

*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	-2.366	12.431	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.744	12.431	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.744	12.431	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.123	12.431	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.120	12.433	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.364	12.445	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.987	12.459	-46.1	-45.7	4.37	0.0	0.0	
568.4										
	+1.340	30.2	1.987	12.459	-46.1	522.7	4.37	0.0	0.0	
	+0.840	35.2	2.609	12.426	211.2	506.4	20.00	0.0	0.0	
	-0.160	45.2	3.837	12.064	698.3	466.2	66.13	0.0	0.0	
	-1.160	55.2	5.010	11.336	1140.2	416.0	107.98	0.0	0.0	
	-1.660	60.2	5.565	10.846	1341.1	387.2	127.01	0.0	0.0	
	-2.160	65.1	6.093	10.279	1527.0	355.8	144.61	0.0	0.0	
	-2.660	70.1	6.591	9.643	1696.5	322.0	160.66	0.0	0.0	
	-3.160	70.1	7.056	8.943	1848.8	286.9	175.08	0.0	0.0	
	-3.160	70.1	7.056	8.943	1848.8	286.9	175.08	0.0	0.0	
	-4.160	70.1	7.874	7.380	2100.6	216.8	198.93	0.0	0.0	
	-4.660	70.1	8.222	6.531	2200.3	181.8	208.37	0.0	0.0	
	-5.160	70.1	8.526	5.646	2282.4	146.7	216.15	0.0	0.0	
	-6.160	70.1	8.999	3.796	2394.1	76.6	226.72	0.0	0.0	
	-6.276	70.0	9.042	3.576	2402.5	68.5	227.52	0.0	0.0	
	-7.160	72.1	9.284	1.885	2435.5	5.7	230.64	0.0	0.0	
	-8.060	74.3	9.376	0.161	2411.1	-60.2	228.33	0.0	0.0	
	-8.160	74.6	9.376	-0.029	2404.7	-67.7	227.72	0.0	0.0	
	-9.160	77.0	9.279	-1.891	2299.3	-143.5	217.75	0.0	0.0	
	-10.160	79.4	9.002	-3.638	2116.9	-221.7	200.48	0.0	0.0	
	-11.160	81.9	8.558	-5.211	1855.1	-302.3	175.68	0.0	0.0	
	-12.060	84.0	8.032	-6.424	1549.6	-377.0	146.75	0.0	0.0	
	-12.160	84.3	7.968	-6.545	1511.5	-385.4	143.14	0.0	0.0	
	-12.160	84.3	7.968	-6.545	1511.5	-385.4	125.88	0.0	0.0	
	-13.060	86.5	7.340	-7.373	1135.7	-462.3	94.58	0.0	0.0	
22.1										
	-13.060	86.5	7.340	-7.373	1135.7	-440.2	94.58	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
	-13.160	86.7	7.265	-7.450	1090.2	-448.8	90.79	0.0	0.0	
	-14.160	89.1	6.488	-8.038	593.1	-536.8	49.39	0.0	0.0	
	-14.350	86.7	6.335	-8.109	489.5	-553.7	40.77	0.0	0.0	
	-14.560	87.1	6.164	-8.172	371.3	-572.0	30.92	0.0	0.0	
	-14.560	73.0	6.164	-8.172	371.3	-572.0	30.92	137.5	137.5	*
	-15.160	71.5	5.670	-8.257	40.9	-527.5	3.41	155.4	155.4	*
	-16.060	69.3	4.930	-8.142	-395.9	-438.9	32.97	182.1	182.1	*
	-16.160	69.1	4.849	-8.113	-439.3	-427.5	36.58	185.1	185.1	*
	-16.350	68.6	4.695	-8.050	-518.3	-404.9	43.17	190.8	190.8	*
	-16.977	67.1	4.199	-7.773	-746.8	-322.0	62.19	209.4	209.4	*
	-16.977	67.1	4.199	-7.773	-746.8	-322.0	62.19	209.9	209.4	
	-17.160	66.6	4.057	-7.674	-803.4	-296.4	66.91	202.8	214.9	
	-18.160	64.2	3.321	-7.028	-1037.6	-177.7	86.41	166.0	244.6	
	-19.160	61.7	2.656	-6.257	-1169.7	-91.6	97.42	132.7	274.3	
	-19.350	29.4	2.539	-6.102	-1185.9	-78.6	98.76	119.6	168.2	
	-20.160	27.1	2.072	-5.423	-1222.2	-13.8	101.79	97.6	171.6	
	-21.160	24.3	1.572	-4.577	-1204.4	46.0	100.30	74.0	175.8	
	-22.160	21.5	1.155	-3.763	-1136.6	86.9	94.65	54.4	180.0	
	-23.160	18.7	0.817	-3.007	-1035.5	113.0	86.24	38.5	184.2	
	-24.160	15.9	0.551	-2.330	-914.4	127.6	76.15	26.0	188.4	
	-25.160	13.1	0.348	-1.741	-783.0	134.1	65.21	16.4	192.6	
	-26.160	10.3	0.200	-1.244	-648.0	135.1	53.97	9.4	196.8	
	-27.160	7.5	0.096	-0.841	-513.7	133.1	42.78	4.5	201.0	
	-27.350	33.9	0.081	-0.775	-488.5	132.5	40.68	7.1	490.0	
	-28.160	31.9	0.029	-0.529	-390.3	109.6	32.51	2.5	512.3	
	-28.160	31.9	0.029	-0.529	-390.3	109.6	36.96	2.5	512.3	
	-28.350	5.2	0.019	-0.472	-370.0	104.0	35.04	0.9	206.8	
	-29.160	2.9	-0.010	-0.262	-287.1	100.8	27.19	0.0	210.2	
	-30.160	0.1	-0.026	-0.075	-187.7	98.4	17.77	0.0	214.4	
	-30.201	0.0	-0.027	-0.069	-183.6	98.3	17.39	0.0	214.6	
	-30.350	25.5	-0.028	-0.048	-169.0	98.1	16.01	0.0	621.2	
	-31.160	22.9	-0.028	0.037	-98.9	75.4	9.36	0.0	644.7	
	-32.160	19.8	-0.021	0.088	-36.1	50.8	3.42	0.0	673.7	
	-33.160	16.6	-0.011	0.100	4.1	30.4	0.39	0.0	702.7	
	-34.160	13.5	-0.002	0.087	26.1	14.5	2.48	0.0	731.8	
	-35.160	10.3	0.006	0.062	34.4	2.8	3.26	0.7	760.8	

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	7.2	0.010	0.035	33.2	-4.8	3.14	1.4	789.8	
	-36.350	8.0	0.011	0.030	32.1	-5.8	3.04	2.2	859.8	
	-37.160	4.7	0.013	0.011	25.9	-9.0	2.46	2.5	884.4	
	-38.160	0.7	0.013	-0.006	16.5	-9.1	1.56	2.6	914.9	
	-38.325	0.0	0.013	-0.008	15.0	-8.8	1.42	2.6	919.9	
	-39.160	0.0	0.012	-0.015	8.6	-6.7	0.81	2.4	945.4	
	-39.574	0.0	0.011	-0.018	6.0	-5.7	0.57	2.2	958.0	
	-40.160	0.0	0.010	-0.020	3.0	-4.5	0.29	2.0	975.8	
	-41.160	0.0	0.008	-0.021	-0.5	-2.7	0.05	1.6	1006.3	
	-42.160	0.0	0.006	-0.019	-2.4	-1.3	0.23	1.2	1036.7	
	-43.160	0.0	0.004	-0.017	-3.2	-0.3	0.30	0.8	1067.2	
	-44.160	0.0	0.003	-0.015	-3.1	0.4	0.30	0.5	1097.6	
	-45.160	0.0	0.001	-0.012	-2.5	0.7	0.24	0.2	1128.1	
	-46.160	0.0	0.000	-0.011	-1.7	0.9	0.16	0.0	1158.5	
	-46.350	0.0	0.000	-0.010	-1.6	0.9	0.15	0.0	659.2	
	-47.160	0.0	-0.001	-0.010	-0.9	0.8	0.08	0.0	666.5	
	-48.160	0.0	-0.002	-0.009	-0.3	0.5	0.02	0.0	675.5	
	-49.160	0.0	-0.003	-0.009	0.0	0.0	0.00	0.0	684.5	

*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	-2.435	12.618	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.173	12.618	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.089	12.619	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.351	12.631	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.983	12.645	-46.1	-45.7	4.37	0.0	0.0	
550.2										
	+1.340	30.2	1.983	12.645	-46.1	504.5	4.37	0.0	0.0	
	+0.840	35.2	2.615	12.614	202.1	488.2	19.14	0.0	0.0	
	-0.160	45.2	3.862	12.267	671.0	448.0	63.55	0.0	0.0	
	-1.160	55.2	5.057	11.567	1094.7	397.8	103.67	0.0	0.0	
	-1.660	60.2	5.623	11.097	1286.5	369.0	121.84	0.0	0.0	
80.3										
	-1.660	60.2	5.623	11.097	1286.5	449.2	121.84	0.0	0.0	
	-2.160	65.1	6.165	10.546	1503.4	417.9	142.38	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-4.160	85.1	7.996	7.587	2195.7	267.7	207.93	0.0	0.0	
	-4.660	90.1	8.354	6.696	2318.6	223.9	219.58	0.0	0.0	
	-5.160	95.1	8.665	5.760	2419.1	177.6	229.09	0.0	0.0	
	-6.160	105.1	9.144	3.794	2547.5	77.5	241.25	0.0	0.0	
	-6.276	106.2	9.186	3.560	2555.7	65.2	242.03	0.0	0.0	
	-7.160	117.1	9.422	1.767	2570.5	-33.5	243.43	0.0	0.0	
	-8.060	128.3	9.499	-0.037	2491.4	-143.9	235.94	0.0	0.0	
	-8.160	129.6	9.498	-0.233	2476.4	-156.8	234.52	0.0	0.0	
	-9.160	142.0	9.379	-2.108	2252.7	-292.6	213.33	0.0	0.0	
	-10.160	154.4	9.084	-3.751	1887.0	-440.8	178.70	0.0	0.0	
	-11.160	166.9	8.641	-5.045	1366.9	-601.5	129.44	0.0	0.0	
	-12.060	178.0	8.149	-5.808	756.4	-756.7	71.63	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	64.65	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	56.86	0.0	0.0	
	-13.060	190.5	7.551	-6.056	190.9	-941.0	15.90	0.0	0.0	
1129.1										

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
	-13.060	190.5	7.551	-6.056	190.9	188.2	15.90	0.0	0.0	
	-13.160	191.7	7.490	-6.050	155.1	169.1	12.92	0.0	0.0	
	-14.160	204.1	6.886	-6.035	-2.4	-28.9	0.20	0.0	0.0	
	-14.350	203.6	6.772	-6.035	-11.5	-67.9	0.96	0.0	0.0	
	-14.560	206.1	6.645	-6.032	-30.3	-110.9	2.52	0.0	0.0	
	-14.560	192.0	6.645	-6.032	-30.3	-110.9	2.52	137.5	137.5	*
	-15.160	190.5	6.284	-6.004	-105.5	-137.8	8.78	155.4	155.4	*
	-16.060	188.3	5.748	-5.897	-239.8	-156.3	19.97	182.1	182.1	*
	-16.160	188.1	5.689	-5.880	-255.4	-156.8	21.27	185.1	185.1	*
	-16.350	187.6	5.577	-5.844	-285.3	-156.8	23.76	190.8	190.8	*
	-17.160	185.6	5.112	-5.649	-408.4	-143.7	34.01	214.9	214.9	*
	-17.867	183.9	4.720	-5.425	-500.7	-115.0	41.70	235.9	235.9	*
	-17.867	183.9	4.720	-5.425	-500.7	-115.0	41.70	235.9	235.9	
	-18.160	183.2	4.562	-5.320	-532.3	-100.8	44.33	228.0	244.6	
	-19.160	180.7	4.050	-4.920	-614.6	-67.7	51.18	202.4	274.3	
	-19.350	180.3	3.957	-4.838	-627.1	-63.9	52.22	197.8	280.0	
	-19.350	100.8	3.957	-4.838	-627.1	-63.9	52.22	120.6	120.6	*
	-20.160	98.5	3.580	-4.472	-671.7	-45.6	55.94	124.0	124.0	*
	-21.160	95.7	3.157	-3.993	-703.4	-16.6	58.58	128.2	128.2	*
	-22.091	93.1	2.806	-3.537	-703.8	16.7	58.61	132.1	132.1	*
	-22.091	93.1	2.806	-3.537	-703.8	16.7	58.61	132.2	132.1	
	-22.160	92.9	2.782	-3.503	-702.5	19.4	58.51	131.0	132.4	
	-23.160	90.1	2.455	-3.027	-666.3	51.0	55.49	115.7	136.6	
	-24.160	87.3	2.175	-2.585	-604.3	71.2	50.33	102.5	140.8	
	-25.160	84.5	1.937	-2.191	-527.0	82.0	43.89	91.2	145.0	
	-26.160	81.7	1.735	-1.855	-442.8	85.3	36.88	81.7	149.2	
	-27.160	78.9	1.564	-1.577	-358.4	82.6	29.85	73.7	153.4	
	-27.350	152.9	1.535	-1.531	-342.8	81.5	28.55	134.2	490.0	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	23.64	124.0	512.3	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	26.88	124.0	512.3	
	-28.350	76.6	1.393	-1.313	-272.4	57.7	25.80	65.6	159.2	
	-29.160	74.3	1.293	-1.153	-229.6	47.8	21.74	60.9	162.6	
	-30.160	71.5	1.186	-0.989	-188.9	33.2	17.89	55.9	166.8	
	-30.350	144.5	1.167	-0.961	-182.9	30.1	17.32	157.1	621.2	
	-31.160	141.9	1.094	-0.853	-155.2	37.3	14.70	147.2	644.7	
	-32.160	138.8	1.014	-0.746	-116.5	38.7	11.04	136.5	673.7	

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
	-33.160	135.6	0.944	-0.668	-80.1	33.2	7.58	127.0	702.7	
	-34.160	132.5	0.880	-0.617	-52.1	21.8	4.94	118.4	731.8	
	-35.160	129.3	0.820	-0.582	-38.2	5.2	3.62	110.3	760.8	
	-36.160	126.2	0.763	-0.552	-43.2	-16.0	4.09	102.7	789.8	
	-36.350	127.0	0.753	-0.545	-46.7	-20.5	4.42	151.9	859.8	
	-37.160	123.7	0.710	-0.511	-55.8	-2.6	5.28	143.3	884.4	
	-38.160	119.7	0.661	-0.469	-49.5	14.0	4.69	133.4	914.9	
	-39.160	115.6	0.616	-0.437	-29.5	25.2	2.79	124.3	945.4	
	-40.160	111.6	0.573	-0.425	-0.8	31.5	0.07	115.6	975.8	
	-41.160	107.5	0.530	-0.437	32.1	33.4	3.04	107.0	1006.3	
	-42.160	103.5	0.485	-0.475	64.4	30.4	6.09	97.8	1036.7	
	-43.160	99.4	0.434	-0.537	90.9	21.8	8.61	87.7	1067.2	
	-44.160	95.3	0.377	-0.615	105.6	6.4	10.00	76.0	1097.6	
	-45.160	91.3	0.311	-0.699	100.9	-17.4	9.56	62.8	1128.1	
	-46.160	87.2	0.238	-0.767	67.5	-51.2	6.40	47.9	1158.5	
	-46.350	8.9	0.223	-0.777	57.1	-58.8	5.41	45.0	569.6	
	-47.160	0.8	0.159	-0.800	20.7	-31.6	1.96	32.1	568.8	
	-47.241	0.0	0.152	-0.802	18.3	-29.1	1.73	30.8	568.7	
	-48.160	0.0	0.078	-0.808	2.5	-7.7	0.23	15.8	567.8	
	-48.240	0.0	0.072	-0.808	1.9	-6.4	0.18	14.5	567.7	
	-49.160	0.0	-0.003	-0.808	0.0	0.0	0.00	0.0	566.7	

*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	-2.435	12.618	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.804	12.618	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.173	12.618	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.089	12.619	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.351	12.631	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.983	12.645	-46.1	-45.7	4.37	0.0	0.0	
550.2										
	+1.340	30.2	1.983	12.645	-46.1	504.5	4.37	0.0	0.0	
	+0.840	35.2	2.615	12.614	202.1	488.2	19.14	0.0	0.0	
	-0.160	45.2	3.862	12.267	671.0	448.0	63.55	0.0	0.0	
	-1.160	55.2	5.057	11.567	1094.7	397.8	103.67	0.0	0.0	
	-1.660	60.2	5.623	11.097	1286.5	369.0	121.84	0.0	0.0	
80.3										
	-1.660	60.2	5.623	11.097	1286.5	449.2	121.84	0.0	0.0	
	-2.160	65.1	6.165	10.546	1503.4	417.9	142.38	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-3.160	75.1	7.155	9.203	1887.1	347.8	178.71	0.0	0.0	
	-4.160	85.1	7.996	7.587	2195.7	267.7	207.93	0.0	0.0	
	-4.660	90.1	8.354	6.696	2318.6	223.9	219.58	0.0	0.0	
0.0										
	-4.660	90.1	8.354	6.696	2318.6	223.9	219.58	0.0	0.0	
	-5.160	95.1	8.665	5.760	2419.1	177.6	229.09	0.0	0.0	
	-6.160	105.1	9.144	3.794	2547.5	77.5	241.25	0.0	0.0	
	-6.276	106.2	9.186	3.560	2555.7	65.2	242.03	0.0	0.0	
	-7.160	117.1	9.422	1.767	2570.5	-33.5	243.43	0.0	0.0	
	-8.060	128.3	9.499	-0.037	2491.4	-143.9	235.94	0.0	0.0	
	-8.160	129.6	9.498	-0.233	2476.4	-156.8	234.52	0.0	0.0	
	-9.160	142.0	9.379	-2.108	2252.7	-292.6	213.33	0.0	0.0	
	-10.160	154.4	9.084	-3.751	1887.0	-440.8	178.70	0.0	0.0	
	-11.160	166.9	8.641	-5.045	1366.9	-601.5	129.44	0.0	0.0	
	-12.060	178.0	8.149	-5.808	756.4	-756.7	71.63	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	64.65	0.0	0.0	
	-12.160	179.3	8.091	-5.864	682.7	-774.6	56.86	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
	-13.060	190.5	7.551	-6.056	190.9	-941.0	15.90	0.0	0.0	
1129.1										
	-13.060	190.5	7.551	-6.056	190.9	188.2	15.90	0.0	0.0	
	-13.160	191.7	7.490	-6.050	155.1	169.1	12.92	0.0	0.0	
	-14.160	204.1	6.886	-6.035	-2.4	-28.9	0.20	0.0	0.0	
	-14.350	203.6	6.772	-6.035	-11.5	-67.9	0.96	0.0	0.0	
	-14.560	206.1	6.645	-6.032	-30.3	-110.9	2.52	0.0	0.0	
	-14.560	192.0	6.645	-6.032	-30.3	-110.9	2.52	137.5	137.5	*
	-15.160	190.5	6.284	-6.004	-105.5	-137.8	8.78	155.4	155.4	*
	-16.060	188.3	5.748	-5.897	-239.8	-156.3	19.97	182.1	182.1	*
	-16.160	188.1	5.689	-5.880	-255.4	-156.8	21.27	185.1	185.1	*
	-16.350	187.6	5.577	-5.844	-285.3	-156.8	23.76	190.8	190.8	*
	-17.160	185.6	5.112	-5.649	-408.4	-143.7	34.01	214.9	214.9	*
	-17.871	183.9	4.718	-5.423	-501.2	-114.7	41.74	236.0	236.0	*
	-17.871	183.9	4.718	-5.423	-501.2	-114.7	41.74	235.8	236.0	
	-18.160	183.2	4.562	-5.320	-532.3	-100.8	44.33	228.0	244.6	
	-19.160	180.7	4.050	-4.920	-614.6	-67.7	51.18	202.4	274.3	
	-19.350	180.3	3.957	-4.838	-627.1	-63.9	52.22	197.8	280.0	
	-19.350	100.8	3.957	-4.838	-627.1	-63.9	52.22	120.6	120.6	*
	-20.160	98.5	3.580	-4.472	-671.7	-45.6	55.94	124.0	124.0	*
	-21.160	95.7	3.157	-3.993	-703.4	-16.6	58.58	128.2	128.2	*
	-22.089	93.1	2.807	-3.538	-703.8	16.7	58.61	132.1	132.1	*
	-22.089	93.1	2.807	-3.538	-703.8	16.7	58.61	132.2	132.1	
	-22.160	92.9	2.782	-3.503	-702.5	19.4	58.51	131.0	132.4	
	-23.160	90.1	2.455	-3.027	-666.3	51.0	55.49	115.7	136.6	
	-24.160	87.3	2.175	-2.585	-604.3	71.2	50.33	102.5	140.8	
	-25.160	84.5	1.937	-2.191	-527.0	82.0	43.89	91.2	145.0	
	-26.160	81.7	1.735	-1.855	-442.8	85.3	36.88	81.7	149.2	
	-27.160	78.9	1.564	-1.577	-358.4	82.6	29.85	73.7	153.4	
	-27.350	152.9	1.535	-1.531	-342.8	81.5	28.55	134.2	490.0	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	23.64	124.0	512.3	
	-28.160	150.9	1.418	-1.355	-283.9	63.0	26.88	124.0	512.3	
	-28.350	76.6	1.393	-1.313	-272.4	57.7	25.80	65.6	159.2	
	-29.160	74.3	1.293	-1.153	-229.6	47.8	21.74	60.9	162.6	
	-30.160	71.5	1.186	-0.989	-188.9	33.2	17.89	55.9	166.8	
	-30.350	144.5	1.167	-0.961	-182.9	30.1	17.32	157.1	621.2	

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
	-31.160	141.9	1.094	-0.853	-155.2	37.3	14.70	147.2	644.7	
	-32.160	138.8	1.014	-0.746	-116.5	38.7	11.04	136.5	673.7	
	-33.160	135.6	0.944	-0.668	-80.1	33.2	7.58	127.0	702.7	
	-34.160	132.5	0.880	-0.617	-52.1	21.8	4.94	118.4	731.8	
	-35.160	129.3	0.820	-0.582	-38.2	5.2	3.62	110.3	760.8	
	-36.160	126.2	0.763	-0.552	-43.2	-16.0	4.09	102.7	789.8	
	-36.350	127.0	0.753	-0.545	-46.7	-20.5	4.42	151.9	859.8	
	-37.160	123.7	0.710	-0.511	-55.8	-2.6	5.28	143.3	884.4	
	-38.160	119.7	0.661	-0.469	-49.5	14.0	4.69	133.4	914.9	
	-39.160	115.6	0.616	-0.437	-29.5	25.2	2.79	124.3	945.4	
	-40.160	111.6	0.573	-0.425	-0.8	31.5	0.07	115.6	975.8	
	-41.160	107.5	0.530	-0.437	32.1	33.4	3.04	107.0	1006.3	
	-42.160	103.5	0.485	-0.475	64.4	30.4	6.09	97.8	1036.7	
	-43.160	99.4	0.434	-0.537	90.9	21.8	8.61	87.7	1067.2	
	-44.160	95.3	0.377	-0.615	105.6	6.4	10.00	76.0	1097.6	
	-45.160	91.3	0.311	-0.699	100.9	-17.4	9.56	62.8	1128.1	
	-46.160	87.2	0.238	-0.767	67.5	-51.2	6.40	47.9	1158.5	
	-46.350	8.9	0.223	-0.777	57.1	-58.8	5.41	45.0	569.6	
	-47.160	0.8	0.159	-0.800	20.7	-31.6	1.96	32.1	568.8	
	-47.241	0.0	0.152	-0.802	18.3	-29.1	1.73	30.8	568.7	
	-48.160	0.0	0.078	-0.808	2.5	-7.7	0.23	15.8	567.8	
	-48.240	0.0	0.072	-0.808	1.9	-6.4	0.18	14.5	567.7	
	-49.160	0.0	-0.003	-0.808	0.0	0.0	0.00	0.0	566.7	

*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	-2.434	12.617	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.803	12.617	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.803	12.617	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.173	12.617	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.089	12.618	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.351	12.630	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.983	12.644	-46.1	-45.7	4.37	0.0	0.0	
551.5										
	+1.340	30.2	1.983	12.644	-46.1	505.8	4.37	0.0	0.0	
	+0.840	35.2	2.615	12.613	202.8	489.4	19.20	0.0	0.0	
	-0.160	45.2	3.862	12.265	673.0	449.3	63.73	0.0	0.0	
	-1.160	55.2	5.056	11.563	1098.0	399.1	103.98	0.0	0.0	
	-1.660	60.2	5.623	11.091	1290.4	370.3	122.20	0.0	0.0	
79.6										
	-1.660	60.2	5.623	11.091	1290.4	449.9	122.20	0.0	0.0	
	-2.160	65.1	6.164	10.538	1507.6	418.5	142.77	0.0	0.0	
	-3.160	75.1	7.153	9.192	1891.9	348.4	179.17	0.0	0.0	
	-3.160	75.1	7.153	9.192	1891.9	348.4	179.17	0.0	0.0	
	-4.160	85.1	7.993	7.572	2201.1	268.3	208.44	0.0	0.0	
	-4.660	90.1	8.350	6.679	2324.3	224.5	220.12	0.0	0.0	
0.0										
	-4.660	90.1	8.350	6.679	2324.3	224.5	220.12	0.0	0.0	
	-5.160	95.1	8.660	5.741	2425.1	178.2	229.66	0.0	0.0	
	-6.160	105.1	9.137	3.769	2554.1	78.1	241.87	0.0	0.0	
	-6.276	106.2	9.179	3.535	2562.4	65.8	242.67	0.0	0.0	
	-7.160	117.1	9.412	1.737	2577.7	-32.9	244.11	0.0	0.0	
	-8.060	950058.6	9.487	-0.072	2499.2	-143.3	236.68	0.0	0.0	
	-8.160	949925.1	9.485	-0.268	2478.0	-280.7	234.67	0.0	0.0	
	-9.160	938089.1	9.365	-2.103	2227.4	-256.3	210.94	0.0	0.0	
	-10.160	908568.8	9.072	-3.717	1882.2	-410.0	178.25	0.0	0.0	
	-11.160	864258.3	8.633	-4.998	1376.3	-546.9	130.34	0.0	0.0	
	-12.060	178.0	8.145	-5.765	768.2	-755.4	72.75	0.0	0.0	
	-12.160	179.3	8.087	-5.823	694.6	-773.3	65.78	0.0	0.0	
	-12.160	179.3	8.087	-5.823	694.6	-773.3	57.85	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
	-13.060	190.5	7.550	-6.022	203.3	-939.7	16.93	0.0	0.0	
1126.4										
	-13.060	190.5	7.550	-6.022	203.3	186.7	16.93	0.0	0.0	
	-13.160	191.7	7.490	-6.017	167.5	167.6	13.95	0.0	0.0	
	-14.160	204.1	6.889	-6.011	9.0	-30.4	0.75	0.0	0.0	
	-14.350	203.6	6.775	-6.012	-0.4	-69.4	0.04	0.0	0.0	
	-14.560	206.1	6.649	-6.010	-19.5	-112.4	1.63	0.0	0.0	
	-14.560	192.0	6.649	-6.010	-19.5	-112.4	1.63	137.5	137.5	*
	-15.160	190.5	6.289	-5.987	-95.6	-139.3	7.96	155.4	155.4	*
	-16.060	188.3	5.754	-5.886	-231.3	-157.9	19.26	182.1	182.1	*
	-16.160	188.1	5.695	-5.869	-247.1	-158.3	20.58	185.1	185.1	*
	-16.350	187.6	5.584	-5.834	-277.2	-158.3	23.09	190.8	190.8	*
	-17.160	185.6	5.118	-5.643	-401.5	-145.2	33.44	214.9	214.9	*
	-17.868	183.9	4.726	-5.422	-495.1	-116.4	41.23	235.9	235.9	*
	-17.868	183.9	4.726	-5.422	-495.1	-116.4	41.23	236.2	235.9	
	-18.160	183.2	4.570	-5.318	-527.0	-102.2	43.89	228.4	244.6	
	-19.160	180.7	4.057	-4.922	-610.5	-68.7	50.84	202.8	274.3	
	-19.350	180.3	3.964	-4.841	-623.2	-64.9	51.90	198.1	280.0	
	-19.350	100.8	3.964	-4.841	-623.2	-64.9	51.90	120.6	120.6	*
	-20.160	98.5	3.587	-4.477	-668.6	-46.6	55.68	124.0	124.0	*
	-21.160	95.7	3.163	-4.000	-701.3	-17.6	58.40	128.2	128.2	*
	-22.105	93.1	2.807	-3.538	-702.4	16.3	58.50	132.2	132.2	*
	-22.105	93.1	2.807	-3.538	-702.4	16.3	58.50	132.2	132.2	
	-22.160	92.9	2.787	-3.511	-701.4	18.4	58.42	131.3	132.4	
	-23.160	90.1	2.460	-3.034	-666.0	50.3	55.47	115.9	136.6	
	-24.160	87.3	2.179	-2.592	-604.7	70.7	50.36	102.6	140.8	
	-25.160	84.5	1.940	-2.199	-527.8	81.7	43.95	91.4	145.0	
	-26.160	81.7	1.738	-1.861	-443.9	85.0	36.97	81.8	149.2	
	-27.160	78.9	1.566	-1.583	-359.7	82.5	29.95	73.8	153.4	
	-27.350	152.9	1.536	-1.536	-344.1	81.4	28.66	134.4	490.0	
	-28.160	150.9	1.419	-1.360	-285.2	63.0	23.75	124.1	512.3	
	-28.160	150.9	1.419	-1.360	-285.2	63.0	27.01	124.1	512.3	
	-28.350	76.6	1.394	-1.318	-273.7	57.7	25.92	65.6	159.2	
	-29.160	74.3	1.294	-1.157	-230.8	47.8	21.86	60.9	162.6	
	-30.160	71.5	1.186	-0.992	-190.1	33.3	18.00	55.9	166.8	
	-30.350	144.5	1.168	-0.964	-184.0	30.3	17.43	157.2	621.2	

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
	-31.160	141.9	1.094	-0.855	-156.2	37.5	14.79	147.3	644.7	
	-32.160	138.8	1.014	-0.747	-117.4	38.9	11.12	136.5	673.7	
	-33.160	135.6	0.944	-0.669	-80.7	33.4	7.65	127.0	702.7	
	-34.160	132.5	0.880	-0.618	-52.6	22.0	4.98	118.4	731.8	
	-35.160	129.3	0.820	-0.583	-38.5	5.4	3.65	110.3	760.8	
	-36.160	126.2	0.763	-0.552	-43.4	-15.9	4.11	102.7	789.8	
	-36.350	127.0	0.753	-0.545	-46.9	-20.4	4.44	151.9	859.8	
	-37.160	123.7	0.710	-0.511	-55.9	-2.5	5.29	143.3	884.4	
	-38.160	119.7	0.661	-0.469	-49.6	14.1	4.69	133.4	914.9	
	-39.160	115.6	0.616	-0.437	-29.5	25.2	2.79	124.3	945.4	
	-40.160	111.6	0.573	-0.424	-0.7	31.6	0.07	115.6	975.8	
	-41.160	107.5	0.530	-0.437	32.1	33.4	3.04	107.0	1006.3	
	-42.160	103.5	0.485	-0.475	64.4	30.3	6.10	97.8	1036.7	
	-43.160	99.4	0.434	-0.537	91.0	21.8	8.62	87.7	1067.2	
	-44.160	95.3	0.377	-0.615	105.7	6.4	10.01	76.0	1097.6	
	-45.160	91.3	0.311	-0.698	100.9	-17.4	9.56	62.8	1128.1	
	-46.160	87.2	0.238	-0.767	67.5	-51.2	6.40	47.9	1158.5	
	-46.350	8.9	0.223	-0.777	57.1	-58.9	5.41	45.0	569.6	
	-47.160	0.8	0.159	-0.800	20.7	-31.6	1.96	32.1	568.8	
	-47.241	0.0	0.152	-0.801	18.3	-29.1	1.73	30.8	568.7	
	-48.160	0.0	0.078	-0.808	2.5	-7.7	0.23	15.8	567.8	
	-48.240	0.0	0.072	-0.808	1.9	-6.4	0.18	14.5	567.7	
	-49.160	0.0	-0.002	-0.808	0.0	0.0	0.00	0.0	566.7	

*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/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-0.181	6.133	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.126	6.133	0.0	0.0	0.00	0.0	0.0	
232.6										
	+4.340	0.3	0.126	6.133	0.0	232.6	0.00	0.0	0.0	
	+3.840	5.3	0.432	6.110	116.0	231.2	10.99	0.0	0.0	
	+2.840	15.2	1.035	5.929	342.9	220.9	32.48	0.0	0.0	
	+1.840	25.2	1.612	5.573	554.6	200.7	52.52	0.0	0.0	
	+1.340	30.2	1.885	5.335	651.6	186.8	61.71	0.0	0.0	
	+0.840	35.2	2.145	5.060	741.0	170.5	70.18	0.0	0.0	
	+0.340	40.2	2.390	4.751	821.7	151.6	77.81	0.0	0.0	
	-0.160	40.2	2.620	4.413	892.5	131.6	84.52	0.0	0.0	
	-1.160	40.2	3.024	3.662	1003.9	91.4	95.07	0.0	0.0	
	-1.660	40.2	3.197	3.257	1044.6	71.3	98.92	0.0	0.0	
	-2.160	40.1	3.349	2.839	1075.2	51.2	101.83	0.0	0.0	
	-3.160	40.1	3.590	1.975	1106.4	11.1	104.77	0.0	0.0	
	-3.160	40.1	3.590	1.975	1106.4	11.1	104.77	0.0	0.0	
	-4.160	40.1	3.744	1.103	1097.4	-29.0	103.92	0.0	0.0	
	-4.660	40.1	3.789	0.674	1077.9	-49.1	102.08	0.0	0.0	
	-5.160	40.1	3.812	0.254	1048.3	-69.1	99.28	0.0	0.0	
	-6.160	40.1	3.797	-0.541	959.1	-109.2	90.83	0.0	0.0	
	-6.276	40.1	3.790	-0.628	946.2	-113.9	89.61	0.0	0.0	
	-6.276	40.0	3.790	-0.628	946.2	-113.9	89.61	0.0	0.0	*
	-7.160	38.7	3.706	-1.250	832.7	-139.6	78.86	20.4	20.4	*
	-8.060	37.3	3.569	-1.796	702.6	-146.2	66.54	41.1	41.1	*
	-8.060	37.3	3.569	-1.796	702.6	-146.2	66.54	41.2	41.1	
	-8.160	37.2	3.550	-1.850	688.0	-145.8	65.16	40.9	43.4	
	-9.160	35.7	3.340	-2.336	544.0	-142.5	51.51	38.5	66.5	
	-10.160	34.2	3.087	-2.710	402.7	-140.4	38.13	35.6	89.5	
	-11.160	32.7	2.802	-2.972	262.7	-139.9	24.88	32.3	112.5	
	-12.060	31.4	2.527	-3.114	136.4	-141.0	12.92	29.1	133.3	
	-12.160	31.3	2.496	-3.124	122.3	-141.3	11.58	28.8	135.6	
	-12.160	31.3	2.496	-3.124	122.3	-141.3	10.19	28.8	135.6	
	-13.060	29.9	2.213	-3.161	-6.1	-144.4	0.51	25.5	156.3	
	-13.160	29.8	2.181	-3.160	-20.6	-144.8	1.71	25.2	158.6	
	-14.160	28.3	1.868	-3.095	-168.0	-150.5	14.00	21.5	181.7	

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
	-14.350	28.7	1.809	-3.071	-196.8	-151.8	16.39	90.4	248.6	
	-15.160	26.9	1.566	-2.929	-300.6	-106.1	25.04	78.2	272.7	
	-16.060	24.8	1.311	-2.716	-376.8	-64.7	31.38	65.5	299.6	
	-16.160	24.5	1.284	-2.689	-383.0	-60.6	31.90	64.2	302.6	
	-16.350	24.1	1.234	-2.638	-393.8	-53.3	32.80	61.7	308.3	
	-17.160	22.2	1.029	-2.407	-425.6	-26.3	35.45	51.4	332.5	
	-18.160	19.9	0.804	-2.105	-438.9	-1.8	36.56	40.2	362.4	
	-19.160	17.6	0.608	-1.802	-431.9	14.6	35.97	30.4	392.2	
	-19.350	13.3	0.575	-1.745	-428.9	16.9	35.72	27.1	188.7	
	-20.160	11.2	0.443	-1.509	-411.1	26.3	34.24	20.9	192.3	
	-21.160	8.7	0.306	-1.234	-380.7	33.9	31.70	14.4	196.8	
	-22.160	6.2	0.195	-0.982	-344.5	38.1	28.69	9.2	201.2	
	-23.160	3.7	0.109	-0.756	-305.2	40.2	25.42	5.1	205.7	
	-23.647	2.5	0.074	-0.656	-285.4	40.8	23.77	3.5	207.9	
	-24.160	1.2	0.043	-0.558	-264.4	41.3	22.02	2.0	210.2	
	-24.624	0.0	0.019	-0.476	-245.2	41.7	20.42	0.9	212.3	
	-25.160	0.0	-0.004	-0.389	-222.7	41.9	18.55	0.0	216.0	
	-26.160	0.0	-0.036	-0.249	-181.2	40.9	15.09	0.0	223.0	
	-27.160	0.0	-0.055	-0.137	-141.4	38.7	11.77	0.0	230.0	
	-27.350	0.0	-0.057	-0.119	-134.1	38.2	11.16	0.0	601.3	
	-28.160	0.0	-0.064	-0.052	-104.8	33.9	8.73	0.0	623.8	
	-28.160	0.0	-0.064	-0.052	-104.8	33.9	9.93	0.0	623.8	
	-28.350	0.0	-0.065	-0.037	-98.5	32.8	9.33	0.0	238.2	
	-29.160	0.0	-0.066	0.018	-72.9	30.3	6.91	0.0	243.8	
	-30.160	0.0	-0.061	0.064	-44.2	27.3	4.18	0.0	250.8	
	-30.350	0.0	-0.060	0.070	-39.0	26.7	3.70	0.0	741.4	
	-31.160	0.0	-0.054	0.088	-20.0	20.5	1.89	0.0	765.1	
	-32.160	0.0	-0.044	0.097	-2.8	13.9	0.27	0.0	794.3	
	-33.160	0.0	-0.035	0.094	8.3	8.6	0.79	0.0	823.6	
	-34.160	0.0	-0.026	0.085	14.8	4.6	1.40	0.0	852.8	
	-34.444	0.0	-0.023	0.082	16.0	3.6	1.51	0.0	861.1	
	-35.160	0.0	-0.018	0.072	17.9	1.7	1.69	0.0	882.0	
	-36.160	0.0	-0.011	0.058	18.5	-0.3	1.75	0.0	911.3	
	-36.350	0.0	-0.010	0.055	18.4	-0.5	1.74	0.0	990.3	
	-37.065	0.0	-0.007	0.045	17.6	-1.7	1.66	0.0	1012.2	
	-37.160	0.0	-0.006	0.043	17.4	-1.9	1.65	0.0	1015.4	

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	-0.003	0.030	15.0	-2.7	1.43	0.0	1048.8	
	-39.160	0.0	0.000	0.020	12.2	-3.0	1.15	0.0	1082.2	
	-40.160	0.0	0.001	0.011	9.2	-2.8	0.87	0.3	1115.6	
	-41.160	0.0	0.002	0.005	6.6	-2.4	0.62	0.5	1149.0	
	-42.160	0.0	0.003	0.001	4.4	-2.0	0.42	0.5	1182.4	
	-43.160	0.0	0.002	-0.002	2.7	-1.5	0.25	0.5	1215.8	
	-44.160	0.0	0.002	-0.004	1.5	-1.0	0.14	0.4	1249.2	
	-45.160	0.0	0.002	-0.005	0.7	-0.6	0.06	0.3	1282.6	
	-46.160	0.0	0.001	-0.005	0.2	-0.3	0.02	0.3	1316.0	
	-46.350	0.0	0.001	-0.005	0.2	-0.3	0.02	0.2	716.2	
	-47.160	0.0	0.001	-0.005	0.0	-0.1	0.00	0.2	723.5	
	-48.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.1	732.5	
	-49.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.0	741.5	

*showing plastic

(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/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.577	10.147	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.070	10.147	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.070	10.147	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.563	10.147	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.452	10.148	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.467	10.160	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.976	10.174	-46.1	-45.7	4.37	0.0	0.0	
431.7										
	+1.340	30.2	1.976	10.174	-46.1	386.0	4.37	0.0	0.0	
	+0.840	35.2	2.484	10.155	142.9	369.6	13.53	0.0	0.0	
	+0.340	40.2	2.990	10.063	323.1	350.8	30.60	0.0	0.0	
	-0.160	40.2	3.489	9.901	493.5	330.7	46.73	0.0	0.0	
	-1.160	40.2	4.456	9.387	804.1	290.5	76.14	0.0	0.0	
	-1.660	40.2	4.917	9.041	944.3	270.4	89.43	0.0	0.0	
	-2.160	40.1	5.359	8.643	1074.5	250.4	101.76	0.0	0.0	
	-3.160	40.1	6.178	7.701	1304.8	210.2	123.56	0.0	0.0	
	-3.160	40.1	6.178	7.701	1304.8	210.2	123.56	0.0	0.0	
	-4.160	40.1	6.894	6.594	1494.9	170.1	141.57	0.0	0.0	
	-4.660	40.1	7.208	5.988	1575.0	150.1	149.15	0.0	0.0	
	-5.160	40.1	7.492	5.352	1645.0	130.0	155.78	0.0	0.0	
	-6.160	40.1	7.961	4.008	1754.9	89.9	166.20	0.0	0.0	
	-6.276	40.0	8.006	3.847	1765.1	85.3	167.16	0.0	0.0	
	-7.160	42.1	8.291	2.593	1824.6	49.0	172.79	0.0	0.0	
	-8.060	44.3	8.466	1.285	1851.3	10.1	175.32	0.0	0.0	
	-8.160	44.6	8.478	1.139	1852.1	5.6	175.39	0.0	0.0	
	-9.160	47.0	8.519	-0.319	1835.0	-40.2	173.78	0.0	0.0	
	-10.160	49.4	8.415	-1.745	1770.9	-88.4	167.71	0.0	0.0	
	-11.160	51.9	8.172	-3.101	1657.4	-139.1	156.96	0.0	0.0	
	-12.060	54.0	7.842	-4.228	1510.9	-186.7	143.09	0.0	0.0	
	-12.160	54.3	7.799	-4.347	1492.0	-192.1	141.29	0.0	0.0	
	-12.160	54.3	7.799	-4.347	1492.0	-192.1	124.25	0.0	0.0	
	-13.060	56.5	7.367	-5.220	1296.8	-242.0	108.00	0.0	0.0	
	-13.160	56.7	7.315	-5.309	1272.3	-247.6	105.96	0.0	0.0	
	-14.160	59.1	6.743	-6.100	995.9	-305.6	82.94	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
	-14.350	56.7	6.625	-6.227	936.8	-316.9	78.02	0.0	0.0	
	-14.560	57.1	6.493	-6.359	869.0	-328.8	72.37	0.0	0.0	
	-14.560	57.1	6.493	-6.359	869.0	-328.8	72.37	0.0	0.0	*
	-15.160	55.7	6.102	-6.678	662.6	-357.3	55.18	17.9	17.9	*
	-16.060	53.6	5.485	-6.989	329.7	-378.2	27.45	44.8	44.8	*
	-16.160	53.4	5.415	-7.011	291.8	-379.0	24.30	47.8	47.8	*
	-16.350	53.0	5.282	-7.044	219.7	-379.4	18.30	53.5	53.5	*
	-17.160	51.1	4.708	-7.082	-84.6	-368.5	7.05	77.7	77.7	*
	-18.160	48.8	4.007	-6.899	-434.4	-325.8	36.18	107.5	107.5	*
	-19.160	46.5	3.336	-6.493	-725.5	-251.0	60.42	137.4	137.4	*
	-19.350	46.0	3.214	-6.394	-771.5	-233.1	64.25	143.1	143.1	*
	-19.350	30.9	3.214	-6.394	-771.5	-233.1	64.25	151.3	168.7	
	-20.160	28.8	2.714	-5.914	-923.2	-144.3	76.88	127.8	172.3	
	-21.160	26.3	2.156	-5.234	-1022.1	-57.5	85.12	101.6	176.8	
	-22.160	23.8	1.669	-4.513	-1045.4	7.3	87.07	78.6	181.3	
	-23.160	21.3	1.254	-3.796	-1013.7	53.3	84.42	59.0	185.8	
	-24.160	18.7	0.909	-3.115	-943.9	84.0	78.61	42.8	190.2	
	-25.160	16.2	0.629	-2.491	-849.8	102.5	70.77	29.6	194.7	
	-26.160	13.7	0.408	-1.938	-742.1	111.7	61.80	19.2	199.2	
	-27.160	11.2	0.239	-1.463	-628.6	114.3	52.35	11.2	203.7	
	-27.350	20.9	0.212	-1.381	-606.9	114.2	50.54	18.5	364.5	
	-28.160	19.0	0.113	-1.066	-516.0	109.4	42.97	9.9	386.9	
	-28.160	19.0	0.113	-1.066	-516.0	109.4	48.86	9.9	386.9	
	-28.350	9.1	0.093	-0.990	-495.4	107.5	46.91	4.4	209.8	
	-29.160	7.1	0.025	-0.701	-410.0	103.1	38.83	1.2	213.4	
	-30.160	4.6	-0.030	-0.417	-309.9	97.1	29.34	0.0	217.9	
	-30.350	12.6	-0.038	-0.372	-291.5	95.9	27.61	0.0	486.6	
	-31.160	10.2	-0.061	-0.209	-219.7	81.3	20.81	0.0	510.3	
	-32.160	7.2	-0.074	-0.065	-147.5	63.3	13.97	0.0	539.5	
	-33.160	4.3	-0.076	0.028	-92.4	47.4	8.75	0.0	568.7	
	-33.392	3.6	-0.075	0.044	-81.8	44.1	7.75	0.0	575.5	
	-34.160	1.3	-0.070	0.084	-51.6	34.8	4.89	0.0	598.0	
	-34.616	0.0	-0.065	0.100	-36.8	30.3	3.49	0.0	611.3	
	-35.160	0.0	-0.060	0.112	-21.6	25.7	2.05	0.0	627.2	
	-36.160	0.0	-0.048	0.120	0.4	18.5	0.03	0.0	656.5	
	-36.350	0.0	-0.046	0.120	3.8	17.3	0.36	0.0	715.9	

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
	-37.160	0.0	-0.036	0.114	15.0	10.6	1.42	0.0	740.9	
	-38.160	0.0	-0.025	0.099	22.4	4.5	2.12	0.0	771.6	
	-39.160	0.0	-0.016	0.080	24.6	0.3	2.33	0.0	802.4	
	-40.160	0.0	-0.009	0.061	23.5	-2.3	2.22	0.0	833.1	
	-41.160	0.0	-0.004	0.043	20.4	-3.6	1.93	0.0	863.9	
	-42.160	0.0	-0.001	0.029	16.5	-4.1	1.56	0.0	894.6	
	-43.160	0.0	0.002	0.017	12.5	-4.0	1.18	0.3	925.4	
	-44.160	0.0	0.003	0.009	8.7	-3.5	0.82	0.6	956.2	
	-45.084	0.0	0.003	0.004	5.7	-2.9	0.54	0.7	984.6	
	-45.160	0.0	0.004	0.003	5.5	-2.8	0.52	0.7	986.9	
	-46.160	0.0	0.004	0.000	3.1	-2.1	0.29	0.7	1017.7	
	-46.350	0.0	0.004	0.000	2.7	-2.0	0.25	0.7	658.2	
	-47.160	0.0	0.004	-0.002	1.3	-1.4	0.13	0.7	665.5	
	-48.160	0.0	0.003	-0.002	0.3	-0.7	0.03	0.7	674.5	
	-49.160	0.0	0.003	-0.002	0.0	0.0	0.00	0.6	683.5	

*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	-2.354	12.449	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.732	12.449	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.732	12.449	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.110	12.449	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.135	12.450	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.381	12.462	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	2.004	12.476	-46.1	-45.7	4.37	0.0	0.0	
568.7										
	+1.340	30.2	2.004	12.476	-46.1	522.9	4.37	0.0	0.0	
	+0.840	35.2	2.628	12.443	211.4	506.6	20.02	0.0	0.0	
	-0.160	45.2	3.857	12.082	698.7	466.4	66.16	0.0	0.0	
	-1.160	55.2	5.032	11.353	1140.8	416.2	108.03	0.0	0.0	
	-1.660	60.2	5.587	10.862	1341.8	387.4	127.07	0.0	0.0	
	-2.160	65.1	6.117	10.296	1527.7	356.0	144.68	0.0	0.0	
	-2.660	70.1	6.616	9.659	1697.4	322.2	160.75	0.0	0.0	
	-3.160	70.1	7.082	8.958	1849.8	287.2	175.18	0.0	0.0	
	-3.160	70.1	7.082	8.958	1849.8	287.2	175.18	0.0	0.0	
	-4.160	70.1	7.901	7.394	2101.9	217.0	199.05	0.0	0.0	
	-4.660	70.1	8.249	6.545	2201.6	182.0	208.50	0.0	0.0	
	-5.160	70.1	8.555	5.659	2283.9	146.9	216.29	0.0	0.0	
	-6.160	70.1	9.029	3.808	2395.8	76.9	226.88	0.0	0.0	
	-6.276	70.0	9.072	3.588	2404.2	68.7	227.68	0.0	0.0	
	-7.160	72.1	9.314	1.896	2437.3	5.9	230.82	0.0	0.0	
	-8.060	74.3	9.407	0.170	2413.2	-60.0	228.53	0.0	0.0	
	-8.160	74.6	9.408	-0.020	2406.8	-67.5	227.93	0.0	0.0	
	-9.160	77.0	9.312	-1.883	2301.6	-143.2	217.97	0.0	0.0	
	-10.160	79.4	9.035	-3.632	2119.5	-221.5	200.72	0.0	0.0	
	-11.160	81.9	8.591	-5.207	1857.9	-302.1	175.95	0.0	0.0	
	-12.060	84.0	8.066	-6.422	1552.6	-376.8	147.03	0.0	0.0	
	-12.160	84.3	8.002	-6.543	1514.5	-385.2	143.43	0.0	0.0	
	-12.160	84.3	8.002	-6.543	1514.5	-385.2	126.13	0.0	0.0	
	-13.060	86.5	7.374	-7.374	1138.4	-462.0	94.80	0.0	0.0	
20.1										
	-13.060	86.5	7.374	-7.374	1138.4	-442.0	94.80	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
	-13.160	86.7	7.299	-7.451	1092.8	-450.6	91.01	0.0	0.0	
	-14.160	89.1	6.522	-8.040	594.3	-538.6	49.50	0.0	0.0	
	-14.350	86.7	6.369	-8.112	490.4	-555.5	40.84	0.0	0.0	
	-14.560	87.1	6.198	-8.175	371.8	-573.8	30.97	0.0	0.0	
	-14.560	73.0	6.198	-8.175	371.8	-573.8	30.97	137.5	137.5	*
	-15.160	71.6	5.704	-8.259	40.3	-529.2	3.36	155.5	155.5	*
	-16.060	69.5	4.964	-8.144	-398.1	-440.7	33.15	182.3	182.3	*
	-16.160	69.3	4.882	-8.114	-441.6	-429.3	36.78	185.3	185.3	*
	-16.350	68.8	4.729	-8.051	-521.0	-406.7	43.39	191.0	191.0	*
	-17.003	67.3	4.212	-7.759	-758.9	-320.1	63.21	210.5	210.5	*
	-17.003	67.3	4.212	-7.759	-758.9	-320.1	63.21	210.5	210.5	
	-17.160	67.0	4.091	-7.673	-807.6	-298.0	67.25	204.5	215.2	
	-18.160	64.7	3.355	-7.024	-1042.7	-178.0	86.84	167.7	245.1	
	-19.160	62.4	2.690	-6.250	-1174.5	-90.8	97.82	134.4	275.0	
	-19.350	30.3	2.573	-6.094	-1190.5	-77.6	99.15	121.2	169.1	
	-20.160	28.2	2.107	-5.412	-1225.8	-12.2	102.09	99.2	172.7	
	-21.160	25.7	1.608	-4.565	-1206.3	47.9	100.46	75.7	177.2	
	-22.160	23.2	1.193	-3.750	-1136.3	89.1	94.63	56.2	181.7	
	-23.160	20.7	0.856	-2.995	-1033.1	115.2	86.03	40.3	186.2	
	-24.160	18.1	0.591	-2.320	-909.9	129.6	75.77	27.8	190.6	
	-25.160	15.6	0.389	-1.735	-776.7	135.5	64.69	18.3	195.1	
	-26.160	13.1	0.241	-1.243	-640.7	135.8	53.36	11.3	199.6	
	-27.160	10.6	0.137	-0.845	-506.2	132.7	42.16	6.5	204.1	
	-27.350	36.4	0.122	-0.780	-481.1	131.9	40.07	10.7	492.5	
	-28.160	34.5	0.069	-0.538	-383.0	109.9	31.90	6.0	514.9	
	-28.160	34.5	0.069	-0.538	-383.0	109.9	36.27	6.0	514.9	
	-28.350	8.5	0.059	-0.482	-362.7	104.4	34.35	2.8	210.2	
	-29.160	6.5	0.029	-0.277	-279.9	100.0	26.51	1.4	213.8	
	-30.160	4.0	0.011	-0.095	-182.3	95.6	17.27	0.5	218.3	
	-30.201	3.9	0.010	-0.089	-178.4	95.4	16.89	0.5	218.5	
	-30.350	28.4	0.009	-0.069	-164.2	95.0	15.55	1.3	624.1	
	-31.160	26.1	0.007	0.014	-96.0	73.7	9.09	1.0	647.8	
	-32.160	23.1	0.012	0.063	-34.3	50.4	3.24	1.6	677.1	
	-33.160	20.2	0.019	0.073	6.0	30.7	0.56	2.5	706.3	
	-34.160	17.2	0.025	0.059	28.5	15.0	2.70	3.4	735.5	
	-35.160	14.3	0.030	0.032	37.3	3.0	3.53	4.0	764.8	

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	11.3	0.032	0.003	35.7	-5.6	3.38	4.3	794.0	
	-36.350	12.1	0.032	-0.003	34.5	-6.9	3.27	6.4	863.9	
	-37.160	9.1	0.031	-0.023	27.4	-10.3	2.60	6.2	888.8	
	-38.160	5.3	0.027	-0.040	16.2	-11.6	1.54	5.5	919.5	
	-38.325	4.7	0.027	-0.042	14.3	-11.5	1.36	5.4	924.6	
	-39.160	1.6	0.023	-0.048	5.2	-9.9	0.50	4.6	950.3	
	-39.574	0.0	0.021	-0.049	1.4	-8.4	0.14	4.2	963.0	
	-40.160	0.0	0.018	-0.049	-2.8	-6.1	0.26	3.6	981.0	
	-41.160	0.0	0.013	-0.045	-7.2	-2.9	0.68	2.7	1011.8	
	-42.160	0.0	0.009	-0.038	-8.9	-0.7	0.85	1.8	1042.6	
	-43.160	0.0	0.006	-0.031	-8.8	0.8	0.83	1.1	1073.3	
	-44.160	0.0	0.003	-0.025	-7.5	1.7	0.71	0.6	1104.1	
	-45.160	0.0	0.001	-0.020	-5.6	2.0	0.53	0.1	1134.8	
	-46.160	0.0	-0.001	-0.016	-3.6	2.0	0.34	0.0	1165.6	
	-46.350	0.0	-0.001	-0.016	-3.2	1.9	0.30	0.0	659.2	
	-47.160	0.0	-0.003	-0.014	-1.8	1.6	0.17	0.0	666.5	
	-48.160	0.0	-0.004	-0.013	-0.5	0.9	0.05	0.0	675.5	
	-49.160	0.0	-0.005	-0.013	0.0	0.0	0.00	0.0	684.5	

*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/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-2.445	12.692	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.176	12.692	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.093	12.694	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.363	12.705	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.998	12.719	-46.1	-45.7	4.37	0.0	0.0	
540.9										
	+1.340	30.2	1.998	12.719	-46.1	495.1	4.37	0.0	0.0	
	+0.840	35.2	2.634	12.689	197.5	478.8	18.70	0.0	0.0	
	-0.160	45.2	3.889	12.350	657.0	438.6	62.22	0.0	0.0	
	-1.160	55.2	5.092	11.664	1071.3	388.4	101.46	0.0	0.0	
	-1.660	60.2	5.664	11.204	1258.4	359.6	119.18	0.0	0.0	
97.0										
	-1.660	60.2	5.664	11.204	1258.4	456.5	119.18	0.0	0.0	
	-2.160	65.1	6.212	10.664	1479.0	425.2	140.06	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-4.160	85.1	8.070	7.732	2185.8	275.0	207.00	0.0	0.0	
	-4.660	90.1	8.434	6.844	2312.5	231.2	218.99	0.0	0.0	
	-5.160	95.1	8.753	5.910	2416.6	184.9	228.85	0.0	0.0	
	-6.160	105.1	9.247	3.943	2552.2	84.8	241.70	0.0	0.0	
	-6.276	106.2	9.291	3.709	2561.4	72.5	242.57	0.0	0.0	
	-7.160	117.1	9.540	1.909	2582.6	-26.2	244.57	0.0	0.0	
	-8.060	128.3	9.629	0.095	2510.1	-136.6	237.71	0.0	0.0	
	-8.160	129.6	9.629	-0.103	2495.8	-149.5	236.35	0.0	0.0	
	-9.160	142.0	9.523	-1.996	2279.4	-285.3	215.86	0.0	0.0	
	-10.160	154.4	9.238	-3.663	1921.0	-433.5	181.92	0.0	0.0	
	-11.160	166.9	8.802	-4.987	1408.2	-594.2	133.35	0.0	0.0	
	-12.060	178.0	8.314	-5.781	804.3	-749.4	76.17	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	69.25	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	60.90	0.0	0.0	
	-13.060	190.5	7.716	-6.066	241.7	-933.7	20.13	0.0	0.0	
1111.4										

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
	-13.060	190.5	7.716	-6.066	241.7	177.8	20.13	0.0	0.0	
	-13.160	191.7	7.656	-6.064	205.7	158.7	17.13	0.0	0.0	
	-14.160	204.1	7.049	-6.083	41.3	-39.3	3.44	0.0	0.0	
	-14.350	203.6	6.933	-6.088	30.2	-78.3	2.51	0.0	0.0	
	-14.560	206.1	6.805	-6.091	9.2	-121.3	0.77	0.0	0.0	
	-14.560	192.0	6.805	-6.091	9.2	-121.3	0.77	137.5	137.5	*
	-15.160	190.6	6.440	-6.078	-72.2	-148.2	6.01	155.5	155.5	*
	-16.060	188.5	5.896	-5.989	-215.9	-166.8	17.98	182.3	182.3	*
	-16.160	188.3	5.837	-5.974	-232.6	-167.2	19.37	185.3	185.3	*
	-16.350	187.8	5.723	-5.941	-264.4	-167.2	22.02	191.0	191.0	*
	-17.160	186.0	5.249	-5.755	-395.9	-154.1	32.97	215.2	215.2	*
	-17.972	184.1	4.792	-5.499	-508.5	-119.7	42.35	239.5	239.5	*
	-17.972	184.1	4.792	-5.499	-508.5	-119.7	42.35	239.5	239.5	
	-18.160	183.7	4.689	-5.431	-530.1	-109.8	44.14	234.4	245.1	
	-19.160	181.4	4.166	-5.030	-618.6	-71.2	51.51	208.2	275.0	
	-19.350	180.9	4.071	-4.948	-631.6	-66.5	52.60	203.5	280.6	
	-19.350	101.7	4.071	-4.948	-631.6	-66.5	52.60	121.5	121.5	*
	-20.160	99.6	3.685	-4.579	-678.3	-48.1	56.49	125.1	125.1	*
	-21.160	97.1	3.251	-4.094	-712.5	-19.1	59.34	129.6	129.6	*
	-22.160	94.6	2.866	-3.597	-714.2	16.9	59.48	134.1	134.1	*
	-22.201	94.5	2.852	-3.577	-713.5	18.5	59.42	134.3	134.3	*
	-22.201	94.5	2.852	-3.577	-713.5	18.5	59.42	134.3	134.3	
	-23.160	92.1	2.531	-3.112	-679.5	50.5	56.59	119.2	138.6	
	-24.160	89.5	2.243	-2.660	-617.4	71.9	51.41	105.6	143.0	
	-25.160	87.0	1.997	-2.258	-539.0	83.3	44.89	94.1	147.5	
	-26.160	84.5	1.789	-1.914	-453.4	86.6	37.76	84.3	152.0	
	-27.160	82.0	1.613	-1.629	-368.0	83.3	30.65	75.9	156.5	
	-27.350	155.4	1.582	-1.582	-352.2	82.1	29.34	138.4	492.5	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	24.34	127.8	514.9	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	27.68	127.8	514.9	
	-28.350	79.9	1.435	-1.358	-280.5	59.7	26.56	67.6	162.6	
	-29.160	77.9	1.332	-1.193	-236.5	48.5	22.39	62.7	166.2	
	-30.160	75.4	1.222	-1.024	-196.0	32.0	18.56	57.5	170.7	
	-30.350	147.4	1.202	-0.995	-190.2	28.5	18.01	161.8	624.1	
	-31.160	145.1	1.127	-0.882	-163.3	36.9	15.46	151.6	647.8	
	-32.160	142.1	1.044	-0.768	-124.5	39.3	11.79	140.5	677.1	

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
	-33.160	139.2	0.972	-0.685	-87.2	34.2	8.26	130.8	706.3	
	-34.160	136.2	0.907	-0.628	-58.3	22.8	5.52	122.0	735.5	
	-35.160	133.3	0.846	-0.589	-43.5	5.9	4.12	113.8	764.8	
	-36.160	130.3	0.789	-0.554	-48.1	-16.0	4.56	106.1	794.0	
	-36.350	131.1	0.778	-0.547	-51.6	-20.7	4.89	157.1	863.9	
	-37.160	128.1	0.735	-0.510	-60.5	-2.0	5.73	148.4	888.8	
	-38.160	124.3	0.687	-0.464	-53.3	15.3	5.05	138.6	919.5	
	-39.160	120.6	0.642	-0.430	-31.8	26.9	3.01	129.6	950.3	
	-40.160	116.8	0.600	-0.416	-1.2	33.5	0.11	121.1	981.0	
	-41.160	113.1	0.558	-0.429	33.8	35.5	3.20	112.6	1011.8	
	-42.160	109.3	0.513	-0.470	68.2	32.5	6.46	103.6	1042.6	
	-43.160	105.5	0.463	-0.535	96.8	23.7	9.17	93.5	1073.3	
	-44.160	101.8	0.406	-0.619	113.3	7.9	10.73	81.9	1104.1	
	-45.160	98.0	0.339	-0.709	109.6	-16.7	10.38	68.5	1134.8	
	-46.160	94.3	0.264	-0.784	76.3	-51.9	7.22	53.3	1165.6	
	-46.350	17.0	0.249	-0.795	65.7	-59.9	6.22	50.3	577.7	
	-47.160	9.7	0.184	-0.824	27.4	-35.3	2.60	37.1	577.7	
	-47.241	9.0	0.177	-0.825	24.7	-33.1	2.34	35.7	577.7	
	-48.160	0.7	0.100	-0.835	4.5	-11.8	0.43	20.3	577.7	
	-48.240	0.0	0.094	-0.835	3.6	-10.3	0.34	18.9	577.7	
	-49.160	0.0	0.017	-0.836	0.0	0.0	0.00	3.4	577.7	

*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	-2.445	12.692	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.811	12.692	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.176	12.692	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.093	12.694	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.363	12.705	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.998	12.719	-46.1	-45.7	4.37	0.0	0.0	
540.9										
	+1.340	30.2	1.998	12.719	-46.1	495.1	4.37	0.0	0.0	
	+0.840	35.2	2.634	12.689	197.5	478.8	18.70	0.0	0.0	
	-0.160	45.2	3.889	12.350	657.0	438.6	62.22	0.0	0.0	
	-1.160	55.2	5.092	11.664	1071.3	388.4	101.46	0.0	0.0	
	-1.660	60.2	5.664	11.204	1258.4	359.6	119.18	0.0	0.0	
97.0										
	-1.660	60.2	5.664	11.204	1258.4	456.5	119.18	0.0	0.0	
	-2.160	65.1	6.212	10.664	1479.0	425.2	140.06	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-3.160	75.1	7.214	9.337	1870.0	355.1	177.09	0.0	0.0	
	-4.160	85.1	8.070	7.732	2185.8	275.0	207.00	0.0	0.0	
	-4.660	90.1	8.434	6.844	2312.5	231.2	218.99	0.0	0.0	
0.0										
	-4.660	90.1	8.434	6.844	2312.5	231.2	218.99	0.0	0.0	
	-5.160	95.1	8.753	5.910	2416.6	184.9	228.85	0.0	0.0	
	-6.160	105.1	9.247	3.943	2552.2	84.8	241.70	0.0	0.0	
	-6.276	106.2	9.291	3.709	2561.4	72.5	242.57	0.0	0.0	
	-7.160	117.1	9.540	1.909	2582.6	-26.2	244.57	0.0	0.0	
	-8.060	128.3	9.629	0.095	2510.1	-136.6	237.71	0.0	0.0	
	-8.160	129.6	9.629	-0.103	2495.8	-149.5	236.35	0.0	0.0	
	-9.160	142.0	9.523	-1.996	2279.4	-285.3	215.86	0.0	0.0	
	-10.160	154.4	9.238	-3.663	1921.0	-433.5	181.92	0.0	0.0	
	-11.160	166.9	8.802	-4.987	1408.2	-594.2	133.35	0.0	0.0	
	-12.060	178.0	8.314	-5.781	804.3	-749.4	76.17	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	69.25	0.0	0.0	
	-12.160	179.3	8.256	-5.842	731.2	-767.3	60.90	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
	-13.060	190.5	7.716	-6.066	241.7	-933.7	20.13	0.0	0.0	
1111.4										
	-13.060	190.5	7.716	-6.066	241.7	177.8	20.13	0.0	0.0	
	-13.160	191.7	7.656	-6.064	205.7	158.7	17.13	0.0	0.0	
	-14.160	204.1	7.049	-6.083	41.3	-39.3	3.44	0.0	0.0	
	-14.350	203.6	6.933	-6.088	30.2	-78.3	2.51	0.0	0.0	
	-14.560	206.1	6.805	-6.091	9.2	-121.3	0.77	0.0	0.0	
	-14.560	192.0	6.805	-6.091	9.2	-121.3	0.77	137.5	137.5	*
	-15.160	190.6	6.440	-6.078	-72.2	-148.2	6.01	155.5	155.5	*
	-16.060	188.5	5.896	-5.989	-215.9	-166.8	17.98	182.3	182.3	*
	-16.160	188.3	5.837	-5.974	-232.6	-167.2	19.37	185.3	185.3	*
	-16.350	187.8	5.723	-5.941	-264.4	-167.2	22.02	191.0	191.0	*
	-17.160	186.0	5.249	-5.755	-395.9	-154.1	32.97	215.2	215.2	*
	-17.975	184.1	4.790	-5.497	-508.9	-119.5	42.38	239.6	239.6	*
	-17.975	184.1	4.790	-5.497	-508.9	-119.5	42.38	239.4	239.6	
	-18.160	183.7	4.689	-5.431	-530.1	-109.8	44.14	234.4	245.1	
	-19.160	181.4	4.166	-5.030	-618.6	-71.2	51.51	208.2	275.0	
	-19.350	180.9	4.071	-4.948	-631.6	-66.5	52.60	203.5	280.6	
	-19.350	101.7	4.071	-4.948	-631.6	-66.5	52.60	121.5	121.5	*
	-20.160	99.6	3.685	-4.579	-678.3	-48.1	56.49	125.1	125.1	*
	-21.160	97.1	3.251	-4.094	-712.5	-19.1	59.34	129.6	129.6	*
	-22.160	94.6	2.866	-3.597	-714.2	16.9	59.48	134.1	134.1	*
	-22.196	94.5	2.854	-3.579	-713.6	18.3	59.43	134.2	134.2	*
	-22.196	94.5	2.854	-3.579	-713.6	18.3	59.43	134.4	134.2	
	-23.160	92.1	2.531	-3.112	-679.5	50.5	56.59	119.2	138.6	
	-24.160	89.5	2.243	-2.660	-617.4	71.9	51.41	105.6	143.0	
	-25.160	87.0	1.997	-2.258	-539.0	83.3	44.89	94.1	147.5	
	-26.160	84.5	1.789	-1.914	-453.4	86.6	37.76	84.3	152.0	
	-27.160	82.0	1.613	-1.629	-368.0	83.3	30.65	75.9	156.5	
	-27.350	155.4	1.582	-1.582	-352.2	82.1	29.34	138.4	492.5	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	24.34	127.8	514.9	
	-28.160	153.5	1.462	-1.401	-292.3	64.8	27.68	127.8	514.9	
	-28.350	79.9	1.435	-1.358	-280.5	59.7	26.56	67.6	162.6	
	-29.160	77.9	1.332	-1.193	-236.5	48.5	22.39	62.7	166.2	
	-30.160	75.4	1.222	-1.024	-196.0	32.0	18.56	57.5	170.7	
	-30.350	147.4	1.202	-0.995	-190.2	28.5	18.01	161.8	624.1	

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
	-31.160	145.1	1.127	-0.882	-163.3	36.9	15.46	151.6	647.8	
	-32.160	142.1	1.044	-0.768	-124.5	39.3	11.79	140.5	677.1	
	-33.160	139.2	0.972	-0.685	-87.2	34.2	8.26	130.8	706.3	
	-34.160	136.2	0.907	-0.628	-58.3	22.8	5.52	122.0	735.5	
	-35.160	133.3	0.846	-0.589	-43.5	5.9	4.12	113.8	764.8	
	-36.160	130.3	0.789	-0.554	-48.1	-16.0	4.56	106.1	794.0	
	-36.350	131.1	0.778	-0.547	-51.6	-20.7	4.89	157.1	863.9	
	-37.160	128.1	0.735	-0.510	-60.5	-2.0	5.73	148.4	888.8	
	-38.160	124.3	0.687	-0.464	-53.3	15.3	5.05	138.6	919.5	
	-39.160	120.6	0.642	-0.430	-31.8	26.9	3.01	129.6	950.3	
	-40.160	116.8	0.600	-0.416	-1.2	33.5	0.11	121.1	981.0	
	-41.160	113.1	0.558	-0.429	33.8	35.5	3.20	112.6	1011.8	
	-42.160	109.3	0.513	-0.470	68.2	32.5	6.46	103.6	1042.6	
	-43.160	105.5	0.463	-0.535	96.8	23.7	9.17	93.5	1073.3	
	-44.160	101.8	0.406	-0.619	113.3	7.9	10.73	81.9	1104.1	
	-45.160	98.0	0.339	-0.709	109.6	-16.7	10.38	68.5	1134.8	
	-46.160	94.3	0.264	-0.784	76.3	-51.9	7.22	53.3	1165.6	
	-46.350	17.0	0.249	-0.795	65.7	-59.9	6.22	50.3	577.7	
	-47.160	9.7	0.184	-0.824	27.4	-35.3	2.60	37.1	577.7	
	-47.241	9.0	0.177	-0.825	24.7	-33.1	2.34	35.7	577.7	
	-48.160	0.7	0.100	-0.835	4.5	-11.8	0.43	20.3	577.7	
	-48.240	0.0	0.094	-0.835	3.6	-10.3	0.34	18.9	577.7	
	-49.160	0.0	0.017	-0.836	0.0	0.0	0.00	3.4	577.7	

*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	-2.445	12.691	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.810	12.691	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.810	12.691	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.176	12.691	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.093	12.693	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.363	12.704	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.999	12.718	-46.1	-45.7	4.37	0.0	0.0	
542.2										
	+1.340	30.2	1.999	12.718	-46.1	496.4	4.37	0.0	0.0	
	+0.840	35.2	2.634	12.688	198.1	480.1	18.76	0.0	0.0	
	-0.160	45.2	3.889	12.347	658.9	439.9	62.40	0.0	0.0	
	-1.160	55.2	5.092	11.660	1074.5	389.7	101.76	0.0	0.0	
	-1.660	60.2	5.664	11.199	1262.3	360.9	119.54	0.0	0.0	
96.3										
	-1.660	60.2	5.664	11.199	1262.3	457.2	119.54	0.0	0.0	
	-2.160	65.1	6.211	10.656	1483.2	425.9	140.46	0.0	0.0	
	-3.160	75.1	7.212	9.327	1874.8	355.7	177.55	0.0	0.0	
	-3.160	75.1	7.212	9.327	1874.8	355.7	177.55	0.0	0.0	
	-4.160	85.1	8.067	7.717	2191.3	275.6	207.52	0.0	0.0	
	-4.660	90.1	8.431	6.827	2318.3	231.8	219.55	0.0	0.0	
0.0										
	-4.660	90.1	8.431	6.827	2318.3	231.8	219.55	0.0	0.0	
	-5.160	95.1	8.749	5.890	2422.7	185.5	229.44	0.0	0.0	
	-6.160	105.1	9.240	3.918	2559.1	85.5	242.35	0.0	0.0	
	-6.276	106.2	9.284	3.683	2568.3	73.2	243.22	0.0	0.0	
	-7.160	117.1	9.530	1.879	2590.1	-25.5	245.28	0.0	0.0	
	-8.060	963066.6	9.617	0.059	2518.1	-136.0	238.47	0.0	0.0	
	-8.160	963063.7	9.616	-0.139	2497.7	-274.4	236.53	0.0	0.0	
	-9.160	952440.0	9.508	-1.992	2254.2	-249.3	213.47	0.0	0.0	
	-10.160	923921.4	9.225	-3.630	1916.3	-403.2	181.47	0.0	0.0	
	-11.160	880344.3	8.793	-4.940	1417.7	-539.1	134.26	0.0	0.0	
	-12.060	178.0	8.309	-5.739	816.2	-748.4	77.30	0.0	0.0	
	-12.160	179.3	8.252	-5.800	743.2	-766.3	70.39	0.0	0.0	
	-12.160	179.3	8.252	-5.800	743.2	-766.3	61.90	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
	-13.060	190.5	7.716	-6.032	253.9	-932.7	21.15	0.0	0.0	
1109.0										
	-13.060	190.5	7.716	-6.032	253.9	176.3	21.15	0.0	0.0	
	-13.160	191.7	7.655	-6.031	217.9	157.2	18.15	0.0	0.0	
	-14.160	204.1	7.051	-6.058	52.6	-40.8	4.38	0.0	0.0	
	-14.350	203.6	6.936	-6.065	41.2	-79.8	3.43	0.0	0.0	
	-14.560	206.1	6.809	-6.069	19.9	-122.8	1.66	0.0	0.0	
	-14.560	192.0	6.809	-6.069	19.9	-122.8	1.66	137.5	137.5	*
	-15.160	190.6	6.445	-6.061	-62.4	-149.7	5.20	155.5	155.5	*
	-16.060	188.5	5.902	-5.977	-207.4	-168.2	17.27	182.3	182.3	*
	-16.160	188.3	5.842	-5.963	-224.3	-168.7	18.68	185.3	185.3	*
	-16.350	187.8	5.729	-5.931	-256.3	-168.7	21.35	191.0	191.0	*
	-17.160	186.0	5.256	-5.749	-389.1	-155.6	32.40	215.2	215.2	*
	-17.971	184.1	4.800	-5.497	-502.7	-121.3	41.87	239.4	239.4	*
	-17.971	184.1	4.800	-5.497	-502.7	-121.3	41.87	239.9	239.4	
	-18.160	183.7	4.696	-5.429	-524.7	-111.2	43.70	234.7	245.1	
	-19.160	181.4	4.173	-5.032	-614.4	-72.2	51.17	208.5	275.0	
	-19.350	180.9	4.078	-4.950	-627.7	-67.5	52.27	203.8	280.6	
	-19.350	101.7	4.078	-4.950	-627.7	-67.5	52.27	121.5	121.5	*
	-20.160	99.6	3.692	-4.583	-675.2	-49.1	56.23	125.1	125.1	*
	-21.160	97.1	3.257	-4.100	-710.4	-20.1	59.16	129.6	129.6	*
	-22.160	94.6	2.872	-3.604	-713.0	15.9	59.38	134.1	134.1	*
	-22.215	94.4	2.852	-3.577	-712.1	18.1	59.30	134.3	134.3	*
	-22.215	94.4	2.852	-3.577	-712.1	18.1	59.30	134.3	134.3	
	-23.160	92.1	2.536	-3.119	-679.1	49.7	56.56	119.4	138.6	
	-24.160	89.5	2.247	-2.668	-617.7	71.4	51.44	105.8	143.0	
	-25.160	87.0	2.001	-2.266	-539.7	83.0	44.95	94.2	147.5	
	-26.160	84.5	1.792	-1.921	-454.5	86.4	37.85	84.4	152.0	
	-27.160	82.0	1.615	-1.635	-369.2	83.2	30.75	76.0	156.5	
	-27.350	155.4	1.584	-1.587	-353.5	82.0	29.44	138.5	492.5	
	-28.160	153.5	1.463	-1.406	-293.6	64.8	24.45	128.0	514.9	
	-28.160	153.5	1.463	-1.406	-293.6	64.8	27.80	128.0	514.9	
	-28.350	79.9	1.437	-1.363	-281.7	59.8	26.68	67.7	162.6	
	-29.160	77.9	1.333	-1.198	-237.7	48.6	22.51	62.8	166.2	
	-30.160	75.4	1.222	-1.027	-197.1	32.1	18.67	57.6	170.7	
	-30.350	147.4	1.203	-0.998	-191.3	28.7	18.12	161.9	624.1	

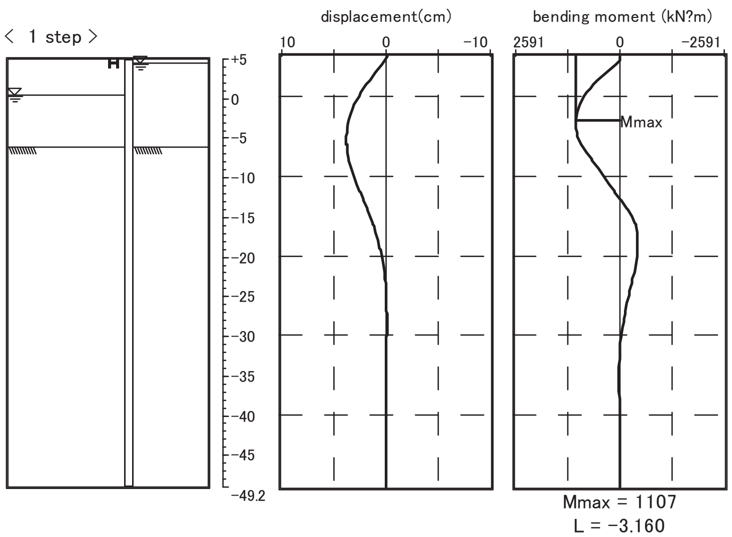
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-31.160	145.1	1.127	-0.884	-164.3	37.1	15.56	151.6	647.8	
	-32.160	142.1	1.044	-0.769	-125.4	39.4	11.87	140.5	677.1	
	-33.160	139.2	0.972	-0.686	-87.9	34.4	8.33	130.8	706.3	
	-34.160	136.2	0.906	-0.628	-58.8	23.0	5.57	122.0	735.5	
	-35.160	133.3	0.846	-0.589	-43.8	6.0	4.15	113.8	764.8	
	-36.160	130.3	0.788	-0.554	-48.4	-15.9	4.58	106.1	794.0	
	-36.350	131.1	0.778	-0.547	-51.8	-20.6	4.91	157.0	863.9	
	-37.160	128.1	0.735	-0.510	-60.6	-1.9	5.74	148.4	888.8	
	-38.160	124.3	0.687	-0.464	-53.3	15.3	5.05	138.6	919.5	
	-39.160	120.6	0.642	-0.430	-31.8	26.9	3.01	129.6	950.3	
	-40.160	116.8	0.600	-0.416	-1.1	33.6	0.11	121.1	981.0	
	-41.160	113.1	0.558	-0.429	33.8	35.5	3.20	112.6	1011.8	
	-42.160	109.3	0.513	-0.469	68.2	32.5	6.46	103.6	1042.6	
	-43.160	105.5	0.463	-0.535	96.9	23.7	9.17	93.5	1073.3	
	-44.160	101.8	0.406	-0.619	113.3	7.9	10.73	81.9	1104.1	
	-45.160	98.0	0.339	-0.709	109.7	-16.8	10.38	68.5	1134.8	
	-46.160	94.3	0.264	-0.784	76.3	-51.9	7.22	53.3	1165.6	
	-46.350	17.0	0.249	-0.795	65.7	-59.9	6.22	50.3	577.7	
	-47.160	9.7	0.184	-0.824	27.4	-35.3	2.60	37.1	577.7	
	-47.241	9.0	0.177	-0.825	24.7	-33.1	2.34	35.7	577.7	
	-48.160	0.7	0.101	-0.835	4.5	-11.8	0.43	20.3	577.7	
	-48.240	0.0	0.094	-0.835	3.6	-10.3	0.34	18.9	577.7	
	-49.160	0.0	0.017	-0.836	0.0	0.0	0.00	3.4	577.7	

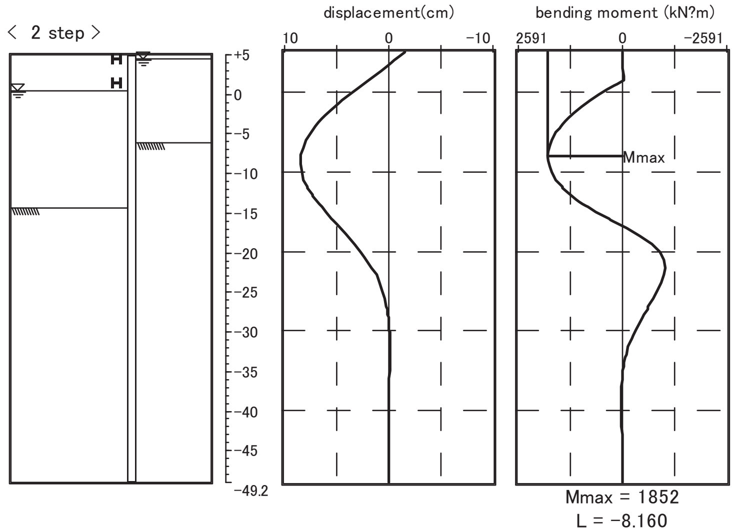
*showing plastic

bending moment at support of footing concrete is reduced value

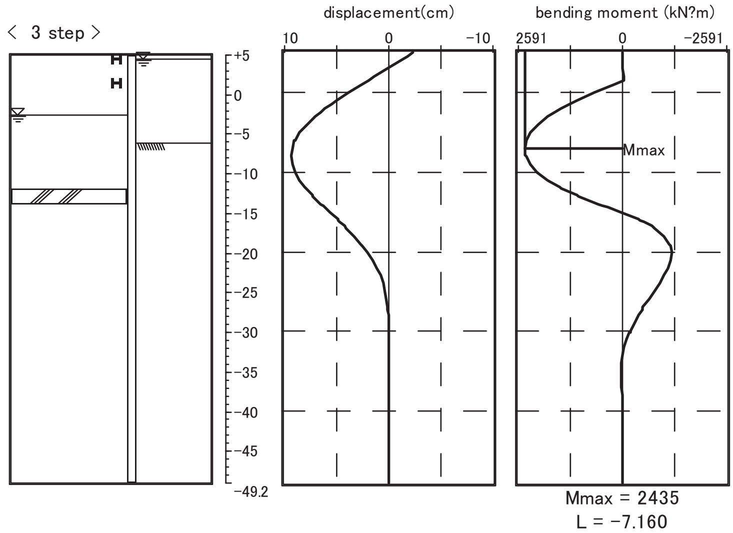
2.11 displacement / member force diagram

bridge axis direction

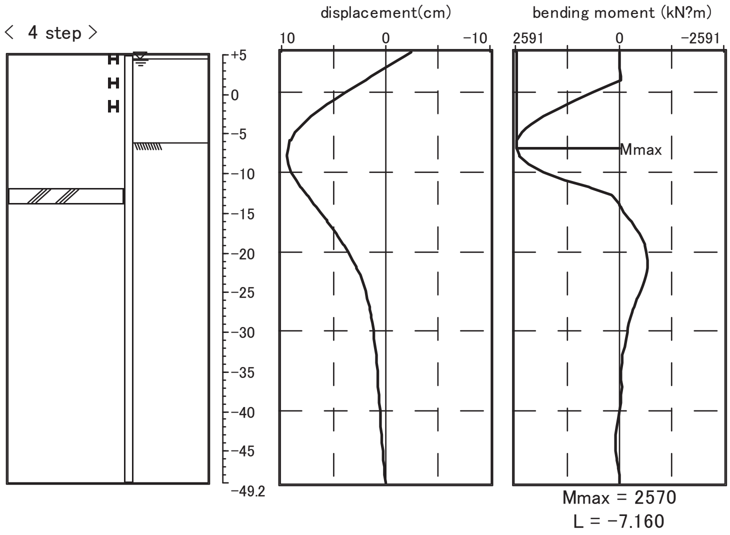


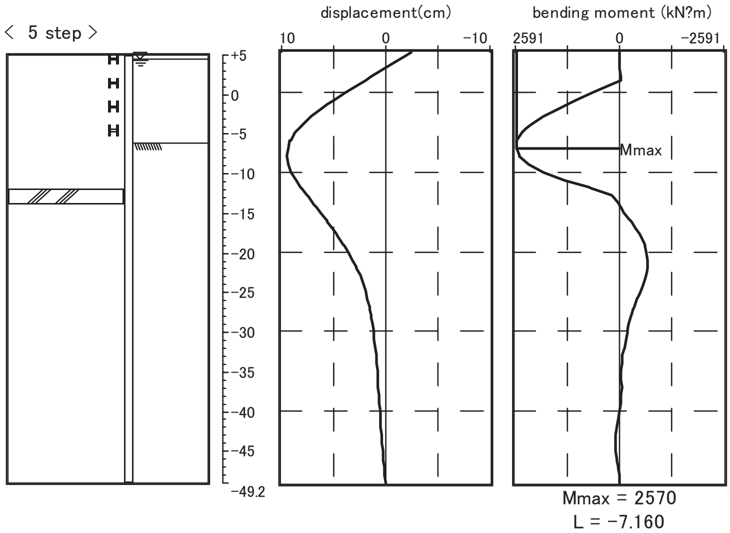


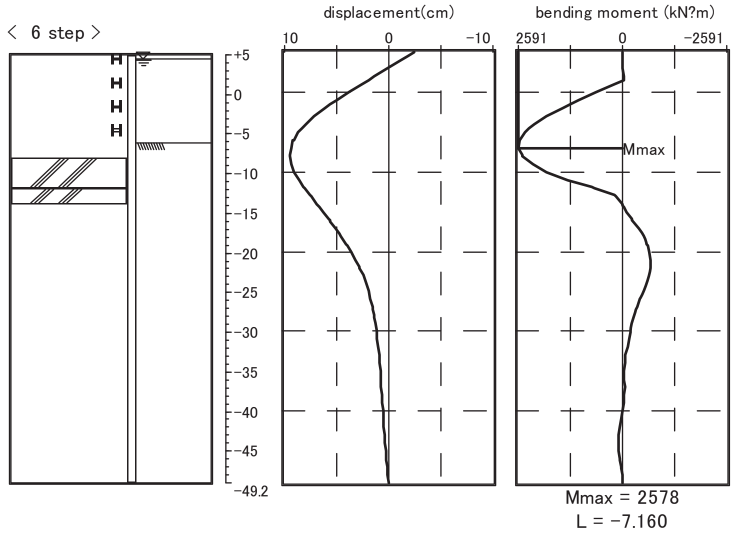
< 2 step >
displacement(cm)
10
0
−10
bending moment (kN?m)
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 1852
L = −8.160



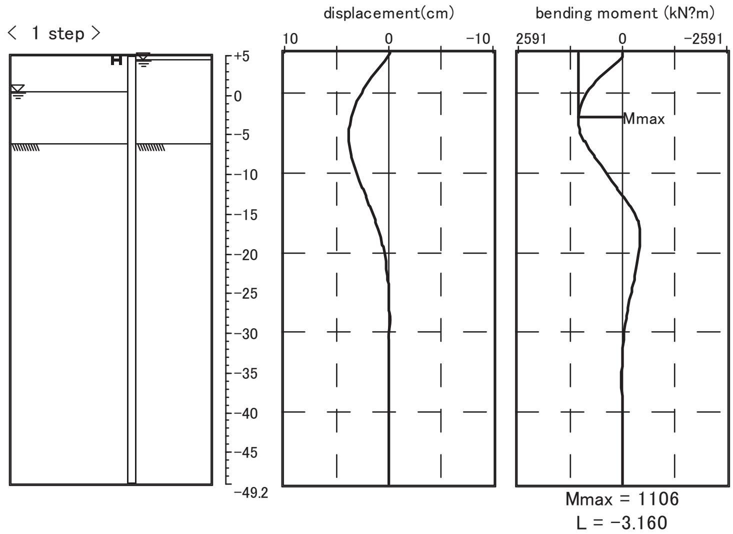
< 3 step >
displacement(cm)
10
0
−10
bending moment (kN?m)
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2435
L = −7.160

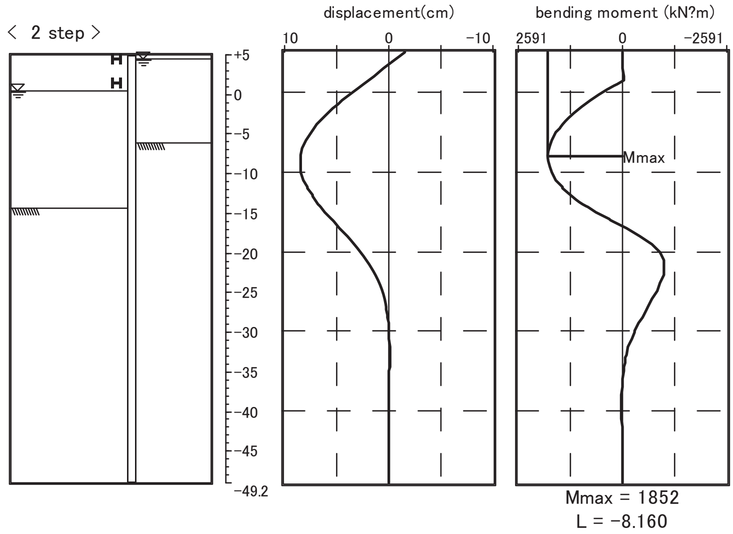

< 4 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2570
L = −7.160

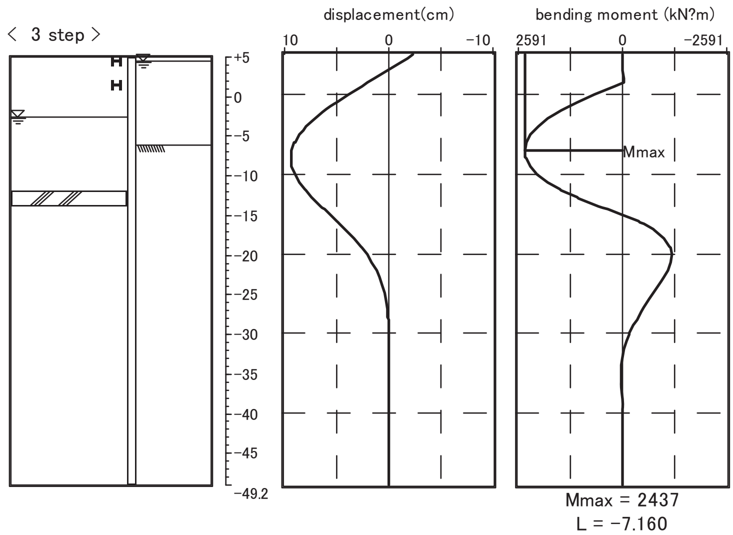

< 5 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2570
L = −7.160

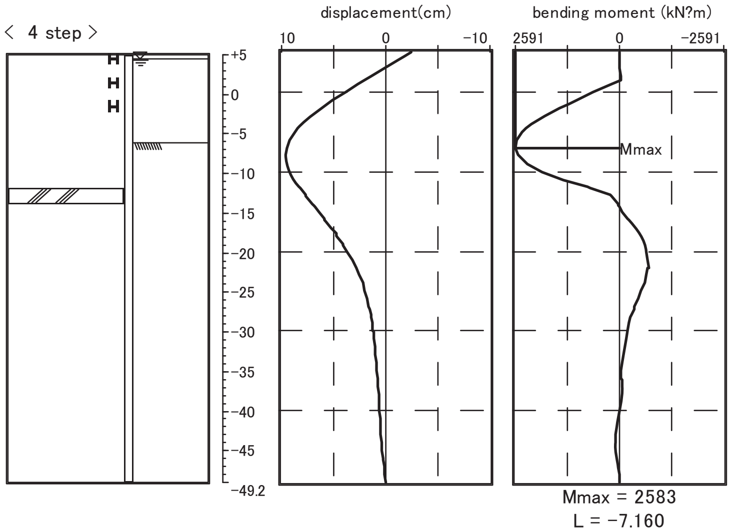


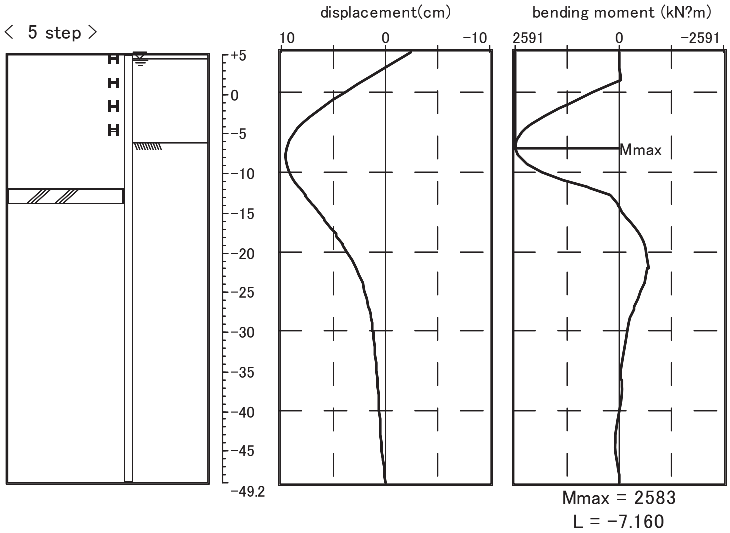
perpendicular direction

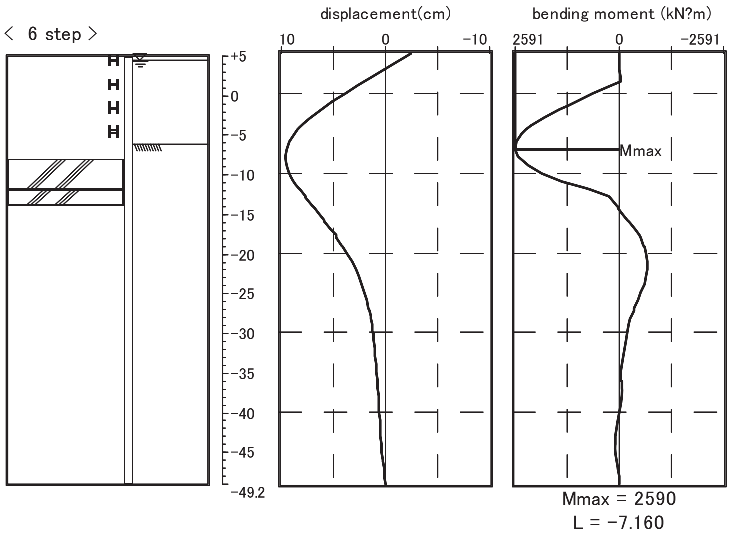



< 2 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 1852
L = −8.160


< 3 step >
displacement(cm)
bending moment (kN?m)
10
0
−10
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2437
L = −7.160


< 4 step >
displacement(cm)
10
0
−10
bending moment (kN?m)
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2583
L = −7.160


< 5 step >
displacement(cm)
10
0
−10
bending moment (kN?m)
2591
0
−2591
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−49.2
Mmax
Mmax = 2583
L = −7.160



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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	232.62	H-350*350*12*19	232.57
2	2H-400*400*13*21	284.21	2H-400*400*13*21	284.33

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
3	H-300*300*10*15	80.29	H-300*300*10*15	96.95
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	431.16	39800	1986.21	232.57	OK
2	2H-400*400*13*21	428.66	66600	3382.15	284.33	OK
3	H-300*300*10*15	433.66	20200	990.74	96.95	OK
4	H-300*300*10*15	433.66	20200	990.74	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	232.57	232.62	431.16
2	2H-400*400*13*21	218.70	3330	284.33	284.21	428.66
3	H-300*300*10*15	118.40	1350	96.95	80.29	433.66
4	H-300*300*10*15	118.40	1350	0.00	0.00	433.66

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	1002.8	86.5	141.3	158.24	210.00	OK
2	2.700	1218.8	104.5	172.7	138.96	210.00	OK
3	2.700	420.4	36.5	48.8	98.65	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)

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

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

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

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

$$N = R1max*r + Del.N$$

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

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

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

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	431.16	4.000	1.300	2.700	2.700	2.700	2.700
2	2H-400*400*13*21	218.70	3330	428.66	4.000	1.300	2.700	2.700	2.700	2.700
3	H-300*300*10*15	118.40	1350	433.66	4.000	1.300	2.700	2.700	2.700	2.700
4	H-300*300*10*15	118.40	1350	433.66	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	26.73	199.26	6.75	201.90	15.43	5041.15
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	232.57	232.62	1152.76	211.98	67.06	92.97
2	284.33	284.21	1368.80	258.99	62.59	77.78
3	96.95	80.29	570.45	73.16	48.18	54.19
4	0.00	0.00	150.00	0.00	12.67	0.00

row	Alp.	Beta	Alp.+Beta	judgement
1	0.344	0.477	0.821	OK
2	0.314	0.390	0.704	OK
3	0.256	0.284	0.541	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	67.06	92.97	3803.13	94.64	161.70	210.00	OK
2	62.59	77.78	5041.15	78.75	141.34	210.00	OK
3	48.18	54.19	2824.86	55.13	103.31	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	232.62	2.700	314.04	37.44	83.88	120.00	OK
2	284.21	2.700	383.69	46.54	82.44	120.00	OK
3	80.29	2.700	108.39	27.00	40.14	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	5.673	8.273	8.273	5.673
2	2H-400*400*13*21	218.70	3330	4.000	5.573	8.173	8.173	5.573
3	H-300*300*10*15	118.40	1350	4.000	5.773	8.373	8.373	5.773
4	H-300*300*10*15	118.40	1350	4.000	5.773	8.373	8.373	5.773

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	63.81	153.65	16.21	167.85	54.43	405.08
2	55.18	164.27	13.93	176.04	46.70	550.17

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
3	76.46	138.09	19.24	156.92	63.92	293.74
4	76.46	138.09	19.24	156.92	63.92	293.74

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	232.57	232.62	1080.50	42.78	62.86	18.76
2	284.33	284.21	1286.86	41.75	58.84	12.54
3	96.95	80.29	471.15	43.82	39.79	32.46
4	0.00	0.00	150.00	43.82	12.67	32.46

row	Alp.	Beta	Alp.+Beta	judgement
1	0.409	0.132	0.541	OK
2	0.358	0.080	0.438	OK
3	0.288	0.239	0.527	OK
4	0.092	0.216	0.308	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	62.86	18.76	405.08	22.21	85.06	210.00	OK
2	58.84	12.54	550.17	14.04	72.88	210.00	OK
3	39.79	32.46	293.74	37.54	77.34	210.00	OK
4	12.67	32.46	293.74	33.92	46.59	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	8.273	20.68	37.44	5.52	120.00	OK
2	8.173	20.43	46.54	4.39	120.00	OK
3	8.373	20.93	27.00	7.75	120.00	OK
4	8.373	20.93	27.00	7.75	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-400*400*13*21	218.70	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	232.62	444.12	25.84	206.70	OK
2	18.20	284.21	542.62	24.81	209.75	OK
3	24.35	80.29	153.28	12.95	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 -6.276 (m)
riverside water table elevation +4.340 (m)
steel pipe sheet pile length 54.000 (m)

(1)final excavation time (5 step)
observing strut elevation = -4.660 (m)
coffered landside excavation area elevation = -14.560 (m)
coffered landside water table elevation = -14.560 (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 -6.276	1.616	------- -------	0.00 0.00	90.00 106.16
2	-6.276 -14.350	8.074	------- -------	0.00 22.41	106.16 186.90
3	-14.350 -14.560	0.210	------- -------	19.04 19.54	186.90 189.00
4	-14.560 -16.350	1.790	0.00 48.58	19.54 23.76	189.00 0.00
5	-16.350 -19.350	3.000	48.58 129.99	23.76 30.83	0.00 0.00
6	-19.350 -27.350	8.000	122.32 182.32	20.59 80.59	0.00 0.00
7	-27.350 -28.350	1.000	319.99 346.03	50.57 53.03	0.00 0.00
8	-28.350 -30.350	2.000	190.32 205.32	88.59 103.59	0.00 0.00
9	-30.350 -30.571	0.221	411.53 417.52	55.30 55.82	0.00 0.00

active earth pressure /water pressure Pa = 3770.2 (kN/m)
ya = 12.474 (m)
Ma = 47028 (kN.m/m)
passive earth pressure Pp = 2350.0 (kN/m)
yp = 20.012 (m)
Mp = 47028 (kN.m/m)

balanced depth Z = 16.011 (m) (elevation = -30.571 (m))
embedment length D = 19.213 (m) (elevation = -33.773 (m))
required sheet pile length L = 38.613 (m)

(2)before installation of the lower strut (4 step)
observing strut elevation = -1.660 (m)
coffered landside excavation area elevation = -14.560 (m)
coffered landside water table elevation = -14.560 (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 -6.276	4.616	------- -------	0.00 0.00	60.00 106.16
2	-6.276 -14.350	8.074	------- -------	0.00 22.41	106.16 186.90
3	-14.350 -14.560	0.210	------- -------	19.04 19.54	186.90 189.00
4	-14.560 -16.350	1.790	0.00 48.58	19.54 23.76	189.00 0.54
5	-16.350 -19.350	3.000	48.58 129.99	23.76 30.83	0.54 0.43
6	-19.350 -27.350	8.000	122.32 182.32	20.59 80.59	0.43 0.14
7	-27.350 -28.350	1.000	319.99 346.03	50.57 53.03	0.14 0.10
8	-28.350 -30.350	2.000	190.32 205.32	88.59 103.59	0.10 0.03
9	-30.350 -31.114	0.764	411.53 432.26	55.30 57.10	0.03 0.00

active earth pressure /water pressure Pa = 4077.2 (kN/m)
ya = 14.915 (m)
Ma = 60813 (kN.m/m)
passive earth pressure Pp = 2580.7 (kN/m)
yp = 23.564 (m)
Mp = 60813 (kN.m/m)
balanced depth Z = 16.554 (m) (elevation = -31.114 (m))
embedment length D = 19.864 (m) (elevation = -34.424 (m))

required sheet pile length L = 39.264 (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	-21.160	69.22	58.58	127.80	189.00
2	Ord+Collision(scour)	-21.160	50.45	58.58	109.03	210.00
3	Earthquake(scour)	-21.160	126.74	58.58	185.32	210.00

2) material :SKY490

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	-12.060	78.60	71.63	150.24	249.75
2	Ord+Collision(scour)	-12.060	55.28	71.63	126.92	277.50
3	Earthquake(scour)	-12.060	124.93	71.63	196.56	277.50

(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	-12.160	41.12	60.90	102.02	175.00
2	Ord+Collision(scour)	-21.160	67.16	59.34	126.50	210.00
3	Earthquake(scour)	-21.160	127.23	59.34	186.57	210.00

2) material :SKY490

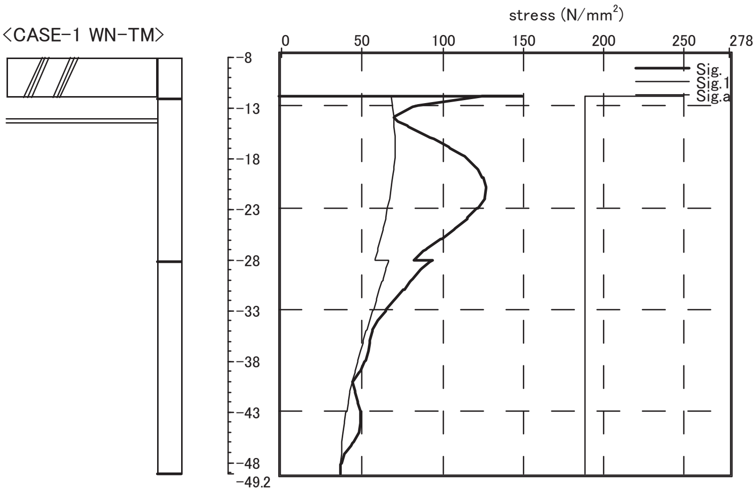
Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Wind	-12.060	46.88	76.17	123.05	231.25
2	Ord+Collision(scour)	-12.060	69.85	76.17	146.02	277.50
3	Earthquake(scour)	-12.060	124.75	76.17	200.91	277.50

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-1 WN-TM>



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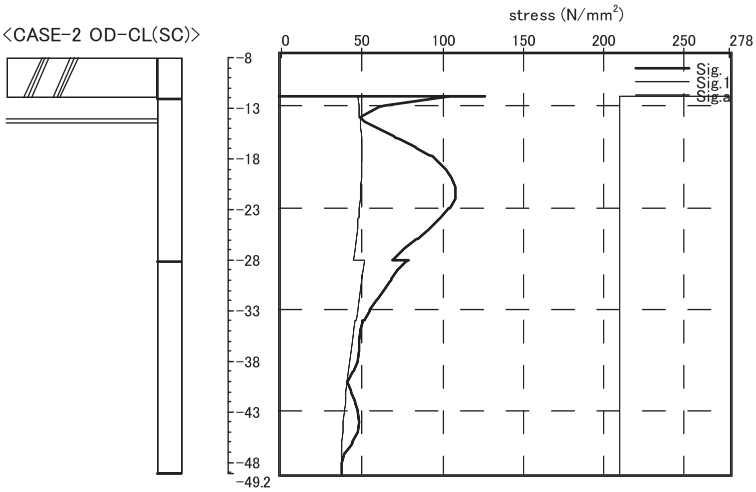

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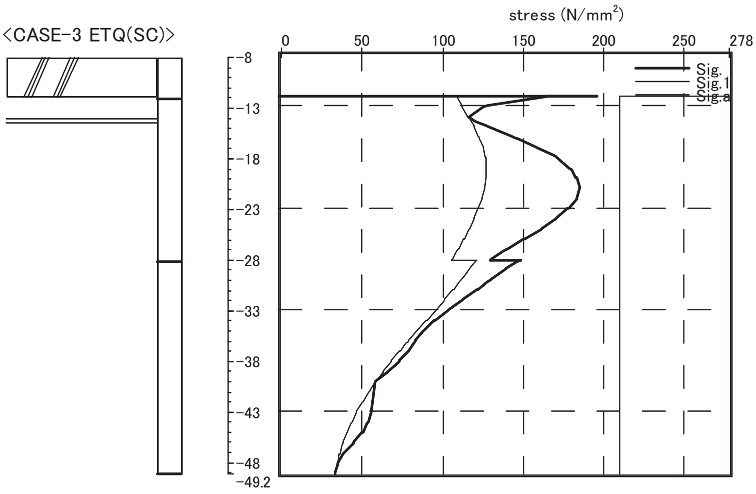

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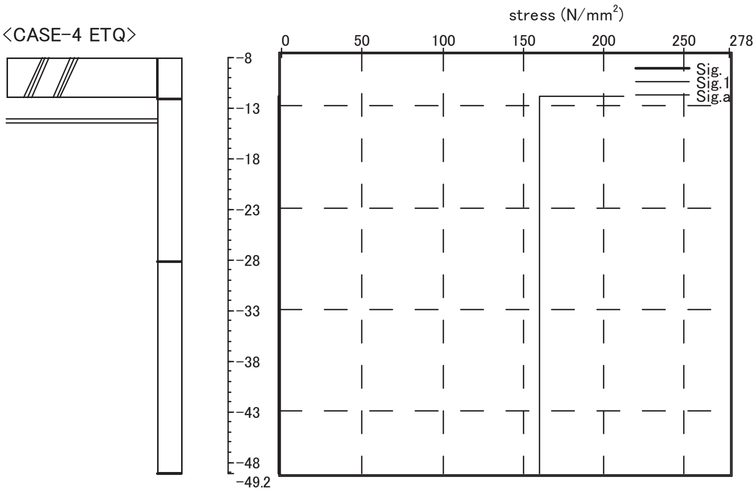

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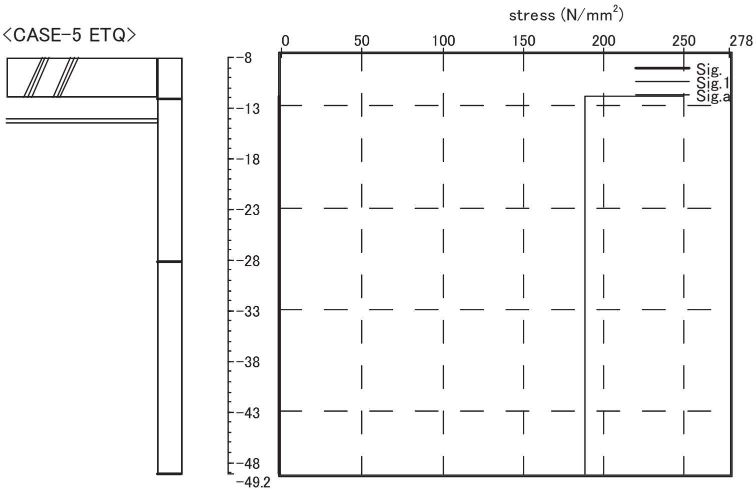

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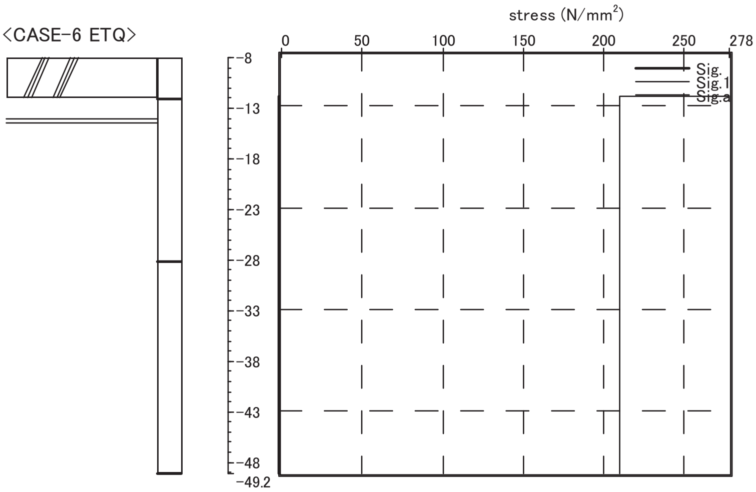
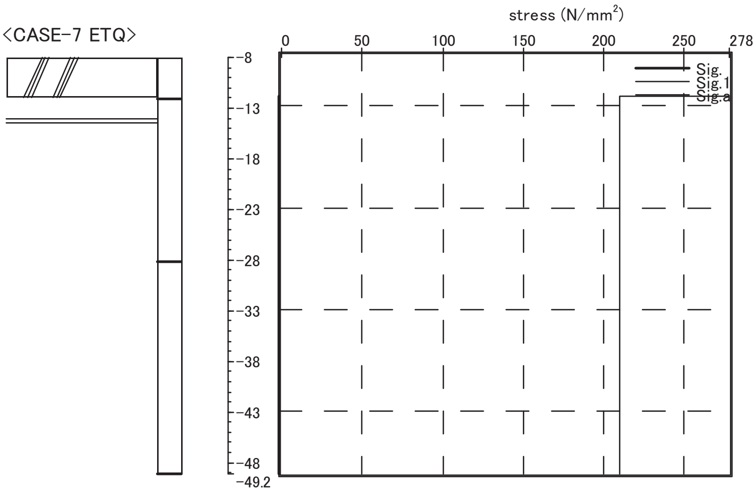


<CASE-7 ETQ>



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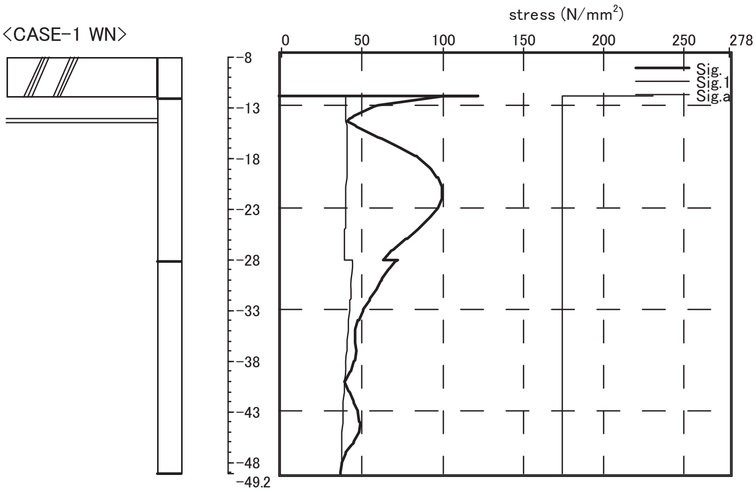
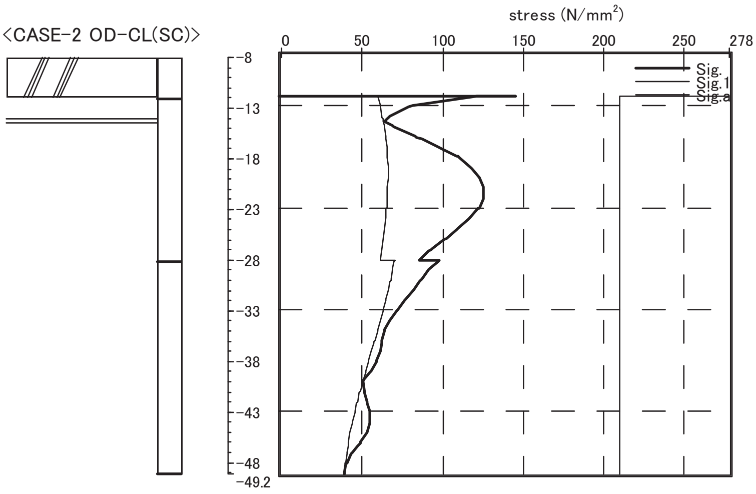
(2)perpendicular direction

<CASE-1 WN>



<CASE-2 OD-CL(SC)>



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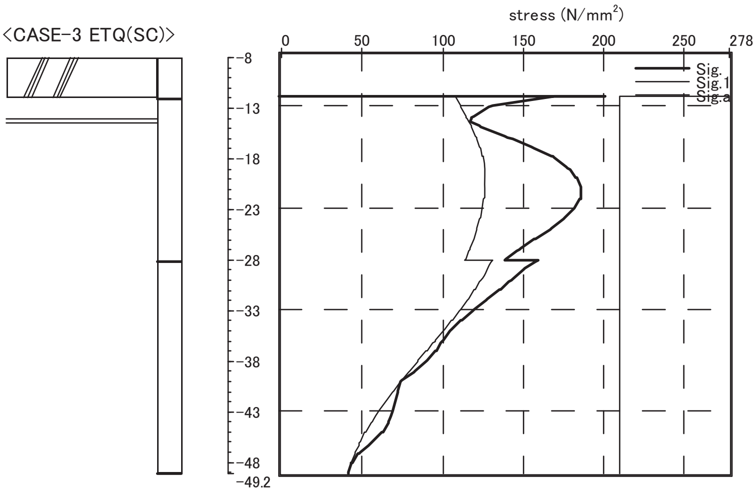

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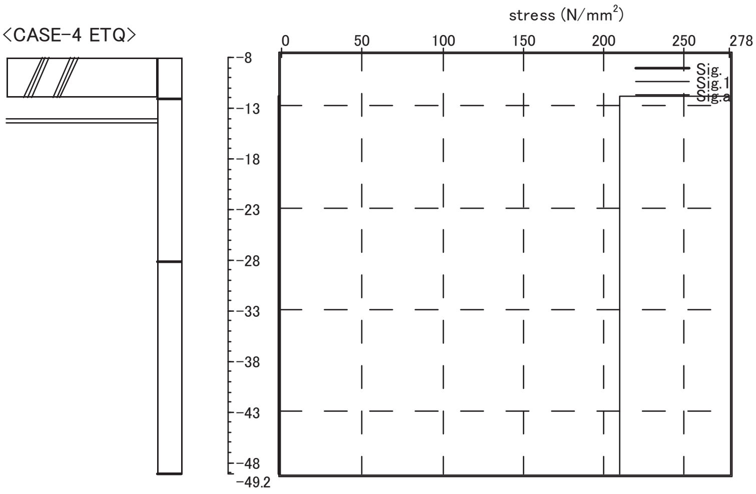

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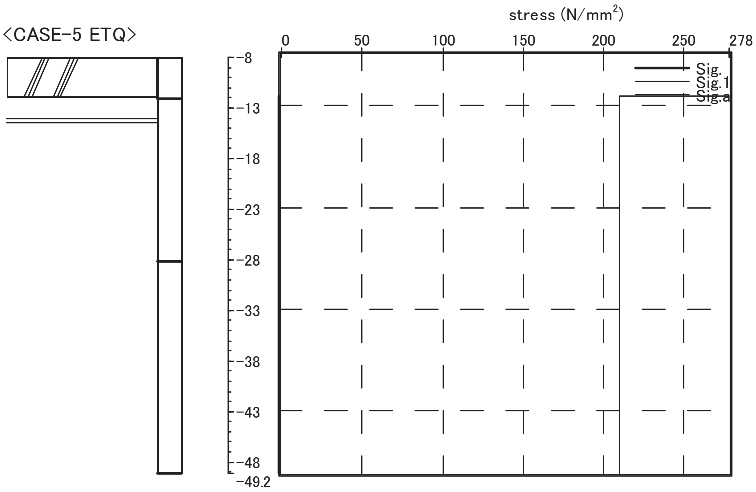

3.3 detail output

(1)bridge axis direction

1)Wind+Temp

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	78.60	71.63	150.24	
-12.160	78.72	64.65	143.37	
-12.160	68.90	56.86	125.75	
-13.060	69.75	15.90	85.65	
-13.160	69.83	12.92	82.75	
-14.060	70.60	1.47	72.07	
-14.160	70.68	0.20	70.87	
-14.350	70.83	0.96	71.79	
-14.560	70.98	2.52	73.51	
-15.060	71.29	7.74	79.03	
-15.160	71.32	8.78	80.11	
-16.060	71.64	19.97	91.61	
-16.160	71.65	21.27	92.93	
-16.350	71.68	23.76	95.44	
-17.060	71.68	32.74	104.42	
-17.160	71.65	34.01	105.66	
-17.871	71.48	41.74	113.22	
-18.060	71.43	43.43	114.87	
-18.160	71.38	44.33	115.71	
-19.060	70.94	50.50	121.44	
-19.160	70.88	51.18	122.06	
-19.350	70.75	52.22	122.98	
-20.060	70.23	55.48	125.71	
-20.160	70.14	55.94	126.08	
-21.060	69.33	58.31	127.64	
-21.160	69.22	58.58	127.80	**
-22.060	68.27	58.61	126.89	
-22.089	68.24	58.61	126.85	
-22.160	68.15	58.51	126.66	
-23.060	67.08	55.79	122.87	
-23.160	66.95	55.49	122.44	
-24.060	65.77	50.84	116.61	
-24.160	65.63	50.33	115.95	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.060	64.36	44.53	108.89	
-25.160	64.21	43.89	108.10	
-26.060	62.87	37.58	100.45	
-26.160	62.71	36.88	99.59	
-27.060	61.31	30.55	91.86	
-27.160	61.15	29.85	91.00	
-27.350	60.85	28.55	89.40	
-28.060	59.69	24.25	83.94	
-28.160	59.52	23.64	83.17	
-28.160	67.96	26.88	94.85	
-28.350	67.60	25.80	93.40	
-29.060	66.22	22.24	88.46	
-29.160	66.03	21.74	87.77	
-30.060	64.26	18.28	82.53	
-30.160	64.06	17.89	81.95	
-30.350	63.68	17.32	81.01	
-31.060	62.26	15.02	77.28	
-31.160	62.06	14.70	76.76	
-32.060	60.24	11.40	71.64	
-32.160	60.04	11.04	71.08	
-33.060	58.21	7.93	66.14	
-33.160	58.01	7.58	65.59	
-34.060	56.20	5.20	61.40	
-34.160	56.00	4.94	60.94	
-35.060	54.22	3.75	57.97	
-35.160	54.02	3.62	57.64	
-36.060	52.28	4.05	56.33	
-36.160	52.09	4.09	56.19	
-36.350	51.73	4.42	56.15	
-37.060	50.42	5.17	55.59	
-37.160	50.24	5.28	55.52	
-38.060	48.65	4.75	53.40	
-38.160	48.48	4.69	53.17	
-39.060	47.00	2.98	49.98	
-39.160	46.84	2.79	49.64	
-40.060	45.47	0.34	45.81	
-40.160	45.33	0.07	45.40	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-41.060	44.07	2.74	46.81	
-41.160	43.94	3.04	46.98	
-42.060	42.80	5.79	48.59	
-42.160	42.69	6.09	48.78	
-43.060	41.67	8.36	50.03	
-43.160	41.58	8.61	50.19	
-44.060	40.69	9.86	50.55	
-44.160	40.60	10.00	50.61	
-45.060	39.84	9.60	49.44	
-45.160	39.77	9.56	49.33	
-46.060	39.14	6.71	45.85	
-46.160	39.08	6.40	45.47	
-46.350	38.96	5.41	44.37	
-47.060	38.57	2.39	40.96	
-47.160	38.53	1.96	40.50	
-47.241	38.50	1.73	40.23	
-48.060	38.15	0.40	38.55	
-48.160	38.13	0.23	38.36	
-48.240	38.11	0.18	38.29	
-49.060	37.90	0.02	37.92	
-49.160	37.92	0.00	37.92	

*   :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)	
-12.060	55.28	71.63	126.92	
-12.160	55.37	64.65	120.02	
-12.160	48.55	56.86	105.41	
-13.060	49.18	15.90	65.08	
-13.160	49.25	12.92	62.17	
-14.060	49.83	1.47	51.30	
-14.160	49.90	0.20	50.09	
-14.350	50.01	0.96	50.98	
-14.560	50.14	2.52	52.66	
-15.060	50.40	7.74	58.14	
-15.160	50.44	8.78	59.22	
-16.060	50.79	19.97	70.75	
-16.160	50.81	21.27	72.09	
-16.350	50.86	23.76	74.62	
-17.060	51.00	32.74	83.74	
-17.160	51.01	34.01	85.01	
-17.871	51.05	41.74	92.79	
-18.060	51.06	43.43	94.49	
-18.160	51.05	44.33	95.38	
-19.060	50.99	50.50	101.48	
-19.160	50.97	51.18	102.15	
-19.350	50.94	52.22	103.16	
-20.060	50.79	55.48	106.27	
-20.160	50.76	55.94	106.70	
-21.060	50.49	58.31	108.81	
-21.160	50.45	58.58	109.03	**
-22.060	50.10	58.61	108.72	
-22.089	50.09	58.61	108.70	
-22.160	50.06	58.51	108.57	
-23.060	49.64	55.79	105.43	
-23.160	49.59	55.49	105.07	
-24.060	49.11	50.84	99.95	
-24.160	49.05	50.33	99.37	
-25.060	48.52	44.53	93.05	
-25.160	48.45	43.89	92.34	
-26.060	47.88	37.58	85.46	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	47.81	36.88	84.69	
-27.060	47.20	30.55	77.76	
-27.160	47.13	29.85	76.99	
-27.350	47.00	28.55	75.56	
-28.060	46.49	24.25	70.74	
-28.160	46.42	23.64	70.06	
-28.160	52.92	26.88	79.80	
-28.350	52.75	25.80	78.55	
-29.060	52.13	22.24	74.38	
-29.160	52.05	21.74	73.79	
-30.060	51.24	18.28	69.52	
-30.160	51.15	17.89	69.05	
-30.350	50.98	17.32	68.31	
-31.060	50.33	15.02	65.35	
-31.160	50.24	14.70	64.94	
-32.060	49.39	11.40	60.80	
-32.160	49.30	11.04	60.34	
-33.060	48.44	7.93	56.37	
-33.160	48.34	7.58	55.93	
-34.060	47.48	5.20	52.68	
-34.160	47.39	4.94	52.32	
-35.060	46.53	3.75	50.28	
-35.160	46.44	3.62	50.06	
-36.060	45.60	4.05	49.64	
-36.160	45.51	4.09	49.60	
-36.350	45.33	4.42	49.75	
-37.060	44.69	5.17	49.86	
-37.160	44.60	5.28	49.88	
-38.060	43.82	4.75	48.57	
-38.160	43.74	4.69	48.43	
-39.060	43.01	2.98	45.99	
-39.160	42.93	2.79	45.72	
-40.060	42.24	0.34	42.59	
-40.160	42.17	0.07	42.25	
-41.060	41.54	2.74	44.28	
-41.160	41.48	3.04	44.52	
-42.060	40.91	5.79	46.69	

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elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	40.85	6.09	46.94	
-43.060	40.33	8.36	48.69	
-43.160	40.28	8.61	48.89	
-44.060	39.83	9.86	49.70	
-44.160	39.79	10.00	49.79	
-45.060	39.40	9.60	49.00	
-45.160	39.36	9.56	48.92	
-46.060	39.04	6.71	45.75	
-46.160	39.01	6.40	45.40	
-46.350	38.95	5.41	44.35	
-47.060	38.75	2.39	41.14	
-47.160	38.73	1.96	40.69	
-47.241	38.71	1.73	40.44	
-48.060	38.53	0.40	38.93	
-48.160	38.52	0.23	38.75	
-48.240	38.51	0.18	38.69	
-49.060	38.39	0.02	38.41	
-49.160	38.38	0.00	38.38	

*   :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)	
-12.060	124.93	71.63	196.56	
-12.160	125.37	64.65	190.02	
-12.160	109.53	56.86	166.38	
-13.060	112.97	15.90	128.87	
-13.160	113.34	12.92	126.26	
-14.060	116.68	1.47	118.15	
-14.160	117.04	0.20	117.24	
-14.350	117.74	0.96	118.70	
-14.560	118.49	2.52	121.01	
-15.060	120.20	7.74	127.94	
-15.160	120.51	8.78	129.30	
-16.060	123.31	19.97	143.28	
-16.160	123.60	21.27	144.87	
-16.350	124.14	23.76	147.90	
-17.060	125.86	32.74	158.61	
-17.160	126.02	34.01	160.03	
-17.871	127.11	41.74	168.85	
-18.060	127.41	43.43	170.84	
-18.160	127.47	44.33	171.80	
-19.060	128.02	50.50	178.51	
-19.160	128.02	51.18	179.20	
-19.350	128.03	52.22	180.26	
-20.060	127.80	55.48	183.29	
-20.160	127.71	55.94	183.66	
-21.060	126.89	58.31	185.21	
-21.160	126.74	58.58	185.32	**
-22.060	125.37	58.61	183.98	
-22.089	125.31	58.61	183.92	
-22.160	125.16	58.51	183.67	
-23.060	123.30	55.79	179.09	
-23.160	123.05	55.49	178.53	
-24.060	120.77	50.84	171.61	
-24.160	120.47	50.33	170.80	
-25.060	117.83	44.53	162.36	
-25.160	117.50	43.89	161.39	
-26.060	114.55	37.58	152.13	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	114.20	36.88	151.07	
-27.060	110.99	30.55	141.54	
-27.160	110.62	29.85	140.47	
-27.350	109.91	28.55	138.46	
-28.060	107.15	24.25	131.40	
-28.160	106.75	23.64	130.39	
-28.160	122.18	26.88	149.06	
-28.350	121.29	25.80	147.09	
-29.060	117.89	22.24	140.13	
-29.160	117.39	21.74	139.13	
-30.060	112.95	18.28	131.23	
-30.160	112.45	17.89	130.34	
-30.350	111.50	17.32	128.82	
-31.060	107.85	15.02	122.87	
-31.160	107.31	14.70	122.01	
-32.060	102.50	11.40	113.90	
-32.160	101.95	11.04	112.99	
-33.060	97.00	7.93	104.93	
-33.160	96.44	7.58	104.03	
-34.060	91.42	5.20	96.62	
-34.160	90.87	4.94	95.80	
-35.060	85.84	3.75	89.59	
-35.160	85.29	3.62	88.91	
-36.060	80.31	4.05	84.36	
-36.160	79.76	4.09	83.86	
-36.350	78.72	4.42	83.15	
-37.060	74.90	5.17	80.07	
-37.160	74.38	5.28	79.66	
-38.060	69.69	4.75	74.44	
-38.160	69.20	4.69	73.89	
-39.060	64.75	2.98	67.73	
-39.160	64.28	2.79	67.08	
-40.060	60.10	0.34	60.44	
-40.160	59.67	0.07	59.74	
-41.060	55.78	2.74	58.52	
-41.160	55.39	3.04	58.42	
-42.060	51.82	5.79	57.61	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	51.46	6.09	57.55	
-43.060	48.22	8.36	56.58	
-43.160	47.90	8.61	56.51	
-44.060	45.01	9.86	54.88	
-44.160	44.73	10.00	54.73	
-45.060	42.19	9.60	51.79	
-45.160	41.95	9.56	51.51	
-46.060	39.77	6.71	46.48	
-46.160	39.55	6.40	45.95	
-46.350	39.14	5.41	44.55	
-47.060	37.75	2.39	40.14	
-47.160	37.59	1.96	39.55	
-47.241	37.46	1.73	39.19	
-48.060	36.13	0.40	36.53	
-48.160	36.01	0.23	36.24	
-48.240	35.91	0.18	36.09	
-49.060	34.92	0.02	34.94	
-49.160	34.82	0.00	34.82	

* :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

4)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	

* :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)	

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

6)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	

*   :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)	

* :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)	
-12.060	46.88	76.17	123.05	
-12.160	46.91	69.25	116.16	
-12.160	41.12	60.90	102.02	**
-13.060	41.31	20.13	61.44	
-13.160	41.33	17.13	58.46	
-14.060	41.51	4.81	46.32	
-14.160	41.53	3.44	44.97	
-14.350	41.57	2.51	44.08	
-14.560	41.60	0.77	42.37	
-15.060	41.68	5.14	46.82	
-15.160	41.69	6.01	47.71	
-16.060	41.79	17.98	59.77	
-16.160	41.80	19.37	61.17	
-16.350	41.82	22.02	63.83	
-17.060	41.85	31.62	73.47	
-17.160	41.85	32.97	74.82	
-17.975	41.86	42.38	84.24	
-18.060	41.86	43.19	85.05	
-18.160	41.85	44.14	86.00	
-19.060	41.82	50.78	92.59	
-19.160	41.81	51.51	93.32	
-19.350	41.80	52.60	94.40	
-20.060	41.74	56.01	97.75	
-20.160	41.72	56.49	98.22	
-21.060	41.62	59.06	100.68	
-21.160	41.60	59.34	100.95	
-22.060	41.47	59.47	100.94	
-22.160	41.45	59.48	100.93	
-22.196	41.44	59.43	100.87	
-23.060	41.29	56.88	98.17	
-23.160	41.27	56.59	97.85	
-24.060	41.08	51.93	93.01	
-24.160	41.06	51.41	92.47	
-25.060	40.85	45.54	86.39	
-25.160	40.83	44.89	85.72	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.060	40.60	38.47	79.08	
-26.160	40.58	37.76	78.34	
-27.060	40.34	31.36	71.69	
-27.160	40.31	30.65	70.96	
-27.350	40.26	29.34	69.59	
-28.060	40.05	24.96	65.01	
-28.160	40.02	24.34	64.36	
-28.160	45.63	27.68	73.31	
-28.350	45.57	26.56	72.13	
-29.060	45.31	22.91	68.22	
-29.160	45.28	22.39	67.67	
-30.060	44.95	18.94	63.89	
-30.160	44.91	18.56	63.47	
-30.350	44.84	18.01	62.85	
-31.060	44.57	15.78	60.34	
-31.160	44.53	15.46	59.99	
-32.060	44.16	12.16	56.32	
-32.160	44.12	11.79	55.91	
-33.060	43.74	8.61	52.36	
-33.160	43.70	8.26	51.96	
-34.060	43.31	5.79	49.10	
-34.160	43.26	5.52	48.78	
-35.060	42.87	4.26	47.12	
-35.160	42.82	4.12	46.94	
-36.060	42.42	4.51	46.94	
-36.160	42.38	4.56	46.93	
-36.350	42.29	4.89	47.18	
-37.060	41.98	5.62	47.60	
-37.160	41.93	5.73	47.66	
-38.060	41.54	5.11	46.65	
-38.160	41.50	5.05	46.54	
-39.060	41.11	3.21	44.32	
-39.160	41.07	3.01	44.08	
-40.060	40.70	0.40	41.10	
-40.160	40.66	0.11	40.77	
-41.060	40.31	2.89	43.20	
-41.160	40.27	3.20	43.47	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.060	39.94	6.13	46.07	
-42.160	39.91	6.46	46.36	
-43.060	39.60	8.90	48.50	
-43.160	39.57	9.17	48.74	
-44.060	39.29	10.57	49.86	
-44.160	39.26	10.73	49.99	
-45.060	39.01	10.42	49.43	
-45.160	38.98	10.38	49.37	
-46.060	38.77	7.54	46.31	
-46.160	38.75	7.22	45.97	
-46.350	38.71	6.22	44.92	
-47.060	38.57	3.04	41.61	
-47.160	38.55	2.60	41.15	
-47.241	38.54	2.34	40.87	
-48.060	38.41	0.64	39.04	
-48.160	38.40	0.43	38.82	
-48.240	38.39	0.34	38.73	
-49.060	38.29	0.04	38.33	
-49.160	38.28	0.00	38.28	

*   :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)	
-12.060	69.85	76.17	146.02	
-12.160	70.02	69.25	139.27	
-12.160	61.14	60.90	122.04	
-13.060	62.41	20.13	82.53	
-13.160	62.54	17.13	79.67	
-14.060	63.75	4.81	68.56	
-14.160	63.88	3.44	67.32	
-14.350	64.12	2.51	66.63	
-14.560	64.38	0.77	65.15	
-15.060	64.96	5.14	70.10	
-15.160	65.06	6.01	71.07	
-16.060	65.91	17.98	83.89	
-16.160	65.99	19.37	85.35	
-16.350	66.13	22.02	88.15	
-17.060	66.60	31.62	98.22	
-17.160	66.64	32.97	99.62	
-17.975	67.02	42.38	109.40	
-18.060	67.05	43.19	110.24	
-18.160	67.08	44.14	111.22	
-19.060	67.29	50.78	118.07	
-19.160	67.30	51.51	118.81	
-19.350	67.32	52.60	119.92	
-20.060	67.33	56.01	123.34	
-20.160	67.31	56.49	123.81	
-21.060	67.19	59.06	126.25	
-21.160	67.16	59.34	126.50	**
-22.060	66.90	59.47	126.37	
-22.160	66.85	59.48	126.34	
-22.196	66.84	59.43	126.27	
-23.060	66.46	56.88	123.34	
-23.160	66.40	56.59	122.99	
-24.060	65.89	51.93	117.83	
-24.160	65.83	51.41	117.24	
-25.060	65.21	45.54	110.75	
-25.160	65.13	44.89	110.02	
-26.060	64.43	38.47	102.90	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	64.34	37.76	102.10	
-27.060	63.55	31.36	94.91	
-27.160	63.46	30.65	94.10	
-27.350	63.28	29.34	92.62	
-28.060	62.58	24.96	87.53	
-28.160	62.47	24.34	86.81	
-28.160	71.56	27.68	99.24	
-28.350	71.32	26.56	97.88	
-29.060	70.42	22.91	93.33	
-29.160	70.29	22.39	92.68	
-30.060	69.10	18.94	88.04	
-30.160	68.96	18.56	87.52	
-30.350	68.70	18.01	86.71	
-31.060	67.69	15.78	83.47	
-31.160	67.53	15.46	83.00	
-32.060	66.15	12.16	78.31	
-32.160	65.98	11.79	77.77	
-33.060	64.50	8.61	73.11	
-33.160	64.32	8.26	72.58	
-34.060	62.76	5.79	68.55	
-34.160	62.58	5.52	68.10	
-35.060	60.96	4.26	65.22	
-35.160	60.78	4.12	64.89	
-36.060	59.12	4.51	63.64	
-36.160	58.94	4.56	63.49	
-36.350	58.58	4.89	63.47	
-37.060	57.26	5.62	62.88	
-37.160	57.07	5.73	62.80	
-38.060	55.39	5.11	60.51	
-38.160	55.21	5.05	60.25	
-39.060	53.54	3.21	56.76	
-39.160	53.36	3.01	56.37	
-40.060	51.74	0.40	52.14	
-40.160	51.57	0.11	51.68	
-41.060	50.00	2.89	52.89	
-41.160	49.84	3.20	53.04	
-42.060	48.35	6.13	54.48	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	48.20	6.46	54.66	
-43.060	46.81	8.90	55.71	
-43.160	46.67	9.17	55.83	
-44.060	45.39	10.57	55.96	
-44.160	45.26	10.73	55.99	
-45.060	44.11	10.42	54.52	
-45.160	44.00	10.38	54.38	
-46.060	42.99	7.54	50.52	
-46.160	42.89	7.22	50.11	
-46.350	42.69	6.22	48.91	
-47.060	42.04	3.04	45.09	
-47.160	41.96	2.60	44.56	
-47.241	41.90	2.34	44.24	
-48.060	41.28	0.64	41.92	
-48.160	41.23	0.43	41.66	
-48.240	41.19	0.34	41.53	
-49.060	40.73	0.04	40.77	
-49.160	40.69	0.00	40.69	

*   :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)	
-12.060	124.75	76.17	200.91	
-12.160	125.15	69.25	194.40	
-12.160	108.82	60.90	169.72	
-13.060	111.92	20.13	132.05	
-13.160	112.26	17.13	129.39	
-14.060	115.29	4.81	120.10	
-14.160	115.62	3.44	119.06	
-14.350	116.25	2.51	118.76	
-14.560	116.94	0.77	117.71	
-15.060	118.52	5.14	123.66	
-15.160	118.81	6.01	124.83	
-16.060	121.47	17.98	139.44	
-16.160	121.74	19.37	141.11	
-16.350	122.27	22.02	144.28	
-17.060	124.00	31.62	155.62	
-17.160	124.18	32.97	157.15	
-17.975	125.65	42.38	168.03	
-18.060	125.80	43.19	168.99	
-18.160	125.91	44.14	170.06	
-19.060	126.90	50.78	177.68	
-19.160	126.97	51.51	178.48	
-19.350	127.10	52.60	179.70	
-20.060	127.37	56.01	183.38	
-20.160	127.36	56.49	183.85	
-21.060	127.28	59.06	186.34	
-21.160	127.23	59.34	186.57	**
-22.060	126.70	59.47	186.17	
-22.160	126.60	59.48	186.08	
-22.196	126.56	59.43	185.99	
-23.060	125.66	56.88	182.54	
-23.160	125.52	56.59	182.11	
-24.060	124.22	51.93	176.15	
-24.160	124.04	51.41	175.45	
-25.060	122.42	45.54	167.96	
-25.160	122.20	44.89	167.09	
-26.060	120.29	38.47	158.76	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	120.05	37.76	157.81	
-27.060	117.88	31.36	149.24	
-27.160	117.62	30.65	148.27	
-27.350	117.14	29.34	146.47	
-28.060	115.18	24.96	140.14	
-28.160	114.89	24.34	139.23	
-28.160	132.15	27.68	159.83	
-28.350	131.50	26.56	158.06	
-29.060	128.97	22.91	151.87	
-29.160	128.59	22.39	150.99	
-30.060	125.23	18.94	144.17	
-30.160	124.84	18.56	143.40	
-30.350	124.11	18.01	142.13	
-31.060	121.25	15.78	137.02	
-31.160	120.81	15.46	136.27	
-32.060	116.87	12.16	129.03	
-32.160	116.40	11.79	128.19	
-33.060	112.16	8.61	120.78	
-33.160	111.67	8.26	119.93	
-34.060	107.21	5.79	113.00	
-34.160	106.69	5.52	112.21	
-35.060	102.07	4.26	106.33	
-35.160	101.54	4.12	105.66	
-36.060	96.81	4.51	101.33	
-36.160	96.28	4.56	100.84	
-36.350	95.27	4.89	100.16	
-37.060	91.49	5.62	97.11	
-37.160	90.96	5.73	96.68	
-38.060	86.15	5.11	91.27	
-38.160	85.63	5.05	90.67	
-39.060	80.87	3.21	84.09	
-39.160	80.36	3.01	83.37	
-40.060	75.71	0.40	76.11	
-40.160	75.21	0.11	75.32	
-41.060	70.73	2.89	73.61	
-41.160	70.25	3.20	73.45	
-42.060	65.97	6.13	72.10	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	65.52	6.46	71.98	
-43.060	61.49	8.90	70.39	
-43.160	61.08	9.17	70.24	
-44.060	57.34	10.57	67.91	
-44.160	56.96	10.73	67.68	
-45.060	53.54	10.42	63.96	
-45.160	53.20	10.38	63.58	
-46.060	50.15	7.54	57.69	
-46.160	49.84	7.22	57.06	
-46.350	49.25	6.22	55.46	
-47.060	47.19	3.04	50.24	
-47.160	46.94	2.60	49.54	
-47.241	46.74	2.34	49.08	
-48.060	44.71	0.64	45.34	
-48.160	44.51	0.43	44.94	
-48.240	44.35	0.34	44.70	
-49.060	42.72	0.04	42.76	
-49.160	42.55	0.00	42.55	

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

4)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	

* :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)	

* :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)

1.4478 (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	WN-TM	-8.060	4.990	58.00
2	OD-CL(SC)	-8.060	3.180	58.00
3	ETQ(SC)	-8.060	0.290	58.00

2)perpendicular direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m^2)
1	WN	-8.060	4.990	58.00
2	OD-CL(SC)	-8.060	3.180	58.00
3	ETQ(SC)	-8.060	0.290	58.00

note: backfilling soil height , water table height is shown in elevation(crest of pile cap elevation = -8.060m)

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)

= 8.973^2*Pai/4 + 8.973*(14.764- 8.973) = 115.205 (m^2)

(2)area of backfilling soil

A2 = A1 - Ap = 74.635 (m^2)

where, Ap:leg column cross sectional area = 40.57 (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	WN-TM	55500.0	5500.0	120100.0	22000.0	142100.0
2	OD-CL(SC)	55500.0	3700.0	44600.0	14800.0	59400.0
3	ETQ(SC)	48500.0	16200.0	244000.0	64800.0	308800.0

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	55500.0	1200.0	28500.0	4800.0	33300.0
2	OD-CL(SC)	55500.0	7300.0	87900.0	29200.0	117100.0
3	ETQ(SC)	48500.0	15100.0	267500.0	60400.0	327900.0

```
(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 )       = 17.0 (kN/m³)
         Gam.sat: unit weight of backfilling soil( saturated ) = 18.0 (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	WN-TM	13.050	0.000	6681.88	0.00	5294.39	1387.50
2	OD-CL(SC)	11.240	0.000	6681.88	0.00	4560.07	2121.82
3	ETQ(SC)	8.350	0.000	6681.88	0.00	3387.60	3294.29

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)	900.51	3.605	3246.34

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	WN	13.050	0.000	6681.88	0.00	5294.39	1387.50
2	OD-CL(SC)	11.240	0.000	6681.88	0.00	4560.07	2121.82
3	ETQ(SC)	8.350	0.000	6681.88	0.00	3387.60	3294.29

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)	900.51	3.605	3246.34

```
(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	56887.5	5500.0	142100.0
2	OD-CL(SC)	0.0	57621.8	3700.0	59400.0
3	ETQ(SC)	0.0	51794.3	17100.5	312046.3

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	WN	0.0	56887.5	1200.0	33300.0
2	OD-CL(SC)	0.0	57621.8	7300.0	117100.0
3	ETQ(SC)	0.0	51794.3	16000.5	331146.3

(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)	30	0.04464	491.60	903.99
separation wall sheet pile(2)	6	0.04464	36.96	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	2948	213	1.35
2	OD-CL(SC)	2172	1029	1.50
3	ETQ(SC)	4442	-1564	1.50

2)perpendicular direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	WN	1872	1288	1.25
2	OD-CL(SC)	2628	573	1.50
3	ETQ(SC)	4344	-1466	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 = 11.3732 (m) (bridge axis direction)

Bx = 17.1644 (m) (perpendicular direction)

periphery steel pipe pile body diameter Do = 1.2000 (m)

leg column shape : oval

leg column dimension : 4.000 (m) (bridge axis direction)

11.000 (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 = 30 (number)

n2 : number of separation wall steel pipe sheet pile = 6 (number)

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

Ao1 : pure cross sectional area of periphery steel pipe sheet pile = 0.04464 (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	491.60	903.99
separation wall steel pipe sheet pile	IB2	36.96	0.00
intermediate driven single pile	IB3	0.00	0.00

1)bridge axis direction

1. check location

X1 = 5.0866 (m)

X2 = -5.0866 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Wind+Temp	56887.5	142100.0	1.35
2	Ord+Collision(scour)	57621.8	59400.0	1.50
3	Earthquake(scour)	51794.3	312046.3	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	5.0866	-5.0866
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Wind+Temp	2947.7	212.7
2	Ord+Collision(scour)	2172.2	1029.0
3	Earthquake(scour)	4441.7	-1564.3

4.separation wall steel pipe sheet pile reaction

coordinated system of center of figure		
pile No	number	Xi (m)
1	1	3.6333
2	1	2.1800

abbreviation	[1] WN-TM		[2] OD-CL(SC)		[3] ETQ(SC)	
pile No	R1	R2	R1	R2	R1	R2
1	2557.0	603.4	2008.9	1192.3	3583.7	-706.3
2	2166.3	994.1	1845.6	1355.6	2725.7	151.7

2)perpendicular direction

1. check location

Y1 = 7.9822 (m)

Y2 = -7.9822 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Wind	56887.5	33300.0	1.25
2	Ord+Collision(scour)	57621.8	117100.0	1.50
3	Earthquake(scour)	51794.3	331146.3	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	7.9822	-7.9822
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Wind	1874.2	1286.2
2	Ord+Collision(scour)	2634.6	566.6
3	Earthquake(scour)	4362.8	-1485.3

(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 = 2.4866 (m)(bridge axis direction)
= 2.2822 (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)
= 1.4478 (m) (perpendicular direction)

d : effective height of pile cap = 3.6245 (m) (bridge axis direction)
= 3.7023 (m) (perpendicular direction)

ai : Do + d

		bridge axis direction	perpendicular direction
separation wall steel pipe sheet pile	ai	4.8245	4.9023

(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	7051	516	2036	2008
2	Ord+Collision(scour)	5201	2469	1500	1472
3	Earthquake(scour)	10605	-3748	3068	3040

2)perpendicular direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
1	Wind	3580	2409	1295	1278
2	Ord+Collision(scour)	5094	977	1820	1803
3	Earthquake(scour)	8534	-3108	3013	2997

4.1.4 stress calculation

(1)bridge axis direction

b = 100.0 (cm)   h = 400.0 (cm)

rebar in use

lower tensile (As = 177.884 (cm²))

1 row	cover	300 (mm)	D51 @ 183
2 row	cover	500 (mm)	D51 @ 302

upper tensile (As = 61.092 (cm²))

1 row	cover	150 (mm)	D32 @ 260
2 row	cover	300 (mm)	D32 @ 260

			unit	WN-TM	OD-CL(SC)	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	7051.0	5201.0	10605.0
	required rebar amount	Asr	cm²	100.875	52.274	109.654
	neutral axis	x	cm	114.9	114.9	114.9
	stress	Sig.c Sig.s	N/mm² N/mm²	3.78 125.89	2.79 92.85	5.68 189.34
	tensile resultant force required rebar amount	T As	kN cm²	3134.0 145.092	2311.4 77.047	4713.3 157.111
top side ten sile	bending moment	MA'	kN.m	516.0	2469.0	-3748.0
	required rebar amount	Asr	cm²	0.000	0.000	35.696
	neutral axis	x	cm	13.1	13.1	74.6
	stress	Sig.c Sig.s	N/mm² N/mm²	0.00 0.00	0.00 0.00	2.85 178.13
	tensile resultant force required rebar amount	T As	kN cm²	0.0 0.000	0.0 0.000	1665.6 55.520
allowable stress		Sig.ca Sig.sa	N/mm² N/mm²	10.80 216.00	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm² N/mm²	2036.0 0.56 1.36	1500.0 0.41 1.53	3068.0 0.85 1.53
average shear force		S Tau.m Tau.a1'	kN N/mm² N/mm²	2008.0 0.55 1.36	1472.0 0.41 1.53	3040.0 0.84 1.53
shear force to share by concrete		SC a	kN	4936.0	5563.0	5563.0
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	----	0.274	0.274	0.274
	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 = 0.669 : effective height   d = 362.45 (cm)

2) correction coefficient about tensile rebar percentage   Cpt = 1.191 : tensile rebar percentage   pt = 0.491 (%)

3) for shear span ratio increment coefficient   Cdc = 5.507 : shear span   a = 2.487 (m)

(2)perpendicular direction

b = 100.0 (cm) h = 400.0 (cm)

rebar in use

lower tensile (As = 146.667 (cm^2))

1 row cover 230 (mm) D51 @ 209

2 row cover 430 (mm) D51 @ 408

upper tensile (As = 57.466 (cm^2))

1 row cover 118 (mm) D32 @ 209

2 row cover 268 (mm) D32 @ 408

			unit	WN	OD-CL(SC)	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	3580.0	5094.0	8534.0
	required rebar amount	Asr	cm^2	52.666	49.868	85.130
	neutral axis	x	cm	107.5	107.5	107.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.99 74.82	2.83 106.45	4.74 178.35
	tensile resultant force required rebar amount	T As	kN cm^2	1591.2 79.558	2263.9 75.464	3792.9 126.431
top side ten sile	bending moment	MA'	kN.m	2409.0	977.0	-3108.0
	required rebar amount	Asr	cm^2	0.000	0.000	28.781
	neutral axis	x	cm	10.5	10.5	73.1
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	2.37 153.16
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	1381.3 46.043
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	1295.0 0.35 1.22	1820.0 0.49 1.49	3013.0 0.81 1.49
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1278.0 0.35 1.22	1803.0 0.49 1.49	2997.0 0.81 1.49
shear force to share by concrete		SC a	kN	4531.0	5516.0	5516.0
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	----	0.247	0.247	0.247
	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 = 370.23 (cm)

2) correction coefficient about tensile rebar percentage Cpt = 1.096 : tensile rebar percentage pt = 0.396 (%)

3) for shear span ratio increment coefficient Cdc = 5.841 : shear span a = 2.282 (m)

(3) required thickness of pile cap

$$h >= 1.94*\sqrt[3]{\frac{kp*Lambda^4}{E}} = 1.236\ (m)$$

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) = 2.7740E+005
Kv2(separation wall steel pipe sheet pile) = 2.7740E+005
Kv3(intermediate driven single pile) = 0.0000E+000
n1 : number of periphery steel pipe sheet pile = 30
n2 : number of separation wall steel pipe sheet pile = 6
n3 : number of intermediate driven single pile = 0
A : area of pile cap (m^2) = 140.2
E : Young's modulus of pile cap (kN/m^2) = $2.50 * 10^7$
Lambda : protrusion length of pile cap (m) = 3.09

(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	21295	5103	18029	17788	OK
	upper tensile	7845	5103	6371	6109	OK
perpendicular direction	lower tensile	18089	5103	14508	14667	OK
	upper tensile	7497	5103	5283	5747	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 :SKY490
(5) diameter of steel material main body :D = 1200.0 (mm)
(6) section coefficient of steel pipe pile body :Z = 13081.0 (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: $A1 = B^2 = PI /4 + B * (L-B)$
$= 8.973^2*Pai/4 + 8.973*(14.764- 8.973) = 115.205\ (m^2)$

(2)area of backfilling soil
$A2 = A1 - Ap = 74.635\ (m^2)$
where, Ap:leg column cross sectional area = 40.57 (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	WN-TM	55500.0	5500.0	120100.0	22000.0	142100.0
2	OD-CL(SC)	55500.0	3700.0	44600.0	14800.0	59400.0
3	ETQ(SC)	48500.0	16200.0	244000.0	64800.0	308800.0

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	55500.0	1200.0	28500.0	4800.0	33300.0
2	OD-CL(SC)	55500.0	7300.0	87900.0	29200.0	117100.0

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
3	ETQ(SC)	48500.0	15100.0	267500.0	60400.0	327900.0

(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) = 17.0 (kN/m³)
Gam.sat: unit weight of backfilling soil(saturated) = 18.0 (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	WN-TM	13.050	0.000	6681.88	0.00	5294.39	1387.50
2	OD-CL(SC)	11.240	0.000	6681.88	0.00	4560.07	2121.82
3	ETQ(SC)	8.350	0.000	6681.88	0.00	3387.60	3294.29

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)	900.51	3.605	3246.34

2)perpendicular direction

1.vertical force

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
1	WN	13.050	0.000	6681.88	0.00	5294.39	1387.50
2	OD-CL(SC)	11.240	0.000	6681.88	0.00	4560.07	2121.82
3	ETQ(SC)	8.350	0.000	6681.88	0.00	3387.60	3294.29

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)	900.51	3.605	3246.34

(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	56887.5	5500.0	142100.0
2	OD-CL(SC)	0.0	57621.8	3700.0	59400.0
3	ETQ(SC)	0.0	51794.3	17100.5	312046.3

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	WN	0.0	56887.5	1200.0	33300.0

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
2	OD-CL(SC)	0.0	57621.8	7300.0	117100.0
3	ETQ(SC)	0.0	51794.3	16000.5	331146.3

(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)	30	0.04464	491.60	903.99
separation wall sheet pile(2)	6	0.04464	36.96	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	2948	183	1.35
2	OD-CL(SC)	2172	123	1.50
3	ETQ(SC)	4442	570	1.50

2)perpendicular direction

No	abbreviation	vertical reaction(kN/num)	horizontal react (kN/num)	increment coefficient
1	WN	1872	40	1.25
2	OD-CL(SC)	2628	243	1.50
3	ETQ(SC)	4344	533	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	2948	183	1.35
2	Ord+Collision(scour)	2172	123	1.50
3	Earthquake(scour)	4442	570	1.50

(2)perpendicular direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Wind	1872	40	1.25
2	Ord+Collision(scour)	2628	243	1.50
3	Earthquake(scour)	4344	533	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) = 185.00 (N/mm^2)

Zo : section coefficient of steel pipe pile body (m^3) = 13081.0 (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) = 2600.00
Sig.s1: moment rebar tensile stress (N/mm²)
nb : number of moment rebar (number/ row) = 20
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 = 76
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	WN-TM	2948.0	1769	3267	3267	1256.5	183.0
2	OD-CL(SC)	2172.0	1303	3630	3630	1396.1	123.0
3	ETQ(SC)	4442.0	2665	3630	3630	1396.1	570.0

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	162.30	11.82	174.12	216.00	20 >= 17	100.21	129.60	76 >= 59
2	180.33	7.94	188.28	300.00	20 >= 13	73.83	180.00	76 >= 32
3	180.33	36.81	217.15	300.00	20 >= 15	150.99	180.00	76 >= 64

perpendicular direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	WN	1872.0	1123	3025	3025	1163.5	40.0
2	OD-CL(SC)	2628.0	1577	3630	3630	1396.1	243.0
3	ETQ(SC)	4344.0	2606	3630	3630	1396.1	533.0

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	150.28	2.58	152.86	200.00	20 >= 16	63.63	120.00	76 >= 41
2	180.33	15.69	196.03	300.00	20 >= 14	89.33	180.00	76 >= 38
3	180.33	34.42	214.76	300.00	20 >= 15	147.66	180.00	76 >= 63

4.3 calculation of pile head joint part

4.3.1 design condition

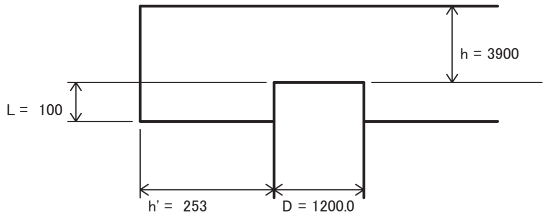
(1) design condition

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	Wind+Temp	1.35	1630	1630	0	0
2	Ord+Collision(scour)	1.50	1693	1693	0	0
3	Earthquake(scour)	1.50	2592	669	150	155

2)perpendicular direction

No	load name	increment coeff.	vertical max(kN)	vertical min(kN)	horizonta force(kN)	moment (kN.m)
1	Wind	1.25	1630	1630	0	0
2	Ord+Collision(scour)	1.50	1693	1693	0	0
3	Earthquake(scour)	1.50	1610	1610	33	37

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	1630	1.44	9.72	0.026	0.900
2	Ord+Collision(scour)	1693	1.50	10.80	0.027	0.900
3	Earthquake(scour)	2592	2.29	10.80	0.041	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	1630	1.44	9.00	0.026	0.900
2	Ord+Collision(scour)	1693	1.50	10.80	0.027	0.900
3	Earthquake(scour)	1610	1.42	10.80	0.026	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)	150	1.250	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)	33	0.275	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	D29 - 12 (@283)	77.088

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	1630.0	0.000	0.00	0.77	10.80	-11.50	216.00
		0.0	1630.0	0.000	0.00	0.77	10.80	-11.50	216.00
2	OD-CL(SC)	0.0	1693.0	0.000	0.00	0.80	12.00	-11.94	300.00
		0.0	1693.0	0.000	0.00	0.80	12.00	-11.94	300.00
3	ETQ(SC)	155.0	2592.0	0.000	346.27	1.59	12.00	-14.58	300.00
		155.0	669.0	0.000	148.13	0.68	12.00	-0.98	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	1630.0	0.000	0.00	0.77	10.00	-11.50	200.00
		0.0	1630.0	0.000	0.00	0.77	10.00	-11.50	200.00
2	OD-CL(SC)	0.0	1693.0	0.000	0.00	0.80	12.00	-11.94	300.00
		0.0	1693.0	0.000	0.00	0.80	12.00	-11.94	300.00
3	ETQ(SC)	37.0	1610.0	0.000	772.86	0.84	12.00	-10.47	300.00
		37.0	1610.0	0.000	772.86	0.84	12.00	-10.47	300.00

Shows upper step : Pmax, lower step : Pmin every load case.

(2) pile head reinforcing rebar anchor length

$$Lo = \frac{Sig.sa}{4*Tau.oa} Phi = 906 \text{ (mm)}$$

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 = 29 (mm)

embedment length L >= Lo + 10 * Phi. = 1196 (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 = 6.424 (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)	21.2	18.2	15.9	14.2

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 Alp.*Eo (kN/m^2)	in quakes Alp.*Eo (kN/m^2)	calculation natural period dyna.het.coef ED(kN/m)	dyna.pois.rate NyuD
1	sandy	6.290	3.0	4800	9600	44339	0.50
2	sandy	2.000	13.0	20800	41600	117855	0.50
3	sandy	3.000	13.0	20800	41600	117855	0.50
4	clay	8.000	7.0	19600	39200	125458	0.50
5	sandy	1.000	13.0	36400	72800	117855	0.50
6	clay	2.000	7.0	19600	39200	125458	0.50
7	sandy	6.000	20.0	56000	112000	157052	0.50
8	sandy	10.000	30.0	84000	168000	205805	0.50
9	clay	2.810	30.0	84000	168000	301510	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	355333	106600
separation wall sheet pile	355333	106600
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 = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m^3) kH	kSVB	side (kN/m^3) kSHD	kSVD
1	-8.850 - -12.060	1283	385	1114	557
2	-12.060 - -14.350	1283	385	1114	557
3	-14.350 - -16.350	5562	1669	4828	2414
4	-16.350 - -19.350	5562	1669	4828	2414
5	-19.350 - -27.350	5241	1572	4550	2275
6	-27.350 - -28.350	9733	2920	8450	4225
7	-28.350 - -30.350	5241	1572	4550	2275
8	-30.350 - -36.350	14974	4492	12999	6500
9	-36.350 - -42.378	22461	6738	19499	9749
10	-42.378 - -46.350	22461	13476	19499	19499
11	-46.350 - -49.160	22461	13476	19499	19499

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.850 - -12.060	1857	557	770	385
2	-12.060 - -14.350	1857	557	770	385
3	-14.350 - -16.350	8047	2414	3337	1669
4	-16.350 - -19.350	8047	2414	3337	1669
5	-19.350 - -27.350	7583	2275	3145	1572
6	-27.350 - -28.350	14083	4225	5840	2920
7	-28.350 - -30.350	7583	2275	3145	1572
8	-30.350 - -36.350	21666	6500	8984	4492
9	-36.350 - -42.378	32498	9749	13476	6738
10	-42.378 - -46.350	32498	19499	13476	13476
11	-46.350 - -49.160	32498	19499	13476	13476

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -42.378(m)
evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

earthquake time
1.bridge axis direction(Be = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.850 - -12.060	855	256	742	371
2	-12.060 - -14.350	855	256	742	371
3	-14.350 - -16.350	3704	1111	3216	1608
4	-16.350 - -19.350	11123	3337	9657	4828
5	-19.350 - -27.350	10482	3145	9100	4550
6	-27.350 - -28.350	19466	5840	16899	8450
7	-28.350 - -30.350	10482	3145	9100	4550
8	-30.350 - -36.350	29948	8984	25999	12999
9	-36.350 - -42.378	44921	13476	38998	19499
10	-42.378 - -46.350	44921	26953	38998	38998

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
11	-46.350 - -49.160	44921	26953	38998	38998

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.850 - -12.060	1237	371	513	256
2	-12.060 - -14.350	1237	371	513	256
3	-14.350 - -16.350	5359	1608	2222	1111
4	-16.350 - -19.350	16094	4828	6674	3337
5	-19.350 - -27.350	15166	4550	6289	3145
6	-27.350 - -28.350	28165	8450	11680	5840
7	-28.350 - -30.350	15166	4550	6289	3145
8	-30.350 - -36.350	43331	12999	17969	8984
9	-36.350 - -42.378	64997	19499	26953	13476
10	-42.378 - -46.350	64997	38998	26953	26953
11	-46.350 - -49.160	64997	38998	26953	26953

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -42.378(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 = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.850 - -12.060	11856	3557	10292	5146
2	-12.060 - -14.350	11856	3557	10292	5146
3	-14.350 - -16.350	31513	9454	27358	13679
4	-16.350 - -19.350	31513	9454	27358	13679
5	-19.350 - -27.350	33546	10064	29123	14561

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
6	-27.350 - -28.350	31513	9454	27358	13679
7	-28.350 - -30.350	33546	10064	29123	14561
8	-30.350 - -36.350	41994	12598	36457	18228
9	-36.350 - -42.378	55030	16509	47774	23887
10	-42.378 - -46.350	55030	33018	47774	47774
11	-46.350 - -49.160	80621	48372	69990	69990

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m³)		side (kN/m³)	
		kH	kSVB	kSHD	kSVD
1	-8.850 - -12.060	17154	5146	7113	3557
2	-12.060 - -14.350	17154	5146	7113	3557
3	-14.350 - -16.350	45596	13679	18908	9454
4	-16.350 - -19.350	45596	13679	18908	9454
5	-19.350 - -27.350	48538	14561	20128	10064
6	-27.350 - -28.350	45596	13679	18908	9454
7	-28.350 - -30.350	48538	14561	20128	10064
8	-30.350 - -36.350	60761	18228	25196	12598
9	-36.350 - -42.378	79623	23887	33018	16509
10	-42.378 - -46.350	79623	47774	33018	33018
11	-46.350 - -49.160	116649	69990	48372	48372

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -42.378(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

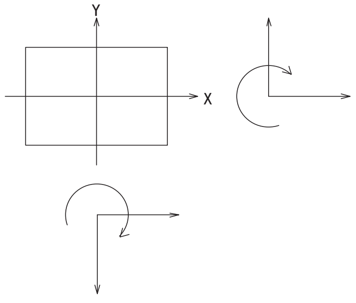
item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.1030E-001	8.9164E-002
ThetaoH	mrad	4.9033E-003	3.2764E-003
Del.oM	mm	4.9033E-002	3.2764E-002
ThetaoM	mrad	4.1699E-003	2.6942E-003
Ass	kN/m	1.8994E+006	2.0276E+006
Asr	kN/rad	-2.2335E+007	-2.4658E+007
Ars	kN.m/m	-2.2335E+007	-2.4658E+007
Arr	kN.m/rad	5.0245E+008	6.7102E+008

earthquake time

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	9.8317E-002	7.7367E-002
ThetaoH	mrad	4.6386E-003	2.9777E-003
Del.oM	mm	4.6386E-002	2.9777E-002
ThetaoM	mrad	4.0494E-003	2.5401E-003
Ass	kN/m	2.2133E+006	2.3551E+006
Asr	kN/rad	-2.5353E+007	-2.7608E+007
Ars	kN.m/m	-2.5353E+007	-2.7608E+007
Arr	kN.m/rad	5.3737E+008	7.1734E+008

to estimate natural period

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	3.0617E-002	2.4540E-002
ThetaoH	mrad	2.0134E-003	1.3197E-003
Del.oM	mm	2.0134E-002	1.3197E-002
ThetaoM	mrad	2.4636E-003	1.5696E-003
Ass	kN/m	7.0605E+006	7.4380E+006
Asr	kN/rad	-5.7700E+007	-6.2536E+007
Ars	kN.m/m	-5.7700E+007	-6.2536E+007
Arr	kN.m/rad	8.7745E+008	1.1629E+009

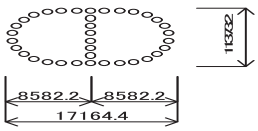


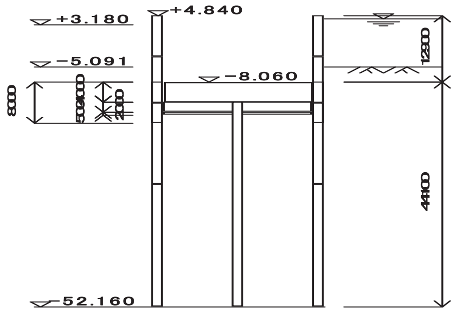
Y direction: bridge axis direction
X direction:perpendicular direction

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 = 57.000(m)
number = 30(number)

steel pipe thickness (mm)	length (m)	material
14.0	8.000	SKY400
14.0	9.000	SKY490
16.0	16.000	SKY400
14.0	24.000	SKY400

2)separation wall sheet pile

external diameter = 1200.0(mm)
pile length = 40.200(m)
number = 6(number)

steel pipe thickness (mm)	length (m)	material
14.0	40.200	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	sand	10.900	3.0	17.0	8.0	0.0	29.00	4800	9600	0.333	0.333	0.333
2	sand	4.300	13.0	17.0	8.0	0.0	33.00	20800	41600	1.000	1.000	1.000
3	chsv	2.300	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
4	sand	3.800	13.0	17.0	8.0	0.0	32.00	36400	72800	1.000	1.000	1.000
5	chsv	4.900	7.0	17.5	7.5	42.0	0.00	19600	39200	1.000	1.000	1.000
6	sand	9.700	20.0	17.0	8.0	0.0	33.00	56000	112000	1.000	1.000	1.000
7	sand	9.600	30.0	17.0	8.0	0.0	34.00	84000	168000	1.000	1.000	1.000
8	chsv	7.500	30.0	18.0	8.0	180.0	0.00	84000	168000	1.000	1.000	1.000

No	soil	layer thick ness (m)	ave rage 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
9	sand	5.600	50.0	19.0	10.0	0.0	34.00	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 = 30

to(mm)	L(m)	Ao(cm²)	Io(cm⁴)	Zo(cm³)	material
14.0	4.100	446.4	782242	13081	SKY490
16.0	16.000	519.9	908031	15184	SKY400
14.0	24.000	446.4	782242	13081	SKY400

2)separation wall sheet pile Do = 1200(mm) number = 6

to(mm)	L(m)	Ao(cm²)	Io(cm⁴)	Zo(cm³)	material
14.0	40.100	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(m²)

	bridge axis direction	perpendicular direction
periphery sheet pile	491.60	903.99
separation wall sheet pile	36.96	0.00

(3)sum of moment of inertia in celler part I(m⁴)

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	4.100	17.976138	30.544184
2	16.000	20.724262	35.565970
3	24.000	17.976138	30.544184

foundation length = 44.100 (m)

(4)coordinates of cetroid of steel pipe sheet pile

1) periphery sheet pile

No	Y(m)	X(m)	number
1	5.0866	0.0000	2
2	5.0866	1.4478	4
3	5.0866	2.8956	4
4	0.7239	7.9304	4
5	2.1131	7.5225	4
6	3.3310	6.7398	4
7	4.2791	5.6456	4
8	4.8806	4.3287	4

2) separation wall sheet pile

No	Y(m)	X(m)	number
1	3.6333	0.0000	2
2	2.1800	0.0000	2
3	0.7267	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	0.000	------	0.000	------	----
1	7.931	4800	7.931	9600	0.333
2	4.300	20800	4.300	41600	1.000
3	2.300	19600	2.300	39200	1.000
4	3.800	36400	3.800	72800	1.000
5	4.900	19600	4.900	39200	1.000
6	9.700	56000	9.700	112000	1.000
7	9.600	84000	9.600	168000	1.000
8	1.569	84000	1.569	168000	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 = 84000

earthquake time = 168000

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	98995	197990
separation wall sheet pile	1200.0	98995	197990

(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 (cm^4)	1.7976E+009		3.0544E+009	
D (cm)	1716.44		1137.32	
Beta(cm^{-1})	0.000420	0.000420	0.000362	0.000362
1/Beta(cm)	2379.4	2379.4	2760.6	2760.6
average Alp.*Eo (N/cm^2)	1842.8	1842.8	2361.6	2361.6
BH, $\sqrt{De*Le}$ (cm)	2020.9 < 2751.3	2020.9 < 2751.3	1771.9 < 2239.6	1771.9 < 2239.6

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	7.931	7.931	4800	9600	1361	906	1502	1000
2	4.300	4.300	20800	41600	5897	11795	6509	13017
3	2.300	2.300	19600	39200	5557	11114	6133	12266
4	3.800	3.800	36400	72800	10320	20640	11390	22780
5	4.900	4.900	19600	39200	5557	11114	6133	12266
6	9.700	9.700	56000	112000	15877	31754	17523	35046
7	9.600	9.600	84000	168000	23816	47632	26284	52569
8	1.569	1.569	84000	168000	23816	47632	26284	52569

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	7.931	7.931	1361	906	1502	1000
2	4.300	4.300	5897	11795	6509	13017
3	2.300	2.300	5557	11114	6133	12266
4	3.800	3.800	10320	20640	11390	22780
5	4.900	4.900	5557	11114	6133	12266
6	9.700	9.700	15877	31754	17523	35046
7	9.600	9.600	23816	47632	26284	52569
8	1.569	1.569	23816	47632	26284	52569

(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	29698	59397
separation wall sheet pile	29698	59397

(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 (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	30	1.1310	6	0.0000	0	4.0306E+006	8.0612E+006

2) shear spring constant

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

usual time	in quakes
1.2092E+006	2.4184E+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 (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	491.60	36.96	5.9178E+007	1.1836E+008
perpendicular direction	903.99	0.00	1.0121E+008	2.0242E+008

spring constant at bottom of celler(using value)

		usual time	in quakes
vertical spring Kv (kN/m)		4.0306E+006	8.0612E+006
shear spring Ks (kN/m)		1.2092E+006	2.4184E+006
rotational spring Kr (kN.m/rad)	bridge axis direction	5.9178E+007	1.1836E+008
	perpendicular direction	1.0121E+008	2.0242E+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)

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

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

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)

$$\frac{\text{equivalent embedment depth to bearing strata}}{\text{pile diameter}} = \frac{1.570}{1.2000} = 1.31$$

$qd / \bar{N} = 78$

$\bar{N}$:design N value in steel pipe sheet pile tip ground $\bar{N}$ = 30.0

qd = 78 * 30.0 = 2355 (kN/m^2)

n1 : celler part periphery steel pipe sheet pile number (number) n1 = 30
n2 : number of steel pipe sheet pile in separation wall part (number) n2 = 6
n3 : intermediate driven single pile number (number) n3 = 0
U1 : enveloping celler part periphery length (m) U1 = 47.312 (m)
U2 : enveloping celler part and separation wall part periphery length
and sum of perimeter of intermediate driven single pile U2 = 55.319 (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 = 6.782 (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	sandy	3.0	7.931	0.0	0.0	0.333	0.0	0.0
2	sandy	13.0	4.300	26.0	26.0	1.000	111.8	111.8
3	cohesv	7.0	2.300	70.0	70.0	1.000	161.0	161.0
4	sandy	13.0	3.800	26.0	26.0	1.000	98.8	98.8
5	cohesv	7.0	4.900	70.0	70.0	1.000	343.0	343.0
6	sandy	20.0	9.700	40.0	40.0	1.000	388.0	388.0
7	sandy	30.0	9.600	60.0	60.0	1.000	576.0	576.0
8	cohesv	30.0	1.569	150.0	150.0	1.000	235.4	235.4
Sum			44.100				1913.9	1913.9

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
7	sandy	30.0	5.213	60.0	60.0	1.000	312.8	312.8
8	cohesv	30.0	1.569	150.0	150.0	1.000	235.4	235.4
Sum			6.782				548.1	548.1

DE: reduction coefficient in earthquake time

ultimate bearing capacity

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

= 2663 + 3358 = 6021 (kN/number) (usual time)
= 2663 + 3358 = 6021 (kN/number) (earthquake time)

allowable compressive bearing capacity

usual time Ra = (1 / 3) * 6021 = 2007 (kN/number)
earthquake Ra = (1 / 2) * 6021 = 3011 (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) =	139.8	139.8
joint weight	w2 (kN) =	0.0	0.0
soil weight inside of pipe	w3 (kN) =	307.0	307.0
filling concrete weight	w4 (kN) =	0.0	0.0
	W (kN) =	446.7	446.7

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	sandy	3.0	7.931	0.0	0.0	0.333	0.0	0.0
2	sandy	13.0	4.300	26.0	26.0	1.000	111.8	111.8
3	cohesv	7.0	2.300	70.0	70.0	1.000	161.0	161.0
4	sandy	13.0	3.800	26.0	26.0	1.000	98.8	98.8
5	cohesv	7.0	4.900	70.0	70.0	1.000	343.0	343.0
6	sandy	20.0	9.700	40.0	40.0	1.000	388.0	388.0
7	sandy	30.0	9.600	60.0	60.0	1.000	576.0	576.0
8	cohesv	30.0	1.569	150.0	150.0	1.000	235.4	235.4
Sum			44.100				1913.9	1913.9

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	sandy	30.0	5.213	60.0	60.0	1.000	312.8	312.8
8	cohesv	30.0	1.569	150.0	150.0	1.000	235.4	235.4
Sum			6.782				548.1	548.1

DE: reduction coefficient in earthquake time

ultimate uplifting force
Pu = 3358 (kN/number) (usual time time)
Pu = 3358 (kN/number) (earthquake time)

allowable uplifting force
usual time Pa - (1 / 6) * 3358 + 447 - 1006 (kN/number)
earthquake Pa - (1 / 3) * 3358 + 447 - 1566 (kN/number)

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

allowable compressive bearing capacity	usual time	2007
	in quakes	3011
allowable uplifting force bearing capacity	usual time	1006
	in quakes	1566

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 : 11.3732 (m) * 17.1644 (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 = 30
filling concrete cast height h2 = 8.000 (m)
leg column cross sectional area Ap = 40.570 (m^2)
shape : oval
dimension : a = 11.000 (m) perpendicular direction
: b = 4.000 (m) bridge axis direction
unit weight : backfilling soil(wet) Gam.t = 17.0 (kN/m^3)
backfilling soil(saturated) Gam.sat = 18.0 (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 = 0.000 (m) (depth from crest of)

1)bridge axis direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-5.091	3.180
2	Oridinary(low tide)	-5.091	-2.390
3	Ord+Temp(high tide)	-5.091	3.180

No	load name	backfilling soil height (m)	water table height (m)
4	Ord+Temp(low tide)	-5.091	-2.390
5	Wind+Temp	-5.091	4.990
6	Wind+Temp	-7.970	4.990
7	Ord+Collision	-5.091	2.530
8	Ord+Collision(scour)	-7.970	2.530
9	Earthquake	-5.091	0.290
10	Earthquake(scour)	-7.970	0.290

2)perpendicular direction

No	load name	backfilling soil height (m)	water table height (m)
1	Oridinary(high tide)	-5.091	3.180
2	Oridinary(low tide)	-5.091	-2.390
3	Wind	-5.091	4.990
4	Ord+Collision	-5.091	2.530
5	Ord+Collision(scour)	-7.970	2.530
6	Earthquake	-5.091	0.290
7	Earthquake(scour)	-7.970	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)	51100.0	0.0	0.0
2	Oridinary(low tide)	51100.0	0.0	0.0
3	Ord+Temp(high tide)	51100.0	3100.0	67000.0
4	Ord+Temp(low tide)	51100.0	3100.0	67000.0
5	Wind+Temp	51100.0	3200.0	68800.0
6	Wind+Temp	51100.0	3200.0	68800.0
7	Ord+Collision	51100.0	3100.0	35400.0
8	Ord+Collision(scour)	51100.0	3100.0	35400.0
9	Earthquake	44300.0	14900.0	237500.0
10	Earthquake(scour)	44300.0	15600.0	238900.0

2)perpendicular direction

No	load name	V(kN)	H(kN)	M(kN.m)
1	Oridinary(high tide)	51100.0	0.0	0.0
2	Oridinary(low tide)	51100.0	0.0	0.0
3	Wind	51100.0	1200.0	28100.0
4	Ord+Collision	51100.0	6300.0	71400.0
5	Ord+Collision(scour)	51100.0	6300.0	71300.0
6	Earthquake	44300.0	13490.0	233800.0
7	Earthquake(scour)	44300.0	13600.0	233800.0

(3) pile cap area

oval

$$A1 = \frac{Pai}{4} * (B-D)^2 + (B-D)*(L-B) - \frac{Pai}{4} * D^2 * \frac{n}{2} = 123.235 \ (m^2)$$

filling concrete area

$$A2 = \frac{Pai}{4} * D^2 * n = 33.929 \ (m^2)$$

backfilling soil area

$$A3 = A1 + A2 - Ap = 116.594 \ (m^2)$$

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)	11.240	2.969	7147.6	3528.6	2769.3	4560.1	8885.5
2	OD(LT)	5.670	2.969	7147.6	3528.6	2769.3	2300.3	11145.3
3	OD-TM(HT)	11.240	2.969	7147.6	3528.6	2769.3	4560.1	8885.5
4	OD-TM(LT)	5.670	2.969	7147.6	3528.6	2769.3	2300.3	11145.3
5	WN-TM	13.050	2.969	7147.6	3528.6	2769.3	5294.4	8151.2
6	WN-TM	13.050	0.090	7147.6	3528.6	83.9	5294.4	5465.8
7	OD-CL	10.590	2.969	7147.6	3528.6	2769.3	4296.4	9149.2
8	OD-CL(SC)	10.590	0.090	7147.6	3528.6	83.9	4296.4	6463.8
9	ETQ	8.350	2.969	7147.6	3528.6	2769.3	3387.6	10058.0
10	ETQ(SC)	8.350	0.090	7147.6	3528.6	83.9	3387.6	7372.6

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)	11.240	2.969	7147.6	3528.6	2769.3	4560.1	8885.5
2	OD(LT)	5.670	2.969	7147.6	3528.6	2769.3	2300.3	11145.3
3	WN	13.050	2.969	7147.6	3528.6	2769.3	5294.4	8151.2
4	OD-CL	10.590	2.969	7147.6	3528.6	2769.3	4296.4	9149.2
5	OD-CL(SC)	10.590	0.090	7147.6	3528.6	83.9	4296.4	6463.8
6	ETQ	8.350	2.969	7147.6	3528.6	2769.3	3387.6	10058.0

No	load abbreviation	hw (m)	backfilling soil thickness (m)	V1 (kN)	V2 (kN)	V3 (kN)	Vp (kN)	Sum.V (kN)
7	ETQ(SC)	8.350	0.090	7147.6	3528.6	83.9	3387.6	7372.6

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)	59985.5	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	62245.3	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	59985.5	3100.0	67000.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	62245.3	3100.0	67000.0	1.15	usual time	usual time
5	Wind+Temp	59251.2	3200.0	68800.0	1.35	usual time	usual time
6	Wind+Temp	56565.8	3200.0	68800.0	1.35	usual time	usual time
7	Ord+Collision	60249.2	3100.0	35400.0	1.50	usual time	usual time
8	Ord+Collision(scour)	57563.8	3100.0	35400.0	1.50	usual time	usual time
9	Earthquake	54358.0	14900.0	237500.0	1.50	earthquake time	earthquake time
10	Earthquake(scour)	51672.6	15600.0	238900.0	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)	59985.5	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	62245.3	0.0	0.0	1.00	usual time	usual time
3	Wind	59251.2	1200.0	28100.0	1.25	usual time	usual time
4	Ord+Collision	60249.2	6300.0	71400.0	1.50	usual time	usual time
5	Ord+Collision(scour)	57563.8	6300.0	71300.0	1.50	usual time	usual time
6	Earthquake	54358.0	13490.0	233800.0	1.50	earthquake time	earthquake time
7	Earthquake(scour)	51672.6	13600.0	233800.0	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)	59985.5	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	62245.3	0.0	0.0	1.00	usual time	usual time
3	Ord+Temp(high tide)	59985.5	3100.0	67000.0	1.15	usual time	usual time
4	Ord+Temp(low tide)	62245.3	3100.0	67000.0	1.15	usual time	usual time
5	Wind+Temp	59251.2	3200.0	68800.0	1.35	usual time	usual time
6	Wind+Temp	56565.8	3200.0	68800.0	1.35	usual time	usual time
7	Ord+Collision	60249.2	3100.0	35400.0	1.50	usual time	usual time
8	Ord+Collision(scour)	57563.8	3100.0	35400.0	1.50	usual time	usual time
9	Earthquake	54358.0	14900.0	237500.0	1.50	earthquake time	earthquake time
10	Earthquake(scour)	51672.6	15600.0	238900.0	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)	59985.5	0.0	0.0	1.00	usual time	usual time
2	Oridinary(low tide)	62245.3	0.0	0.0	1.00	usual time	usual time
3	Wind	59251.2	1200.0	28100.0	1.25	usual time	usual time

No	load name	Vo(kN)	Ho(kN)	Mo(kN.m)	increment coefficient	ground spring	bearing capacity
4	Ord+Collision	60249.2	6300.0	71400.0	1.50	usual time	usual time
5	Ord+Collision(scour)	57563.8	6300.0	71300.0	1.50	usual time	usual time
6	Earthquake	54358.0	13490.0	233800.0	1.50	earthquake time	earthquake time
7	Earthquake(scour)	51672.6	13600.0	233800.0	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	59985.5	62245.3	59985.5
		Ho	kN	0.0	0.0	3100.0
		Mo	kN.m	0.0	0.0	67000.0
foundation crest	displacement	Del.1	cm	0.000	0.000	0.664
	deflexion angle	Theta.1	mrad	0.000	0.000	-0.510
design ground surface	displacement	Del.2	cm	0.000	0.000	0.664
	deflexion angle	Theta.2	mrad	0.000	0.000	-0.510
celler part maximum bending moment		Mmax	kN.m	0.0	0.0	-83551.0
Mmax accrue location		Lm	m	-8.060	-8.060	-18.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	37.33	38.74	54.83
		Lm	m	-28.160	-28.160	-28.160
	periphery sheet pile(SKY490)	Sigmax	N/mm²	37.33	38.74	59.83
		Lm	m	-8.060	-8.060	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	37.33	38.74	55.28
		Lm	m	-8.060	-8.060	-12.160
	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	793.0
vertical reaction	maximum	Rmax	kN/num	1666	1729	1674
	minimum	Rmin	kN/num	1666	1729	1659
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2007	2007	2007
	uplifting force	Pa	kN/num	-1006	-1006	-1006
	stress(SKY400)	Sig.a	N/mm²	140.00	140.00	161.00
	stress(SKY490)	Sig.a	N/mm²	185.00	185.00	212.75

note)Lm is elevation

item			unit	OD-TM(LT)	WN-TM	WN-TM
working force		Vo	kN	62245.3	59251.2	56565.8
		Ho	kN	3100.0	3200.0	3200.0
		Mo	kN.m	67000.0	68800.0	68800.0
foundation crest	displacement	Del.1	cm	0.664	0.684	0.684
	deflexion angle	Theta.1	mrad	-0.510	-0.524	-0.524
design ground surface	displacement	Del.2	cm	0.664	0.684	0.684
	deflexion angle	Theta.2	mrad	-0.510	-0.524	-0.524
celler part maximum bending moment		Mmax	kN.m	-83551.0	-85926.0	-85926.0
Mmax accrue location		Lm	m	-18.060	-18.060	-18.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	56.23	54.88	53.21
		Lm	m	-28.160	-28.160	-28.160
	periphery sheet pile(SKY490)	Sigmax	N/mm²	61.24	60.00	58.33
		Lm	m	-12.160	-12.160	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	56.68	55.31	53.64
		Lm	m	-12.160	-12.160	-12.160
	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	793.0	814.0	814.0
vertical reaction	maximum	Rmax	kN/num	1737	1654	1579
	minimum	Rmin	kN/num	1721	1638	1563
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2007	2007	2007
	uplifting force	Pa	kN/num	-1006	-1006	-1006
	stress(SKY400)	Sig.a	N/mm²	161.00	189.00	189.00
	stress(SKY490)	Sig.a	N/mm²	212.75	249.75	249.75

note)Lm is elevation

item			unit	OD-CL	OD-CL(SC)	ETQ
working force		Vo	kN	60249.2	57563.8	54358.0
		Ho	kN	3100.0	3100.0	14900.0
		Mo	kN.m	35400.0	35400.0	237500.0
foundation crest	displacement	Del.1	cm	0.492	0.492	3.051
	deflexion angle	Theta.1	mrad	-0.349	-0.349	-2.200
design ground surface	displacement	Del.2	cm	0.492	0.492	3.051
	deflexion angle	Theta.2	mrad	-0.349	-0.349	-2.200
celler part maximum bending moment		Mmax	kN.m	-55773.0	-55773.0	-358035.0
Mmax accrue location		Lm	m	-19.060	-19.060	-19.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	50.14	48.47	120.83
		Lm	m	-28.160	-28.160	-19.060
	periphery sheet pile(SKY490)	Sigmax	N/mm²	50.97	49.30	119.65
		Lm	m	-12.160	-12.160	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	48.24	46.57	102.46
		Lm	m	-12.160	-12.160	-19.060
	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	390.0	390.0	6345.0
vertical reaction	maximum	Rmax	kN/num	1677	1603	1571
	minimum	Rmin	kN/num	1670	1595	1449
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2007	2007	3011
	uplifting force	Pa	kN/num	-1006	-1006	-1566
	stress(SKY400)	Sig.a	N/mm²	210.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	277.50	277.50	277.50

note)Lm is elevation

item			unit	ETQ(SC)
working force		Vo	kN	51672.6
		Ho	kN	15600.0
		Mo	kN.m	238900.0
foundation crest	displacement	Del.1	cm	3.161
	deflexion angle	Theta.1	mrad	-2.260
design ground surface	displacement	Del.2	cm	3.161
	deflexion angle	Theta.2	mrad	-2.260
celler part maximum bending moment		Mmax	kN.m	-366186.0
Mmax accrue location		Lm	m	-19.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	121.43
		Lm	m	-19.060
	periphery sheet pile(SKY490)	Sigmax	N/mm²	119.20
		Lm	m	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	102.65
		Lm	m	-19.060
	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	6306.0
vertical reaction	maximum	Rmax	kN/num	1496
	minimum	Rmin	kN/num	1375
allowable value	displacement	Del.a	cm	5.000
	compressive bearing capacity	Ra	kN/num	3011
	uplifting force	Pa	kN/num	-1566
	stress(SKY400)	Sig.a	N/mm²	210.00
	stress(SKY490)	Sig.a	N/mm²	277.50

note)Lm is elevation

2)perpendicular direction

item			unit	OD(HT)	OD(LT)	WN
working force		Vo	kN	59985.5	62245.3	59251.2
		Ho	kN	0.0	0.0	1200.0
		Mo	kN.m	0.0	0.0	28100.0
foundation crest	displacement	Del.1	cm	0.000	0.000	0.248
	deflexion angle	Theta.1	mrad	0.000	0.000	-0.156
design ground surface	displacement	Del.2	cm	0.000	0.000	0.248
	deflexion angle	Theta.2	mrad	0.000	0.000	-0.156
celler part maximum bending moment		Mmax	kN.m	0.0	0.0	-36004.0
Mmax accrue location		Lm	m	-8.060	-8.060	-19.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	37.33	38.74	44.99
		Lm	m	-28.160	-28.160	-28.160
	periphery sheet pile(SKY490)	Sigmax	N/mm²	37.33	38.74	45.71
		Lm	m	-8.060	-8.060	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	37.33	38.74	39.62
		Lm	m	-8.060	-8.060	-12.160
	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	-711.0
vertical reaction	maximum	Rmax	kN/num	1666	1729	1652
	minimum	Rmin	kN/num	1666	1729	1640
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2007	2007	2007
	uplifting force	Pa	kN/num	-1006	-1006	-1006
	stress(SKY400)	Sig.a	N/mm²	140.00	140.00	175.00
	stress(SKY490)	Sig.a	N/mm²	185.00	185.00	231.25

note)Lm is elevation

item			unit	OD-CL	OD-CL(SC)	ETQ
working force		Vo	kN	60249.2	57563.8	54358.0
		Ho	kN	6300.0	6300.0	13490.0
		Mo	kN.m	71400.0	71300.0	233800.0
foundation crest	displacement	Del.1	cm	0.951	0.951	2.412
	deflexion angle	Theta.1	mrad	-0.547	-0.546	-1.492
design ground surface	displacement	Del.2	cm	0.951	0.951	2.412
	deflexion angle	Theta.2	mrad	-0.547	-0.546	-1.492
celler part maximum bending moment		Mmax	kN.m	-121626.0	-121540.0	-354436.0
Mmax accrue location		Lm	m	-21.060	-21.060	-21.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	66.82	65.13	116.96
		Lm	m	-28.160	-28.160	-28.160
	periphery sheet pile(SKY490)	Sigmax	N/mm²	63.33	61.63	112.10
		Lm	m	-12.160	-12.160	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	46.60	44.92	59.63
		Lm	m	-28.160	-28.160	-28.160
	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	-3770.0	-3770.0	-6261.0
vertical reaction	maximum	Rmax	kN/num	1707	1632	1565
	minimum	Rmin	kN/num	1641	1566	1455
allowable value	displacement	Del.a	cm	5.000	5.000	5.000
	compressive bearing capacity	Ra	kN/num	2007	2007	3011
	uplifting force	Pa	kN/num	-1006	-1006	-1566
	stress(SKY400)	Sig.a	N/mm²	210.00	210.00	210.00
	stress(SKY490)	Sig.a	N/mm²	277.50	277.50	277.50

note)Lm is elevation

item			unit	ETQ(SC)
working force		Vo	kN	51672.6
		Ho	kN	13600.0
		Mo	kN.m	233800.0
foundation crest	displacement	Del.1	cm	2.426
	deflexion angle	Theta.1	mrad	-1.498
design ground surface	displacement	Del.2	cm	2.426
	deflexion angle	Theta.2	mrad	-1.498
celler part maximum bending moment		Mmax	kN.m	-355659.0
Mmax accrue location		Lm	m	-21.060
stress	periphery sheet pile(SKY400)	Sigmax	N/mm²	115.66
		Lm	m	-28.160
	periphery sheet pile(SKY490)	Sigmax	N/mm²	110.55
		Lm	m	-12.160
	separation wall sheet pile(SKY400)	Sigmax	N/mm²	58.08
		Lm	m	-28.160
	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	-6407.0
vertical reaction	maximum	Rmax	kN/num	1492
	minimum	Rmin	kN/num	1379
allowable value	displacement	Del.a	cm	5.000
	compressive bearing capacity	Ra	kN/num	3011
	uplifting force	Pa	kN/num	-1566
	stress(SKY400)	Sig.a	N/mm²	210.00
	stress(SKY490)	Sig.a	N/mm²	277.50

note)Lm is elevation

1.10 detail output

(1)bridge axis direction

1)Oridinary(high tide)

working force	vertical force	Vo	kN	59985.5
	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	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.000	0.000	0.0	0.0	37.33	37.33	*
-9.060	0.000	0.000	0.0	0.0	37.33	37.33	
-10.060	0.000	0.000	0.0	0.0	37.33	37.33	
-11.060	0.000	0.000	0.0	0.0	37.33	37.33	
-12.060	0.000	0.000	0.0	0.0	37.33	37.33	
-12.160	0.000	0.000	0.0	0.0	37.33	37.33	
-12.160	0.000	0.000	0.0	0.0	32.83	32.83	
-13.060	0.000	0.000	0.0	0.0	32.83	32.83	
-14.060	0.000	0.000	0.0	0.0	32.83	32.83	
-14.560	0.000	0.000	0.0	0.0	32.83	32.83	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.060	0.000	0.000	0.0	0.0	32.83	32.83	
-15.991	0.000	0.000	0.0	0.0	32.83	32.83	
-16.060	0.000	0.000	0.0	0.0	32.83	32.83	
-17.060	0.000	0.000	0.0	0.0	32.83	32.83	
-18.060	0.000	0.000	0.0	0.0	32.83	32.83	
-19.060	0.000	0.000	0.0	0.0	32.83	32.83	
-20.060	0.000	0.000	0.0	0.0	32.83	32.83	
-20.291	0.000	0.000	0.0	0.0	32.83	32.83	
-21.060	0.000	0.000	0.0	0.0	32.83	32.83	
-22.060	0.000	0.000	0.0	0.0	32.83	32.83	
-22.591	0.000	0.000	0.0	0.0	32.83	32.83	
-23.060	0.000	0.000	0.0	0.0	32.83	32.83	
-24.060	0.000	0.000	0.0	0.0	32.83	32.83	
-25.060	0.000	0.000	0.0	0.0	32.83	32.83	
-26.060	0.000	0.000	0.0	0.0	32.83	32.83	
-26.391	0.000	0.000	0.0	0.0	32.83	32.83	
-27.060	0.000	0.000	0.0	0.0	32.83	32.83	
-28.060	0.000	0.000	0.0	0.0	32.83	32.83	
-28.160	0.000	0.000	0.0	0.0	32.83	32.83	
-28.160	0.000	0.000	0.0	0.0	37.33	37.33	
-29.060	0.000	0.000	0.0	0.0	37.33	37.33	
-30.060	0.000	0.000	0.0	0.0	37.33	37.33	
-31.060	0.000	0.000	0.0	0.0	37.33	37.33	
-31.291	0.000	0.000	0.0	0.0	37.33	37.33	
-32.060	0.000	0.000	0.0	0.0	37.33	37.33	
-33.060	0.000	0.000	0.0	0.0	37.33	37.33	
-34.060	0.000	0.000	0.0	0.0	37.33	37.33	
-35.060	0.000	0.000	0.0	0.0	37.33	37.33	
-36.060	0.000	0.000	0.0	0.0	37.33	37.33	
-37.060	0.000	0.000	0.0	0.0	37.33	37.33	
-38.060	0.000	0.000	0.0	0.0	37.33	37.33	
-39.060	0.000	0.000	0.0	0.0	37.33	37.33	
-40.060	0.000	0.000	0.0	0.0	37.33	37.33	
-40.991	0.000	0.000	0.0	0.0	37.33	37.33	
-41.060	0.000	0.000	0.0	0.0	37.33	37.33	
-42.060	0.000	0.000	0.0	0.0	37.33	37.33	
-43.060	0.000	0.000	0.0	0.0	37.33	37.33	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-44.060	0.000	0.000	0.0	0.0	37.33	37.33	
-45.060	0.000	0.000	0.0	0.0	37.33	37.33	
-46.060	0.000	0.000	0.0	0.0	37.33	37.33	
-47.060	0.000	0.000	0.0	0.0	37.33	37.33	
-48.060	0.000	0.000	0.0	0.0	37.33	37.33	
-49.060	0.000	0.000	0.0	0.0	37.33	37.33	
-50.060	0.000	0.000	0.0	0.0	37.33	37.33	
-50.591	0.000	0.000	0.0	0.0	37.33	37.33	
-51.060	0.000	0.000	0.0	0.0	37.33	37.33	
-52.060	0.000	0.000	0.0	0.0	37.33	37.33	
-52.160	0.000	0.000	0.0	0.0	37.33	37.33	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	37.33	-28.160
periphery sheet pile (SKY490)	37.33	-8.060
separation wall sheet pile (SKY400)	37.33	-8.060
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 (m²)
Sum(IBi*Aoi) = 23.593 (m⁴)

periphery	n1 = 30 (number)	IB1 =	491.60 (m²)	Ao1 = 0.0446 (m²/number)
separation wall	n1 = 6 (number)	IB1 =	36.96 (m²)	Ao1 = 0.0446 (m²/number)
intermediate drive	n1 = 0 (number)	IB1 =	0.00 (m²)	Ao1 = 0.0000 (m²/number)

x = 5.087
maximum Rmax = 1666 (kN/number)
minimum Rmin = 1666 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	62245.3
	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	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.000	0.000	0.0	0.0	38.74	38.74	*
-9.060	0.000	0.000	0.0	0.0	38.74	38.74	
-10.060	0.000	0.000	0.0	0.0	38.74	38.74	
-11.060	0.000	0.000	0.0	0.0	38.74	38.74	
-12.060	0.000	0.000	0.0	0.0	38.74	38.74	
-12.160	0.000	0.000	0.0	0.0	38.74	38.74	
-12.160	0.000	0.000	0.0	0.0	34.06	34.06	
-13.060	0.000	0.000	0.0	0.0	34.06	34.06	
-14.060	0.000	0.000	0.0	0.0	34.06	34.06	
-14.560	0.000	0.000	0.0	0.0	34.06	34.06	
-15.060	0.000	0.000	0.0	0.0	34.06	34.06	
-15.991	0.000	0.000	0.0	0.0	34.06	34.06	
-16.060	0.000	0.000	0.0	0.0	34.06	34.06	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.000	0.000	0.0	0.0	34.06	34.06	
-18.060	0.000	0.000	0.0	0.0	34.06	34.06	
-19.060	0.000	0.000	0.0	0.0	34.06	34.06	
-20.060	0.000	0.000	0.0	0.0	34.06	34.06	
-20.291	0.000	0.000	0.0	0.0	34.06	34.06	
-21.060	0.000	0.000	0.0	0.0	34.06	34.06	
-22.060	0.000	0.000	0.0	0.0	34.06	34.06	
-22.591	0.000	0.000	0.0	0.0	34.06	34.06	
-23.060	0.000	0.000	0.0	0.0	34.06	34.06	
-24.060	0.000	0.000	0.0	0.0	34.06	34.06	
-25.060	0.000	0.000	0.0	0.0	34.06	34.06	
-26.060	0.000	0.000	0.0	0.0	34.06	34.06	
-26.391	0.000	0.000	0.0	0.0	34.06	34.06	
-27.060	0.000	0.000	0.0	0.0	34.06	34.06	
-28.060	0.000	0.000	0.0	0.0	34.06	34.06	
-28.160	0.000	0.000	0.0	0.0	34.06	34.06	
-28.160	0.000	0.000	0.0	0.0	38.74	38.74	
-29.060	0.000	0.000	0.0	0.0	38.74	38.74	
-30.060	0.000	0.000	0.0	0.0	38.74	38.74	
-31.060	0.000	0.000	0.0	0.0	38.74	38.74	
-31.291	0.000	0.000	0.0	0.0	38.74	38.74	
-32.060	0.000	0.000	0.0	0.0	38.74	38.74	
-33.060	0.000	0.000	0.0	0.0	38.74	38.74	
-34.060	0.000	0.000	0.0	0.0	38.74	38.74	
-35.060	0.000	0.000	0.0	0.0	38.74	38.74	
-36.060	0.000	0.000	0.0	0.0	38.74	38.74	
-37.060	0.000	0.000	0.0	0.0	38.74	38.74	
-38.060	0.000	0.000	0.0	0.0	38.74	38.74	
-39.060	0.000	0.000	0.0	0.0	38.74	38.74	
-40.060	0.000	0.000	0.0	0.0	38.74	38.74	
-40.991	0.000	0.000	0.0	0.0	38.74	38.74	
-41.060	0.000	0.000	0.0	0.0	38.74	38.74	
-42.060	0.000	0.000	0.0	0.0	38.74	38.74	
-43.060	0.000	0.000	0.0	0.0	38.74	38.74	
-44.060	0.000	0.000	0.0	0.0	38.74	38.74	
-45.060	0.000	0.000	0.0	0.0	38.74	38.74	
-46.060	0.000	0.000	0.0	0.0	38.74	38.74	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	0.000	0.000	0.0	0.0	38.74	38.74	
-48.060	0.000	0.000	0.0	0.0	38.74	38.74	
-49.060	0.000	0.000	0.0	0.0	38.74	38.74	
-50.060	0.000	0.000	0.0	0.0	38.74	38.74	
-50.591	0.000	0.000	0.0	0.0	38.74	38.74	
-51.060	0.000	0.000	0.0	0.0	38.74	38.74	
-52.060	0.000	0.000	0.0	0.0	38.74	38.74	
-52.160	0.000	0.000	0.0	0.0	38.74	38.74	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	38.74	-28.160
periphery sheet pile (SKY490)	38.74	-8.060
separation wall sheet pile (SKY400)	38.74	-8.060
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 (m²)
Sum(IBi*Aoi) = 23.593 (m⁴)
periphery n1 = 30 (number) IB1 = 491.60 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (number) IB1 = 36.96 (m²) Ao1 = 0.0446 (m²/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m²) Ao1 = 0.0000 (m²/number)
x = 5.087
maximum Rmax = 1729 (kN/number)
minimum Rmin = 1729 (kN/number)

3)Ord+Temp(high tide)

working force	vertical force	Vo	kN	59985.5
	horizontal force	Ho	kN	3100.0
	moment	Mo	kN.m	67000.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.664

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.664	-0.510	-3100.0	-67000.0	56.89	52.93	
-9.060	0.614	-0.491	-2766.3	-69931.0	57.74	53.61	
-10.060	0.566	-0.471	-2458.2	-72541.1	58.51	54.22	
-11.060	0.520	-0.450	-2174.7	-74855.5	59.18	54.76	
-12.060	0.476	-0.429	-1914.7	-76898.3	59.78	55.23	
-12.160	0.472	-0.427	-1889.9	-77088.5	59.83	55.28	
-12.160	0.472	-0.427	-1889.9	-77088.5	52.44	48.48	
-13.060	0.434	-0.410	-1677.1	-78692.4	52.84	48.81	
-14.060	0.394	-0.391	-1460.9	-80259.6	53.24	49.13	
-14.560	0.375	-0.381	-1360.6	-80964.8	53.42	49.27	
-15.060	0.356	-0.371	-1265.2	-81621.0	53.59	49.40	
-15.991	0.322	-0.353	-1100.4	-82721.0	53.87	49.63	
-16.060	0.320	-0.351	-1050.3	-82795.1	53.89	49.64	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-17.060	0.286	-0.331	-365.7	-83496.7	54.07	49.78	
-18.060	0.253	-0.311	244.0	-83551.5	54.08	49.80	*
-19.060	0.223	-0.291	783.2	-83032.2	53.95	49.69	
-20.060	0.195	-0.271	1256.4	-82007.1	53.69	49.48	
-20.291	0.189	-0.267	1356.9	-81705.2	53.61	49.42	
-21.060	0.169	-0.252	1650.3	-80546.9	53.32	49.18	
-22.060	0.145	-0.232	1984.8	-78725.0	52.85	48.81	
-22.591	0.133	-0.222	2142.0	-77628.7	52.57	48.59	
-23.060	0.123	-0.214	2379.1	-76567.8	52.30	48.38	
-24.060	0.102	-0.195	2823.5	-73959.7	51.64	47.85	
-25.060	0.083	-0.178	3190.5	-70946.5	50.87	47.23	
-26.060	0.067	-0.161	3487.0	-67602.2	50.02	46.56	
-26.391	0.061	-0.156	3570.7	-66433.9	49.73	46.32	
-27.060	0.051	-0.145	3650.8	-64017.6	49.11	45.83	
-28.060	0.037	-0.130	3745.0	-60317.2	48.17	45.08	
-28.160	0.036	-0.129	3752.8	-59942.3	48.07	45.00	
-28.160	0.036	-0.129	3752.8	-59942.3	54.83	51.28	
-29.060	0.025	-0.114	3811.4	-56536.8	53.83	50.49	
-30.060	0.014	-0.099	3853.4	-52702.5	52.72	49.60	
-31.060	0.005	-0.085	3874.3	-48837.0	51.59	48.70	
-31.291	0.003	-0.082	3876.4	-47941.8	51.33	48.49	
-32.060	-0.003	-0.072	3878.0	-44958.5	50.45	47.80	
-33.060	-0.009	-0.060	3841.7	-41095.3	49.33	46.90	
-34.060	-0.015	-0.049	3768.8	-37287.2	48.22	46.01	
-35.060	-0.019	-0.039	3665.9	-33567.6	47.13	45.14	
-36.060	-0.022	-0.030	3539.1	-29963.3	46.08	44.31	
-37.060	-0.025	-0.023	3393.6	-26495.6	45.06	43.50	
-38.060	-0.027	-0.016	3234.3	-23180.7	44.10	42.73	
-39.060	-0.028	-0.010	3065.4	-20030.2	43.18	41.99	
-40.060	-0.029	-0.005	2890.6	-17051.9	42.31	41.30	
-40.991	-0.029	0.000	2725.2	-14437.7	41.54	40.69	
-41.060	-0.029	0.000	2706.8	-14250.3	41.49	40.65	
-42.060	-0.029	0.003	2440.0	-11677.0	40.74	40.05	
-43.060	-0.029	0.006	2176.4	-9369.1	40.07	39.51	
-44.060	-0.028	0.009	1918.5	-7322.2	39.47	39.03	
-45.060	-0.027	0.010	1668.5	-5529.5	38.94	38.62	
-46.060	-0.026	0.012	1428.0	-3982.1	38.49	38.26	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-47.060	-0.025	0.013	1198.2	-2669.9	38.11	37.95	
-48.060	-0.023	0.013	979.9	-1581.9	37.79	37.70	
-49.060	-0.022	0.014	773.7	-706.1	37.54	37.49	
-50.060	-0.021	0.014	580.0	-30.3	37.34	37.34	
-50.591	-0.020	0.014	482.2	251.6	37.40	37.39	
-51.060	-0.019	0.014	398.7	458.0	37.46	37.44	
-52.060	-0.018	0.013	229.8	771.2	37.56	37.51	
-52.160	-0.018	0.013	213.6	793.4	37.56	37.51	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.664	-0.510	5.000

maximum stress

	Sig.(N/mm^2)	elevation(m)
periphery sheet pile (SKY400)	54.83	-28.160
periphery sheet pile (SKY490)	59.83	-12.160
separation wall sheet pile (SKY400)	55.28	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 793.4 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)

periphery	n1 = 30 (number)	IB1 =	491.60 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (number)	IB1 =	36.96 (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 = 5.087
maximum Rmax = 1674 (kN/number)
minimum Rmin = 1659 (kN/number)

4)Ord+Temp(low tide)

working force	vertical force	Vo	kN	62245.3
	horizontal force	Ho	kN	3100.0
	moment	Mo	kN.m	67000.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.664

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.664	-0.510	-3100.0	-67000.0	58.30	54.33	
-9.060	0.614	-0.491	-2766.3	-69931.0	59.15	55.02	
-10.060	0.566	-0.471	-2458.2	-72541.1	59.91	55.62	
-11.060	0.520	-0.450	-2174.7	-74855.5	60.59	56.16	
-12.060	0.476	-0.429	-1914.7	-76898.3	61.18	56.64	
-12.160	0.472	-0.427	-1889.9	-77088.5	61.24	56.68	
-12.160	0.472	-0.427	-1889.9	-77088.5	53.67	49.72	
-13.060	0.434	-0.410	-1677.1	-78692.4	54.08	50.04	
-14.060	0.394	-0.391	-1460.9	-80259.6	54.48	50.36	
-14.560	0.375	-0.381	-1360.6	-80964.8	54.66	50.51	
-15.060	0.356	-0.371	-1265.2	-81621.0	54.83	50.64	
-15.991	0.322	-0.353	-1100.4	-82721.0	55.10	50.86	
-16.060	0.320	-0.351	-1050.3	-82795.1	55.12	50.88	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.286	-0.331	-365.7	-83496.7	55.30	51.02	
-18.060	0.253	-0.311	244.0	-83551.5	55.32	51.03	*
-19.060	0.223	-0.291	783.2	-83032.2	55.18	50.93	
-20.060	0.195	-0.271	1256.4	-82007.1	54.92	50.72	
-20.291	0.189	-0.267	1356.9	-81705.2	54.85	50.66	
-21.060	0.169	-0.252	1650.3	-80546.9	54.55	50.42	
-22.060	0.145	-0.232	1984.8	-78725.0	54.09	50.05	
-22.591	0.133	-0.222	2142.0	-77628.7	53.81	49.83	
-23.060	0.123	-0.214	2379.1	-76567.8	53.54	49.61	
-24.060	0.102	-0.195	2823.5	-73959.7	52.88	49.08	
-25.060	0.083	-0.178	3190.5	-70946.5	52.11	48.47	
-26.060	0.067	-0.161	3487.0	-67602.2	51.26	47.79	
-26.391	0.061	-0.156	3570.7	-66433.9	50.96	47.55	
-27.060	0.051	-0.145	3650.8	-64017.6	50.35	47.06	
-28.060	0.037	-0.130	3745.0	-60317.2	49.41	46.31	
-28.160	0.036	-0.129	3752.8	-59942.3	49.31	46.24	
-28.160	0.036	-0.129	3752.8	-59942.3	56.23	52.69	
-29.060	0.025	-0.114	3811.4	-56536.8	55.24	51.90	
-30.060	0.014	-0.099	3853.4	-52702.5	54.12	51.00	
-31.060	0.005	-0.085	3874.3	-48837.0	52.99	50.10	
-31.291	0.003	-0.082	3876.4	-47941.8	52.73	49.90	
-32.060	-0.003	-0.072	3878.0	-44958.5	51.86	49.20	
-33.060	-0.009	-0.060	3841.7	-41095.3	50.73	48.30	
-34.060	-0.015	-0.049	3768.8	-37287.2	49.62	47.42	
-35.060	-0.019	-0.039	3665.9	-33567.6	48.54	46.55	
-36.060	-0.022	-0.030	3539.1	-29963.3	47.48	45.71	
-37.060	-0.025	-0.023	3393.6	-26495.6	46.47	44.90	
-38.060	-0.027	-0.016	3234.3	-23180.7	45.50	44.13	
-39.060	-0.028	-0.010	3065.4	-20030.2	44.58	43.40	
-40.060	-0.029	-0.005	2890.6	-17051.9	43.71	42.71	
-40.991	-0.029	0.000	2725.2	-14437.7	42.95	42.10	
-41.060	-0.029	0.000	2706.8	-14250.3	42.90	42.05	
-42.060	-0.029	0.003	2440.0	-11677.0	42.15	41.45	
-43.060	-0.029	0.006	2176.4	-9369.1	41.47	40.92	
-44.060	-0.028	0.009	1918.5	-7322.2	40.87	40.44	
-45.060	-0.027	0.010	1668.5	-5529.5	40.35	40.02	
-46.060	-0.026	0.012	1428.0	-3982.1	39.90	39.66	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.025	0.013	1198.2	-2669.9	39.52	39.36	
-48.060	-0.023	0.013	979.9	-1581.9	39.20	39.10	
-49.060	-0.022	0.014	773.7	-706.1	38.94	38.90	
-50.060	-0.021	0.014	580.0	-30.3	38.75	38.74	
-50.591	-0.020	0.014	482.2	251.6	38.81	38.80	
-51.060	-0.019	0.014	398.7	458.0	38.87	38.84	
-52.060	-0.018	0.013	229.8	771.2	38.96	38.92	
-52.160	-0.018	0.013	213.6	793.4	38.97	38.92	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.664	-0.510	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	56.23	-28.160
periphery sheet pile (SKY490)	61.24	-12.160
separation wall sheet pile (SKY400)	56.68	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 793.4 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 23.593 (m⁴)
periphery n1 = 30 (number) IB1 = 491.60 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (number) IB1 = 36.96 (m²) Ao1 = 0.0446 (m²/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m²) Ao1 = 0.0000 (m²/number)
x = 5.087
maximum Rmax = 1737 (kN/number)
minimum Rmin = 1721 (kN/number)

5)Wind+Temp

working force	vertical force	Vo	kN	59251.2
	horizontal force	Ho	kN	3200.0
	moment	Mo	kN.m	68800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.684

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.684	-0.524	-3200.0	-68800.0	56.96	52.89	
-9.060	0.632	-0.505	-2856.5	-71826.0	57.84	53.59	
-10.060	0.583	-0.484	-2539.4	-74521.8	58.63	54.22	
-11.060	0.535	-0.463	-2247.5	-76913.1	59.33	54.78	
-12.060	0.490	-0.441	-1979.8	-79024.8	59.94	55.27	
-12.160	0.486	-0.439	-1954.3	-79221.5	60.00	55.31	
-12.160	0.486	-0.439	-1954.3	-79221.5	52.58	48.51	
-13.060	0.447	-0.422	-1735.2	-80880.5	53.00	48.85	
-14.060	0.406	-0.402	-1512.7	-82502.6	53.41	49.18	
-14.560	0.386	-0.392	-1409.3	-83232.9	53.60	49.33	
-15.060	0.366	-0.382	-1311.1	-83912.9	53.77	49.47	
-15.991	0.332	-0.363	-1141.5	-85053.2	54.06	49.70	
-16.060	0.329	-0.362	-1089.8	-85130.2	54.08	49.71	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.294	-0.341	-384.8	-85860.9	54.27	49.86	
-18.060	0.261	-0.320	243.0	-85925.5	54.28	49.88	*
-19.060	0.230	-0.300	798.4	-85399.0	54.15	49.77	
-20.060	0.201	-0.279	1285.8	-84351.4	53.88	49.56	
-20.291	0.195	-0.274	1389.3	-84042.4	53.80	49.49	
-21.060	0.174	-0.259	1691.6	-82855.6	53.50	49.25	
-22.060	0.149	-0.239	2036.2	-80987.3	53.03	48.87	
-22.591	0.137	-0.229	2198.2	-79862.4	52.74	48.64	
-23.060	0.126	-0.220	2442.5	-78773.4	52.46	48.42	
-24.060	0.105	-0.201	2900.6	-76094.9	51.78	47.88	
-25.060	0.086	-0.183	3278.8	-72998.8	50.99	47.25	
-26.060	0.069	-0.166	3584.5	-69561.4	50.12	46.55	
-26.391	0.063	-0.161	3670.9	-68360.4	49.81	46.31	
-27.060	0.053	-0.150	3753.5	-65876.2	49.18	45.80	
-28.060	0.039	-0.134	3850.7	-62071.5	48.21	45.03	
-28.160	0.037	-0.133	3858.8	-61686.0	48.12	44.95	
-28.160	0.037	-0.133	3858.8	-61686.0	54.88	51.23	
-29.060	0.026	-0.118	3919.3	-58184.2	53.86	50.42	
-30.060	0.015	-0.102	3962.8	-54241.2	52.71	49.50	
-31.060	0.006	-0.088	3984.5	-50265.9	51.55	48.57	
-31.291	0.004	-0.084	3986.7	-49345.2	51.28	48.36	
-32.060	-0.003	-0.074	3988.8	-46276.8	50.38	47.65	
-33.060	-0.009	-0.062	3952.0	-42302.9	49.22	46.72	
-34.060	-0.015	-0.051	3877.4	-38385.4	48.08	45.81	
-35.060	-0.019	-0.041	3771.9	-34558.4	46.96	44.92	
-36.060	-0.023	-0.031	3641.7	-30849.7	45.88	44.05	
-37.060	-0.026	-0.023	3492.3	-27281.3	44.84	43.22	
-38.060	-0.028	-0.016	3328.7	-23869.8	43.84	42.43	
-39.060	-0.029	-0.010	3155.1	-20627.3	42.89	41.67	
-40.060	-0.030	-0.005	2975.3	-17561.7	42.00	40.96	
-40.991	-0.030	-0.001	2805.3	-14870.7	41.21	40.33	
-41.060	-0.030	0.000	2786.3	-14677.8	41.16	40.29	
-42.060	-0.030	0.003	2512.0	-12028.8	40.38	39.67	
-43.060	-0.029	0.006	2240.8	-9652.7	39.69	39.12	
-44.060	-0.029	0.009	1975.5	-7545.1	39.08	38.63	
-45.060	-0.028	0.011	1718.3	-5699.0	38.54	38.20	
-46.060	-0.026	0.012	1470.7	-4105.3	38.07	37.83	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.025	0.013	1234.2	-2753.9	37.68	37.51	
-48.060	-0.024	0.014	1009.5	-1633.0	37.35	37.25	
-49.060	-0.023	0.014	797.2	-730.8	37.09	37.04	
-50.060	-0.021	0.014	597.6	-34.4	36.88	36.88	
-50.591	-0.020	0.014	496.9	256.0	36.95	36.93	
-51.060	-0.020	0.014	410.9	468.7	37.01	36.98	
-52.060	-0.018	0.014	236.8	791.5	37.10	37.06	
-52.160	-0.018	0.014	220.1	814.4	37.11	37.06	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.684	-0.524	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	54.88	-28.160
periphery sheet pile (SKY490)	60.00	-12.160
separation wall sheet pile (SKY400)	55.31	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 814.4 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)
periphery n1 = 30 (number) IB1 = 491.60 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (number) IB1 = 36.96 (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 = 5.087
maximum Rmax = 1654 (kN/number)
minimum Rmin = 1638 (kN/number)

6)Wind+Temp

working force	vertical force	Vo	kN	56565.8
	horizontal force	Ho	kN	3200.0
	moment	Mo	kN.m	68800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.684

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.684	-0.524	-3200.0	-68800.0	55.29	51.22	
-9.060	0.632	-0.505	-2856.5	-71826.0	56.17	51.92	
-10.060	0.583	-0.484	-2539.4	-74521.8	56.96	52.55	
-11.060	0.535	-0.463	-2247.5	-76913.1	57.65	53.11	
-12.060	0.490	-0.441	-1979.8	-79024.8	58.27	53.60	
-12.160	0.486	-0.439	-1954.3	-79221.5	58.33	53.64	
-12.160	0.486	-0.439	-1954.3	-79221.5	51.11	47.04	
-13.060	0.447	-0.422	-1735.2	-80880.5	51.53	47.38	
-14.060	0.406	-0.402	-1512.7	-82502.6	51.94	47.71	
-14.560	0.386	-0.392	-1409.3	-83232.9	52.13	47.86	
-15.060	0.366	-0.382	-1311.1	-83912.9	52.30	48.00	
-15.991	0.332	-0.363	-1141.5	-85053.2	52.59	48.23	
-16.060	0.329	-0.362	-1089.8	-85130.2	52.61	48.24	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.294	-0.341	-384.8	-85860.9	52.80	48.39	
-18.060	0.261	-0.320	243.0	-85925.5	52.81	48.41	*
-19.060	0.230	-0.300	798.4	-85399.0	52.68	48.30	
-20.060	0.201	-0.279	1285.8	-84351.4	52.41	48.09	
-20.291	0.195	-0.274	1389.3	-84042.4	52.33	48.02	
-21.060	0.174	-0.259	1691.6	-82855.6	52.03	47.78	
-22.060	0.149	-0.239	2036.2	-80987.3	51.56	47.40	
-22.591	0.137	-0.229	2198.2	-79862.4	51.27	47.17	
-23.060	0.126	-0.220	2442.5	-78773.4	50.99	46.95	
-24.060	0.105	-0.201	2900.6	-76094.9	50.31	46.41	
-25.060	0.086	-0.183	3278.8	-72998.8	49.52	45.78	
-26.060	0.069	-0.166	3584.5	-69561.4	48.65	45.08	
-26.391	0.063	-0.161	3670.9	-68360.4	48.34	44.84	
-27.060	0.053	-0.150	3753.5	-65876.2	47.71	44.33	
-28.060	0.039	-0.134	3850.7	-62071.5	46.74	43.56	
-28.160	0.037	-0.133	3858.8	-61686.0	46.65	43.48	
-28.160	0.037	-0.133	3858.8	-61686.0	53.21	49.56	
-29.060	0.026	-0.118	3919.3	-58184.2	52.19	48.75	
-30.060	0.015	-0.102	3962.8	-54241.2	51.04	47.83	
-31.060	0.006	-0.088	3984.5	-50265.9	49.88	46.90	
-31.291	0.004	-0.084	3986.7	-49345.2	49.61	46.69	
-32.060	-0.003	-0.074	3988.8	-46276.8	48.71	45.97	
-33.060	-0.009	-0.062	3952.0	-42302.9	47.55	45.05	
-34.060	-0.015	-0.051	3877.4	-38385.4	46.41	44.14	
-35.060	-0.019	-0.041	3771.9	-34558.4	45.29	43.25	
-36.060	-0.023	-0.031	3641.7	-30849.7	44.21	42.38	
-37.060	-0.026	-0.023	3492.3	-27281.3	43.17	41.55	
-38.060	-0.028	-0.016	3328.7	-23869.8	42.17	40.76	
-39.060	-0.029	-0.010	3155.1	-20627.3	41.22	40.00	
-40.060	-0.030	-0.005	2975.3	-17561.7	40.33	39.29	
-40.991	-0.030	-0.001	2805.3	-14870.7	39.54	38.66	
-41.060	-0.030	0.000	2786.3	-14677.8	39.49	38.62	
-42.060	-0.030	0.003	2512.0	-12028.8	38.71	38.00	
-43.060	-0.029	0.006	2240.8	-9652.7	38.02	37.45	
-44.060	-0.029	0.009	1975.5	-7545.1	37.40	36.96	
-45.060	-0.028	0.011	1718.3	-5699.0	36.87	36.53	
-46.060	-0.026	0.012	1470.7	-4105.3	36.40	36.16	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.025	0.013	1234.2	-2753.9	36.01	35.84	
-48.060	-0.024	0.014	1009.5	-1633.0	35.68	35.58	
-49.060	-0.023	0.014	797.2	-730.8	35.42	35.37	
-50.060	-0.021	0.014	597.6	-34.4	35.21	35.21	
-50.591	-0.020	0.014	496.9	256.0	35.28	35.26	
-51.060	-0.020	0.014	410.9	468.7	35.34	35.31	
-52.060	-0.018	0.014	236.8	791.5	35.43	35.39	
-52.160	-0.018	0.014	220.1	814.4	35.44	35.39	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.684	-0.524	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	53.21	-28.160
periphery sheet pile (SKY490)	58.33	-12.160
separation wall sheet pile (SKY400)	53.64	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 814.4 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)
periphery n1 = 30 (number) IB1 = 491.60 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (number) IB1 = 36.96 (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 = 5.087
maximum Rmax = 1579 (kN/number)
minimum Rmin = 1563 (kN/number)

7)Ord+Collision

working force	vertical force	Vo	kN	60249.2
	horizontal force	Ho	kN	3100.0
	moment	Mo	kN.m	35400.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.492

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.492	-0.349	-3100.0	-35400.0	47.83	45.73	
-9.060	0.458	-0.338	-2851.9	-38374.5	48.70	46.43	
-10.060	0.425	-0.327	-2621.5	-41109.7	49.49	47.06	
-11.060	0.392	-0.316	-2408.2	-43623.1	50.23	47.65	
-12.060	0.361	-0.303	-2211.3	-45931.5	50.90	48.19	
-12.160	0.358	-0.302	-2192.5	-46151.7	50.97	48.24	
-12.160	0.358	-0.302	-2192.5	-46151.7	44.71	42.34	
-13.060	0.332	-0.292	-2030.3	-48051.1	45.19	42.73	
-14.060	0.303	-0.280	-1864.6	-49997.3	45.69	43.12	
-14.560	0.289	-0.274	-1787.2	-50910.1	45.92	43.31	
-15.060	0.276	-0.268	-1713.4	-51785.1	46.14	43.49	
-15.991	0.251	-0.256	-1585.3	-53319.7	46.53	43.80	
-16.060	0.250	-0.255	-1546.1	-53427.7	46.56	43.82	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.225	-0.242	-1009.4	-54700.8	46.88	44.08	
-18.060	0.201	-0.228	-527.4	-55464.8	47.08	44.23	
-19.060	0.179	-0.215	-97.0	-55772.8	47.16	44.30	*
-20.060	0.158	-0.202	284.6	-55675.1	47.13	44.28	
-20.291	0.154	-0.199	366.2	-55599.8	47.11	44.26	
-21.060	0.139	-0.188	605.9	-55224.5	47.02	44.19	
-22.060	0.121	-0.175	882.4	-54477.1	46.83	44.03	
-22.591	0.112	-0.168	1013.9	-53973.2	46.70	43.93	
-23.060	0.104	-0.162	1213.9	-53450.3	46.57	43.83	
-24.060	0.088	-0.149	1593.8	-52041.3	46.21	43.54	
-25.060	0.074	-0.137	1914.7	-50282.3	45.76	43.18	
-26.060	0.061	-0.125	2181.3	-48230.0	45.24	42.77	
-26.391	0.057	-0.121	2258.4	-47495.1	45.05	42.62	
-27.060	0.049	-0.114	2333.8	-45958.4	44.66	42.30	
-28.060	0.038	-0.103	2426.4	-43576.4	44.05	41.82	
-28.160	0.037	-0.102	2434.4	-43333.4	43.99	41.77	
-28.160	0.037	-0.102	2434.4	-43333.4	50.14	47.58	
-29.060	0.028	-0.091	2497.1	-41112.9	49.50	47.06	
-30.060	0.020	-0.080	2548.4	-38588.6	48.76	46.48	
-31.060	0.012	-0.070	2582.6	-36021.8	48.01	45.88	
-31.291	0.011	-0.067	2588.3	-35424.5	47.84	45.74	
-32.060	0.006	-0.060	2627.1	-33417.7	47.25	45.27	
-33.060	0.000	-0.051	2645.6	-30778.5	46.48	44.66	
-34.060	-0.004	-0.043	2632.9	-28136.9	45.71	44.04	
-35.060	-0.008	-0.035	2593.9	-25521.5	44.94	43.44	
-36.060	-0.011	-0.029	2533.3	-22956.2	44.20	42.84	
-37.060	-0.014	-0.023	2455.1	-20460.7	43.47	42.26	
-38.060	-0.016	-0.017	2363.1	-18050.6	42.76	41.70	
-39.060	-0.018	-0.013	2260.4	-15738.1	42.09	41.16	
-40.060	-0.019	-0.009	2150.0	-13532.4	41.44	40.64	
-40.991	-0.019	-0.005	2042.4	-11580.6	40.87	40.19	
-41.060	-0.019	-0.005	2030.2	-11440.1	40.83	40.16	
-42.060	-0.020	-0.002	1851.9	-9498.7	40.27	39.71	
-43.060	-0.020	0.000	1671.5	-7737.0	39.75	39.30	
-44.060	-0.020	0.002	1491.3	-6155.7	39.29	38.93	
-45.060	-0.019	0.004	1312.9	-4753.8	38.88	38.60	
-46.060	-0.019	0.005	1137.8	-3528.8	38.52	38.32	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.018	0.006	967.0	-2476.8	38.22	38.07	
-48.060	-0.018	0.006	801.3	-1593.1	37.96	37.87	
-49.060	-0.017	0.006	641.2	-872.3	37.75	37.70	
-50.060	-0.017	0.007	487.0	-308.7	37.58	37.57	
-50.591	-0.016	0.007	407.6	-71.2	37.52	37.51	
-51.060	-0.016	0.007	338.9	103.8	37.52	37.52	
-52.060	-0.015	0.007	196.9	371.2	37.60	37.58	
-52.160	-0.015	0.007	183.1	390.2	37.61	37.59	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.492	-0.349	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	50.14	-28.160
periphery sheet pile (SKY490)	50.97	-12.160
separation wall sheet pile (SKY400)	48.24	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 390.2 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)
periphery n1 = 30 (number) IB1 = 491.60 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (number) IB1 = 36.96 (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 = 5.087
maximum Rmax = 1677 (kN/number)
minimum Rmin = 1670 (kN/number)

8)Ord+Collision(scour)

working force	vertical force	Vo	kN	57563.8
	horizontal force	Ho	kN	3100.0
	moment	Mo	kN.m	35400.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.492

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

No	standardKH1(kN/m^3)	calculation KH1(kN/m^3)
1	1361	3043
2	5897	13187
3	5557	12426
4	10320	23077
5	5557	12426
6	15877	35503
7	23816	53254
8	23816	53254

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	0.492	-0.349	-3100.0	-35400.0	46.16	44.06	
-9.060	0.458	-0.338	-2851.9	-38374.5	47.03	44.76	
-10.060	0.425	-0.327	-2621.5	-41109.7	47.82	45.39	
-11.060	0.392	-0.316	-2408.2	-43623.1	48.56	45.98	
-12.060	0.361	-0.303	-2211.3	-45931.5	49.23	46.52	
-12.160	0.358	-0.302	-2192.5	-46151.7	49.30	46.57	
-12.160	0.358	-0.302	-2192.5	-46151.7	43.24	40.87	
-13.060	0.332	-0.292	-2030.3	-48051.1	43.72	41.26	
-14.060	0.303	-0.280	-1864.6	-49997.3	44.22	41.65	
-14.560	0.289	-0.274	-1787.2	-50910.1	44.45	41.84	
-15.060	0.276	-0.268	-1713.4	-51785.1	44.67	42.02	
-15.991	0.251	-0.256	-1585.3	-53319.7	45.06	42.33	
-16.060	0.250	-0.255	-1546.1	-53427.7	45.09	42.35	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-17.060	0.225	-0.242	-1009.4	-54700.8	45.42	42.61	
-18.060	0.201	-0.228	-527.4	-55464.8	45.61	42.77	
-19.060	0.179	-0.215	-97.0	-55772.8	45.69	42.83	*
-20.060	0.158	-0.202	284.6	-55675.1	45.66	42.81	
-20.291	0.154	-0.199	366.2	-55599.8	45.64	42.79	
-21.060	0.139	-0.188	605.9	-55224.5	45.55	42.72	
-22.060	0.121	-0.175	882.4	-54477.1	45.36	42.56	
-22.591	0.112	-0.168	1013.9	-53973.2	45.23	42.46	
-23.060	0.104	-0.162	1213.9	-53450.3	45.10	42.36	
-24.060	0.088	-0.149	1593.8	-52041.3	44.74	42.07	
-25.060	0.074	-0.137	1914.7	-50282.3	44.29	41.71	
-26.060	0.061	-0.125	2181.3	-48230.0	43.77	41.30	
-26.391	0.057	-0.121	2258.4	-47495.1	43.58	41.15	
-27.060	0.049	-0.114	2333.8	-45958.4	43.19	40.83	
-28.060	0.038	-0.103	2426.4	-43576.4	42.59	40.35	
-28.160	0.037	-0.102	2434.4	-43333.4	42.52	40.30	
-28.160	0.037	-0.102	2434.4	-43333.4	48.47	45.91	
-29.060	0.028	-0.091	2497.1	-41112.9	47.82	45.39	
-30.060	0.020	-0.080	2548.4	-38588.6	47.09	44.81	
-31.060	0.012	-0.070	2582.6	-36021.8	46.34	44.21	
-31.291	0.011	-0.067	2588.3	-35424.5	46.16	44.07	
-32.060	0.006	-0.060	2627.1	-33417.7	45.58	43.60	
-33.060	0.000	-0.051	2645.6	-30778.5	44.81	42.99	
-34.060	-0.004	-0.043	2632.9	-28136.9	44.04	42.37	
-35.060	-0.008	-0.035	2593.9	-25521.5	43.27	41.76	
-36.060	-0.011	-0.029	2533.3	-22956.2	42.52	41.17	
-37.060	-0.014	-0.023	2455.1	-20460.7	41.80	40.59	
-38.060	-0.016	-0.017	2363.1	-18050.6	41.09	40.02	
-39.060	-0.018	-0.013	2260.4	-15738.1	40.42	39.49	
-40.060	-0.019	-0.009	2150.0	-13532.4	39.77	38.97	
-40.991	-0.019	-0.005	2042.4	-11580.6	39.20	38.52	
-41.060	-0.019	-0.005	2030.2	-11440.1	39.16	38.49	
-42.060	-0.020	-0.002	1851.9	-9498.7	38.60	38.03	
-43.060	-0.020	0.000	1671.5	-7737.0	38.08	37.62	
-44.060	-0.020	0.002	1491.3	-6155.7	37.62	37.26	
-45.060	-0.019	0.004	1312.9	-4753.8	37.21	36.93	
-46.060	-0.019	0.005	1137.8	-3528.8	36.85	36.64	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.018	0.006	967.0	-2476.8	36.55	36.40	
-48.060	-0.018	0.006	801.3	-1593.1	36.29	36.19	
-49.060	-0.017	0.006	641.2	-872.3	36.08	36.03	
-50.060	-0.017	0.007	487.0	-308.7	35.91	35.90	
-50.591	-0.016	0.007	407.6	-71.2	35.84	35.84	
-51.060	-0.016	0.007	338.9	103.8	35.85	35.85	
-52.060	-0.015	0.007	196.9	371.2	35.93	35.91	
-52.160	-0.015	0.007	183.1	390.2	35.94	35.91	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.492	-0.349	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	48.47	-28.160
periphery sheet pile (SKY490)	49.30	-12.160
separation wall sheet pile (SKY400)	46.57	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 390.2 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 23.593 (m⁴)
periphery n1 = 30 (number) IB1 = 491.60 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (number) IB1 = 36.96 (m²) Ao1 = 0.0446 (m²/number)
intermediate drive n1 = 0 (number) IB1 = 0.00 (m²) Ao1 = 0.0000 (m²/number)
x = 5.087
maximum Rmax = 1603 (kN/number)
minimum Rmin = 1595 (kN/number)

9)Earthquake

working force	vertical force	Vo	kN	54358.0
	horizontal force	Ho	kN	14900.0
	moment	Mo	kN.m	237500.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	3.066
	calculation displacement	Del.	cm	3.051

convergence rate (Del.1 - Del.) / Del.1 = 0.50 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	906	1157
2	11795	15062
3	11114	14193
4	20640	26358
5	11114	14193
6	31754	40550
7	47632	60826
8	47632	60826

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	3.051	-2.200	-14900.0	-237500.0	103.16	89.11	
-9.060	2.834	-2.132	-14315.6	-252104.2	107.42	92.51	
-10.060	2.625	-2.060	-13773.5	-266145.2	111.52	95.78	
-11.060	2.422	-1.984	-13272.3	-279664.8	115.47	98.93	
-12.060	2.228	-1.904	-12810.5	-292702.9	119.27	101.96	
-12.160	2.209	-1.896	-12766.4	-293981.7	119.65	102.26	
-12.160	2.209	-1.896	-12766.4	-293981.7	104.53	89.46	
-13.060	2.041	-1.831	-12386.5	-305298.3	107.41	91.75	
-14.060	1.862	-1.756	-11999.0	-317488.1	110.51	94.23	
-14.560	1.775	-1.717	-11818.4	-323442.1	112.03	95.44	
-15.060	1.690	-1.678	-11646.3	-329307.9	113.52	96.63	
-15.991	1.537	-1.603	-11347.9	-340009.5	116.24	98.80	
-16.060	1.526	-1.597	-11074.6	-340783.1	116.44	98.96	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-17.060	1.371	-1.513	-7331.4	-349952.6	118.77	100.82	
-18.060	1.224	-1.428	-3979.4	-355576.3	120.20	101.97	
-19.060	1.085	-1.342	-996.7	-358034.5	120.83	102.46	*
-20.060	0.955	-1.256	1639.1	-357685.3	120.74	102.39	
-20.291	0.927	-1.236	2201.0	-357241.4	120.62	102.30	
-21.060	0.834	-1.170	3849.4	-354903.9	120.03	101.83	
-22.060	0.721	-1.085	5742.2	-350085.3	118.80	100.85	
-22.591	0.665	-1.040	6638.6	-346794.9	117.97	100.18	
-23.060	0.617	-1.001	7998.4	-343358.5	117.09	99.48	
-24.060	0.521	-0.919	10570.1	-334038.1	114.72	97.59	
-25.060	0.433	-0.840	12725.7	-322357.1	111.75	95.22	
-26.060	0.353	-0.764	14501.3	-308713.3	108.28	92.45	
-26.391	0.328	-0.739	15011.2	-303828.0	107.04	91.46	
-27.060	0.280	-0.691	15506.5	-293615.5	104.44	89.38	
-28.060	0.215	-0.622	16108.0	-277794.9	100.41	86.17	
-28.160	0.208	-0.615	16159.6	-276181.5	100.00	85.84	
-28.160	0.208	-0.615	16159.6	-276181.5	114.45	98.12	
-29.060	0.156	-0.548	16558.2	-261449.9	110.15	94.69	
-30.060	0.105	-0.478	16874.7	-244723.1	105.27	90.80	
-31.060	0.060	-0.412	17074.7	-227739.4	100.31	86.84	
-31.291	0.051	-0.398	17106.0	-223791.4	99.16	85.92	
-32.060	0.022	-0.351	17300.8	-210552.1	95.29	82.84	
-33.060	-0.010	-0.295	17340.5	-193212.8	90.23	78.80	
-34.060	-0.037	-0.244	17174.7	-175939.5	85.19	74.78	
-35.060	-0.059	-0.197	16839.0	-158920.0	80.22	70.82	
-36.060	-0.076	-0.155	16365.9	-142307.3	75.37	66.95	
-37.060	-0.090	-0.118	15784.4	-126224.3	70.68	63.21	
-38.060	-0.100	-0.085	15120.8	-110765.9	66.16	59.61	
-39.060	-0.107	-0.056	14397.7	-96002.5	61.85	56.18	
-40.060	-0.111	-0.031	13635.4	-81983.5	57.76	52.91	
-40.991	-0.113	-0.012	12905.4	-69627.7	54.15	50.04	
-41.060	-0.114	-0.010	12823.7	-68740.1	53.89	49.83	
-42.060	-0.114	0.007	11635.7	-56510.3	50.32	46.98	
-43.060	-0.112	0.021	10454.7	-45466.3	47.10	44.41	
-44.060	-0.110	0.032	9295.5	-35593.5	44.22	42.11	
-45.060	-0.106	0.041	8169.7	-26864.1	41.67	40.08	
-46.060	-0.101	0.047	7086.5	-19239.9	39.44	38.31	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-47.060	-0.097	0.052	6052.6	-12674.7	37.53	36.78	
-48.060	-0.091	0.054	5072.5	-7116.8	35.91	35.48	
-49.060	-0.086	0.056	4149.3	-2510.7	34.56	34.41	
-50.060	-0.080	0.056	3284.2	1201.2	34.18	34.11	
-50.591	-0.077	0.056	2848.6	2828.7	34.65	34.49	
-51.060	-0.074	0.055	2477.5	4077.2	35.02	34.78	
-52.060	-0.069	0.054	1728.4	6175.4	35.63	35.27	
-52.160	-0.069	0.054	1656.6	6344.6	35.68	35.31	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	3.051	-2.200	5.000

maximum stress

	Sig.(N/mm^2)	elevation(m)
periphery sheet pile (SKY400)	120.83	-19.060
periphery sheet pile (SKY490)	119.65	-12.160
separation wall sheet pile (SKY400)	102.46	-19.060
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 6344.6 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)

periphery	n1 = 30 (number)	IB1 = 491.60 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (number)	IB1 = 36.96 (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 = 5.087
maximum Rmax = 1571 (kN/number)
minimum Rmin = 1449 (kN/number)

10)Earthquake(scour)

working force	vertical force	Vo	kN	51672.6
	horizontal force	Ho	kN	15600.0
	moment	Mo	kN.m	238900.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	3.176
	calculation displacement	Del.	cm	3.161

convergence rate (Del.1 - Del.) / Del.1 = 0.47 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	906	1137
2	11795	14799
3	11114	13945
4	20640	25899
5	11114	13945
6	31754	39844
7	47632	59766
8	47632	59766

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	3.161	-2.260	-15600.0	-238900.0	101.90	87.77	
-9.060	2.938	-2.192	-15004.8	-254198.8	106.36	91.33	
-10.060	2.723	-2.119	-14452.5	-268923.9	110.66	94.76	
-11.060	2.514	-2.042	-13941.4	-283117.5	114.80	98.06	
-12.060	2.314	-1.962	-13470.3	-296820.1	118.80	101.25	
-12.160	2.295	-1.953	-13425.3	-298164.9	119.20	101.56	
-12.160	2.295	-1.953	-13425.3	-298164.9	104.13	88.84	
-13.060	2.122	-1.887	-13037.4	-310070.8	107.15	91.25	
-14.060	1.937	-1.811	-12641.4	-322907.2	110.42	93.86	
-14.560	1.847	-1.772	-12456.7	-329181.4	112.02	95.14	
-15.060	1.760	-1.731	-12280.7	-335365.4	113.59	96.39	
-15.991	1.602	-1.655	-11975.3	-346654.4	116.46	98.68	
-16.060	1.591	-1.649	-11695.5	-347471.0	116.67	98.85	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	1.430	-1.564	-7860.7	-357215.1	119.15	100.83	
-18.060	1.278	-1.477	-4423.1	-363324.8	120.70	102.07	
-19.060	1.135	-1.389	-1360.7	-366186.4	121.43	102.65	*
-20.060	1.000	-1.301	1348.9	-366163.8	121.42	102.65	
-20.291	0.970	-1.280	1927.0	-365785.1	121.33	102.57	
-21.060	0.875	-1.212	3624.2	-363639.3	120.78	102.13	
-22.060	0.758	-1.125	5576.0	-359015.9	119.61	101.19	
-22.591	0.699	-1.079	6501.5	-355806.1	118.79	100.54	
-23.060	0.649	-1.039	7907.0	-352423.2	117.93	99.86	
-24.060	0.550	-0.955	10569.2	-343148.2	115.57	97.97	
-25.060	0.458	-0.874	12806.6	-331426.3	112.59	95.59	
-26.060	0.375	-0.796	14655.4	-317664.4	109.09	92.80	
-26.391	0.349	-0.771	15187.8	-312724.3	107.83	91.79	
-27.060	0.299	-0.721	15706.1	-302385.9	105.20	89.69	
-28.060	0.231	-0.650	16338.4	-286350.0	101.12	86.44	
-28.160	0.224	-0.643	16392.8	-284713.4	100.70	86.10	
-28.160	0.224	-0.643	16392.8	-284713.4	115.27	98.43	
-29.060	0.169	-0.574	16815.4	-269760.8	110.90	94.95	
-30.060	0.116	-0.501	17155.1	-252764.9	105.94	91.00	
-31.060	0.069	-0.433	17374.7	-235490.7	100.90	86.97	
-31.291	0.059	-0.418	17410.2	-231472.9	99.73	86.04	
-32.060	0.029	-0.370	17640.2	-217985.8	95.79	82.90	
-33.060	-0.005	-0.312	17718.2	-200287.3	90.62	78.78	
-34.060	-0.034	-0.258	17582.7	-182620.6	85.47	74.67	
-35.060	-0.057	-0.210	17270.2	-165180.8	80.38	70.61	
-36.060	-0.076	-0.167	16813.8	-148128.2	75.40	66.64	
-37.060	-0.090	-0.128	16243.2	-131591.3	70.57	62.79	
-38.060	-0.101	-0.093	15585.0	-115671.0	65.92	59.08	
-39.060	-0.109	-0.063	14862.8	-100442.6	61.48	55.54	
-40.060	-0.114	-0.037	14097.2	-85959.8	57.25	52.17	
-40.991	-0.117	-0.017	13360.9	-73176.9	53.52	49.19	
-41.060	-0.117	-0.015	13278.2	-72257.8	53.25	48.98	
-42.060	-0.117	0.003	12075.0	-59580.7	49.55	46.03	
-43.060	-0.116	0.018	10874.6	-48106.8	46.20	43.36	
-44.060	-0.114	0.030	9692.3	-37825.4	43.20	40.96	
-45.060	-0.110	0.039	8540.4	-28712.0	40.54	38.84	
-46.060	-0.106	0.046	7428.4	-20731.3	38.21	36.98	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.101	0.051	6363.3	-13839.6	36.20	35.38	
-48.060	-0.096	0.054	5350.1	-7987.4	34.49	34.02	
-49.060	-0.091	0.055	4391.8	-3121.1	33.07	32.88	
-50.060	-0.085	0.056	3490.1	815.1	32.39	32.35	
-50.591	-0.082	0.055	3034.4	2546.6	32.90	32.75	
-51.060	-0.080	0.055	2645.3	3878.1	33.29	33.06	
-52.060	-0.074	0.053	1856.7	6124.4	33.94	33.58	
-52.160	-0.074	0.053	1780.9	6306.3	34.00	33.62	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	3.161	-2.260	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	121.43	-19.060
periphery sheet pile (SKY490)	119.20	-12.160
separation wall sheet pile (SKY400)	102.65	-19.060
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = 6306.3 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 23.593 (m^4)
periphery n1 = 30 (number) IB1 = 491.60 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (number) IB1 = 36.96 (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 = 5.087
maximum Rmax = 1496 (kN/number)
minimum Rmin = 1375 (kN/number)

(2)perpendicular direction

1)Oridinary(high tide)

working force	vertical force	Vo	kN	59985.5
	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	1502	3359
2	6509	14554
3	6133	13714
4	11390	25469
5	6133	13714
6	17523	39183
7	26284	58774
8	26284	58774

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.000	0.000	0.0	0.0	37.33	37.33	*
-9.060	0.000	0.000	0.0	0.0	37.33	37.33	
-10.060	0.000	0.000	0.0	0.0	37.33	37.33	
-11.060	0.000	0.000	0.0	0.0	37.33	37.33	
-12.060	0.000	0.000	0.0	0.0	37.33	37.33	
-12.160	0.000	0.000	0.0	0.0	37.33	37.33	
-12.160	0.000	0.000	0.0	0.0	32.83	32.83	
-13.060	0.000	0.000	0.0	0.0	32.83	32.83	
-14.060	0.000	0.000	0.0	0.0	32.83	32.83	
-14.560	0.000	0.000	0.0	0.0	32.83	32.83	
-15.060	0.000	0.000	0.0	0.0	32.83	32.83	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-15.991	0.000	0.000	0.0	0.0	32.83	32.83	
-16.060	0.000	0.000	0.0	0.0	32.83	32.83	
-17.060	0.000	0.000	0.0	0.0	32.83	32.83	
-18.060	0.000	0.000	0.0	0.0	32.83	32.83	
-19.060	0.000	0.000	0.0	0.0	32.83	32.83	
-20.060	0.000	0.000	0.0	0.0	32.83	32.83	
-20.291	0.000	0.000	0.0	0.0	32.83	32.83	
-21.060	0.000	0.000	0.0	0.0	32.83	32.83	
-22.060	0.000	0.000	0.0	0.0	32.83	32.83	
-22.591	0.000	0.000	0.0	0.0	32.83	32.83	
-23.060	0.000	0.000	0.0	0.0	32.83	32.83	
-24.060	0.000	0.000	0.0	0.0	32.83	32.83	
-25.060	0.000	0.000	0.0	0.0	32.83	32.83	
-26.060	0.000	0.000	0.0	0.0	32.83	32.83	
-26.391	0.000	0.000	0.0	0.0	32.83	32.83	
-27.060	0.000	0.000	0.0	0.0	32.83	32.83	
-28.060	0.000	0.000	0.0	0.0	32.83	32.83	
-28.160	0.000	0.000	0.0	0.0	32.83	32.83	
-28.160	0.000	0.000	0.0	0.0	37.33	37.33	
-29.060	0.000	0.000	0.0	0.0	37.33	37.33	
-30.060	0.000	0.000	0.0	0.0	37.33	37.33	
-31.060	0.000	0.000	0.0	0.0	37.33	37.33	
-31.291	0.000	0.000	0.0	0.0	37.33	37.33	
-32.060	0.000	0.000	0.0	0.0	37.33	37.33	
-33.060	0.000	0.000	0.0	0.0	37.33	37.33	
-34.060	0.000	0.000	0.0	0.0	37.33	37.33	
-35.060	0.000	0.000	0.0	0.0	37.33	37.33	
-36.060	0.000	0.000	0.0	0.0	37.33	37.33	
-37.060	0.000	0.000	0.0	0.0	37.33	37.33	
-38.060	0.000	0.000	0.0	0.0	37.33	37.33	
-39.060	0.000	0.000	0.0	0.0	37.33	37.33	
-40.060	0.000	0.000	0.0	0.0	37.33	37.33	
-40.991	0.000	0.000	0.0	0.0	37.33	37.33	
-41.060	0.000	0.000	0.0	0.0	37.33	37.33	
-42.060	0.000	0.000	0.0	0.0	37.33	37.33	
-43.060	0.000	0.000	0.0	0.0	37.33	37.33	
-44.060	0.000	0.000	0.0	0.0	37.33	37.33	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-45.060	0.000	0.000	0.0	0.0	37.33	37.33	
-46.060	0.000	0.000	0.0	0.0	37.33	37.33	
-47.060	0.000	0.000	0.0	0.0	37.33	37.33	
-48.060	0.000	0.000	0.0	0.0	37.33	37.33	
-49.060	0.000	0.000	0.0	0.0	37.33	37.33	
-50.060	0.000	0.000	0.0	0.0	37.33	37.33	
-50.591	0.000	0.000	0.0	0.0	37.33	37.33	
-51.060	0.000	0.000	0.0	0.0	37.33	37.33	
-52.060	0.000	0.000	0.0	0.0	37.33	37.33	
-52.160	0.000	0.000	0.0	0.0	37.33	37.33	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	37.33	-28.160
periphery sheet pile (SKY490)	37.33	-8.060
separation wall sheet pile (SKY400)	37.33	-8.060
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) = 40.350 (m^4)

periphery	n1 = 30 (number)	IB1 =	903.99 (m^2)	Ao1 = 0.0446 (m^2/number)
separation wall	n1 = 6 (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 = 7.930
maximum Rmax = 1666 (kN/number)
minimum Rmin = 1666 (kN/number)

2)Oridinary(low tide)

working force	vertical force	Vo	kN	62245.3
	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	1502	3359
2	6509	14554
3	6133	13714
4	11390	25469
5	6133	13714
6	17523	39183
7	26284	58774
8	26284	58774

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-8.060	0.000	0.000	0.0	0.0	38.74	38.74	*
-9.060	0.000	0.000	0.0	0.0	38.74	38.74	
-10.060	0.000	0.000	0.0	0.0	38.74	38.74	
-11.060	0.000	0.000	0.0	0.0	38.74	38.74	
-12.060	0.000	0.000	0.0	0.0	38.74	38.74	
-12.160	0.000	0.000	0.0	0.0	38.74	38.74	
-12.160	0.000	0.000	0.0	0.0	34.06	34.06	
-13.060	0.000	0.000	0.0	0.0	34.06	34.06	
-14.060	0.000	0.000	0.0	0.0	34.06	34.06	
-14.560	0.000	0.000	0.0	0.0	34.06	34.06	
-15.060	0.000	0.000	0.0	0.0	34.06	34.06	
-15.991	0.000	0.000	0.0	0.0	34.06	34.06	
-16.060	0.000	0.000	0.0	0.0	34.06	34.06	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.000	0.000	0.0	0.0	34.06	34.06	
-18.060	0.000	0.000	0.0	0.0	34.06	34.06	
-19.060	0.000	0.000	0.0	0.0	34.06	34.06	
-20.060	0.000	0.000	0.0	0.0	34.06	34.06	
-20.291	0.000	0.000	0.0	0.0	34.06	34.06	
-21.060	0.000	0.000	0.0	0.0	34.06	34.06	
-22.060	0.000	0.000	0.0	0.0	34.06	34.06	
-22.591	0.000	0.000	0.0	0.0	34.06	34.06	
-23.060	0.000	0.000	0.0	0.0	34.06	34.06	
-24.060	0.000	0.000	0.0	0.0	34.06	34.06	
-25.060	0.000	0.000	0.0	0.0	34.06	34.06	
-26.060	0.000	0.000	0.0	0.0	34.06	34.06	
-26.391	0.000	0.000	0.0	0.0	34.06	34.06	
-27.060	0.000	0.000	0.0	0.0	34.06	34.06	
-28.060	0.000	0.000	0.0	0.0	34.06	34.06	
-28.160	0.000	0.000	0.0	0.0	34.06	34.06	
-28.160	0.000	0.000	0.0	0.0	38.74	38.74	
-29.060	0.000	0.000	0.0	0.0	38.74	38.74	
-30.060	0.000	0.000	0.0	0.0	38.74	38.74	
-31.060	0.000	0.000	0.0	0.0	38.74	38.74	
-31.291	0.000	0.000	0.0	0.0	38.74	38.74	
-32.060	0.000	0.000	0.0	0.0	38.74	38.74	
-33.060	0.000	0.000	0.0	0.0	38.74	38.74	
-34.060	0.000	0.000	0.0	0.0	38.74	38.74	
-35.060	0.000	0.000	0.0	0.0	38.74	38.74	
-36.060	0.000	0.000	0.0	0.0	38.74	38.74	
-37.060	0.000	0.000	0.0	0.0	38.74	38.74	
-38.060	0.000	0.000	0.0	0.0	38.74	38.74	
-39.060	0.000	0.000	0.0	0.0	38.74	38.74	
-40.060	0.000	0.000	0.0	0.0	38.74	38.74	
-40.991	0.000	0.000	0.0	0.0	38.74	38.74	
-41.060	0.000	0.000	0.0	0.0	38.74	38.74	
-42.060	0.000	0.000	0.0	0.0	38.74	38.74	
-43.060	0.000	0.000	0.0	0.0	38.74	38.74	
-44.060	0.000	0.000	0.0	0.0	38.74	38.74	
-45.060	0.000	0.000	0.0	0.0	38.74	38.74	
-46.060	0.000	0.000	0.0	0.0	38.74	38.74	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	0.000	0.000	0.0	0.0	38.74	38.74	
-48.060	0.000	0.000	0.0	0.0	38.74	38.74	
-49.060	0.000	0.000	0.0	0.0	38.74	38.74	
-50.060	0.000	0.000	0.0	0.0	38.74	38.74	
-50.591	0.000	0.000	0.0	0.0	38.74	38.74	
-51.060	0.000	0.000	0.0	0.0	38.74	38.74	
-52.060	0.000	0.000	0.0	0.0	38.74	38.74	
-52.160	0.000	0.000	0.0	0.0	38.74	38.74	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.000	0.000	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	38.74	-28.160
periphery sheet pile (SKY490)	38.74	-8.060
separation wall sheet pile (SKY400)	38.74	-8.060
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) = 40.350 (m^4)
periphery n1 = 30 (number) IB1 = 903.99 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (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 = 7.930
maximum Rmax = 1729 (kN/number)
minimum Rmin = 1729 (kN/number)

3)Wind

working force	vertical force	Vo	kN	59251.2
	horizontal force	Ho	kN	1200.0
	moment	Mo	kN.m	28100.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.248

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1502	3359
2	6509	14554
3	6133	13714
4	11390	25469
5	6133	13714
6	17523	39183
7	26284	58774
8	26284	58774

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.248	-0.156	-1200.0	-28100.0	44.56	39.26	
-9.060	0.233	-0.151	-1108.1	-29253.6	44.88	39.36	
-10.060	0.218	-0.146	-1022.1	-30318.2	45.17	39.45	
-11.060	0.204	-0.141	-941.6	-31299.6	45.44	39.53	
-12.060	0.190	-0.136	-866.5	-32203.1	45.68	39.61	
-12.160	0.188	-0.136	-859.2	-32289.4	45.71	39.62	
-12.160	0.188	-0.136	-859.2	-32289.4	40.07	34.84	
-13.060	0.176	-0.132	-796.6	-33034.2	40.25	34.90	
-14.060	0.163	-0.127	-731.7	-33798.0	40.43	34.95	
-14.560	0.157	-0.124	-701.1	-34156.1	40.52	34.98	
-15.060	0.151	-0.122	-671.7	-34499.3	40.60	35.01	
-15.991	0.140	-0.117	-620.0	-35100.2	40.74	35.05	
-16.060	0.139	-0.117	-604.1	-35142.5	40.75	35.06	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.128	-0.112	-383.6	-35634.7	40.87	35.09	
-18.060	0.117	-0.107	-181.6	-35915.8	40.93	35.11	
-19.060	0.106	-0.102	2.6	-36003.8	40.95	35.12	*
-20.060	0.096	-0.097	170.0	-35916.1	40.93	35.11	
-20.291	0.094	-0.096	206.3	-35872.6	40.92	35.11	
-21.060	0.087	-0.092	314.7	-35671.7	40.87	35.10	
-22.060	0.078	-0.087	442.9	-35291.8	40.78	35.07	
-22.591	0.073	-0.084	505.4	-35039.9	40.72	35.05	
-23.060	0.069	-0.082	602.2	-34779.9	40.66	35.03	
-24.060	0.061	-0.077	791.4	-34081.1	40.50	34.98	
-25.060	0.054	-0.072	958.2	-33204.5	40.29	34.91	
-26.060	0.047	-0.068	1104.1	-32171.7	40.04	34.83	
-26.391	0.045	-0.066	1147.9	-31798.9	39.96	34.81	
-27.060	0.040	-0.063	1192.3	-31015.9	39.77	34.75	
-28.060	0.034	-0.059	1250.3	-29793.8	39.48	34.65	
-28.160	0.034	-0.059	1255.6	-29668.5	39.45	34.65	
-28.160	0.034	-0.059	1255.6	-29668.5	44.99	39.39	
-29.060	0.029	-0.054	1299.1	-28518.3	44.68	39.30	
-30.060	0.023	-0.050	1339.5	-27198.4	44.32	39.18	
-31.060	0.019	-0.046	1372.0	-25842.0	43.94	39.07	
-31.291	0.017	-0.045	1378.5	-25524.3	43.86	39.04	
-32.060	0.014	-0.041	1432.7	-24442.7	43.56	38.95	
-33.060	0.010	-0.038	1486.9	-22981.4	43.16	38.83	
-34.060	0.007	-0.034	1524.4	-21474.5	42.75	38.70	
-35.060	0.003	-0.031	1546.8	-19937.7	42.33	38.57	
-36.060	0.001	-0.027	1555.6	-18385.4	41.90	38.43	
-37.060	-0.002	-0.024	1552.2	-16830.5	41.48	38.30	
-38.060	-0.004	-0.022	1537.8	-15284.7	41.06	38.17	
-39.060	-0.006	-0.019	1513.7	-13758.2	40.64	38.04	
-40.060	-0.008	-0.017	1480.9	-12260.2	40.23	37.91	
-40.991	-0.010	-0.016	1443.4	-10898.4	39.86	37.80	
-41.060	-0.010	-0.015	1438.9	-10798.9	39.83	37.79	
-42.060	-0.011	-0.014	1367.7	-9394.8	39.44	37.67	
-43.060	-0.013	-0.012	1287.3	-8066.5	39.08	37.56	
-44.060	-0.014	-0.011	1198.7	-6822.9	38.74	37.45	
-45.060	-0.015	-0.010	1102.5	-5671.7	38.43	37.36	
-46.060	-0.016	-0.009	999.5	-4620.2	38.14	37.27	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.017	-0.009	890.3	-3674.7	37.88	37.19	
-48.060	-0.018	-0.008	775.4	-2841.4	37.65	37.11	
-49.060	-0.018	-0.008	655.0	-2125.8	37.45	37.05	
-50.060	-0.019	-0.007	529.4	-1533.2	37.29	37.00	
-50.591	-0.020	-0.007	460.8	-1270.2	37.22	36.98	
-51.060	-0.020	-0.007	399.0	-1068.6	37.17	36.96	
-52.060	-0.021	-0.007	263.7	-736.9	37.07	36.94	
-52.160	-0.021	-0.007	249.9	-711.2	37.07	36.93	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.248	-0.156	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	44.99	-28.160
periphery sheet pile (SKY490)	45.71	-12.160
separation wall sheet pile (SKY400)	39.62	-12.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -711.2 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 40.350 (m⁴)
periphery n1 = 30 (number) IB1 = 903.99 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (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 = 7.930
maximum Rmax = 1652 (kN/number)
minimum Rmin = 1640 (kN/number)

4)Ord+Collision

working force	vertical force	Vo	kN	60249.2
	horizontal force	Ho	kN	6300.0
	moment	Mo	kN.m	71400.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.951

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1502	3359
2	6509	14554
3	6133	13714
4	11390	25469
5	6133	13714
6	17523	39183
7	26284	58774
8	26284	58774

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.951	-0.547	-6300.0	-71400.0	57.03	43.56	
-9.060	0.897	-0.534	-5947.1	-77521.8	58.71	44.08	
-10.060	0.844	-0.521	-5614.6	-83301.0	60.29	44.57	
-11.060	0.793	-0.507	-5302.0	-88757.6	61.78	45.03	
-12.060	0.743	-0.492	-5008.8	-93911.4	63.19	45.47	
-12.160	0.738	-0.491	-4980.5	-94410.9	63.33	45.51	
-12.160	0.738	-0.491	-4980.5	-94410.9	55.34	40.04	
-13.060	0.694	-0.479	-4734.4	-98781.5	56.37	40.37	
-14.060	0.647	-0.464	-4478.2	-103386.3	57.46	40.71	
-14.560	0.624	-0.457	-4356.9	-105594.9	57.99	40.88	
-15.060	0.601	-0.449	-4239.8	-107743.9	58.49	41.04	
-15.991	0.560	-0.435	-4033.3	-111593.9	59.41	41.33	
-16.060	0.557	-0.434	-3969.5	-111870.0	59.47	41.35	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-17.060	0.515	-0.418	-3082.7	-115390.2	60.31	41.61	
-18.060	0.474	-0.402	-2265.0	-118058.5	60.94	41.81	
-19.060	0.434	-0.385	-1513.9	-119942.5	61.38	41.95	
-20.060	0.397	-0.368	-826.4	-121107.4	61.66	42.04	
-20.291	0.388	-0.364	-676.3	-121280.9	61.70	42.05	
-21.060	0.361	-0.351	-227.3	-121626.3	61.78	42.08	*
-22.060	0.326	-0.334	308.4	-121581.3	61.77	42.08	
-22.591	0.309	-0.325	571.5	-121347.0	61.72	42.06	
-23.060	0.294	-0.317	981.1	-120982.1	61.63	42.03	
-24.060	0.263	-0.300	1787.5	-119590.4	61.30	41.93	
-25.060	0.234	-0.283	2507.2	-117436.0	60.79	41.77	
-26.060	0.207	-0.267	3144.8	-114603.3	60.12	41.55	
-26.391	0.198	-0.261	3338.6	-113530.1	59.87	41.47	
-27.060	0.181	-0.251	3536.0	-111229.6	59.32	41.30	
-28.060	0.156	-0.236	3798.5	-107559.2	58.45	41.03	
-28.160	0.154	-0.234	3822.7	-107178.1	58.36	41.00	
-28.160	0.154	-0.234	3822.7	-107178.1	66.82	46.60	
-29.060	0.134	-0.218	4024.4	-103644.7	65.85	46.30	
-30.060	0.113	-0.202	4216.2	-99521.7	64.73	45.95	
-31.060	0.093	-0.186	4376.5	-95222.8	63.55	45.58	
-31.291	0.089	-0.182	4409.3	-94208.0	63.27	45.50	
-32.060	0.075	-0.171	4690.7	-90706.1	62.31	45.20	
-33.060	0.059	-0.156	4989.7	-85859.8	60.99	44.79	
-34.060	0.044	-0.143	5219.1	-80749.9	59.59	44.35	
-35.060	0.031	-0.130	5384.9	-75442.8	58.14	43.90	
-36.060	0.018	-0.118	5492.8	-69999.4	56.65	43.44	
-37.060	0.007	-0.107	5548.2	-64474.7	55.14	42.97	
-38.060	-0.003	-0.097	5555.9	-58918.9	53.62	42.50	
-39.060	-0.012	-0.088	5520.4	-53377.4	52.10	42.03	
-40.060	-0.021	-0.079	5445.8	-47891.2	50.60	41.56	
-40.991	-0.028	-0.072	5344.5	-42866.0	49.22	41.14	
-41.060	-0.028	-0.072	5331.5	-42497.7	49.12	41.10	
-42.060	-0.035	-0.065	5118.5	-37268.9	47.69	40.66	
-43.060	-0.041	-0.060	4861.7	-32275.3	46.33	40.24	
-44.060	-0.047	-0.055	4565.0	-27558.8	45.03	39.84	
-45.060	-0.052	-0.051	4231.5	-23157.6	43.83	39.46	
-46.060	-0.057	-0.047	3864.2	-19107.0	42.72	39.12	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm^2)	separation wall Sig.(N/mm^2)	Mmax
-47.060	-0.062	-0.044	3465.3	-15439.7	41.72	38.81	
-48.060	-0.066	-0.042	3036.6	-12186.4	40.83	38.53	
-49.060	-0.070	-0.040	2579.8	-9375.8	40.06	38.29	
-50.060	-0.074	-0.039	2096.0	-7035.8	39.42	38.09	
-50.591	-0.076	-0.038	1828.4	-5993.5	39.13	38.00	
-51.060	-0.078	-0.038	1586.0	-5192.6	38.92	37.94	
-52.060	-0.082	-0.037	1050.6	-3872.2	38.55	37.82	
-52.160	-0.082	-0.037	995.7	-3769.9	38.53	37.81	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.951	-0.547	5.000

maximum stress

	Sig.(N/mm^2)	elevation(m)
periphery sheet pile (SKY400)	66.82	-28.160
periphery sheet pile (SKY490)	63.33	-12.160
separation wall sheet pile (SKY400)	46.60	-28.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -3769.9 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 40.350 (m^4)
periphery n1 = 30 (number) IB1 = 903.99 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (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 = 7.930
maximum Rmax = 1707 (kN/number)
minimum Rmin = 1641 (kN/number)

5)Ord+Collision(scour)

working force	vertical force	Vo	kN	57563.8
	horizontal force	Ho	kN	6300.0
	moment	Mo	kN.m	71300.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	1.000
	calculation displacement	Del.	cm	0.951

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

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1502	3359
2	6509	14554
3	6133	13714
4	11390	25469
5	6133	13714
6	17523	39183
7	26284	58774
8	26284	58774

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	0.951	-0.546	-6300.0	-71300.0	55.33	41.88	
-9.060	0.897	-0.534	-5947.3	-77421.9	57.01	42.40	
-10.060	0.844	-0.521	-5614.9	-83201.3	58.59	42.89	
-11.060	0.792	-0.507	-5302.5	-88658.4	60.08	43.35	
-12.060	0.742	-0.492	-5009.4	-93812.7	61.49	43.79	
-12.160	0.738	-0.490	-4981.1	-94312.2	61.63	43.83	
-12.160	0.738	-0.490	-4981.1	-94312.2	53.84	38.56	
-13.060	0.694	-0.478	-4735.1	-98683.4	54.88	38.89	
-14.060	0.647	-0.464	-4479.1	-103289.0	55.97	39.24	
-14.560	0.624	-0.457	-4357.8	-105498.0	56.49	39.40	
-15.060	0.601	-0.449	-4240.8	-107647.5	57.00	39.56	
-15.991	0.560	-0.435	-4034.4	-111498.4	57.91	39.85	
-16.060	0.557	-0.434	-3970.6	-111774.6	57.98	39.87	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	0.514	-0.418	-3084.1	-115296.1	58.81	40.14	
-18.060	0.473	-0.401	-2266.8	-117965.8	59.45	40.34	
-19.060	0.434	-0.385	-1515.9	-119851.7	59.89	40.48	
-20.060	0.397	-0.368	-828.6	-121018.8	60.17	40.56	
-20.291	0.388	-0.364	-678.7	-121192.8	60.21	40.58	
-21.060	0.361	-0.351	-229.8	-121540.0	60.29	40.60	*
-22.060	0.326	-0.334	305.8	-121497.6	60.28	40.60	
-22.591	0.309	-0.325	568.8	-121264.7	60.23	40.58	
-23.060	0.294	-0.317	978.2	-120901.2	60.14	40.56	
-24.060	0.263	-0.300	1784.4	-119512.4	59.81	40.45	
-25.060	0.234	-0.283	2503.9	-117361.2	59.30	40.29	
-26.060	0.206	-0.267	3141.3	-114532.0	58.63	40.08	
-26.391	0.198	-0.261	3335.1	-113459.9	58.38	40.00	
-27.060	0.181	-0.251	3532.4	-111161.8	57.83	39.83	
-28.060	0.156	-0.235	3794.9	-107495.0	56.97	39.55	
-28.160	0.154	-0.234	3819.1	-107114.3	56.88	39.52	
-28.160	0.154	-0.234	3819.1	-107114.3	65.13	44.92	
-29.060	0.134	-0.218	4020.7	-103584.2	64.17	44.62	
-30.060	0.113	-0.202	4212.5	-99464.9	63.04	44.27	
-31.060	0.093	-0.186	4372.8	-95169.7	61.86	43.91	
-31.291	0.089	-0.182	4405.6	-94155.8	61.59	43.82	
-32.060	0.075	-0.171	4687.0	-90656.7	60.63	43.52	
-33.060	0.059	-0.156	4986.0	-85814.1	59.30	43.11	
-34.060	0.044	-0.143	5215.4	-80707.9	57.91	42.68	
-35.060	0.031	-0.130	5381.3	-75404.4	56.46	42.23	
-36.060	0.018	-0.118	5489.3	-69964.5	54.97	41.77	
-37.060	0.007	-0.107	5544.8	-64443.3	53.46	41.30	
-38.060	-0.003	-0.097	5552.5	-58890.9	51.94	40.83	
-39.060	-0.012	-0.088	5517.2	-53352.6	50.42	40.35	
-40.060	-0.021	-0.079	5442.7	-47869.6	48.92	39.89	
-40.991	-0.028	-0.072	5341.6	-42847.2	47.55	39.46	
-41.060	-0.028	-0.072	5328.6	-42479.1	47.45	39.43	
-42.060	-0.035	-0.065	5115.8	-37253.0	46.02	38.99	
-43.060	-0.041	-0.060	4859.2	-32262.0	44.65	38.56	
-44.060	-0.047	-0.055	4562.7	-27547.9	43.36	38.16	
-45.060	-0.052	-0.051	4229.5	-23148.9	42.16	37.79	
-46.060	-0.057	-0.047	3862.4	-19100.2	41.05	37.45	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.062	-0.044	3463.7	-15434.7	40.05	37.13	
-48.060	-0.066	-0.042	3035.3	-12182.8	39.16	36.86	
-49.060	-0.070	-0.040	2578.7	-9373.5	38.39	36.62	
-50.060	-0.074	-0.039	2095.1	-7034.4	37.75	36.42	
-50.591	-0.076	-0.038	1827.6	-5992.6	37.46	36.33	
-51.060	-0.078	-0.038	1585.3	-5192.1	37.24	36.26	
-52.060	-0.082	-0.037	1050.2	-3872.2	36.88	36.15	
-52.160	-0.082	-0.037	995.3	-3769.9	36.85	36.14	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	0.951	-0.546	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	65.13	-28.160
periphery sheet pile (SKY490)	61.63	-12.160
separation wall sheet pile (SKY400)	44.92	-28.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -3769.9 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 40.350 (m^4)
periphery n1 = 30 (number) IB1 = 903.99 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (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 = 7.930
maximum Rmax = 1632 (kN/number)
minimum Rmin = 1566 (kN/number)

6)Earthquake

working force	vertical force	Vo	kN	54358.0
	horizontal force	Ho	kN	13490.0
	moment	Mo	kN.m	233800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	2.434
	calculation displacement	Del.	cm	2.412

convergence rate (Del.1 - Del.) / Del.1 = 0.92 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1000	1434
2	13017	18655
3	12266	17579
4	22780	32646
5	12266	17579
6	35046	50225
7	52569	75338
8	52569	75338

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	2.412	-1.492	-13490.0	-233800.0	97.80	53.69	
-9.060	2.265	-1.452	-13108.8	-247097.4	101.44	54.82	
-10.060	2.122	-1.411	-12751.3	-260025.5	104.98	55.91	
-11.060	1.983	-1.367	-12416.7	-272607.6	108.42	56.98	
-12.060	1.848	-1.322	-12104.5	-284866.3	111.77	58.02	
-12.160	1.835	-1.317	-12074.5	-286075.3	112.10	58.13	
-12.160	1.835	-1.317	-12074.5	-286075.3	97.52	51.17	
-13.060	1.718	-1.280	-11813.8	-296823.7	100.06	51.98	
-14.060	1.592	-1.238	-11544.0	-308500.9	102.83	52.85	
-14.560	1.531	-1.216	-11416.7	-314240.9	104.19	53.28	
-15.060	1.471	-1.193	-11294.4	-319918.4	105.54	53.71	
-15.991	1.362	-1.151	-11079.5	-330332.2	108.00	54.49	
-16.060	1.354	-1.148	-10880.7	-331089.8	108.18	54.55	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	1.241	-1.100	-8128.9	-340574.7	110.43	55.26	
-18.060	1.134	-1.052	-5610.6	-347425.4	112.05	55.77	
-19.060	1.031	-1.003	-3315.4	-351870.3	113.10	56.10	
-20.060	0.933	-0.953	-1233.1	-354127.2	113.64	56.27	
-20.291	0.911	-0.942	-781.2	-354359.7	113.69	56.29	
-21.060	0.840	-0.903	564.6	-354435.9	113.71	56.29	*
-22.060	0.752	-0.854	2155.7	-353061.2	113.39	56.19	
-22.591	0.708	-0.827	2930.5	-351708.7	113.07	56.09	
-23.060	0.669	-0.804	4129.3	-350050.6	112.67	55.97	
-24.060	0.591	-0.755	6468.5	-344727.5	111.41	55.57	
-25.060	0.518	-0.707	8527.2	-337207.0	109.63	55.00	
-26.060	0.450	-0.661	10323.2	-327760.7	107.39	54.30	
-26.391	0.428	-0.645	10862.8	-324253.6	106.56	54.03	
-27.060	0.386	-0.615	11407.2	-316801.1	104.80	53.48	
-28.060	0.327	-0.572	12119.2	-305028.0	102.01	52.59	
-28.160	0.321	-0.567	12183.9	-303812.9	101.72	52.50	
-28.160	0.321	-0.567	12183.9	-303812.9	116.96	59.63	
-29.060	0.272	-0.523	12717.0	-292600.8	113.89	58.68	
-30.060	0.222	-0.477	13210.1	-279628.9	110.34	57.58	
-31.060	0.177	-0.432	13607.9	-266212.4	106.67	56.44	
-31.291	0.167	-0.422	13687.2	-263059.7	105.81	56.17	
-32.060	0.136	-0.389	14350.5	-252270.4	102.85	55.26	
-33.060	0.099	-0.349	15017.8	-237568.7	98.83	54.01	
-34.060	0.066	-0.312	15485.5	-222301.3	94.65	52.71	
-35.060	0.036	-0.277	15775.0	-206657.1	90.37	51.38	
-36.060	0.010	-0.244	15906.4	-190804.0	86.04	50.04	
-37.060	-0.013	-0.214	15898.3	-174890.7	81.68	48.68	
-38.060	-0.033	-0.187	15767.9	-159048.1	77.35	47.34	
-39.060	-0.050	-0.162	15530.6	-143390.6	73.06	46.01	
-40.060	-0.065	-0.140	15200.7	-128017.8	68.86	44.70	
-40.991	-0.077	-0.121	14821.4	-114037.5	65.03	43.51	
-41.060	-0.078	-0.120	14775.5	-113016.4	64.75	43.43	
-42.060	-0.089	-0.103	14057.6	-98591.9	60.80	42.20	
-43.060	-0.099	-0.088	13251.5	-84930.5	57.07	41.04	
-44.060	-0.107	-0.075	12370.1	-72113.9	53.56	39.95	
-45.060	-0.114	-0.064	11424.4	-60211.7	50.30	38.94	
-46.060	-0.120	-0.055	10423.6	-49283.4	47.31	38.01	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.125	-0.048	9375.5	-39380.2	44.60	37.17	
-48.060	-0.129	-0.042	8286.3	-30546.1	42.19	36.42	
-49.060	-0.133	-0.038	7160.8	-22819.7	40.07	35.77	
-50.060	-0.137	-0.035	6002.8	-16235.3	38.27	35.21	
-50.591	-0.139	-0.033	5375.7	-13214.0	37.44	34.95	
-51.060	-0.140	-0.032	4815.1	-10824.0	36.79	34.75	
-52.060	-0.143	-0.031	3599.5	-6614.5	35.64	34.39	
-52.160	-0.144	-0.031	3476.4	-6260.7	35.54	34.36	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	2.412	-1.492	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	116.96	-28.160
periphery sheet pile (SKY490)	112.10	-12.160
separation wall sheet pile (SKY400)	59.63	-28.160
separation wall sheet pile (SKY490)	------	--------

vertical reaction

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

MB = -6260.7 (kN.m)
Sum(ni*Aoi) = 1.607 (m^2)
Sum(IBi*Aoi) = 40.350 (m^4)
periphery n1 = 30 (number) IB1 = 903.99 (m^2) Ao1 = 0.0446 (m^2/number)
separation wall n1 = 6 (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 = 7.930
maximum Rmax = 1565 (kN/number)
minimum Rmin = 1455 (kN/number)

7)Earthquake(scour)

working force	vertical force	Vo	kN	51672.6
	horizontal force	Ho	kN	13600.0
	moment	Mo	kN.m	233800.0
calcu lation kh	standard displacement	Del.o	cm	5.000
	assumed displacement	Del.1	cm	2.449
	calculation displacement	Del.	cm	2.426

convergence rate (Del.1 - Del.) / Del.1 = 0.91 (%) < 1.00 (%)

No	standardKH1(kN/m³)	calculation KH1(kN/m³)
1	1000	1429
2	13017	18601
3	12266	17528
4	22780	32551
5	12266	17528
6	35046	50079
7	52569	75118
8	52569	75118

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-8.060	2.426	-1.498	-13600.0	-233800.0	96.13	52.02	
-9.060	2.278	-1.459	-13217.6	-247206.8	99.80	53.15	
-10.060	2.135	-1.417	-12859.0	-260243.2	103.36	54.26	
-11.060	1.995	-1.374	-12523.4	-272932.5	106.84	55.34	
-12.060	1.860	-1.328	-12210.1	-285297.3	110.22	56.39	
-12.160	1.847	-1.323	-12180.0	-286516.8	110.55	56.49	
-12.160	1.847	-1.323	-12180.0	-286516.8	96.15	49.74	
-13.060	1.729	-1.286	-11918.4	-297359.8	98.72	50.55	
-14.060	1.603	-1.244	-11647.6	-309141.1	101.51	51.43	
-14.560	1.541	-1.222	-11519.9	-314932.8	102.88	51.87	
-15.060	1.481	-1.200	-11397.1	-320661.8	104.24	52.29	
-15.991	1.371	-1.157	-11181.4	-331170.8	106.73	53.08	
-16.060	1.363	-1.154	-10981.8	-331935.4	106.91	53.14	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-17.060	1.250	-1.106	-8219.1	-341516.0	109.18	53.86	
-18.060	1.142	-1.058	-5690.4	-348451.7	110.83	54.38	
-19.060	1.038	-1.008	-3385.5	-352971.5	111.90	54.72	
-20.060	0.940	-0.959	-1293.9	-355293.8	112.45	54.89	
-20.291	0.918	-0.947	-840.0	-355540.1	112.50	54.91	
-21.060	0.847	-0.909	512.1	-355659.1	112.53	54.92	*
-22.060	0.758	-0.859	2110.9	-354332.9	112.22	54.82	
-22.591	0.713	-0.832	2889.6	-353003.2	111.90	54.72	
-23.060	0.675	-0.809	4094.6	-351362.8	111.51	54.59	
-24.060	0.596	-0.760	6446.2	-346068.2	110.26	54.20	
-25.060	0.523	-0.712	8516.4	-338564.3	108.48	53.64	
-26.060	0.454	-0.665	10323.0	-329123.3	106.25	52.93	
-26.391	0.432	-0.650	10866.0	-325615.8	105.42	52.67	
-27.060	0.390	-0.619	11413.8	-318160.1	103.65	52.11	
-28.060	0.330	-0.575	12130.6	-306377.9	100.86	51.23	
-28.160	0.324	-0.571	12195.8	-305161.6	100.57	51.13	
-28.160	0.324	-0.571	12195.8	-305161.6	115.66	58.08	
-29.060	0.275	-0.527	12732.7	-293937.1	112.58	57.12	
-30.060	0.225	-0.480	13229.8	-280947.4	109.03	56.02	
-31.060	0.179	-0.435	13631.1	-267509.4	105.35	54.88	
-31.291	0.169	-0.425	13711.2	-264351.3	104.49	54.61	
-32.060	0.137	-0.392	14381.2	-253540.9	101.53	53.69	
-33.060	0.100	-0.352	15056.4	-238804.4	97.50	52.44	
-34.060	0.067	-0.314	15530.8	-223495.0	93.31	51.14	
-35.060	0.037	-0.279	15826.2	-207802.5	89.02	49.81	
-36.060	0.011	-0.246	15962.5	-191895.7	84.66	48.46	
-37.060	-0.012	-0.216	15958.4	-175924.3	80.29	47.10	
-38.060	-0.032	-0.189	15831.1	-160020.0	75.94	45.75	
-39.060	-0.050	-0.164	15596.2	-144297.9	71.64	44.41	
-40.060	-0.065	-0.141	15268.0	-128858.6	67.42	43.10	
-40.991	-0.077	-0.123	14889.6	-114815.2	63.57	41.91	
-41.060	-0.078	-0.122	14843.7	-113789.4	63.29	41.82	
-42.060	-0.089	-0.104	14126.3	-99296.4	59.33	40.59	
-43.060	-0.099	-0.089	13319.8	-85566.5	55.57	39.43	
-44.060	-0.107	-0.076	12437.1	-72682.2	52.04	38.33	
-45.060	-0.114	-0.065	11489.2	-60714.0	48.77	37.31	
-46.060	-0.120	-0.056	10485.6	-49722.3	45.76	36.38	

elevation(m)	Del.(cm)	Theta(mrad)	S(kN)	M(kN.m)	external wall Sig.(N/mm²)	separation wall Sig.(N/mm²)	Mmax
-47.060	-0.126	-0.049	9433.9	-39758.9	43.04	35.53	
-48.060	-0.130	-0.043	8340.3	-30868.5	40.60	34.78	
-49.060	-0.134	-0.039	7209.9	-23090.5	38.47	34.12	
-50.060	-0.138	-0.035	6046.4	-16459.8	36.66	33.56	
-50.591	-0.140	-0.034	5416.1	-13416.1	35.83	33.30	
-51.060	-0.141	-0.033	4852.5	-11007.9	35.17	33.09	
-52.060	-0.145	-0.032	3630.2	-6764.2	34.01	32.73	
-52.160	-0.145	-0.032	3506.5	-6407.4	33.91	32.70	

design ground surface displacement

elevation (m)	Del.(cm)	Theta(mrad)	Del.a(cm)
-8.060	2.426	-1.498	5.000

maximum stress

	Sig.(N/mm²)	elevation(m)
periphery sheet pile (SKY400)	115.66	-28.160
periphery sheet pile (SKY490)	110.55	-12.160
separation wall sheet pile (SKY400)	58.08	-28.160
separation wall sheet pile (SKY490)	------	--------

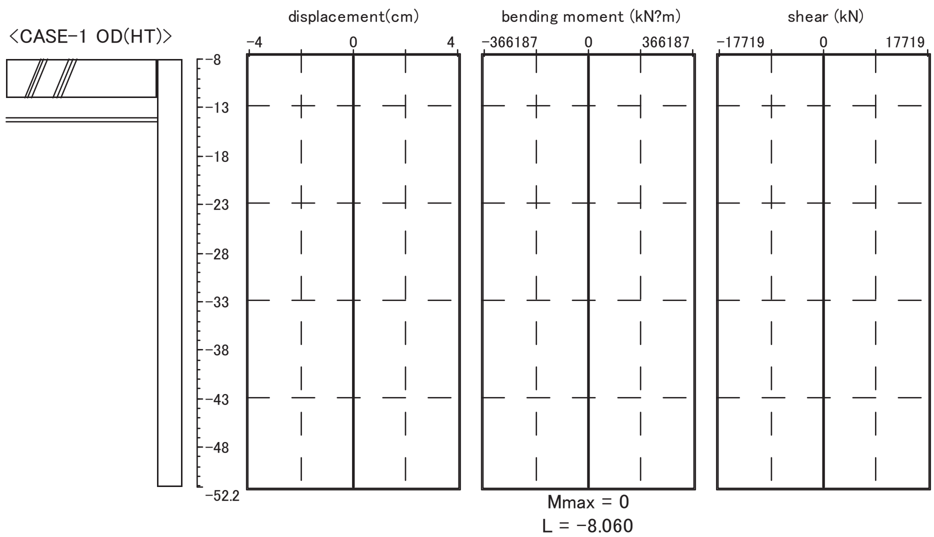
vertical reaction

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

MB = -6407.4 (kN.m)
Sum(ni*Aoi) = 1.607 (m²)
Sum(IBi*Aoi) = 40.350 (m⁴)
periphery n1 = 30 (number) IB1 = 903.99 (m²) Ao1 = 0.0446 (m²/number)
separation wall n1 = 6 (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 = 7.930
maximum Rmax = 1492 (kN/number)
minimum Rmin = 1379 (kN/number)

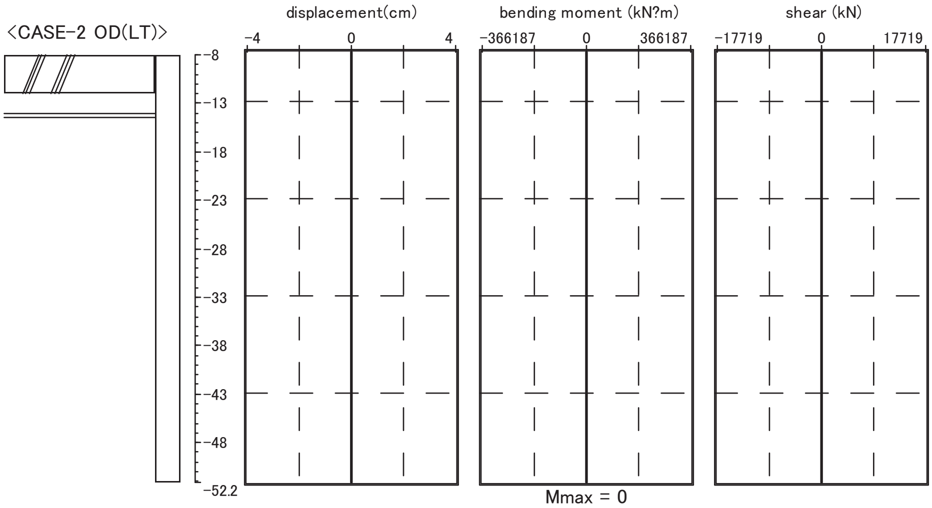
1.11 displacement / member force diagram

bridge axis direction



- 83 -

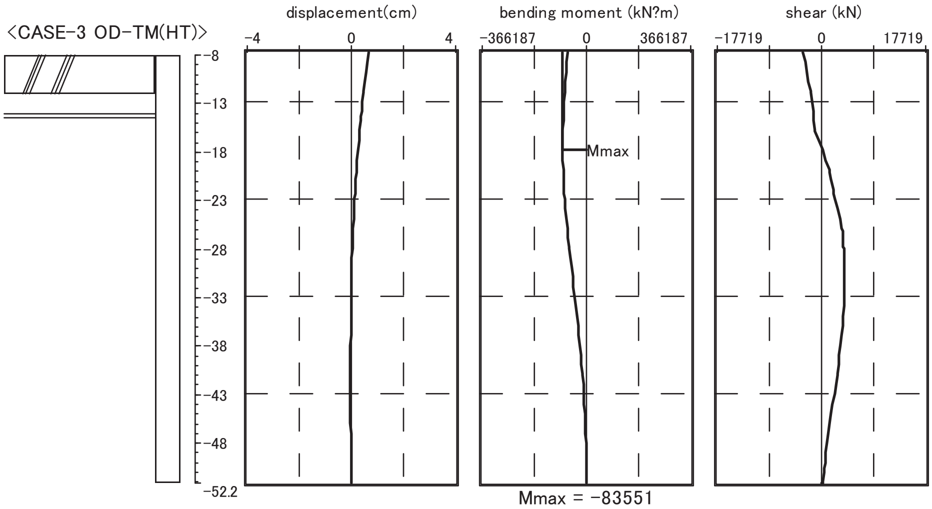
<CASE-2 OD(LT)>



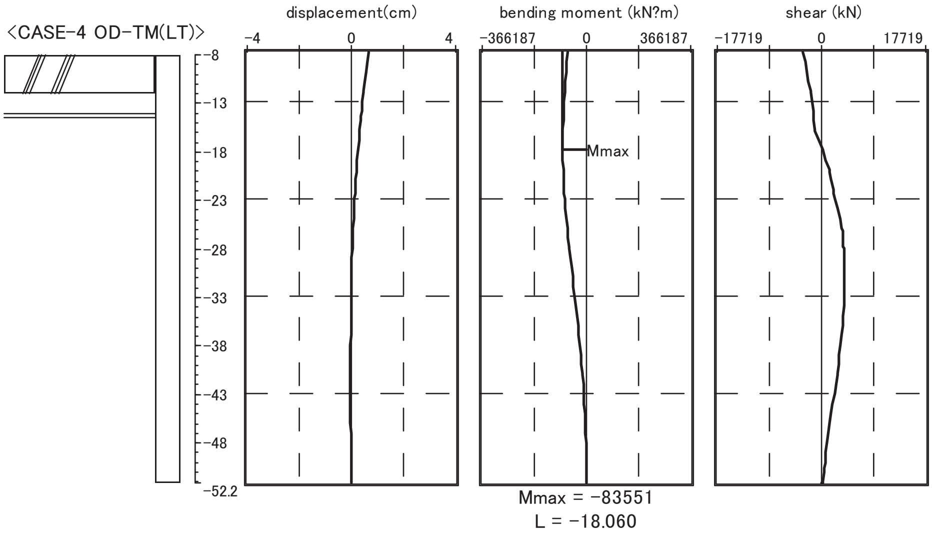
Mmax = 0
L = -8.060

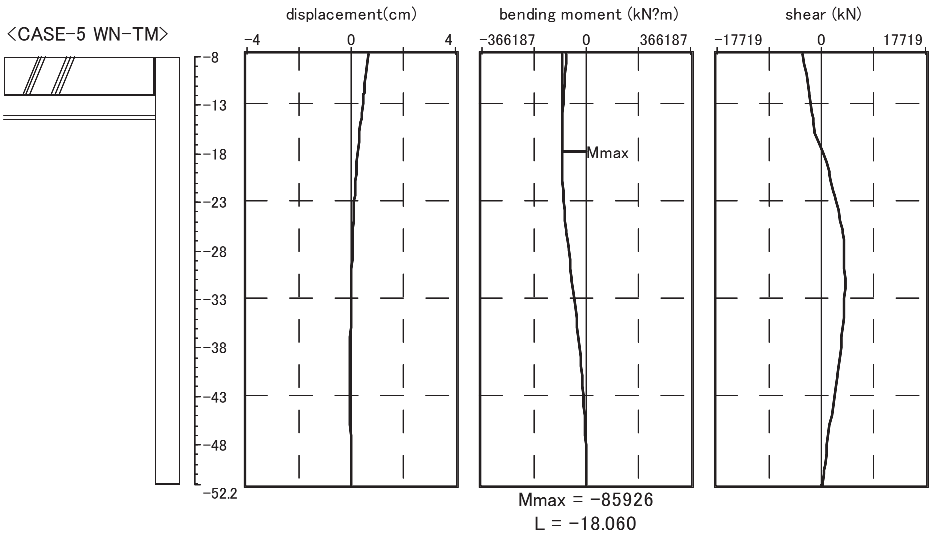
- 84 -

<CASE-3 OD-TM(HT)>

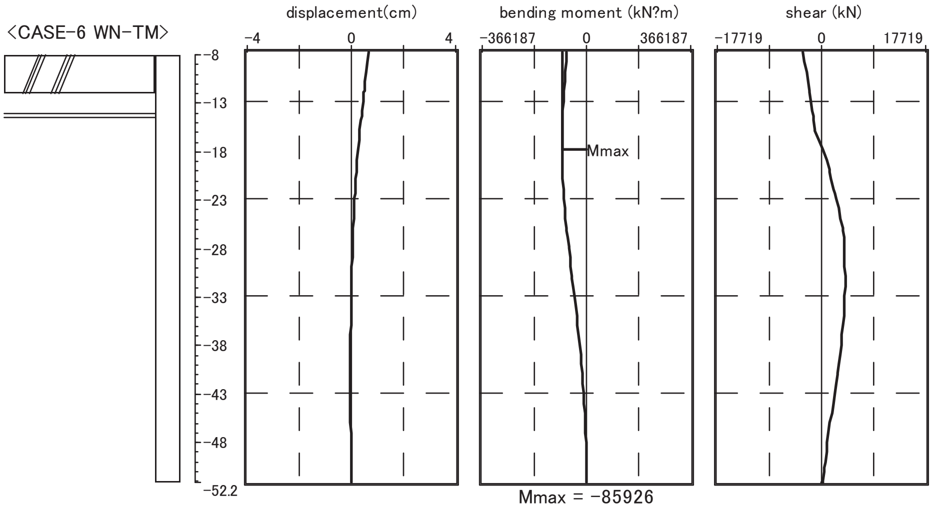


Mmax = -83551
L = -18.060


<CASE-4 OD-TM(LT)>
displacement(cm)
bending moment (kN?m)
shear (kN)
-4
0
4
-366187
0
366187
-17719
0
17719
-8
-13
-18
-23
-28
-33
-38
-43
-48
-52.2
Mmax
Mmax = -83551
L = -18.060

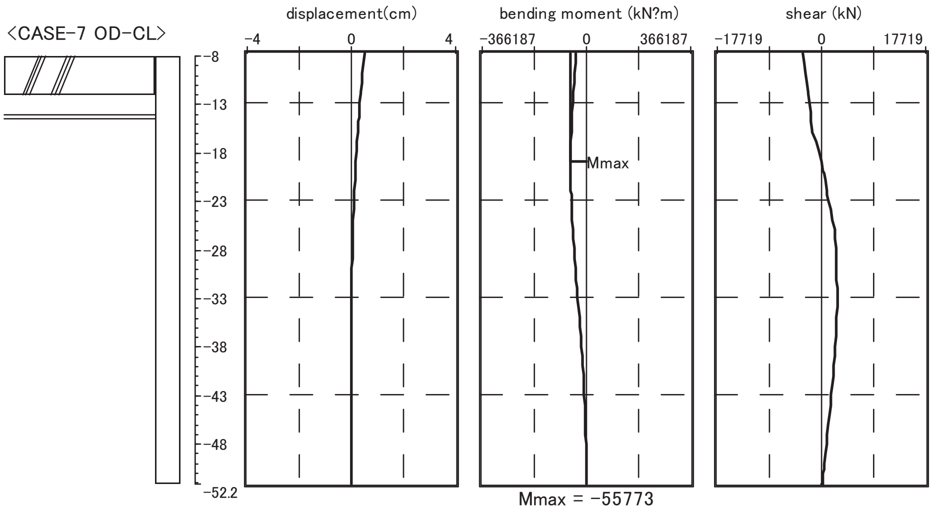

<CASE-5 WN-TM>
displacement(cm)
bending moment (kN?m)
shear (kN)
-4
0
4
-366187
0
366187
-17719
0
17719
-8
-13
-18
-23
-28
-33
-38
-43
-48
-52.2
Mmax
Mmax = -85926
L = -18.060

<CASE-6 WN-TM>

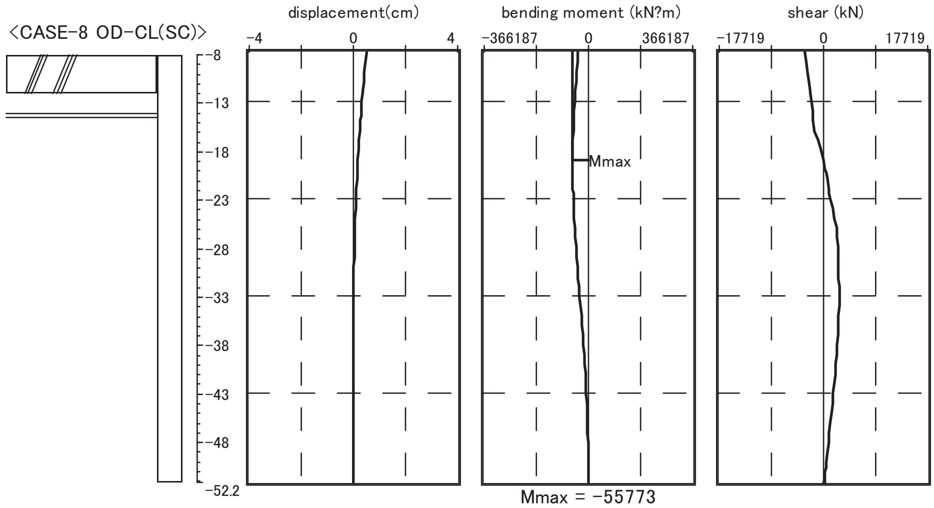


Mmax = -85926
L = -18.060

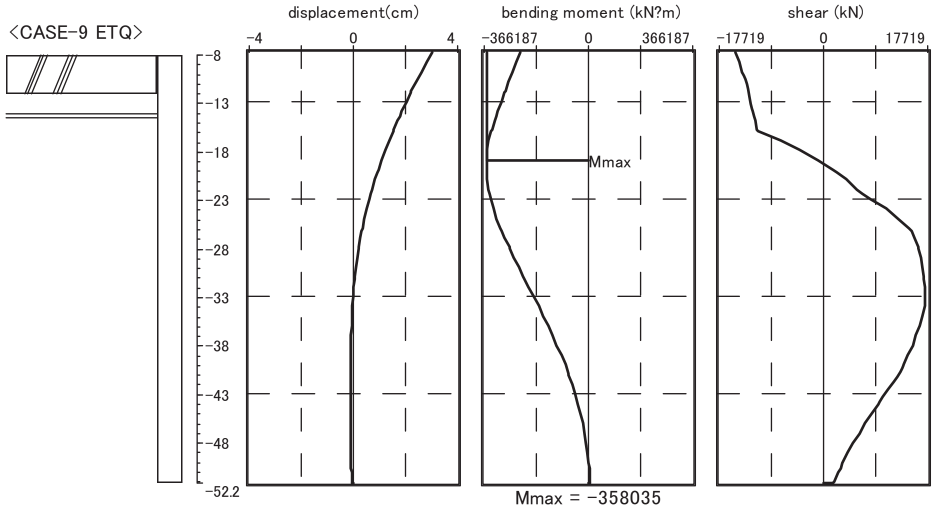
<CASE-7 OD-CL>



Mmax = -55773
L = -19.060

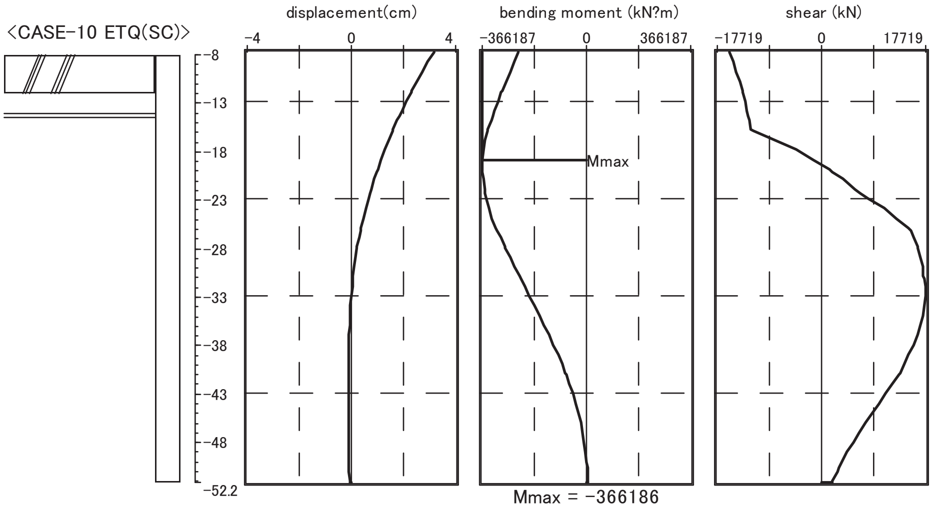


Mmax = -55773
L = -19.060



Mmax = -358035
L = -19.060

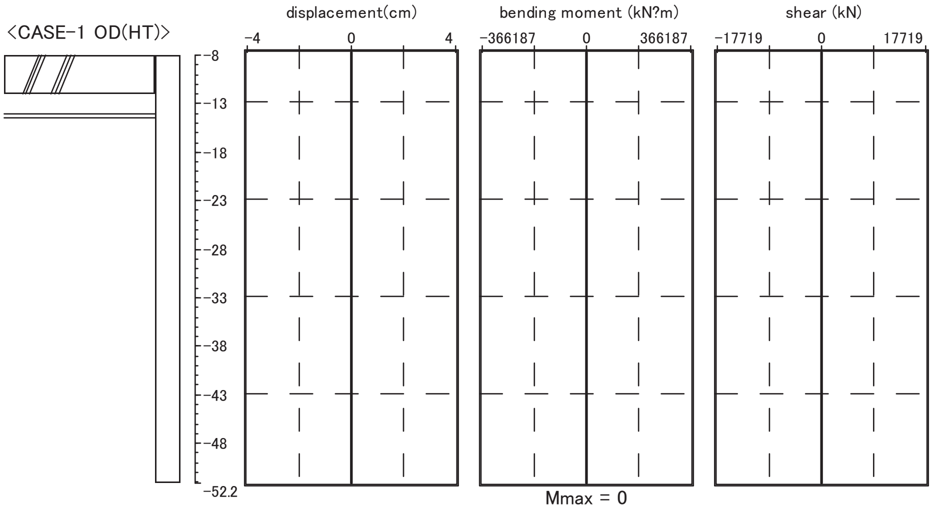
<CASE-10 ETQ(SC)>



Mmax = −366186
L = −19.060

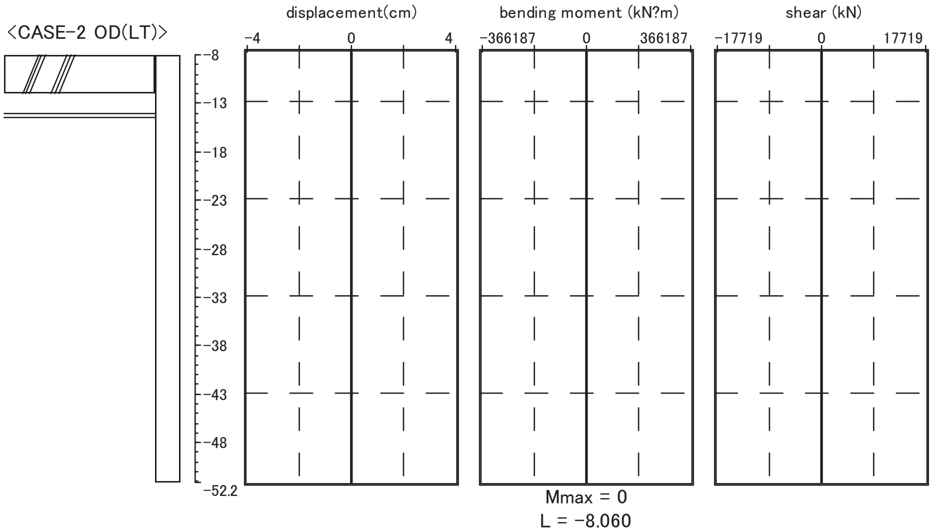
perpendicular direction

<CASE-1 OD(HT)>

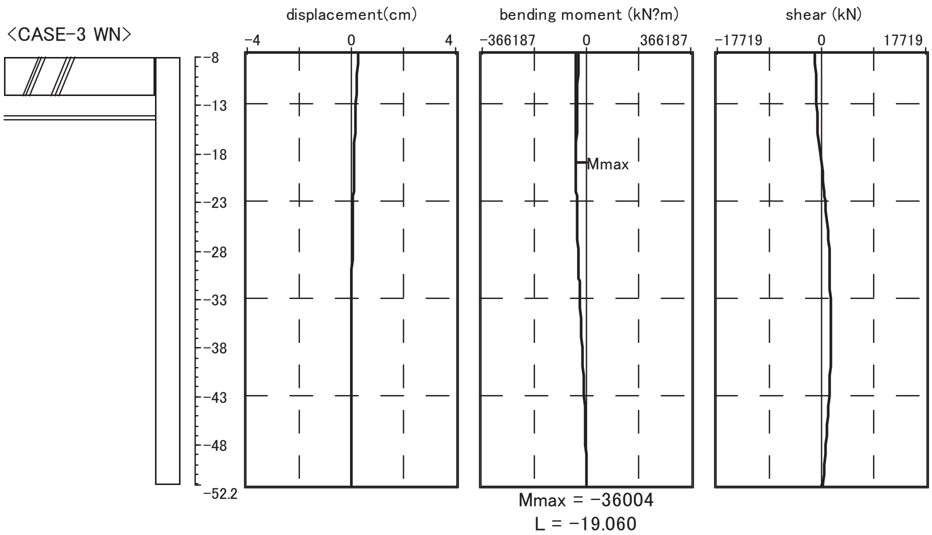


Mmax = 0
L = −8.060

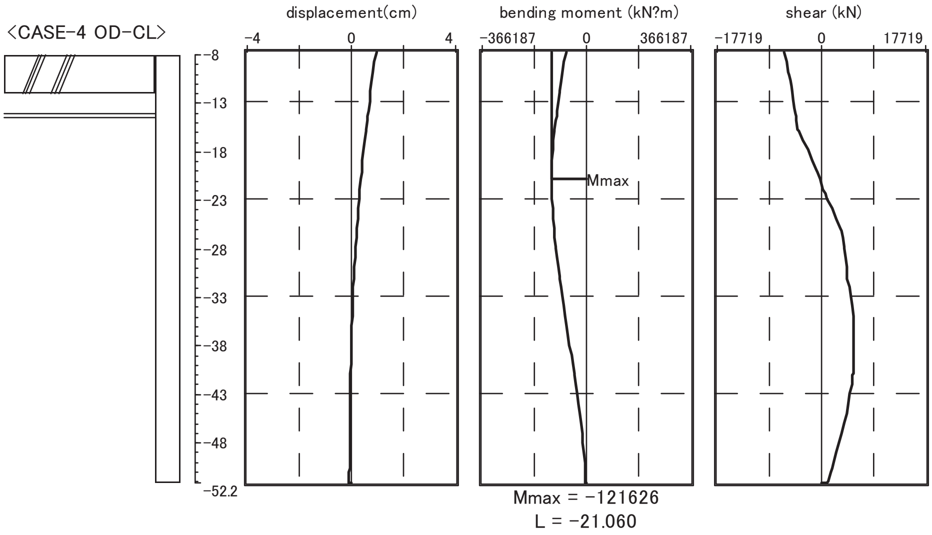
<CASE-2 OD(LT)>



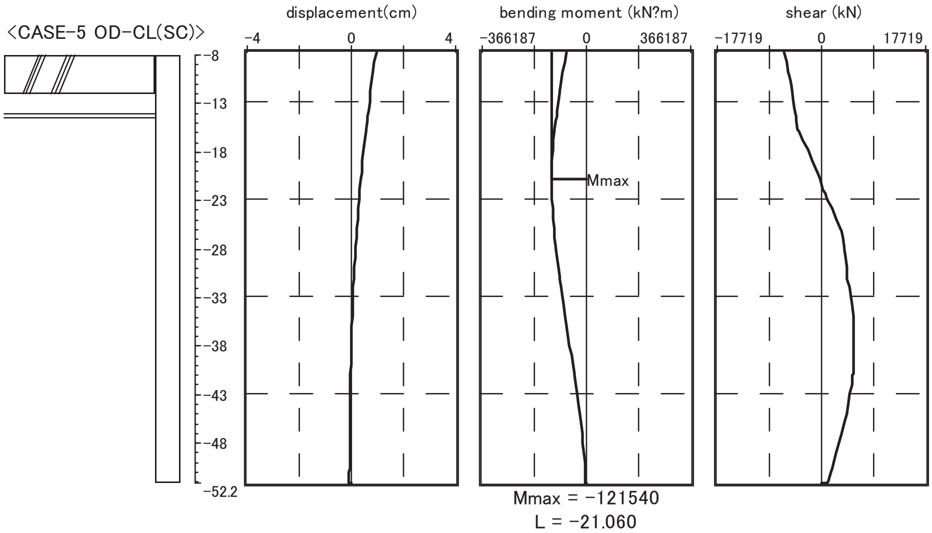
<CASE-3 WN>



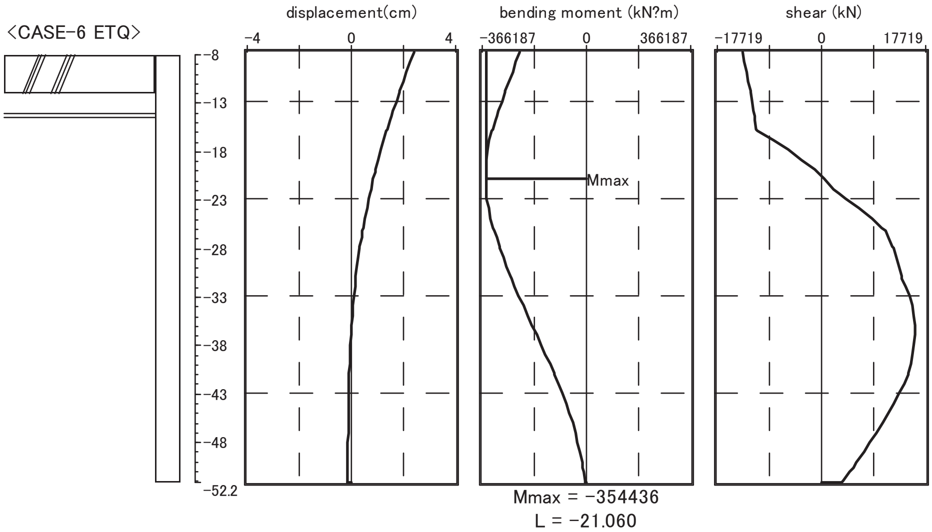
<CASE-4 OD-CL>



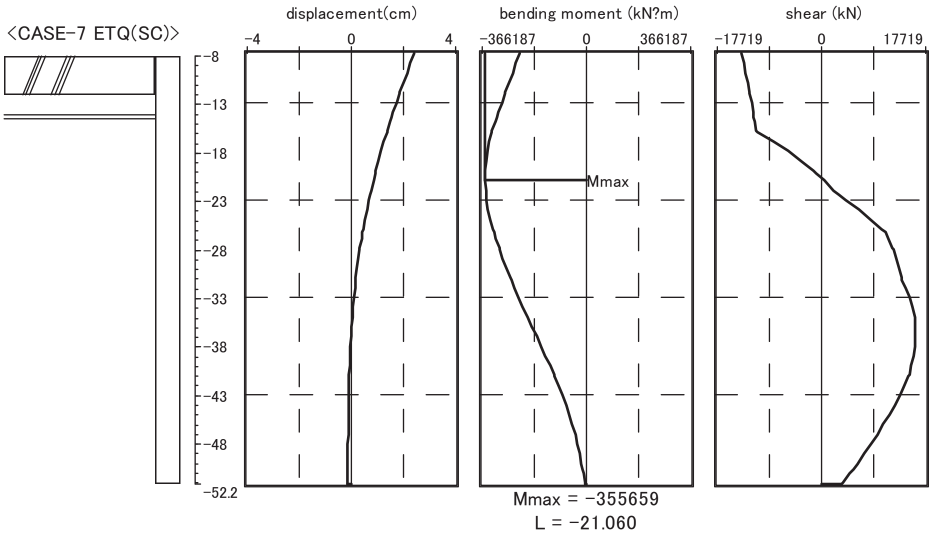
<CASE-5 OD-CL(SC)>



<CASE-6 ETQ>

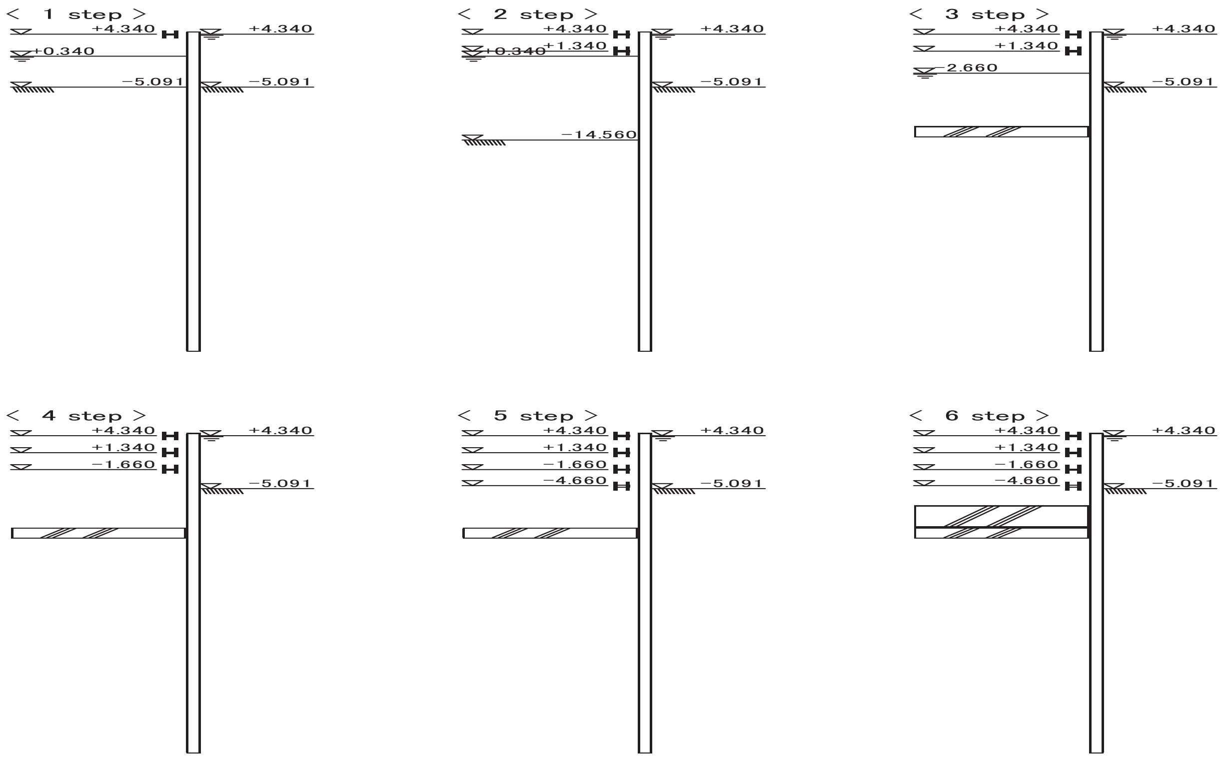


<CASE-7 ETQ(SC)>



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	8.000	633569.6	10559.5	633569.6	10559.5	SKY400
2	9.000	633569.6	10559.5	633569.6	10559.5	SKY490
3	16.000	720452.4	12007.5	720452.4	12007.5	SKY400
4	24.000	633569.6	10559.5	633569.6	10559.5	SKY400
					Sig.= 57.000 (m)	

2.3 soil condition

current ground surface elevation   -5.091 (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	sandy	10.900	3.0	17.0	8.0	0.0	29.0	0
2	sandy	4.300	13.0	17.0	8.0	0.0	33.0	0
3	cohesv	2.300	7.0	17.5	7.5	42.0	0.0	0
4	sandy	3.800	13.0	17.0	8.0	0.0	32.0	0
5	cohesv	4.900	7.0	17.5	7.5	42.0	0.0	0
6	sandy	9.700	20.0	17.0	8.0	0.0	33.0	0
7	sandy	9.600	30.0	17.0	8.0	0.0	34.0	0
8	cohesv	1.569	30.0	18.0	8.0	180.0	0.0	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	1153	1153	1153	1153	0
2	4998	4998	4998	4998	0
3	4710	4710	4710	4710	0
4	8746	8746	8746	8746	0
5	4710	4710	4710	4710	0
6	13456	13456	13456	13456	0
7	20184	20184	20184	20184	0
8	20184	20184	20184	20184	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-400*400*13*21	2H-400*400*13*21	2H-400*400*13*21
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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 (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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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 (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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	-5.091	+0.340
2	-14.560	+0.340
3	-14.560	-2.660
4	-14.560	-14.560

step	excavation area(m)	inside water level(m)
5	-14.560	-14.560
6	-14.560	-14.560

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	9.431	0.271	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

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

linear part

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

Here, E : Young's modulus of timbering = 2.00 * 10^8(kN/m²)
A1 : sectional area of wailing(m²)
A2 : sectional area of strut (m²)
r : timbering radius in arc part (m)
L1 : strut length (m)
L2 : strut spacing (m)

1)bridge axis direction

linear part

row	A2 (cm²)	L1 (m)	L2 (m)	K (kN/m/m)
1	171.90	8.623	4.000	1.9935E+005
2	437.40	8.573	4.000	5.1019E+005
3	118.40	8.673	4.000	1.3651E+005
4	118.40	8.673	4.000	1.3651E+005

arc part

row	A1 (cm²)	r (m)	K (kN/m/m)
1	171.90	4.312	1.8494E+005
2	437.40	4.287	4.7608E+005
3	118.40	4.337	1.2592E+005
4	118.40	4.337	1.2592E+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 = 8.973
perpendicular direction B = 14.764

1)bridge axis direction
K = 5.2378E+005 (kN/m/m)
2)perpendicular direction
K = 3.1833E+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	1.9935E+005	1.8494E+005
timbering 2row	invld	5.1019E+005	4.7608E+005
timbering 3row	invld	1.3651E+005	1.2592E+005
timbering 4row	invld	1.3651E+005	1.2592E+005
footing concrete	invld	5.2378E+005	3.1833E+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/m²)

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/m²)

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

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)

(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 = 57.000 (m)
design water tableelevation +4.340 (m)
design ground elevation -5.091 (m)

(4)sum up

1) 1 step

excavation area elevation = -5.091 (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 -5.091	5.431	40.00 94.31	0.00 54.31	0.00 54.31	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	-5.091 -15.991	10.900	94.31 229.78	54.31 457.15	54.31 206.37	40.00 23.41	0.00 250.78
4	-15.991 -20.291	4.300	225.80 277.68	536.58 726.83	201.37 263.75	24.43 13.93	335.21 463.08
5	-20.291 -22.591	2.300	211.63 235.78	396.71 436.96	199.47 230.08	12.16 5.70	197.24 206.88
6	-22.591 -24.799	2.208	307.30 334.13	797.92 891.07	301.78 334.13	5.52 0.00	496.14 556.94
7	-24.799 -25.556	0.757	334.13 343.33	891.07 922.99	334.13 345.22	0.00 0.00	556.94 577.77
8	-25.556 -26.391	0.835	343.33 353.48	922.99 958.24	345.22 357.46	0.00 0.00	577.77 600.78
9	-26.391 -27.046	0.655	274.54 281.41	501.56 513.02	274.54 281.41	0.00 0.00	227.02 231.60
10	-27.046 -31.291	4.245	281.41 325.99	513.02 587.31	281.41 325.99	0.00 0.00	231.60 261.32
11	-31.291 -36.538	5.247	411.44 474.73	1231.13 1463.27	430.81 510.65	0.00 0.00	800.32 952.62
12	-36.538 -38.790	2.252	474.73 501.90	1463.27 1562.91	510.65 540.35	0.00 0.00	952.62 1022.56
13	-38.790 -40.991	2.201	501.90 528.45	1562.91 1660.31	540.35 569.38	0.00 0.00	1022.56 1090.93
14	-40.991 -50.591	9.600	525.37 640.37	1741.96 2188.23	565.67 691.29	0.00 0.00	1176.29 1496.94
15	-50.591 -52.160	1.569	435.70 449.83	1191.41 1219.65	435.70 449.83	0.00 0.00	755.71 769.82

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 -5.091	5.431	40.00 94.31	0.00 54.31	0.00 54.31	40.00 40.00	0.00 0.00
3	-5.091 -15.991	10.900	94.31 229.78	54.31 457.15	54.31 205.99	40.00 23.79	0.00 251.16

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
4	-15.991 -20.291	4.300	225.80 277.68	536.58 726.83	201.03 262.83	24.77 14.85	335.55 464.00
5	-20.291 -22.591	2.300	211.63 235.78	396.71 436.96	198.26 228.20	13.37 7.58	198.45 208.76
6	-22.591 -24.799	2.208	307.30 334.13	797.92 891.07	300.31 332.35	6.99 1.78	497.61 558.73
7	-24.799 -25.556	0.757	334.13 343.33	891.07 922.99	332.35 343.33	1.78 0.00	558.73 579.66
8	-25.556 -26.391	0.835	343.33 353.48	922.99 958.24	343.33 355.45	0.00 0.00	579.66 602.79
9	-26.391 -27.046	0.655	274.54 281.41	501.56 513.02	272.89 281.41	1.65 0.00	228.67 231.60
10	-27.046 -31.291	4.245	281.41 325.99	513.02 587.31	281.41 325.99	0.00 0.00	231.60 261.32
11	-31.291 -36.538	5.247	411.44 474.73	1231.13 1463.27	427.80 506.55	0.00 0.00	803.33 956.72
12	-36.538 -38.790	2.252	474.73 501.90	1463.27 1562.91	506.55 540.35	0.00 0.00	956.72 1022.56
13	-38.790 -40.991	2.201	501.90 528.45	1562.91 1660.31	540.35 569.38	0.00 0.00	1022.56 1090.93
14	-40.991 -50.591	9.600	525.37 640.37	1741.96 2188.23	565.67 691.29	0.00 0.00	1176.29 1496.94
15	-50.591 -52.160	1.569	435.70 449.83	1191.41 1219.65	435.70 449.83	0.00 0.00	755.71 769.82

2) 2 step

excavation area elevation = -14.560 (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 -5.091	5.431	40.00 94.31	0.00 54.31	0.00 54.31	40.00 40.00	0.00 0.00
3	-5.091 -14.560	9.469	94.31 212.00	54.31 149.00	54.31 149.00	40.00 63.00	0.00 0.00
4	-14.560 -15.991	1.431	212.00 229.78	149.00 201.89	149.00 168.96	63.00 60.82	0.00 32.92
5	-15.991 -20.291	4.300	225.80 277.68	212.31 402.57	168.31 230.69	57.50 46.99	44.01 171.88
6	-20.291 -22.591	2.300	187.45 211.60	330.43 370.68	155.91 186.52	31.55 25.09	174.52 184.16
7	-22.591 -26.391	3.800	307.30 353.48	493.11 653.43	267.64 323.32	39.66 30.15	225.47 330.11
8	-26.391 -31.291	4.900	250.36 301.81	435.28 521.03	231.88 297.09	18.48 4.72	203.40 223.93
9	-31.291 -35.632	4.341	411.44 463.80	906.87 1098.92	397.75 463.80	13.69 0.00	509.12 635.12
10	-35.632 -36.861	1.230	463.80 478.64	1098.92 1153.33	463.80 482.52	0.00 0.00	635.12 670.82
11	-36.861 -40.991	4.130	478.64 528.45	1153.33 1336.04	482.52 545.36	0.00 0.00	670.82 790.69
12	-40.991 -49.315	8.324	525.37 625.09	1396.46 1783.42	541.14 674.60	0.00 0.00	855.33 1108.82
13	-49.315 -50.591	1.276	625.09 640.37	1783.42 1842.74	674.60 691.29	0.00 0.00	1108.82 1151.44
14	-50.591 -52.160	1.569	411.53 425.65	1125.13 1153.37	435.70 449.83	0.00 0.00	689.42 703.54

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 -5.091	5.431	40.00 94.31	0.00 54.31	0.00 54.31	40.00 40.00	0.00 0.00
3	-5.091 -14.560	9.469	94.31 212.00	54.31 149.00	54.31 149.00	40.00 63.00	0.00 0.00
4	-14.560 -15.991	1.431	212.00 229.78	149.00 201.89	149.00 168.91	63.00 60.87	0.00 32.97
5	-15.991 -20.291	4.300	225.80 277.68	212.31 402.57	168.26 230.06	57.54 47.62	44.05 172.51
6	-20.291 -22.591	2.300	187.45 211.60	330.43 370.68	155.08 185.03	32.37 26.58	175.35 185.65
7	-22.591 -26.391	3.800	307.30 353.48	493.11 653.43	266.48 321.63	40.83 31.85	226.64 331.81
8	-26.391 -31.291	4.900	250.36 301.81	435.28 521.03	229.71 293.51	20.65 8.30	205.56 227.52
9	-31.291 -35.632	4.341	411.44 463.80	906.87 1098.92	395.03 460.18	16.41 3.62	511.84 638.74
10	-35.632 -36.861	1.230	463.80 478.64	1098.92 1153.33	460.18 478.64	3.62 0.00	638.74 674.70
11	-36.861 -40.991	4.130	478.64 528.45	1153.33 1336.04	478.64 540.62	0.00 0.00	674.70 795.43
12	-40.991 -49.315	8.324	525.37 625.09	1396.46 1783.42	536.55 667.49	0.00 0.00	859.91 1115.93
13	-49.315 -50.591	1.276	625.09 640.37	1783.42 1842.74	667.49 687.56	0.00 0.00	1115.93 1155.18
14	-50.591 -52.160	1.569	411.53 425.65	1125.13 1153.37	435.70 449.83	0.00 0.00	689.42 703.54

3) 3 step

excavation area elevation = -14.560 (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/m²)	passive side pressure (kN/m²)	at rest side pressure (kN/m²)	effective side pressure (kN/m²)	
						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 -5.091	2.431	70.00 94.31	0.00 24.31	0.00 24.31	70.00 70.00	0.00 0.00
3	-5.091 -14.560	9.469	94.31 212.00	24.31 119.00	24.31 119.00	70.00 93.00	0.00 0.00
4	-14.560 -15.991	1.431	212.00 229.78	238.38 291.27	134.97 154.93	77.03 74.85	103.41 136.34
5	-15.991 -20.291	4.300	225.80 277.68	333.97 524.22	152.42 214.80	73.38 62.87	181.55 309.42
6	-20.291 -22.591	2.300	187.45 211.60	331.43 371.68	156.51 187.12	30.95 24.49	174.92 184.56
7	-22.591 -26.391	3.800	307.30 353.48	605.67 765.99	252.22 307.90	55.09 45.58	353.45 458.09
8	-26.391 -31.291	4.900	250.36 301.81	436.28 522.03	232.48 297.69	17.88 4.12	203.80 224.33
9	-31.291 -40.668	9.377	411.44 524.56	1028.52 1443.41	381.86 524.56	29.57 0.00	646.66 918.85
10	-40.668 -40.991	0.323	524.56 528.45	1443.41 1457.70	524.56 529.47	0.00 0.00	918.85 928.23
11	-40.991 -41.132	0.141	525.37 527.06	1528.05 1534.61	524.80 527.06	0.57 0.00	1003.25 1007.54
12	-41.132 -42.366	1.234	527.06 541.85	1534.61 1591.99	527.06 546.86	0.00 0.00	1007.54 1045.14
13	-42.366 -50.591	8.225	541.85 640.37	1591.99 1974.32	546.86 678.72	0.00 0.00	1045.14 1295.60
14	-50.591 -52.160	1.569	411.53 425.65	1126.13 1154.37	435.70 449.83	0.00 0.00	690.42 704.54

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 -5.091	2.431	70.00 94.31	0.00 24.31	0.00 24.31	70.00 70.00	0.00 0.00
3	-5.091 -14.560	9.469	94.31 212.00	24.31 119.00	24.31 119.00	70.00 93.00	0.00 0.00
4	-14.560 -15.991	1.431	212.00 229.78	238.38 291.27	134.97 154.88	77.03 74.90	103.41 136.39
5	-15.991 -20.291	4.300	225.80 277.68	333.97 524.22	152.38 214.18	73.42 63.50	181.59 310.05
6	-20.291 -22.591	2.300	187.45 211.60	331.43 371.68	155.68 185.63	31.77 25.98	175.75 186.05
7	-22.591 -26.391	3.800	307.30 353.48	605.67 765.99	251.05 306.20	56.25 47.28	354.62 459.79
8	-26.391 -31.291	4.900	250.36 301.81	436.28 522.03	230.31 294.11	20.05 7.70	205.96 227.92
9	-31.291 -40.668	9.377	411.44 524.56	1028.52 1443.41	379.15 519.89	32.29 4.67	649.38 923.52
10	-40.668 -40.991	0.323	524.56 528.45	1443.41 1457.70	519.89 524.73	4.67 3.72	923.52 932.96
11	-40.991 -41.132	0.141	525.37 527.06	1528.05 1534.61	520.21 522.43	5.16 4.63	1007.83 1012.18
12	-41.132 -42.366	1.234	527.06 541.85	1534.61 1591.99	522.43 541.85	4.63 0.00	1012.18 1050.14
13	-42.366 -50.591	8.225	541.85 640.37	1591.99 1974.32	541.85 671.23	0.00 0.00	1050.14 1303.10
14	-50.591 -52.160	1.569	411.53 425.65	1126.13 1154.37	435.70 449.83	0.00 0.00	690.42 704.54

4) 4 step

excavation area elevation = -14.560 (m)

landside water table elevation = -14.560 (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 -5.091	9.431	0.00 94.31	0.00 0.00	0.00 0.00	0.00 94.31	0.00 0.00
2	-5.091 -14.560	9.469	94.31 212.00	0.00 0.00	0.00 0.00	94.31 212.00	0.00 0.00
3	-14.560 -15.991	1.431	212.00 229.78	119.38 172.27	15.97 35.93	196.03 193.85	103.41 136.34
4	-15.991 -20.291	4.300	225.80 277.68	214.97 405.22	33.42 95.80	192.38 181.87	181.55 309.42
5	-20.291 -22.591	2.300	187.45 211.60	212.43 252.68	85.11 115.72	102.35 95.89	127.32 136.96
6	-22.591 -26.391	3.800	307.30 353.48	486.67 646.99	133.22 188.90	174.09 164.58	353.45 458.09
7	-26.391 -31.291	4.900	250.36 301.81	317.28 403.03	161.08 226.29	89.28 75.52	156.20 176.73
8	-31.291 -40.991	9.700	411.44 528.45	909.52 1338.70	262.86 410.47	148.57 117.98	646.66 928.23
9	-40.991 -50.591	9.600	525.37 640.37	1409.05 1855.32	405.80 559.72	119.57 80.65	1003.25 1295.60
10	-50.591 -51.108	0.517	411.53 416.19	1007.13 1016.44	406.34 416.19	5.19 0.00	600.78 600.25
11	-51.108 -52.112	1.004	416.19 425.22	1016.44 1034.51	416.19 435.29	0.00 0.00	600.25 599.22
12	-52.112 -52.160	0.048	425.22 425.65	1034.51 1035.37	435.29 436.20	0.00 0.00	599.22 599.17

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 -5.091	9.431	0.00 94.31	0.00 0.00	0.00 0.00	0.00 94.31	0.00 0.00
2	-5.091 -14.560	9.469	94.31 212.00	0.00 0.00	0.00 0.00	94.31 212.00	0.00 0.00
3	-14.560 -15.991	1.431	212.00 229.78	119.38 172.27	15.97 35.88	196.03 193.90	103.41 136.39
4	-15.991 -20.291	4.300	225.80 277.68	214.97 405.22	33.38 95.18	192.42 182.50	181.59 310.05
5	-20.291 -22.591	2.300	187.45 211.60	212.43 252.68	84.28 114.23	103.17 97.38	128.15 138.45
6	-22.591 -26.391	3.800	307.30 353.48	486.67 646.99	132.05 187.20	175.25 166.28	354.62 459.79
7	-26.391 -31.291	4.900	250.36 301.81	317.28 403.03	158.91 222.71	91.45 79.10	158.36 180.32
8	-31.291 -40.991	9.700	411.44 528.45	909.52 1338.70	260.15 405.73	151.29 122.72	649.38 932.96
9	-40.991 -50.591	9.600	525.37 640.37	1409.05 1855.32	401.21 552.23	124.16 88.15	1007.83 1303.10
10	-50.591 -51.108	0.517	411.53 416.19	1007.13 1016.44	397.84 407.16	13.69 9.03	609.28 609.28
11	-51.108 -52.112	1.004	416.19 425.22	1016.44 1034.51	407.16 425.22	9.03 0.00	609.28 609.28
12	-52.112 -52.160	0.048	425.22 425.65	1034.51 1035.37	425.22 426.08	0.00 0.00	609.28 609.28

5) 5 step

excavation area elevation = -14.560 (m)

landside water table elevation = -14.560 (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 -5.091	9.431	0.00 94.31	0.00 0.00	0.00 0.00	0.00 94.31	0.00 0.00
2	-5.091 -14.560	9.469	94.31 212.00	0.00 0.00	0.00 0.00	94.31 212.00	0.00 0.00
3	-14.560 -15.991	1.431	212.00 229.78	119.38 172.27	15.97 35.93	196.03 193.85	103.41 136.34
4	-15.991 -20.291	4.300	225.80 277.68	214.97 405.22	33.42 95.80	192.38 181.87	181.55 309.42
5	-20.291 -22.591	2.300	187.45 211.60	212.43 252.68	85.11 115.72	102.35 95.89	127.32 136.96
6	-22.591 -26.391	3.800	307.30 353.48	486.67 646.99	133.22 188.90	174.09 164.58	353.45 458.09
7	-26.391 -31.291	4.900	250.36 301.81	317.28 403.03	161.08 226.29	89.28 75.52	156.20 176.73
8	-31.291 -40.991	9.700	411.44 528.45	909.52 1338.70	262.86 410.47	148.57 117.98	646.66 928.23
9	-40.991 -50.591	9.600	525.37 640.37	1409.05 1855.32	405.80 559.72	119.57 80.65	1003.25 1295.60
10	-50.591 -51.108	0.517	411.53 416.19	1007.13 1016.44	406.34 416.19	5.19 0.00	600.78 600.25
11	-51.108 -52.112	1.004	416.19 425.22	1016.44 1034.51	416.19 435.29	0.00 0.00	600.25 599.22
12	-52.112 -52.160	0.048	425.22 425.65	1034.51 1035.37	435.29 436.20	0.00 0.00	599.22 599.17

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 -5.091	9.431	0.00 94.31	0.00 0.00	0.00 0.00	0.00 94.31	0.00 0.00
2	-5.091 -14.560	9.469	94.31 212.00	0.00 0.00	0.00 0.00	94.31 212.00	0.00 0.00
3	-14.560 -15.991	1.431	212.00 229.78	119.38 172.27	15.97 35.88	196.03 193.90	103.41 136.39
4	-15.991 -20.291	4.300	225.80 277.68	214.97 405.22	33.38 95.18	192.42 182.50	181.59 310.05
5	-20.291 -22.591	2.300	187.45 211.60	212.43 252.68	84.28 114.23	103.17 97.38	128.15 138.45
6	-22.591 -26.391	3.800	307.30 353.48	486.67 646.99	132.05 187.20	175.25 166.28	354.62 459.79
7	-26.391 -31.291	4.900	250.36 301.81	317.28 403.03	158.91 222.71	91.45 79.10	158.36 180.32
8	-31.291 -40.991	9.700	411.44 528.45	909.52 1338.70	260.15 405.73	151.29 122.72	649.38 932.96
9	-40.991 -50.591	9.600	525.37 640.37	1409.05 1855.32	401.21 552.23	124.16 88.15	1007.83 1303.10
10	-50.591 -51.108	0.517	411.53 416.19	1007.13 1016.44	397.84 407.16	13.69 9.03	609.28 609.28
11	-51.108 -52.112	1.004	416.19 425.22	1016.44 1034.51	407.16 425.22	9.03 0.00	609.28 609.28
12	-52.112 -52.160	0.048	425.22 425.65	1034.51 1035.37	425.22 426.08	0.00 0.00	609.28 609.28

6) 6 step

excavation area elevation = -14.560 (m)

landside water table elevation = -14.560 (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 -5.091	9.431	0.00 94.31	0.00 0.00	0.00 0.00	0.00 94.31	0.00 0.00
2	-5.091 -14.560	9.469	94.31 212.00	0.00 0.00	0.00 0.00	94.31 212.00	0.00 0.00
3	-14.560 -15.991	1.431	212.00 229.78	119.38 172.27	15.97 35.93	196.03 193.85	103.41 136.34
4	-15.991 -20.291	4.300	225.80 277.68	214.97 405.22	33.42 95.80	192.38 181.87	181.55 309.42
5	-20.291 -22.591	2.300	187.45 211.60	212.43 252.68	85.11 115.72	102.35 95.89	127.32 136.96
6	-22.591 -26.391	3.800	307.30 353.48	486.67 646.99	133.22 188.90	174.09 164.58	353.45 458.09
7	-26.391 -31.291	4.900	250.36 301.81	317.28 403.03	161.08 226.29	89.28 75.52	156.20 176.73
8	-31.291 -40.991	9.700	411.44 528.45	909.52 1338.70	262.86 410.47	148.57 117.98	646.66 928.23
9	-40.991 -50.591	9.600	525.37 640.37	1409.05 1855.32	405.80 559.72	119.57 80.65	1003.25 1295.60
10	-50.591 -51.108	0.517	411.53 416.19	1007.13 1016.44	406.34 416.19	5.19 0.00	600.78 600.25
11	-51.108 -52.112	1.004	416.19 425.22	1016.44 1034.51	416.19 435.29	0.00 0.00	600.25 599.22
12	-52.112 -52.160	0.048	425.22 425.65	1034.51 1035.37	435.29 436.20	0.00 0.00	599.22 599.17

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 -5.091	9.431	0.00 94.31	0.00 0.00	0.00 0.00	0.00 94.31	0.00 0.00
2	-5.091 -14.560	9.469	94.31 212.00	0.00 0.00	0.00 0.00	94.31 212.00	0.00 0.00
3	-14.560 -15.991	1.431	212.00 229.78	119.38 172.27	15.97 35.88	196.03 193.90	103.41 136.39
4	-15.991 -20.291	4.300	225.80 277.68	214.97 405.22	33.38 95.18	192.42 182.50	181.59 310.05
5	-20.291 -22.591	2.300	187.45 211.60	212.43 252.68	84.28 114.23	103.17 97.38	128.15 138.45
6	-22.591 -26.391	3.800	307.30 353.48	486.67 646.99	132.05 187.20	175.25 166.28	354.62 459.79
7	-26.391 -31.291	4.900	250.36 301.81	317.28 403.03	158.91 222.71	91.45 79.10	158.36 180.32
8	-31.291 -40.991	9.700	411.44 528.45	909.52 1338.70	260.15 405.73	151.29 122.72	649.38 932.96
9	-40.991 -50.591	9.600	525.37 640.37	1409.05 1855.32	401.21 552.23	124.16 88.15	1007.83 1303.10
10	-50.591 -51.108	0.517	411.53 416.19	1007.13 1016.44	397.84 407.16	13.69 9.03	609.28 609.28
11	-51.108 -52.112	1.004	416.19 425.22	1016.44 1034.51	407.16 425.22	9.03 0.00	609.28 609.28
12	-52.112 -52.160	0.048	425.22 425.65	1034.51 1035.37	425.22 426.08	0.00 0.00	609.28 609.28

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 -5.091	5.431	----	----	----	----
3	sandy	-5.091 -15.991	10.900	17.0	0.0	29.00	3.0
4	sandy	-15.991 -20.291	4.300	17.0	0.0	33.00	13.0
5	cohesv	-20.291 -22.591	2.300	17.5	42.0	0.00	7.0
6	sandy	-22.591 -24.799	2.208	17.0	0.0	32.00	13.0
7	sandy	-24.799 -25.553	0.754	17.0	0.0	32.00	13.0
8	sandy	-25.553 -26.391	0.838	17.0	0.0	32.00	13.0
9	cohesv	-26.391 -27.043	0.652	17.5	42.0	0.00	7.0
10	cohesv	-27.043 -31.291	4.248	17.5	42.0	0.00	7.0
11	sandy	-31.291 -36.537	5.246	17.0	0.0	33.00	20.0
12	sandy	-36.537 -38.792	2.255	17.0	0.0	33.00	20.0
13	sandy	-38.792 -40.991	2.199	17.0	0.0	33.00	20.0
14	sandy	-40.991 -50.591	9.600	17.0	0.0	34.00	30.0
15	cohesv	-50.591 -52.160	1.569	18.0	180.0	0.00	30.0

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 -5.091	5.431	0.00 0.00	-------- --------	40.00 94.31	------- -------	------- -------	0.00 0.00	40.00 94.31
3	sandy	-5.091 -15.991	10.900	94.31 279.61	0.000 0.000	94.31 203.31	0.3470 0.3470	------- -------	0.00 26.47	94.31 229.78
4	sandy	-15.991 -20.291	4.300	279.61 352.71	0.000 0.000	203.31 246.31	0.2948 0.2948	------- -------	22.49 31.37	225.80 277.68
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	258.400 298.650	-------- --------	0.6000 0.6000	0.6000 0.6000	211.63 235.78	211.63 235.78
6	sandy	-22.591 -24.799	2.208	392.96 430.49	0.000 0.000	269.31 291.39	0.3073 0.3073	------- -------	37.99 42.74	307.30 334.13
7	sandy	-24.799 -25.553	0.754	430.49 443.31	0.000 0.000	291.39 298.93	0.3073 0.3073	------- -------	42.74 44.36	334.13 343.29
8	sandy	-25.553 -26.391	0.838	443.31 457.56	0.000 0.000	298.93 307.31	0.3073 0.3073	------- -------	44.36 46.17	343.29 353.48
9	cohesv	-26.391 -27.043	0.652	457.56 468.98	363.250 374.667	-------- --------	0.6000 0.6000	0.6000 0.6000	274.54 281.39	274.54 281.39
10	cohesv	-27.043 -31.291	4.248	468.98 543.31	374.667 449.000	-------- --------	0.6000 0.6000	0.6000 0.6000	281.39 325.99	281.39 325.99
11	sandy	-31.291 -36.537	5.246	543.31 632.49	0.000 0.000	356.31 408.77	0.2948 0.2948	------- -------	55.13 65.95	411.44 474.72
12	sandy	-36.537 -38.792	2.255	632.49 670.82	0.000 0.000	408.77 431.32	0.2948 0.2948	------- -------	65.95 70.61	474.72 501.92
13	sandy	-38.792 -40.991	2.199	670.82 708.21	0.000 0.000	431.32 453.31	0.2948 0.2948	------- -------	70.61 75.14	501.92 528.45
14	sandy	-40.991 -50.591	9.600	708.21 871.41	0.000 0.000	453.31 549.31	0.2827 0.2827	------- -------	72.06 91.06	525.37 640.37
15	cohesv	-50.591 -52.160	1.569	871.41 899.65	777.100 805.342	-------- --------	0.5000 0.5000	0.5000 0.5000	435.70 449.83	435.70 449.83

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -5.091	5.431	0.00 0.00	0.00 54.31	0.0000 0.0000	0.00 0.00	0.00 54.31
3	sandy	-5.091 -15.991	10.900	54.31 239.61	54.31 163.31	3.8511 3.8511	0.00 293.84	54.31 457.15
4	sandy	-15.991 -20.291	4.300	239.61 312.71	163.31 206.31	4.8921 4.8921	373.27 520.52	536.58 726.83
5	cohesv	-20.291 -22.591	2.300	312.71 352.96	-------- --------	1.0000 1.0000	396.71 436.96	396.71 436.96
6	sandy	-22.591 -24.799	2.208	352.96 390.49	229.31 251.39	4.5985 4.5985	568.61 639.67	797.92 891.06
7	sandy	-24.799 -25.553	0.754	390.49 403.31	251.39 258.93	4.5985 4.5985	639.67 663.95	891.06 922.88
8	sandy	-25.553 -26.391	0.838	403.31 417.56	258.93 267.31	4.5985 4.5985	663.95 690.93	922.88 958.24
9	cohesv	-26.391 -27.043	0.652	417.56 428.98	-------- --------	1.0000 1.0000	501.56 512.98	501.56 512.98
10	cohesv	-27.043 -31.291	4.248	428.98 503.31	-------- --------	1.0000 1.0000	512.98 587.31	512.98 587.31
11	sandy	-31.291 -36.537	5.246	503.31 592.49	316.31 368.77	4.8921 4.8921	914.82 1094.46	1231.13 1463.23
12	sandy	-36.537 -38.792	2.255	592.49 630.82	368.77 391.32	4.8921 4.8921	1094.46 1171.68	1463.23 1563.00
13	sandy	-38.792 -40.991	2.199	630.82 668.21	391.32 413.31	4.8921 4.8921	1171.68 1247.00	1563.00 1660.31
14	sandy	-40.991 -50.591	9.600	668.21 831.41	413.31 509.31	5.2124 5.2124	1328.65 1678.92	1741.96 2188.23
15	cohesv	-50.591 -52.160	1.569	831.41 859.65	-------- --------	1.0000 1.0000	1191.41 1219.65	1191.41 1219.65

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -5.091	5.431	0.00 0.00	40.00 94.31	0.0000 0.0000	0.00 0.00	40.00 94.31
3	sandy	-5.091 -15.991	10.900	94.31 279.61	94.31 203.31	0.5152 0.5152	0.00 39.31	94.31 242.62
4	sandy	-15.991 -20.291	4.300	279.61 352.71	203.31 246.31	0.4554 0.4554	34.74 48.45	238.05 294.76
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	-------- --------	0.6000 0.6000	211.63 235.78	211.63 235.78
6	sandy	-22.591 -24.799	2.208	392.96 430.49	269.31 291.39	0.4701 0.4701	58.13 65.39	327.44 356.78
7	sandy	-24.799 -25.553	0.754	430.49 443.31	291.39 298.93	0.4701 0.4701	65.39 67.87	356.78 366.80
8	sandy	-25.553 -26.391	0.838	443.31 457.56	298.93 307.31	0.4701 0.4701	67.87 70.63	366.80 377.94
9	cohesv	-26.391 -27.043	0.652	457.56 468.98	-------- --------	0.6000 0.6000	274.54 281.39	274.54 281.39
10	cohesv	-27.043 -31.291	4.248	468.98 543.31	-------- --------	0.6000 0.6000	281.39 325.99	281.39 325.99
11	sandy	-31.291 -36.537	5.246	543.31 632.49	356.31 408.77	0.4554 0.4554	85.15 101.87	441.46 510.64
12	sandy	-36.537 -38.792	2.255	632.49 670.82	408.77 431.32	0.4554 0.4554	101.87 109.06	510.64 540.38
13	sandy	-38.792 -40.991	2.199	670.82 708.21	431.32 453.31	0.4554 0.4554	109.06 116.07	540.38 569.38
14	sandy	-40.991 -50.591	9.600	708.21 871.41	453.31 549.31	0.4408 0.4408	112.36 141.98	565.67 691.29
15	cohesv	-50.591 -52.160	1.569	871.41 899.65	-------- --------	0.5000 0.5000	435.70 449.83	435.70 449.83

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 -5.091	5.431	0.00 0.00	0.00 54.31	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 54.31
3	sandy	-5.091 -15.991	10.900	54.31 239.61	54.31 163.31	3.00	0.00 32.70	0.5152 0.5152	0.00 43.06	54.31 206.37
4	sandy	-15.991 -20.291	4.300	239.61 312.71	163.31 206.31	13.00	32.70 88.60	0.4554 0.4554	38.06 57.44	201.37 263.75
5	cohesv	-20.291 -22.591	2.300	312.71 352.96	-------- --------	21.00	88.60 136.90	0.6000 0.6000	199.47 230.08	199.47 230.08
6	sandy	-22.591 -24.799	2.208	352.96 390.49	229.31 251.39	13.00	136.90 165.60	0.4701 0.4701	72.47 82.74	301.78 334.13
7	sandy	-24.799 -25.553	0.754	390.49 403.31	251.39 258.93	13.00	165.60 175.41	0.4701 0.4701	82.74 86.25	334.13 345.18
8	sandy	-25.553 -26.391	0.838	403.31 417.56	258.93 267.31	13.00	175.41 186.30	0.4701 0.4701	86.25 90.15	345.18 357.46
9	cohesv	-26.391 -27.043	0.652	417.56 428.98	-------- --------	21.00	186.30 200.00	0.6000 0.6000	275.45 284.13	275.45 284.13
10	cohesv	-27.043 -31.291	4.248	428.98 503.31	-------- --------	21.00	200.00 289.20	0.6000 0.6000	284.13 340.66	284.13 340.66
11	sandy	-31.291 -36.537	5.246	503.31 592.49	316.31 368.77	20.00	289.20 394.11	0.4554 0.4554	114.50 141.87	430.81 510.64
12	sandy	-36.537 -38.792	2.255	592.49 630.82	368.77 391.32	20.00	394.11 439.21	0.4554 0.4554	141.87 153.64	510.64 544.95
13	sandy	-38.792 -40.991	2.199	630.82 668.21	391.32 413.31	20.00	439.21 483.20	0.4554 0.4554	153.64 165.11	544.95 578.42
14	sandy	-40.991 -50.591	9.600	668.21 831.41	413.31 509.31	30.00	483.20 771.20	0.4408 0.4408	159.84 217.75	573.15 727.06

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	cohesv	-50.591 -52.160	1.569	831.41 859.65	-------- --------	90.00	771.20 912.41	0.5000 0.5000	501.65 531.51	501.65 531.51

friction force B7027influence range B = 4.487 (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 -5.091	5.431	0.00 0.00	0.00 54.31	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 54.31
3	sandy	-5.091 -15.991	10.900	54.31 239.61	54.31 163.31	3.00	0.00 32.70	0.5152 0.5152	0.00 42.68	54.31 205.99
4	sandy	-15.991 -20.291	4.300	239.61 312.71	163.31 206.31	13.00	32.70 88.60	0.4554 0.4554	37.72 56.52	201.03 262.83
5	cohesv	-20.291 -22.591	2.300	312.71 352.96	-------- --------	21.00	88.60 136.90	0.6000 0.6000	198.26 228.20	198.26 228.20
6	sandy	-22.591 -24.799	2.208	352.96 390.49	229.31 251.39	13.00	136.90 165.60	0.4701 0.4701	71.00 80.96	300.31 332.35
7	sandy	-24.799 -25.553	0.754	390.49 403.31	251.39 258.93	13.00	165.60 175.41	0.4701 0.4701	80.96 84.36	332.35 343.29
8	sandy	-25.553 -26.391	0.838	403.31 417.56	258.93 267.31	13.00	175.41 186.30	0.4701 0.4701	84.36 88.14	343.29 355.45
9	cohesv	-26.391 -27.043	0.652	417.56 428.98	-------- --------	21.00	186.30 200.00	0.6000 0.6000	272.89 281.39	272.89 281.39
10	cohesv	-27.043 -31.291	4.248	428.98 503.31	-------- --------	21.00	200.00 289.20	0.6000 0.6000	281.39 336.69	281.39 336.69
11	sandy	-31.291 -36.537	5.246	503.31 592.49	316.31 368.77	20.00	289.20 394.11	0.4554 0.4554	111.49 137.77	427.80 506.53

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	sandy	-36.537 -38.792	2.255	592.49 630.82	368.77 391.32	20.00	394.11 439.21	0.4554 0.4554	137.77 149.06	506.53 540.38
13	sandy	-38.792 -40.991	2.199	630.82 668.21	391.32 413.31	20.00	439.21 483.20	0.4554 0.4554	149.06 160.08	540.38 573.39
14	sandy	-40.991 -50.591	9.600	668.21 831.41	413.31 509.31	30.00	483.20 771.20	0.4408 0.4408	154.96 209.97	568.27 719.28
15	cohesv	-50.591 -52.160	1.569	831.41 859.65	-------- --------	90.00	771.20 912.41	0.5000 0.5000	492.82 521.07	492.82 521.07

friction force B7027influence range B = 5.000 (m)

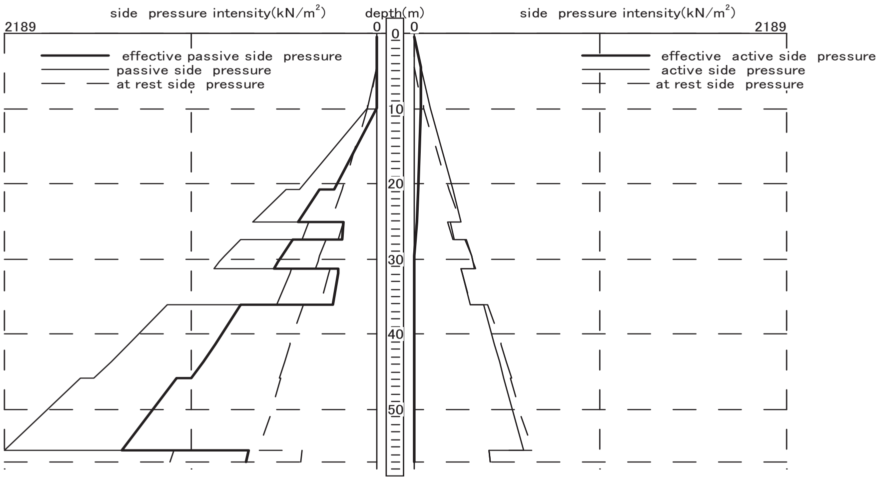
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

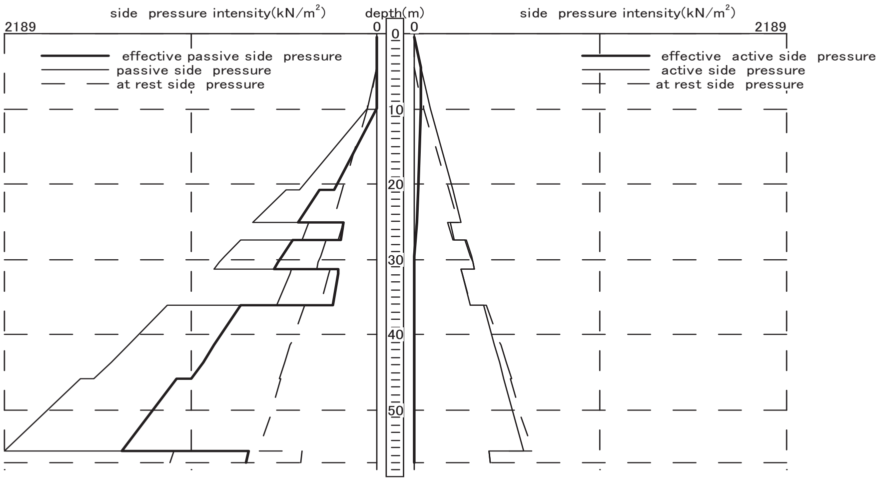
bridge axis direction

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 -5.091	5.431	----	----	----	----
3	sandy	-5.091 -14.560	9.469	17.0	0.0	29.00	3.0
4	sandy	-14.560 -15.991	1.431	17.0	0.0	29.00	3.0
5	sandy	-15.991 -20.291	4.300	17.0	0.0	33.00	13.0
6	cohesv	-20.291 -22.591	2.300	17.5	42.0	0.00	7.0
7	sandy	-22.591 -26.391	3.800	17.0	0.0	32.00	13.0
8	cohesv	-26.391 -31.291	4.900	17.5	42.0	0.00	7.0
9	sandy	-31.291 -35.632	4.341	17.0	0.0	33.00	20.0
10	sandy	-35.632 -36.861	1.230	17.0	0.0	33.00	20.0
11	sandy	-36.861 -40.991	4.130	17.0	0.0	33.00	20.0
12	sandy	-40.991 -49.315	8.324	17.0	0.0	34.00	30.0
13	sandy	-49.315 -50.591	1.276	17.0	0.0	34.00	30.0
14	cohesv	-50.591 -52.160	1.569	18.0	180.0	0.00	30.0

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/m²)	Gam.*(h-H) (kN/m²)	pw1 (kN/m²)	Ka1	Ka2	Pa1 (kN/m²)	Pa (kN/m²)
2	----	+0.340 -5.091	5.431	0.00 0.00	-------- --------	40.00 94.31	------- -------	------- -------	0.00 0.00	40.00 94.31
3	sandy	-5.091 -14.560	9.469	94.31 255.28	-------- --------	94.31 189.00	0.3470 0.3470	------- -------	0.00 23.00	94.31 212.00
4	sandy	-14.560 -15.991	1.431	255.28 279.61	0.000 0.000	189.00 203.31	0.3470 0.3470	------- -------	23.00 26.47	212.00 229.78
5	sandy	-15.991 -20.291	4.300	279.61 352.71	0.000 0.000	203.31 246.31	0.2948 0.2948	------- -------	22.49 31.37	225.80 277.68
6	cohesv	-20.291 -22.591	2.300	352.71 392.96	97.427 137.677	-------- --------	0.5053 0.5053	0.6000 0.6000	187.45 211.60	187.45 211.60
7	sandy	-22.591 -26.391	3.800	392.96 457.56	0.000 0.000	269.31 307.31	0.3073 0.3073	------- -------	37.99 46.17	307.30 353.48
8	cohesv	-26.391 -31.291	4.900	457.56 543.31	202.277 288.027	-------- --------	0.5053 0.5053	0.6000 0.6000	250.36 301.81	250.36 301.81
9	sandy	-31.291 -35.632	4.341	543.31 617.10	0.000 0.000	356.31 399.72	0.2948 0.2948	------- -------	55.13 64.08	411.44 463.80
10	sandy	-35.632 -36.861	1.230	617.10 638.01	0.000 0.000	399.72 412.01	0.2948 0.2948	------- -------	64.08 66.62	463.80 478.64
11	sandy	-36.861 -40.991	4.130	638.01 708.21	0.000 0.000	412.01 453.31	0.2948 0.2948	------- -------	66.62 75.14	478.64 528.45
12	sandy	-40.991 -49.315	8.324	708.21 849.72	0.000 0.000	453.31 536.55	0.2827 0.2827	------- -------	72.06 88.54	525.37 625.09
13	sandy	-49.315 -50.591	1.276	849.72 871.41	0.000 0.000	536.55 549.31	0.2827 0.2827	------- -------	88.54 91.06	625.09 640.37
14	cohesv	-50.591 -52.160	1.569	871.41 899.65	616.127 644.369	-------- --------	0.4053 0.4053	0.5000 0.5000	411.53 425.65	411.53 425.65

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

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 -5.091	5.431	0.00 0.00	0.00 54.31	0.0000 0.0000	0.00 0.00	0.00 54.31
3	sandy	-5.091 -14.560	9.469	0.00 0.00	54.31 149.00	0.0000 0.0000	0.00 0.00	54.31 149.00
4	sandy	-14.560 -15.991	1.431	149.00 173.33	149.00 163.31	3.8511 3.8511	0.00 38.58	149.00 201.89
5	sandy	-15.991 -20.291	4.300	173.33 246.43	163.31 206.31	4.8921 4.8921	49.00 196.26	212.31 402.57
6	cohesv	-20.291 -22.591	2.300	246.43 286.68	-------- --------	1.0000 1.0000	330.43 370.68	330.43 370.68
7	sandy	-22.591 -26.391	3.800	286.68 351.28	229.31 267.31	4.5985 4.5985	263.80 386.12	493.11 653.43
8	cohesv	-26.391 -31.291	4.900	351.28 437.03	-------- --------	1.0000 1.0000	435.28 521.03	435.28 521.03
9	sandy	-31.291 -35.632	4.341	437.03 510.82	316.31 359.72	4.8921 4.8921	590.56 739.20	906.87 1098.92
10	sandy	-35.632 -36.861	1.230	510.82 531.72	359.72 372.01	4.8921 4.8921	739.20 781.32	1098.92 1153.33
11	sandy	-36.861 -40.991	4.130	531.72 601.93	372.01 413.31	4.8921 4.8921	781.32 922.73	1153.33 1336.04
12	sandy	-40.991 -49.315	8.324	601.93 743.43	413.31 496.55	5.2124 5.2124	983.15 1286.87	1396.46 1783.42
13	sandy	-49.315 -50.591	1.276	743.43 765.13	496.55 509.31	5.2124 5.2124	1286.87 1333.43	1783.42 1842.74
14	cohesv	-50.591 -52.160	1.569	765.13 793.37	-------- --------	1.0000 1.0000	1125.13 1153.37	1125.13 1153.37

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 +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 -5.091	5.431	0.00 0.00	40.00 94.31	0.0000 0.0000	0.00 0.00	40.00 94.31
3	sandy	-5.091 -14.560	9.469	94.31 255.28	94.31 189.00	0.5152 0.5152	0.00 34.15	94.31 223.15
4	sandy	-14.560 -15.991	1.431	255.28 279.61	189.00 203.31	0.5152 0.5152	34.15 39.31	223.15 242.62
5	sandy	-15.991 -20.291	4.300	279.61 352.71	203.31 246.31	0.4554 0.4554	34.74 48.45	238.05 294.76
6	cohesv	-20.291 -22.591	2.300	352.71 392.96	-------- --------	0.6000 0.6000	211.63 235.78	211.63 235.78
7	sandy	-22.591 -26.391	3.800	392.96 457.56	269.31 307.31	0.4701 0.4701	58.13 70.63	327.44 377.94
8	cohesv	-26.391 -31.291	4.900	457.56 543.31	-------- --------	0.6000 0.6000	274.54 325.99	274.54 325.99
9	sandy	-31.291 -35.632	4.341	543.31 617.10	356.31 399.72	0.4554 0.4554	85.15 98.99	441.46 498.70
10	sandy	-35.632 -36.861	1.230	617.10 638.01	399.72 412.01	0.4554 0.4554	98.99 102.91	498.70 514.92
11	sandy	-36.861 -40.991	4.130	638.01 708.21	412.01 453.31	0.4554 0.4554	102.91 116.07	514.92 569.38
12	sandy	-40.991 -49.315	8.324	708.21 849.72	453.31 536.55	0.4408 0.4408	112.36 138.05	565.67 674.60
13	sandy	-49.315 -50.591	1.276	849.72 871.41	536.55 549.31	0.4408 0.4408	138.05 141.98	674.60 691.29
14	cohesv	-50.591 -52.160	1.569	871.41 899.65	-------- --------	0.5000 0.5000	435.70 449.83	435.70 449.83

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (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 -5.091	5.431	0.00 0.00	0.00 54.31	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 54.31
3	sandy	-5.091 -14.560	9.469	0.00 0.00	54.31 149.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	54.31 149.00
4	sandy	-14.560 -15.991	1.431	149.00 173.33	149.00 163.31	3.00	0.00 4.29	0.5152 0.5152	0.00 5.65	149.00 168.96
5	sandy	-15.991 -20.291	4.300	173.33 246.43	163.31 206.31	13.00	4.29 60.19	0.4554 0.4554	5.00 24.38	168.31 230.69
6	cohesv	-20.291 -22.591	2.300	246.43 286.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	155.91 186.52	155.91 186.52
7	sandy	-22.591 -26.391	3.800	286.68 351.28	229.31 267.31	13.00	108.49 157.89	0.4701 0.4701	38.33 56.01	267.64 323.32
8	cohesv	-26.391 -31.291	4.900	351.28 437.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	231.88 297.09	231.88 297.09
9	sandy	-31.291 -35.632	4.341	437.03 510.82	316.31 359.72	20.00	260.79 347.60	0.4554 0.4554	81.44 104.09	397.75 463.80
10	sandy	-35.632 -36.861	1.230	510.82 531.72	359.72 372.01	20.00	347.60 372.20	0.4554 0.4554	104.09 110.50	463.80 482.52
11	sandy	-36.861 -40.991	4.130	531.72 601.93	372.01 413.31	20.00	372.20 454.79	0.4554 0.4554	110.50 132.05	482.52 545.36
12	sandy	-40.991 -49.315	8.324	601.93 743.43	413.31 496.55	30.00	454.79 704.51	0.4408 0.4408	127.83 178.05	541.14 674.60
13	sandy	-49.315 -50.591	1.276	743.43 765.13	496.55 509.31	30.00	704.51 742.79	0.4408 0.4408	178.05 185.74	674.60 695.05
14	cohesv	-50.591 -52.160	1.569	765.13 793.37	-------- --------	90.00	742.79 884.00	0.5000 0.5000	465.34 495.20	465.34 495.20

friction force B7027influence range B = 4.487 (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 -5.091	5.431	0.00 0.00	0.00 54.31	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 54.31
3	sandy	-5.091 -14.560	9.469	0.00 0.00	54.31 149.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	54.31 149.00
4	sandy	-14.560 -15.991	1.431	149.00 173.33	149.00 163.31	3.00	0.00 4.29	0.5152 0.5152	0.00 5.60	149.00 168.91
5	sandy	-15.991 -20.291	4.300	173.33 246.43	163.31 206.31	13.00	4.29 60.19	0.4554 0.4554	4.95 23.75	168.26 230.06
6	cohesv	-20.291 -22.591	2.300	246.43 286.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	155.08 185.03	155.08 185.03
7	sandy	-22.591 -26.391	3.800	286.68 351.28	229.31 267.31	13.00	108.49 157.89	0.4701 0.4701	37.17 54.32	266.48 321.63
8	cohesv	-26.391 -31.291	4.900	351.28 437.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	229.71 293.51	229.71 293.51
9	sandy	-31.291 -35.632	4.341	437.03 510.82	316.31 359.72	20.00	260.79 347.60	0.4554 0.4554	78.72 100.46	395.03 460.18
10	sandy	-35.632 -36.861	1.230	510.82 531.72	359.72 372.01	20.00	347.60 372.20	0.4554 0.4554	100.46 106.62	460.18 478.64
11	sandy	-36.861 -40.991	4.130	531.72 601.93	372.01 413.31	20.00	372.20 454.79	0.4554 0.4554	106.62 127.31	478.64 540.62
12	sandy	-40.991 -49.315	8.324	601.93 743.43	413.31 496.55	30.00	454.79 704.51	0.4408 0.4408	123.24 170.94	536.55 667.49
13	sandy	-49.315 -50.591	1.276	743.43 765.13	496.55 509.31	30.00	704.51 742.79	0.4408 0.4408	170.94 178.25	667.49 687.56
14	cohesv	-50.591 -52.160	1.569	765.13 793.37	-------- --------	90.00	742.79 884.00	0.5000 0.5000	456.84 485.08	456.84 485.08

friction force B7027influence range B = 5.000 (m)

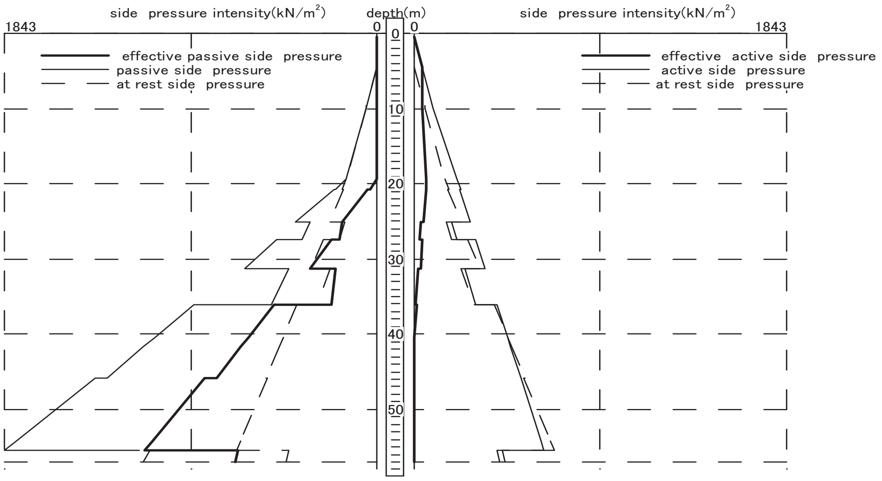
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B }   (sand soil)

Po' = Po1'+ pw2   (sand soil)

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

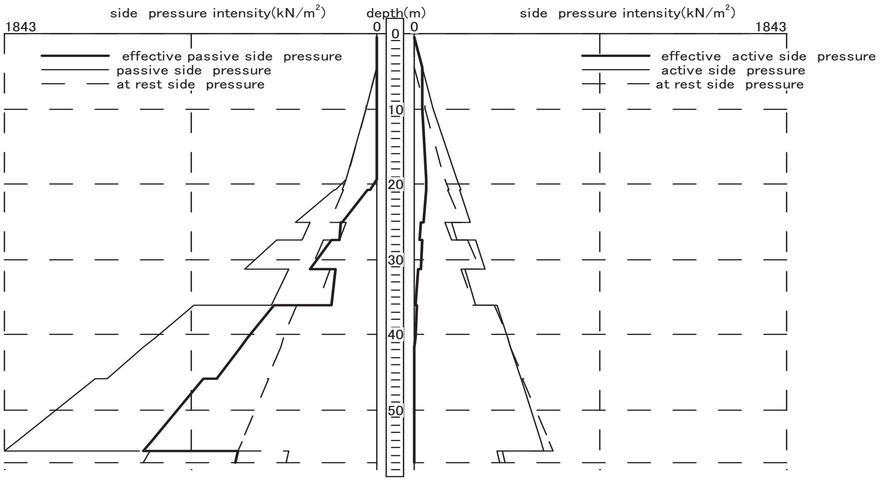
bridge axis direction

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 -2.660	7.000	----	----	----	----
2	-------	-2.660 -5.091	2.431	----	----	----	----
3	sandy	-5.091 -14.560	9.469	17.0	0.0	29.00	3.0
4	sandy	-14.560 -15.991	1.431	17.0	0.0	29.00	3.0
5	sandy	-15.991 -20.291	4.300	17.0	0.0	33.00	13.0
6	cohesv	-20.291 -22.591	2.300	17.5	42.0	0.00	7.0
7	sandy	-22.591 -26.391	3.800	17.0	0.0	32.00	13.0
8	cohesv	-26.391 -31.291	4.900	17.5	42.0	0.00	7.0
9	sandy	-31.291 -40.668	9.377	17.0	0.0	33.00	20.0
10	sandy	-40.668 -40.991	0.323	17.0	0.0	33.00	20.0
11	sandy	-40.991 -41.132	0.141	17.0	0.0	34.00	30.0
12	sandy	-41.132 -42.366	1.234	17.0	0.0	34.00	30.0
13	sandy	-42.366 -50.591	8.225	17.0	0.0	34.00	30.0
14	cohesv	-50.591 -52.160	1.569	18.0	180.0	0.00	30.0

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 -5.091	2.431	0.00 0.00	-------- --------	70.00 94.31	------- -------	------- -------	0.00 0.00	70.00 94.31
3	sandy	-5.091 -14.560	9.469	94.31 255.28	-------- --------	94.31 189.00	0.3470 0.3470	------- -------	0.00 23.00	94.31 212.00
4	sandy	-14.560 -15.991	1.431	255.28 279.61	0.000 0.000	189.00 203.31	0.3470 0.3470	------- -------	23.00 26.47	212.00 229.78
5	sandy	-15.991 -20.291	4.300	279.61 352.71	0.000 0.000	203.31 246.31	0.2948 0.2948	------- -------	22.49 31.37	225.80 277.68
6	cohesv	-20.291 -22.591	2.300	352.71 392.96	97.427 137.677	-------- --------	0.5053 0.5053	0.6000 0.6000	187.45 211.60	187.45 211.60
7	sandy	-22.591 -26.391	3.800	392.96 457.56	0.000 0.000	269.31 307.31	0.3073 0.3073	------- -------	37.99 46.17	307.30 353.48
8	cohesv	-26.391 -31.291	4.900	457.56 543.31	202.277 288.027	-------- --------	0.5053 0.5053	0.6000 0.6000	250.36 301.81	250.36 301.81
9	sandy	-31.291 -40.668	9.377	543.31 702.72	0.000 0.000	356.31 450.08	0.2948 0.2948	------- -------	55.13 74.48	411.44 524.56
10	sandy	-40.668 -40.991	0.323	702.72 708.21	0.000 0.000	450.08 453.31	0.2948 0.2948	------- -------	74.48 75.14	524.56 528.45
11	sandy	-40.991 -41.132	0.141	708.21 710.61	0.000 0.000	453.31 454.72	0.2827 0.2827	------- -------	72.06 72.34	525.37 527.06
12	sandy	-41.132 -42.366	1.234	710.61 731.59	0.000 0.000	454.72 467.06	0.2827 0.2827	------- -------	72.34 74.79	527.06 541.85
13	sandy	-42.366 -50.591	8.225	731.59 871.41	0.000 0.000	467.06 549.31	0.2827 0.2827	------- -------	74.79 91.06	541.85 640.37
14	cohesv	-50.591 -52.160	1.569	871.41 899.65	616.127 644.369	-------- --------	0.4053 0.4053	0.5000 0.5000	411.53 425.65	411.53 425.65

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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	2.431	0.00	0.00	0.0000	0.00	0.00
		-5.091		0.00	24.31	0.0000	0.00	24.31
3	sandy	-5.091	9.469	0.00	24.31	0.0000	0.00	24.31
		-14.560		0.00	119.00	0.0000	0.00	119.00
4	sandy	-14.560	1.431	150.00	119.00	3.8511	119.38	238.38
		-15.991		174.33	133.31	3.8511	157.96	291.27
5	sandy	-15.991	4.300	174.33	133.31	4.8921	200.66	333.97
		-20.291		247.43	176.31	4.8921	347.91	524.22
6	cohesv	-20.291	2.300	247.43	--------	1.0000	331.43	331.43
		-22.591		287.68	--------	1.0000	371.68	371.68
7	sandy	-22.591	3.800	287.68	199.31	4.5985	406.36	605.67
		-26.391		352.28	237.31	4.5985	528.68	765.99
8	cohesv	-26.391	4.900	352.28	--------	1.0000	436.28	436.28
		-31.291		438.03	--------	1.0000	522.03	522.03
9	sandy	-31.291	9.377	438.03	286.31	4.8921	742.21	1028.52
		-40.668		597.44	380.08	4.8921	1063.33	1443.41
10	sandy	-40.668	0.323	597.44	380.08	4.8921	1063.33	1443.41
		-40.991		602.93	383.31	4.8921	1074.39	1457.70
11	sandy	-40.991	0.141	602.93	383.31	5.2124	1144.74	1528.05
		-41.132		605.33	384.72	5.2124	1149.89	1534.61
12	sandy	-41.132	1.234	605.33	384.72	5.2124	1149.89	1534.61
		-42.366		626.31	397.06	5.2124	1194.93	1591.99
13	sandy	-42.366	8.225	626.31	397.06	5.2124	1194.93	1591.99
		-50.591		766.13	479.31	5.2124	1495.01	1974.32
14	cohesv	-50.591	1.569	766.13	--------	1.0000	1126.13	1126.13
		-52.160		794.37	--------	1.0000	1154.37	1154.37

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

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

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

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	7.000	0.00	0.00	0.0000	0.00	0.00
		-2.660		0.00	70.00	0.0000	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	2.431	0.00	70.00	0.0000	0.00	70.00
		-5.091		0.00	94.31	0.0000	0.00	94.31
3	sandy	-5.091	9.469	94.31	94.31	0.5152	0.00	94.31
		-14.560		255.28	189.00	0.5152	34.15	223.15
4	sandy	-14.560	1.431	255.28	189.00	0.5152	34.15	223.15
		-15.991		279.61	203.31	0.5152	39.31	242.62
5	sandy	-15.991	4.300	279.61	203.31	0.4554	34.74	238.05
		-20.291		352.71	246.31	0.4554	48.45	294.76
6	cohesv	-20.291	2.300	352.71	--------	0.6000	211.63	211.63
		-22.591		392.96	--------	0.6000	235.78	235.78
7	sandy	-22.591	3.800	392.96	269.31	0.4701	58.13	327.44
		-26.391		457.56	307.31	0.4701	70.63	377.94
8	cohesv	-26.391	4.900	457.56	--------	0.6000	274.54	274.54
		-31.291		543.31	--------	0.6000	325.99	325.99
9	sandy	-31.291	9.377	543.31	356.31	0.4554	85.15	441.46
		-40.668		702.72	450.08	0.4554	115.04	565.12
10	sandy	-40.668	0.323	702.72	450.08	0.4554	115.04	565.12
		-40.991		708.21	453.31	0.4554	116.07	569.38
11	sandy	-40.991	0.141	708.21	453.31	0.4408	112.36	565.67
		-41.132		710.61	454.72	0.4408	112.80	567.52
12	sandy	-41.132	1.234	710.61	454.72	0.4408	112.80	567.52
		-42.366		731.59	467.06	0.4408	116.61	583.67
13	sandy	-42.366	8.225	731.59	467.06	0.4408	116.61	583.67
		-50.591		871.41	549.31	0.4408	141.98	691.29
14	cohesv	-50.591	1.569	871.41	--------	0.5000	435.70	435.70
		-52.160		899.65	--------	0.5000	449.83	449.83

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

$$Po = Po1 + pw1 \quad \text{(sand soil)}$$

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

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 -5.091	2.431	0.00 0.00	0.00 24.31	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 24.31
3	sandy	-5.091 -14.560	9.469	0.00 0.00	24.31 119.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	24.31 119.00
4	sandy	-14.560 -15.991	1.431	150.00 174.33	119.00 133.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.62	134.97 154.93
5	sandy	-15.991 -20.291	4.300	174.33 247.43	133.31 176.31	13.00	4.29 60.19	0.4554 0.4554	19.11 38.49	152.42 214.80
6	cohesv	-20.291 -22.591	2.300	247.43 287.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	156.51 187.12	156.51 187.12
7	sandy	-22.591 -26.391	3.800	287.68 352.28	199.31 237.31	13.00	108.49 157.89	0.4701 0.4701	52.91 70.59	252.22 307.90
8	cohesv	-26.391 -31.291	4.900	352.28 438.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	232.48 297.69	232.48 297.69
9	sandy	-31.291 -40.668	9.377	438.03 597.44	286.31 380.08	20.00	260.79 448.33	0.4554 0.4554	95.55 144.48	381.86 524.56
10	sandy	-40.668 -40.991	0.323	597.44 602.93	380.08 383.31	20.00	448.33 454.79	0.4554 0.4554	144.48 146.16	524.56 529.47
11	sandy	-40.991 -41.132	0.141	602.93 605.33	383.31 384.72	30.00	454.79 459.03	0.4408 0.4408	141.49 142.34	524.80 527.06
12	sandy	-41.132 -42.366	1.234	605.33 626.31	384.72 397.06	30.00	459.03 496.06	0.4408 0.4408	142.34 149.79	527.06 546.86
13	sandy	-42.366 -50.591	8.225	626.31 766.13	397.06 479.31	30.00	496.06 742.79	0.4408 0.4408	149.79 199.41	546.86 678.72
14	cohesv	-50.591 -52.160	1.569	766.13 794.37	-------- --------	90.00	742.79 884.00	0.5000 0.5000	465.84 495.70	465.84 495.70

friction force B7027influence range B = 4.487 (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 -5.091	2.431	0.00 0.00	0.00 24.31	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 24.31
3	sandy	-5.091 -14.560	9.469	0.00 0.00	24.31 119.00	3.00	0.00 0.00	0.0000 0.0000	0.00 0.00	24.31 119.00
4	sandy	-14.560 -15.991	1.431	150.00 174.33	119.00 133.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.57	134.97 154.88
5	sandy	-15.991 -20.291	4.300	174.33 247.43	133.31 176.31	13.00	4.29 60.19	0.4554 0.4554	19.07 37.87	152.38 214.18
6	cohesv	-20.291 -22.591	2.300	247.43 287.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	155.68 185.63	155.68 185.63
7	sandy	-22.591 -26.391	3.800	287.68 352.28	199.31 237.31	13.00	108.49 157.89	0.4701 0.4701	51.74 68.89	251.05 306.20
8	cohesv	-26.391 -31.291	4.900	352.28 438.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	230.31 294.11	230.31 294.11
9	sandy	-31.291 -40.668	9.377	438.03 597.44	286.31 380.08	20.00	260.79 448.33	0.4554 0.4554	92.84 139.81	379.15 519.89
10	sandy	-40.668 -40.991	0.323	597.44 602.93	380.08 383.31	20.00	448.33 454.79	0.4554 0.4554	139.81 141.42	519.89 524.73
11	sandy	-40.991 -41.132	0.141	602.93 605.33	383.31 384.72	30.00	454.79 459.03	0.4408 0.4408	136.90 137.71	520.21 522.43
12	sandy	-41.132 -42.366	1.234	605.33 626.31	384.72 397.06	30.00	459.03 496.06	0.4408 0.4408	137.71 144.79	522.43 541.85
13	sandy	-42.366 -50.591	8.225	626.31 766.13	397.06 479.31	30.00	496.06 742.79	0.4408 0.4408	144.79 191.92	541.85 671.23
14	cohesv	-50.591 -52.160	1.569	766.13 794.37	-------- --------	90.00	742.79 884.00	0.5000 0.5000	457.34 485.58	457.34 485.58

friction force B7027influence range B = 5.000 (m)

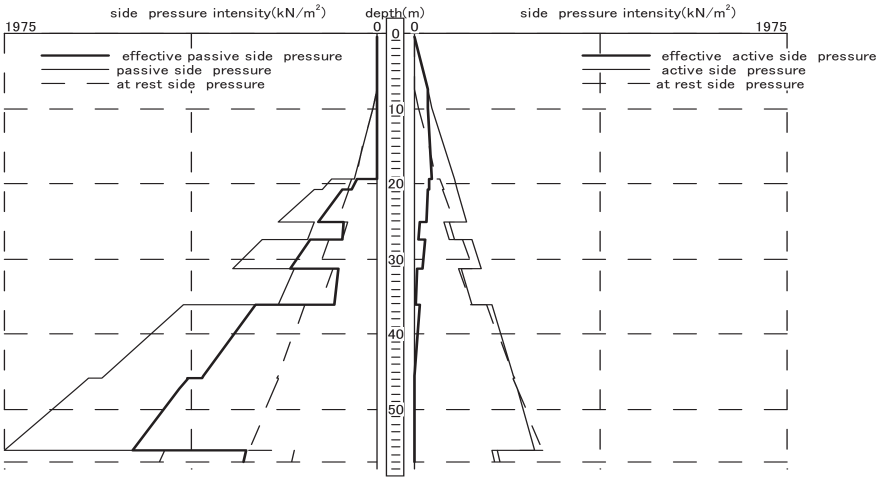
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

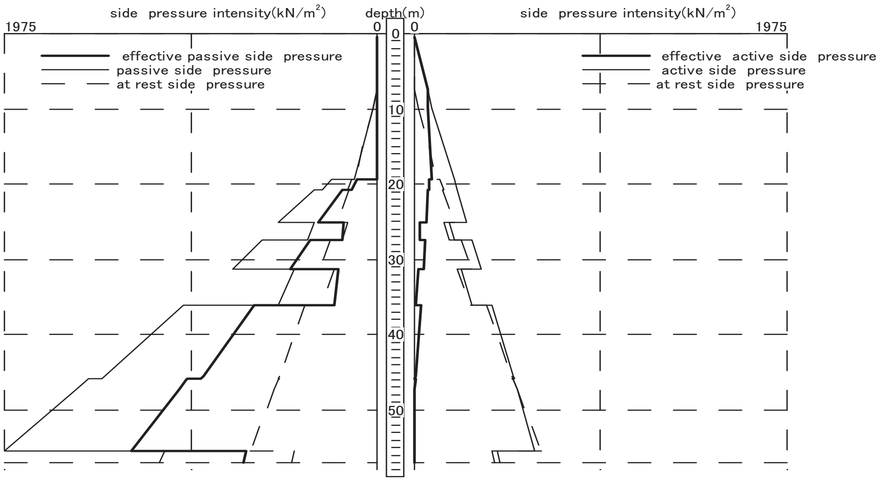
bridge axis direction

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 -5.091	9.431	----	----	----	----
2	sandy	-5.091 -14.560	9.469	17.0	0.0	29.00	3.0
3	sandy	-14.560 -15.991	1.431	17.0	0.0	29.00	3.0
4	sandy	-15.991 -20.291	4.300	17.0	0.0	33.00	13.0
5	cohesv	-20.291 -22.591	2.300	17.5	42.0	0.00	7.0
6	sandy	-22.591 -26.391	3.800	17.0	0.0	32.00	13.0
7	cohesv	-26.391 -31.291	4.900	17.5	42.0	0.00	7.0
8	sandy	-31.291 -40.991	9.700	17.0	0.0	33.00	20.0
9	sandy	-40.991 -50.591	9.600	17.0	0.0	34.00	30.0
10	cohesv	-50.591 -51.108	0.517	18.0	180.0	0.00	30.0
11	cohesv	-51.108 -52.112	1.004	18.0	180.0	0.00	30.0
12	cohesv	-52.112 -52.160	0.048	18.0	180.0	0.00	30.0

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 -5.091	9.431	0.00 0.00	-------- --------	0.00 94.31	------- -------	------- -------	0.00 0.00	0.00 94.31
2	sandy	-5.091 -14.560	9.469	94.31 255.28	-------- --------	94.31 189.00	0.3470 0.3470	------- -------	0.00 23.00	94.31 212.00
3	sandy	-14.560 -15.991	1.431	255.28 279.61	0.000 0.000	189.00 203.31	0.3470 0.3470	------- -------	23.00 26.47	212.00 229.78

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	sandy	-15.991 -20.291	4.300	279.61 352.71	0.000 0.000	203.31 246.31	0.2948 0.2948	------- -------	22.49 31.37	225.80 277.68
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	97.427 137.677	-------- --------	0.5053 0.5053	0.6000 0.6000	187.45 211.60	187.45 211.60
6	sandy	-22.591 -26.391	3.800	392.96 457.56	0.000 0.000	269.31 307.31	0.3073 0.3073	------- -------	37.99 46.17	307.30 353.48
7	cohesv	-26.391 -31.291	4.900	457.56 543.31	202.277 288.027	-------- --------	0.5053 0.5053	0.6000 0.6000	250.36 301.81	250.36 301.81
8	sandy	-31.291 -40.991	9.700	543.31 708.21	0.000 0.000	356.31 453.31	0.2948 0.2948	------- -------	55.13 75.14	411.44 528.45
9	sandy	-40.991 -50.591	9.600	708.21 871.41	0.000 0.000	453.31 549.31	0.2827 0.2827	------- -------	72.06 91.06	525.37 640.37
10	cohesv	-50.591 -51.108	0.517	871.41 880.72	616.127 625.441	-------- --------	0.4053 0.4053	0.5000 0.5000	411.53 416.19	411.53 416.19
11	cohesv	-51.108 -52.112	1.004	880.72 898.79	625.441 643.506	-------- --------	0.4053 0.4053	0.5000 0.5000	416.19 425.22	416.19 425.22
12	cohesv	-52.112 -52.160	0.048	898.79 899.65	643.506 644.369	-------- --------	0.4053 0.4053	0.5000 0.5000	425.22 425.65	425.22 425.65

$Pa1 = Ka1 * \left\{ Sum.\left((Gam.*h)\right) + q - pw1 \right\} - 2 * c * \sqrt{Ka1}$ (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 -5.091	9.431	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.8511 3.8511	119.38 157.96	119.38 172.27
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	4.8921 4.8921	200.66 347.91	214.97 405.22
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	1.0000 1.0000	212.43 252.68	212.43 252.68

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	4.5985 4.5985	406.36 528.68	486.67 646.99
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	1.0000 1.0000	317.28 403.03	317.28 403.03
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	4.8921 4.8921	742.21 1074.39	909.52 1338.70
9	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	5.2124 5.2124	1144.74 1495.01	1409.05 1855.32
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	1.0000 1.0000	1007.13 1016.44	1007.13 1016.44
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	1.0000 1.0000	1016.44 1034.51	1016.44 1034.51
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	1.0000 1.0000	1034.51 1035.37	1034.51 1035.37

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -5.091	9.431	0.00 0.00	0.00 94.31	0.0000 0.0000	0.00 0.00	0.00 94.31
2	sandy	-5.091 -14.560	9.469	94.31 255.28	94.31 189.00	0.5152 0.5152	0.00 34.15	94.31 223.15
3	sandy	-14.560 -15.991	1.431	255.28 279.61	189.00 203.31	0.5152 0.5152	34.15 39.31	223.15 242.62
4	sandy	-15.991 -20.291	4.300	279.61 352.71	203.31 246.31	0.4554 0.4554	34.74 48.45	238.05 294.76
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	-------- --------	0.6000 0.6000	211.63 235.78	211.63 235.78
6	sandy	-22.591 -26.391	3.800	392.96 457.56	269.31 307.31	0.4701 0.4701	58.13 70.63	327.44 377.94
7	cohesv	-26.391 -31.291	4.900	457.56 543.31	-------- --------	0.6000 0.6000	274.54 325.99	274.54 325.99

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
8	sandy	-31.291 -40.991	9.700	543.31 708.21	356.31 453.31	0.4554 0.4554	85.15 116.07	441.46 569.38
9	sandy	-40.991 -50.591	9.600	708.21 871.41	453.31 549.31	0.4408 0.4408	112.36 141.98	565.67 691.29
10	cohesv	-50.591 -51.108	0.517	871.41 880.72	-------- --------	0.5000 0.5000	435.70 440.36	435.70 440.36
11	cohesv	-51.108 -52.112	1.004	880.72 898.79	-------- --------	0.5000 0.5000	440.36 449.39	440.36 449.39
12	cohesv	-52.112 -52.160	0.048	898.79 899.65	-------- --------	0.5000 0.5000	449.39 449.83	449.39 449.83

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (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 -5.091	9.431	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	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
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.62	15.97 35.93
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	13.00	4.29 60.19	0.4554 0.4554	19.11 38.49	33.42 95.80
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	85.11 115.72	85.11 115.72
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	13.00	108.49 157.89	0.4701 0.4701	52.91 70.59	133.22 188.90
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	161.08 226.29	161.08 226.29
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	20.00	260.79 454.79	0.4554 0.4554	95.55 146.16	262.86 410.47

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	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	30.00	454.79 742.79	0.4408 0.4408	141.49 199.41	405.80 559.72
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	90.00	742.79 789.36	0.5000 0.5000	406.34 416.19	406.34 416.19
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	90.00	789.36 879.69	0.5000 0.5000	416.19 435.29	416.19 435.29
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	90.00	879.69 884.00	0.5000 0.5000	435.29 436.20	435.29 436.20

friction force B7027influence range B = 4.487 (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 -5.091	9.431	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	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
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.57	15.97 35.88
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	13.00	4.29 60.19	0.4554 0.4554	19.07 37.87	33.38 95.18
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	84.28 114.23	84.28 114.23
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	13.00	108.49 157.89	0.4701 0.4701	51.74 68.89	132.05 187.20
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	158.91 222.71	158.91 222.71
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	20.00	260.79 454.79	0.4554 0.4554	92.84 141.42	260.15 405.73

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	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	30.00	454.79 742.79	0.4408 0.4408	136.90 191.92	401.21 552.23
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	90.00	742.79 789.36	0.5000 0.5000	397.84 407.16	397.84 407.16
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	90.00	789.36 879.69	0.5000 0.5000	407.16 425.22	407.16 425.22
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	90.00	879.69 884.00	0.5000 0.5000	425.22 426.08	425.22 426.08

friction force B7027influence range B = 5.000 (m)

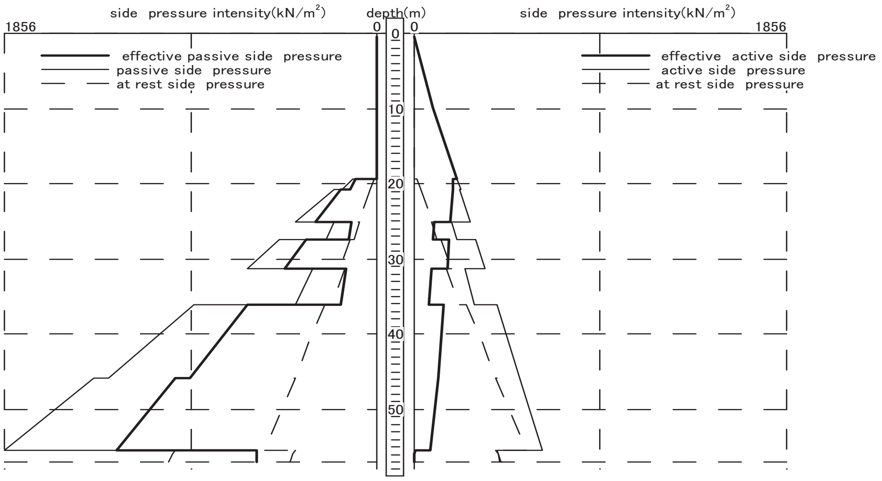
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

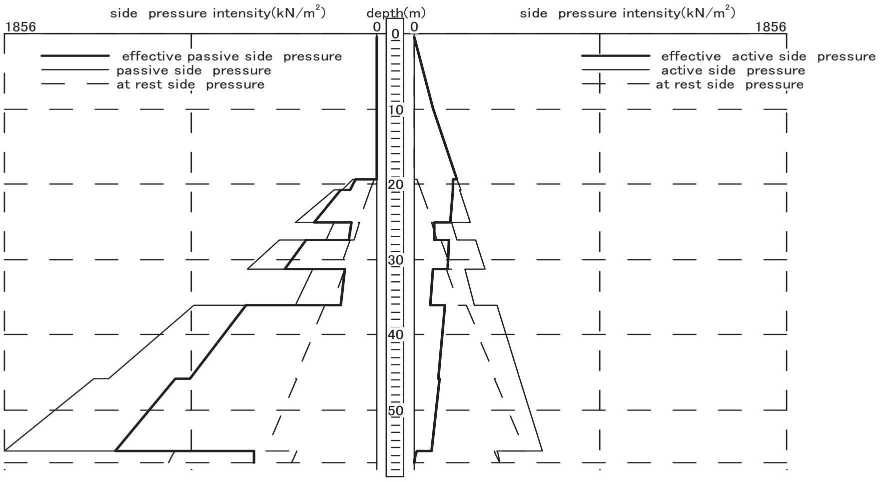
bridge axis direction

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



(5)construction step [5]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.091	9.431	----	----	----	----
2	sandy	-5.091 -14.560	9.469	17.0	0.0	29.00	3.0
3	sandy	-14.560 -15.991	1.431	17.0	0.0	29.00	3.0
4	sandy	-15.991 -20.291	4.300	17.0	0.0	33.00	13.0
5	cohesv	-20.291 -22.591	2.300	17.5	42.0	0.00	7.0
6	sandy	-22.591 -26.391	3.800	17.0	0.0	32.00	13.0
7	cohesv	-26.391 -31.291	4.900	17.5	42.0	0.00	7.0
8	sandy	-31.291 -40.991	9.700	17.0	0.0	33.00	20.0
9	sandy	-40.991 -50.591	9.600	17.0	0.0	34.00	30.0
10	cohesv	-50.591 -51.108	0.517	18.0	180.0	0.00	30.0
11	cohesv	-51.108 -52.112	1.004	18.0	180.0	0.00	30.0
12	cohesv	-52.112 -52.160	0.048	18.0	180.0	0.00	30.0

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 -5.091	9.431	0.00 0.00	-------- --------	0.00 94.31	------- -------	------- -------	0.00 0.00	0.00 94.31
2	sandy	-5.091 -14.560	9.469	94.31 255.28	-------- --------	94.31 189.00	0.3470 0.3470	------- -------	0.00 23.00	94.31 212.00
3	sandy	-14.560 -15.991	1.431	255.28 279.61	0.000 0.000	189.00 203.31	0.3470 0.3470	------- -------	23.00 26.47	212.00 229.78

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	sandy	-15.991 -20.291	4.300	279.61 352.71	0.000 0.000	203.31 246.31	0.2948 0.2948	------- -------	22.49 31.37	225.80 277.68
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	97.427 137.677	-------- --------	0.5053 0.5053	0.6000 0.6000	187.45 211.60	187.45 211.60
6	sandy	-22.591 -26.391	3.800	392.96 457.56	0.000 0.000	269.31 307.31	0.3073 0.3073	------- -------	37.99 46.17	307.30 353.48
7	cohesv	-26.391 -31.291	4.900	457.56 543.31	202.277 288.027	-------- --------	0.5053 0.5053	0.6000 0.6000	250.36 301.81	250.36 301.81
8	sandy	-31.291 -40.991	9.700	543.31 708.21	0.000 0.000	356.31 453.31	0.2948 0.2948	------- -------	55.13 75.14	411.44 528.45
9	sandy	-40.991 -50.591	9.600	708.21 871.41	0.000 0.000	453.31 549.31	0.2827 0.2827	------- -------	72.06 91.06	525.37 640.37
10	cohesv	-50.591 -51.108	0.517	871.41 880.72	616.127 625.441	-------- --------	0.4053 0.4053	0.5000 0.5000	411.53 416.19	411.53 416.19
11	cohesv	-51.108 -52.112	1.004	880.72 898.79	625.441 643.506	-------- --------	0.4053 0.4053	0.5000 0.5000	416.19 425.22	416.19 425.22
12	cohesv	-52.112 -52.160	0.048	898.79 899.65	643.506 644.369	-------- --------	0.4053 0.4053	0.5000 0.5000	425.22 425.65	425.22 425.65

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

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

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

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 -5.091	9.431	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.8511 3.8511	119.38 157.96	119.38 172.27
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	4.8921 4.8921	200.66 347.91	214.97 405.22
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	1.0000 1.0000	212.43 252.68	212.43 252.68

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw2 (kN/m²)	Kp	Pp1 (kN/m²)	Pp (kN/m²)
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	4.5985 4.5985	406.36 528.68	486.67 646.99
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	1.0000 1.0000	317.28 403.03	317.28 403.03
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	4.8921 4.8921	742.21 1074.39	909.52 1338.70
9	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	5.2124 5.2124	1144.74 1495.01	1409.05 1855.32
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	1.0000 1.0000	1007.13 1016.44	1007.13 1016.44
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	1.0000 1.0000	1016.44 1034.51	1016.44 1034.51
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	1.0000 1.0000	1034.51 1035.37	1034.51 1035.37

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -5.091	9.431	0.00 0.00	0.00 94.31	0.0000 0.0000	0.00 0.00	0.00 94.31
2	sandy	-5.091 -14.560	9.469	94.31 255.28	94.31 189.00	0.5152 0.5152	0.00 34.15	94.31 223.15
3	sandy	-14.560 -15.991	1.431	255.28 279.61	189.00 203.31	0.5152 0.5152	34.15 39.31	223.15 242.62
4	sandy	-15.991 -20.291	4.300	279.61 352.71	203.31 246.31	0.4554 0.4554	34.74 48.45	238.05 294.76
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	-------- --------	0.6000 0.6000	211.63 235.78	211.63 235.78
6	sandy	-22.591 -26.391	3.800	392.96 457.56	269.31 307.31	0.4701 0.4701	58.13 70.63	327.44 377.94
7	cohesv	-26.391 -31.291	4.900	457.56 543.31	-------- --------	0.6000 0.6000	274.54 325.99	274.54 325.99

No	soil	elevation (m)	layer thick (m)	Gam.*h+q (kN/m²)	pw1 (kN/m²)	Ko	Po1 (kN/m²)	Po (kN/m²)
8	sandy	-31.291 -40.991	9.700	543.31 708.21	356.31 453.31	0.4554 0.4554	85.15 116.07	441.46 569.38
9	sandy	-40.991 -50.591	9.600	708.21 871.41	453.31 549.31	0.4408 0.4408	112.36 141.98	565.67 691.29
10	cohesv	-50.591 -51.108	0.517	871.41 880.72	-------- --------	0.5000 0.5000	435.70 440.36	435.70 440.36
11	cohesv	-51.108 -52.112	1.004	880.72 898.79	-------- --------	0.5000 0.5000	440.36 449.39	440.36 449.39
12	cohesv	-52.112 -52.160	0.048	898.79 899.65	-------- --------	0.5000 0.5000	449.39 449.83	449.39 449.83

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (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 -5.091	9.431	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	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
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.62	15.97 35.93
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	13.00	4.29 60.19	0.4554 0.4554	19.11 38.49	33.42 95.80
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	85.11 115.72	85.11 115.72
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	13.00	108.49 157.89	0.4701 0.4701	52.91 70.59	133.22 188.90
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	161.08 226.29	161.08 226.29
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	20.00	260.79 454.79	0.4554 0.4554	95.55 146.16	262.86 410.47

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)
9	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	30.00	454.79 742.79	0.4408 0.4408	141.49 199.41	405.80 559.72
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	90.00	742.79 789.36	0.5000 0.5000	406.34 416.19	406.34 416.19
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	90.00	789.36 879.69	0.5000 0.5000	416.19 435.29	416.19 435.29
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	90.00	879.69 884.00	0.5000 0.5000	435.29 436.20	435.29 436.20

friction force B7027influence range B = 4.487 (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 -5.091	9.431	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	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
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.57	15.97 35.88
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	13.00	4.29 60.19	0.4554 0.4554	19.07 37.87	33.38 95.18
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	84.28 114.23	84.28 114.23
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	13.00	108.49 157.89	0.4701 0.4701	51.74 68.89	132.05 187.20
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	158.91 222.71	158.91 222.71
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	20.00	260.79 454.79	0.4554 0.4554	92.84 141.42	260.15 405.73

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)
9	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	30.00	454.79 742.79	0.4408 0.4408	136.90 191.92	401.21 552.23
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	90.00	742.79 789.36	0.5000 0.5000	397.84 407.16	397.84 407.16
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	90.00	789.36 879.69	0.5000 0.5000	407.16 425.22	407.16 425.22
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	90.00	879.69 884.00	0.5000 0.5000	425.22 426.08	425.22 426.08

friction force B7027influence range B = 5.000 (m)

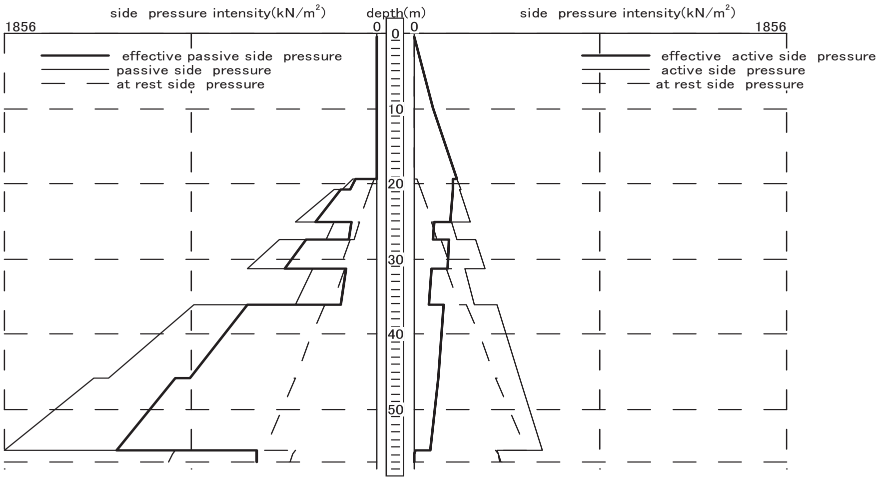
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B } (sand soil)

Po' = Po1'+ pw2 (sand soil)

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

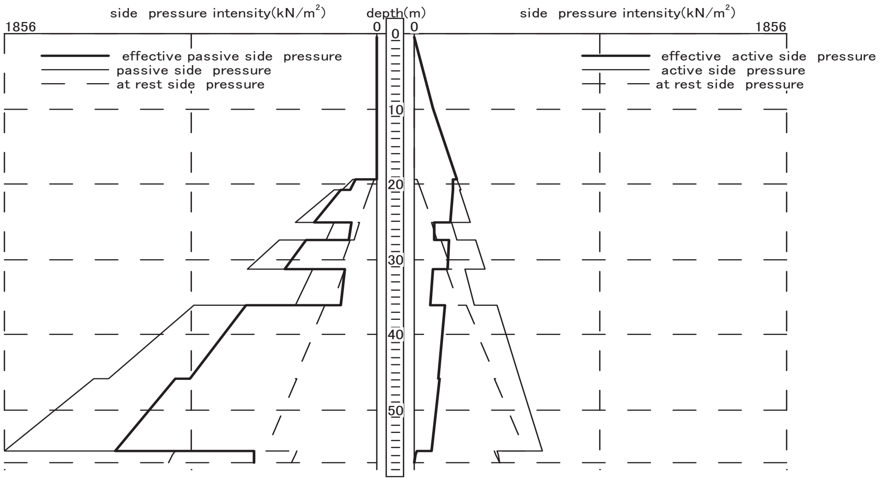
bridge axis direction

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



(6)construction step [6]

No	soil	elevation (m)	layer thick (m)	Gam. (kN/m³)	c (kN/m²)	Phi. (angle)	N
1	-------	+4.340 -5.091	9.431	----	----	----	----
2	sandy	-5.091 -14.560	9.469	17.0	0.0	29.00	3.0
3	sandy	-14.560 -15.991	1.431	17.0	0.0	29.00	3.0
4	sandy	-15.991 -20.291	4.300	17.0	0.0	33.00	13.0
5	cohesv	-20.291 -22.591	2.300	17.5	42.0	0.00	7.0
6	sandy	-22.591 -26.391	3.800	17.0	0.0	32.00	13.0
7	cohesv	-26.391 -31.291	4.900	17.5	42.0	0.00	7.0
8	sandy	-31.291 -40.991	9.700	17.0	0.0	33.00	20.0
9	sandy	-40.991 -50.591	9.600	17.0	0.0	34.00	30.0
10	cohesv	-50.591 -51.108	0.517	18.0	180.0	0.00	30.0
11	cohesv	-51.108 -52.112	1.004	18.0	180.0	0.00	30.0
12	cohesv	-52.112 -52.160	0.048	18.0	180.0	0.00	30.0

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 -5.091	9.431	0.00 0.00	-------- --------	0.00 94.31	------- -------	------- -------	0.00 0.00	0.00 94.31
2	sandy	-5.091 -14.560	9.469	94.31 255.28	-------- --------	94.31 189.00	0.3470 0.3470	------- -------	0.00 23.00	94.31 212.00
3	sandy	-14.560 -15.991	1.431	255.28 279.61	0.000 0.000	189.00 203.31	0.3470 0.3470	------- -------	23.00 26.47	212.00 229.78

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	sandy	-15.991 -20.291	4.300	279.61 352.71	0.000 0.000	203.31 246.31	0.2948 0.2948	------- -------	22.49 31.37	225.80 277.68
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	97.427 137.677	-------- --------	0.5053 0.5053	0.6000 0.6000	187.45 211.60	187.45 211.60
6	sandy	-22.591 -26.391	3.800	392.96 457.56	0.000 0.000	269.31 307.31	0.3073 0.3073	------- -------	37.99 46.17	307.30 353.48
7	cohesv	-26.391 -31.291	4.900	457.56 543.31	202.277 288.027	-------- --------	0.5053 0.5053	0.6000 0.6000	250.36 301.81	250.36 301.81
8	sandy	-31.291 -40.991	9.700	543.31 708.21	0.000 0.000	356.31 453.31	0.2948 0.2948	------- -------	55.13 75.14	411.44 528.45
9	sandy	-40.991 -50.591	9.600	708.21 871.41	0.000 0.000	453.31 549.31	0.2827 0.2827	------- -------	72.06 91.06	525.37 640.37
10	cohesv	-50.591 -51.108	0.517	871.41 880.72	616.127 625.441	-------- --------	0.4053 0.4053	0.5000 0.5000	411.53 416.19	411.53 416.19
11	cohesv	-51.108 -52.112	1.004	880.72 898.79	625.441 643.506	-------- --------	0.4053 0.4053	0.5000 0.5000	416.19 425.22	416.19 425.22
12	cohesv	-52.112 -52.160	0.048	898.79 899.65	643.506 644.369	-------- --------	0.4053 0.4053	0.5000 0.5000	425.22 425.65	425.22 425.65

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

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

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

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 -5.091	9.431	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	0.00 0.00	0.00 0.00	0.0000 0.0000	0.00 0.00	0.00 0.00
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.8511 3.8511	119.38 157.96	119.38 172.27
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	4.8921 4.8921	200.66 347.91	214.97 405.22
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	1.0000 1.0000	212.43 252.68	212.43 252.68

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	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	4.5985 4.5985	406.36 528.68	486.67 646.99
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	1.0000 1.0000	317.28 403.03	317.28 403.03
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	4.8921 4.8921	742.21 1074.39	909.52 1338.70
9	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	5.2124 5.2124	1144.74 1495.01	1409.05 1855.32
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	1.0000 1.0000	1007.13 1016.44	1007.13 1016.44
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	1.0000 1.0000	1016.44 1034.51	1016.44 1034.51
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	1.0000 1.0000	1034.51 1035.37	1034.51 1035.37

$Pp1 = Kp * \left\{ Sum.\left((Gam.*h)\right) + q - pw2 \right\} + 2*c*\sqrt{Kp}$ (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 -5.091	9.431	0.00 0.00	0.00 94.31	0.0000 0.0000	0.00 0.00	0.00 94.31
2	sandy	-5.091 -14.560	9.469	94.31 255.28	94.31 189.00	0.5152 0.5152	0.00 34.15	94.31 223.15
3	sandy	-14.560 -15.991	1.431	255.28 279.61	189.00 203.31	0.5152 0.5152	34.15 39.31	223.15 242.62
4	sandy	-15.991 -20.291	4.300	279.61 352.71	203.31 246.31	0.4554 0.4554	34.74 48.45	238.05 294.76
5	cohesv	-20.291 -22.591	2.300	352.71 392.96	-------- --------	0.6000 0.6000	211.63 235.78	211.63 235.78
6	sandy	-22.591 -26.391	3.800	392.96 457.56	269.31 307.31	0.4701 0.4701	58.13 70.63	327.44 377.94
7	cohesv	-26.391 -31.291	4.900	457.56 543.31	-------- --------	0.6000 0.6000	274.54 325.99	274.54 325.99

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)
8	sandy	-31.291 -40.991	9.700	543.31 708.21	356.31 453.31	0.4554 0.4554	85.15 116.07	441.46 569.38
9	sandy	-40.991 -50.591	9.600	708.21 871.41	453.31 549.31	0.4408 0.4408	112.36 141.98	565.67 691.29
10	cohesv	-50.591 -51.108	0.517	871.41 880.72	-------- --------	0.5000 0.5000	435.70 440.36	435.70 440.36
11	cohesv	-51.108 -52.112	1.004	880.72 898.79	-------- --------	0.5000 0.5000	440.36 449.39	440.36 449.39
12	cohesv	-52.112 -52.160	0.048	898.79 899.65	-------- --------	0.5000 0.5000	449.39 449.83	449.39 449.83

$Po1 = Ko * \left\{ Sum.(Gam.*h) + q - pw1 \right\}$ (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 -5.091	9.431	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	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
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.62	15.97 35.93
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	13.00	4.29 60.19	0.4554 0.4554	19.11 38.49	33.42 95.80
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	85.11 115.72	85.11 115.72
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	13.00	108.49 157.89	0.4701 0.4701	52.91 70.59	133.22 188.90
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	161.08 226.29	161.08 226.29
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	20.00	260.79 454.79	0.4554 0.4554	95.55 146.16	262.86 410.47

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	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	30.00	454.79 742.79	0.4408 0.4408	141.49 199.41	405.80 559.72
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	90.00	742.79 789.36	0.5000 0.5000	406.34 416.19	406.34 416.19
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	90.00	789.36 879.69	0.5000 0.5000	416.19 435.29	416.19 435.29
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	90.00	879.69 884.00	0.5000 0.5000	435.29 436.20	435.29 436.20

friction force B7027influence range B = 4.487 (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 -5.091	9.431	0.00 0.00	0.00 0.00	-------	-------- --------	0.0000 0.0000	0.00 0.00	0.00 0.00
2	sandy	-5.091 -14.560	9.469	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
3	sandy	-14.560 -15.991	1.431	31.00 55.33	0.00 14.31	3.00	0.00 4.29	0.5152 0.5152	15.97 21.57	15.97 35.88
4	sandy	-15.991 -20.291	4.300	55.33 128.43	14.31 57.31	13.00	4.29 60.19	0.4554 0.4554	19.07 37.87	33.38 95.18
5	cohesv	-20.291 -22.591	2.300	128.43 168.68	-------- --------	21.00	60.19 108.49	0.6000 0.6000	84.28 114.23	84.28 114.23
6	sandy	-22.591 -26.391	3.800	168.68 233.28	80.31 118.31	13.00	108.49 157.89	0.4701 0.4701	51.74 68.89	132.05 187.20
7	cohesv	-26.391 -31.291	4.900	233.28 319.03	-------- --------	21.00	157.89 260.79	0.6000 0.6000	158.91 222.71	158.91 222.71
8	sandy	-31.291 -40.991	9.700	319.03 483.93	167.31 264.31	20.00	260.79 454.79	0.4554 0.4554	92.84 141.42	260.15 405.73

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	sandy	-40.991 -50.591	9.600	483.93 647.13	264.31 360.31	30.00	454.79 742.79	0.4408 0.4408	136.90 191.92	401.21 552.23
10	cohesv	-50.591 -51.108	0.517	647.13 656.44	-------- --------	90.00	742.79 789.36	0.5000 0.5000	397.84 407.16	397.84 407.16
11	cohesv	-51.108 -52.112	1.004	656.44 674.51	-------- --------	90.00	789.36 879.69	0.5000 0.5000	407.16 425.22	407.16 425.22
12	cohesv	-52.112 -52.160	0.048	674.51 675.37	-------- --------	90.00	879.69 884.00	0.5000 0.5000	425.22 426.08	425.22 426.08

friction force B7027influence range B = 5.000 (m)

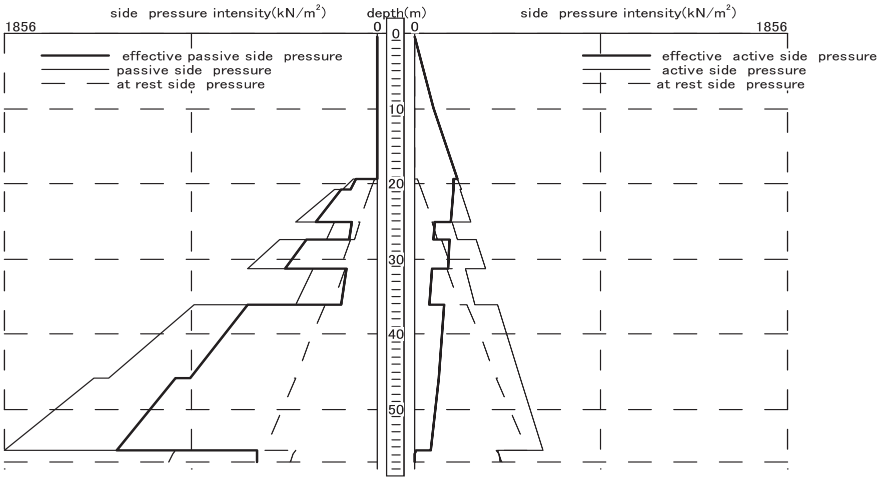
Po1'= Ko * { Sum.(Gam.*h) + q - pw2 } + Ko * { Sum.(f*h)—B }   (sand soil)

Po' = Po1'+ pw2   (sand soil)

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

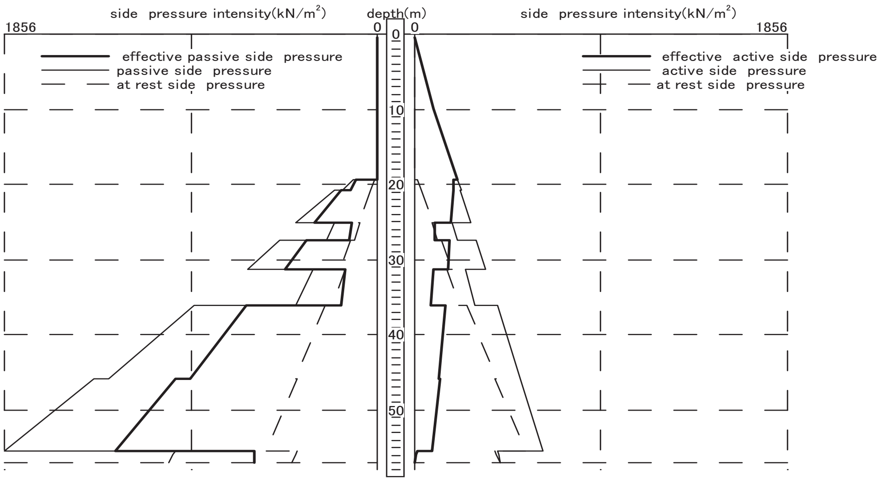
bridge axis direction

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



2.9 calculation result table

1)bridge axis direction

item			unit	the1step	the2step	the3step	the4step
displacement	max displacement	Del.max	cm	3.563	9.032	9.830	9.956
	accrue location	Lm	m	-5.160	-9.160	-8.160	-8.160
displace coffer displace part	max bending moment	Mmax	kN.m	1001.0	1983.0	2518.0	2655.0
		Sig.	N/mm²	94.80	187.79	238.42	251.46
		Lm	m	-3.160	-8.060	-7.160	-7.160
	SKY400	M	kN.m	1001.0	1372.0	1894.0	1932.0
		Sig.max	N/mm²	94.80	129.89	179.35	182.94
		Lm	m	-3.160	-3.160	-3.160	-3.160
	SKY490	M	kN.m	1001.0	1983.0	2518.0	2655.0
		Sig.max	N/mm²	94.80	187.79	238.42	251.46
		Lm	m	-3.160	-8.060	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	606.0	1985.0	2497.0	2581.0
		Sig.	N/mm²	57.38	187.94	236.51	244.43
		Lm	m	-8.060	-8.160	-8.060	-8.060
	SKY400	M	kN.m	-387.0	1633.0	1588.0	-800.0
		Sig.max	N/mm²	32.20	135.99	132.21	66.67
		Lm	m	-20.160	-12.160	-12.160	-22.591
	SKY490	M	kN.m	606.0	1985.0	2497.0	2581.0
		Sig.max	N/mm²	57.38	187.94	236.51	244.43
		Lm	m	-8.060	-8.160	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	218.5	0.0	0.0	0.0
		2nd row	kN/m	------	446.5	578.4	559.7
		3rd row	kN/m	------	------	------	81.6
		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	108.2	1212.5

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	9.956	9.942
	accrue location	Lm	m	-8.160	-8.160
displace coffer displace part	max bending moment	Mmax	kN.m	2655.0	2663.0
		Sig.	N/mm^2	251.46	252.19
		Lm	m	-7.160	-7.160
	SKY400	M	kN.m	1932.0	1937.0
		Sig.max	N/mm^2	182.94	183.41
		Lm	m	-3.160	-3.160
	SKY490	M	kN.m	2655.0	2663.0
		Sig.max	N/mm^2	251.46	252.19
		Lm	m	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	2581.0	2589.0
		Sig.	N/mm^2	244.43	245.22
		Lm	m	-8.060	-8.060
	SKY400	M	kN.m	-800.0	-800.0
		Sig.max	N/mm^2	66.67	66.65
		Lm	m	-22.591	-22.591
	SKY490	M	kN.m	2581.0	2589.0
		Sig.max	N/mm^2	244.43	245.22
		Lm	m	-8.060	-8.060
(SKY400)		Sig.a	N/mm^2	210.00	210.00
(SKY490)		Sig.a	N/mm^2	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	559.7	561.0
		3rd row	kN/m	81.6	80.9
		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	1212.5	1208.5

note)Lm shows elevation

2)perpendicular direction

item			unit	the1step	the2step	the3step	the4step
displace ment	max displacement	Del.max	cm	3.576	9.046	9.859	10.086
	accrue location	Lm	m	-5.160	-9.160	-8.160	-8.160
displace coffer displace part	max bending moment	Mmax	kN.m	1001.0	1982.0	2520.0	2670.0
		Sig.	N/mm²	94.80	187.71	238.66	252.85
		Lm	m	-3.160	-8.060	-7.160	-7.160
	SKY400	M	kN.m	1001.0	1371.0	1895.0	1915.0
		Sig.max	N/mm²	94.80	129.85	179.47	181.34
		Lm	m	-3.160	-3.160	-3.160	-3.160
	SKY490	M	kN.m	1001.0	1982.0	2520.0	2670.0
		Sig.max	N/mm²	94.80	187.71	238.66	252.85
		Lm	m	-3.160	-8.060	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	606.0	1984.0	2500.0	2603.0
		Sig.	N/mm²	57.39	187.86	236.77	246.49
		Lm	m	-8.060	-8.160	-8.060	-8.060
	SKY400	M	kN.m	-383.0	1632.0	1591.0	-824.0
		Sig.max	N/mm²	31.90	135.89	132.54	68.65
		Lm	m	-20.160	-12.160	-12.160	-22.591
	SKY490	M	kN.m	606.0	1984.0	2500.0	2603.0
		Sig.max	N/mm²	57.39	187.86	236.77	246.49
		Lm	m	-8.060	-8.160	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	218.5	0.0	0.0	0.0
		2nd row	kN/m	------	446.4	578.7	550.1
		3rd row	kN/m	------	------	------	99.0
		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	105.8	1191.0

note)Lm shows elevation

item			unit	the5step	the6step
displace ment	max displacement	Del.max	cm	10.086	10.073
	accrue location	Lm	m	-8.160	-8.160
displace coffer displace part	max bending moment	Mmax	kN.m	2670.0	2678.0
		Sig.	N/mm²	252.85	253.61
		Lm	m	-7.160	-7.160
	SKY400	M	kN.m	1915.0	1920.0
		Sig.max	N/mm²	181.34	181.82
		Lm	m	-3.160	-3.160
	SKY490	M	kN.m	2670.0	2678.0
		Sig.max	N/mm²	252.85	253.61
		Lm	m	-7.160	-7.160
displace celler displace part	max bending moment	Mmax	kN.m	2603.0	2612.0
		Sig.	N/mm²	246.49	247.31
		Lm	m	-8.060	-8.060
	SKY400	M	kN.m	-824.0	832.0
		Sig.max	N/mm²	68.65	69.27
		Lm	m	-22.591	-12.160
	SKY490	M	kN.m	2603.0	2612.0
		Sig.max	N/mm²	246.49	247.31
		Lm	m	-8.060	-8.060
(SKY400)		Sig.a	N/mm²	210.00	210.00
(SKY490)		Sig.a	N/mm²	280.00	280.00

support point reaction force	timbering reaction	1st row	kN/m	0.0	0.0
		2nd row	kN/m	550.1	551.4
		3rd row	kN/m	99.0	98.4
		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	1191.0	1187.6

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	-0.176	5.722	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.110	5.722	0.0	0.0	0.00	0.0	0.0	
218.5										
	+4.340	0.3	0.110	5.722	0.0	218.5	0.00	0.0	0.0	
	+3.840	5.3	0.395	5.700	109.0	217.1	10.32	0.0	0.0	
	+2.840	15.2	0.958	5.529	321.9	206.9	30.48	0.0	0.0	
	+1.840	25.2	1.496	5.196	519.5	186.7	49.19	0.0	0.0	
	+1.340	30.2	1.750	4.973	609.4	172.8	57.71	0.0	0.0	
	+0.840	35.2	1.993	4.716	691.8	156.4	65.52	0.0	0.0	
	+0.340	40.2	2.221	4.428	765.5	137.6	72.49	0.0	0.0	
	-0.160	40.2	2.435	4.113	829.2	117.5	78.53	0.0	0.0	
	-1.160	40.2	2.812	3.418	926.7	77.3	87.76	0.0	0.0	
	-1.660	40.1	2.974	3.045	960.3	57.3	90.94	0.0	0.0	
	-2.160	40.1	3.116	2.661	983.9	37.2	93.18	0.0	0.0	
	-3.160	40.1	3.343	1.875	1001.1	-2.9	94.80	0.0	0.0	
	-3.160	40.1	3.343	1.875	1001.1	-2.9	94.80	0.0	0.0	
	-4.160	40.1	3.492	1.092	978.1	-43.0	92.63	0.0	0.0	
	-4.660	40.1	3.537	0.711	951.6	-63.1	90.12	0.0	0.0	
	-5.091	40.1	3.560	0.392	920.7	-80.3	87.19	0.0	0.0	
	-5.091	40.0	3.560	0.392	920.7	-80.3	87.19	0.0	0.0	*
	-5.160	39.9	3.563	0.342	915.1	-83.0	86.66	1.6	1.6	*
	-6.160	38.4	3.562	-0.343	817.0	-109.1	77.37	24.6	24.6	*
	-6.855	37.3	3.523	-0.770	739.2	-112.7	70.00	40.6	40.6	*
	-6.855	37.3	3.523	-0.770	739.2	-112.7	70.00	40.6	40.6	
	-7.160	36.9	3.497	-0.944	705.0	-111.7	66.76	40.3	47.6	
	-8.060	35.5	3.391	-1.409	605.9	-108.5	57.38	39.1	68.3	
	-8.160	35.3	3.376	-1.457	595.1	-108.1	56.36	38.9	70.6	
	-9.160	33.8	3.209	-1.884	488.7	-104.7	46.28	37.0	93.6	
	-10.160	32.3	3.002	-2.229	385.5	-101.9	36.51	34.6	116.6	
	-11.160	30.8	2.766	-2.493	284.6	-100.1	26.96	31.9	139.6	
	-12.060	29.4	2.533	-2.663	194.8	-99.7	18.45	29.2	160.3	
	-12.160	29.2	2.506	-2.678	184.9	-99.7	17.51	28.9	162.6	
	-12.160	29.2	2.506	-2.678	184.9	-99.7	15.39	28.9	162.6	
	-13.060	27.9	2.261	-2.766	94.8	-100.7	7.89	26.1	183.3	

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
	-13.160	27.7	2.233	-2.772	84.7	-100.9	7.05	25.7	185.6	
	-14.160	26.2	1.954	-2.795	-17.4	-103.7	1.45	22.5	208.7	
	-15.160	24.7	1.677	-2.747	-123.2	-108.2	10.26	19.3	231.7	
	-15.991	24.4	1.452	-2.650	-215.1	-113.2	17.91	72.6	335.2	
	-16.060	24.3	1.434	-2.639	-222.8	-109.9	18.56	71.7	337.3	
	-16.160	24.0	1.407	-2.623	-233.6	-105.2	19.45	70.3	340.2	
	-17.160	21.6	1.154	-2.430	-317.3	-64.1	26.43	57.7	370.0	
	-18.160	19.1	0.923	-2.191	-364.9	-32.6	30.39	46.1	399.7	
	-19.160	16.7	0.717	-1.929	-385.4	-9.7	32.10	35.8	429.4	
	-20.160	14.2	0.537	-1.661	-386.6	6.1	32.20	26.9	459.2	
	-20.291	12.2	0.516	-1.626	-385.7	7.7	32.12	24.3	197.2	
	-21.160	9.7	0.385	-1.396	-374.9	16.6	31.22	18.1	200.9	
	-22.160	6.9	0.258	-1.142	-354.8	23.3	29.54	12.1	205.1	
	-22.591	5.5	0.211	-1.038	-344.3	25.3	28.67	18.4	496.1	
	-23.160	4.1	0.156	-0.905	-328.0	31.6	27.32	13.6	511.8	
	-24.160	1.6	0.076	-0.689	-292.4	38.8	24.35	6.7	539.3	
	-24.799	0.0	0.036	-0.565	-266.8	41.3	22.22	3.2	556.9	
	-25.160	0.0	0.017	-0.500	-251.7	42.2	20.96	1.5	566.9	
	-25.556	0.0	-0.002	-0.433	-234.9	42.4	19.56	0.0	577.8	
	-26.160	0.0	-0.025	-0.340	-209.4	41.7	17.44	0.0	594.4	
	-26.391	0.0	-0.032	-0.307	-199.8	41.1	16.64	0.0	227.0	
	-27.046	0.0	-0.050	-0.223	-173.3	39.8	14.43	0.0	231.6	
	-27.160	0.0	-0.052	-0.209	-168.8	39.6	14.06	0.0	232.4	
	-28.160	0.0	-0.068	-0.105	-130.6	36.7	10.87	0.0	239.4	
	-28.160	0.0	-0.068	-0.105	-130.6	36.7	12.36	0.0	239.4	
	-29.160	0.0	-0.073	-0.016	-95.5	33.4	9.05	0.0	246.4	
	-30.160	0.0	-0.072	0.046	-63.9	29.9	6.05	0.0	253.4	
	-31.160	0.0	-0.065	0.085	-35.6	26.7	3.37	0.0	260.4	
	-31.291	0.0	-0.064	0.089	-32.2	26.3	3.05	0.0	800.3	
	-32.160	0.0	-0.055	0.104	-12.4	19.3	1.18	0.0	825.5	
	-33.160	0.0	-0.045	0.107	3.4	12.5	0.32	0.0	854.6	
	-34.160	0.0	-0.034	0.100	13.1	7.2	1.24	0.0	883.6	
	-35.160	0.0	-0.025	0.087	18.3	3.3	1.73	0.0	912.6	
	-36.160	0.0	-0.017	0.072	20.1	0.5	1.90	0.0	941.7	
	-36.538	0.0	-0.014	0.066	20.1	-0.3	1.90	0.0	952.6	
	-37.160	0.0	-0.010	0.056	19.5	-1.4	1.85	0.0	971.9	

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
	-38.160	0.0	-0.006	0.042	17.6	-2.4	1.67	0.0	1003.0	
	-38.790	0.0	-0.003	0.033	15.9	-2.8	1.51	0.0	1022.6	
	-39.160	0.0	-0.002	0.029	14.9	-2.9	1.41	0.0	1034.1	
	-40.160	0.0	0.000	0.018	11.9	-3.0	1.13	0.0	1065.1	
	-40.991	0.0	0.001	0.011	9.4	-2.9	0.89	0.3	1176.3	
	-41.160	0.0	0.002	0.010	8.9	-2.9	0.84	0.3	1181.9	
	-42.160	0.0	0.002	0.004	6.2	-2.5	0.59	0.5	1215.3	
	-43.160	0.0	0.003	0.000	4.0	-2.0	0.38	0.5	1248.7	
	-44.160	0.0	0.002	-0.002	2.3	-1.4	0.22	0.5	1282.1	
	-45.160	0.0	0.002	-0.004	1.1	-1.0	0.11	0.4	1315.5	
	-46.160	0.0	0.002	-0.004	0.3	-0.6	0.03	0.3	1348.9	
	-47.160	0.0	0.001	-0.004	-0.1	-0.3	0.01	0.3	1382.3	
	-48.160	0.0	0.001	-0.004	-0.3	-0.1	0.03	0.2	1415.7	
	-49.160	0.0	0.000	-0.004	-0.3	0.1	0.02	0.1	1449.1	
	-50.160	0.0	0.000	-0.004	-0.2	0.1	0.02	0.0	1482.5	
	-50.591	0.0	0.000	-0.004	-0.1	0.1	0.01	0.0	755.7	
	-51.160	0.0	0.000	-0.004	-0.1	0.1	0.01	0.0	760.8	
	-52.160	0.0	-0.001	-0.004	0.0	0.0	0.00	0.0	769.8	

*showing plastic

(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	-2.007	10.980	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.458	10.980	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.458	10.980	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.909	10.980	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.189	10.982	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.288	10.994	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.838	11.008	-46.1	-45.7	4.37	0.0	0.0	
446.5										
	+1.340	30.2	1.838	11.008	-46.1	400.8	4.37	0.0	0.0	
	+0.840	35.2	2.388	10.987	150.3	384.4	14.23	0.0	0.0	
	+0.340	40.2	2.935	10.890	337.9	365.6	32.00	0.0	0.0	
	-0.160	40.2	3.476	10.722	515.7	345.5	48.84	0.0	0.0	
	-1.160	40.2	4.523	10.184	841.1	305.3	79.65	0.0	0.0	
	-1.660	40.1	5.023	9.822	988.8	285.3	93.64	0.0	0.0	
	-2.160	40.1	5.504	9.405	1126.4	265.2	106.67	0.0	0.0	
	-3.160	40.1	6.397	8.416	1371.5	225.1	129.89	0.0	0.0	
	-3.160	40.1	6.397	8.416	1371.5	225.1	129.89	0.0	0.0	
	-4.160	40.1	7.182	7.250	1576.6	185.0	149.30	0.0	0.0	
	-4.660	40.1	7.528	6.611	1664.1	164.9	157.59	0.0	0.0	
	-5.091	40.0	7.801	6.033	1731.4	147.7	163.97	0.0	0.0	
	-5.160	40.2	7.842	5.939	1741.5	144.9	164.92	0.0	0.0	
	-6.160	42.6	8.366	4.512	1865.9	103.5	176.71	0.0	0.0	
	-7.160	45.0	8.742	3.005	1947.8	59.7	184.46	0.0	0.0	
	-8.060	47.2	8.950	1.606	1983.0	18.2	187.79	0.0	0.0	
	-8.160	47.5	8.965	1.450	1984.6	13.5	187.94	0.0	0.0	
	-9.160	49.9	9.032	-0.115	1973.9	-35.2	186.93	0.0	0.0	
	-10.160	52.3	8.943	-1.653	1913.4	-86.3	181.20	0.0	0.0	
	-11.160	54.7	8.703	-3.122	1800.5	-139.8	170.51	0.0	0.0	
	-12.060	56.9	8.366	-4.350	1652.2	-190.1	156.47	0.0	0.0	
	-12.160	57.2	8.322	-4.480	1632.9	-195.8	154.64	0.0	0.0	
	-12.160	57.2	8.322	-4.480	1632.9	-195.8	135.99	0.0	0.0	
	-13.060	59.4	7.875	-5.440	1433.3	-248.2	119.37	0.0	0.0	
	-13.160	59.6	7.820	-5.539	1408.2	-254.2	117.27	0.0	0.0	
	-14.160	62.0	7.220	-6.421	1123.8	-315.0	93.59	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
	-14.560	63.0	6.958	-6.715	992.8	-340.0	82.68	0.0	0.0	
	-14.560	63.0	6.958	-6.715	992.8	-340.0	82.68	0.0	0.0	*
	-15.160	62.1	6.543	-7.084	778.4	-373.4	64.83	13.8	13.8	*
	-15.991	57.5	5.938	-7.441	453.8	-405.0	37.79	44.0	44.0	*
	-16.060	57.3	5.887	-7.462	425.8	-405.9	35.46	46.1	46.1	*
	-16.160	57.1	5.812	-7.490	385.2	-406.8	32.08	49.0	49.0	*
	-17.160	54.6	5.054	-7.616	-20.3	-398.8	1.69	78.8	78.8	*
	-18.160	52.2	4.298	-7.468	-401.6	-358.6	33.45	108.5	108.5	*
	-19.160	49.8	3.569	-7.072	-726.7	-286.2	60.52	138.2	138.2	*
	-19.777	48.2	3.143	-6.726	-885.1	-225.5	73.71	156.6	156.6	*
	-19.777	48.2	3.143	-6.726	-885.1	-225.5	73.71	157.1	156.6	
	-20.160	47.3	2.890	-6.479	-963.8	-186.0	80.27	144.5	168.0	
	-20.291	31.5	2.806	-6.391	-987.3	-173.5	82.23	132.2	174.5	
	-21.160	29.1	2.278	-5.757	-1103.1	-96.0	91.86	107.3	178.2	
	-22.160	26.3	1.741	-4.966	-1163.9	-29.4	96.93	82.0	182.4	
	-22.591	39.7	1.535	-4.617	-1171.7	-7.3	97.58	134.2	225.5	
	-23.160	38.2	1.285	-4.155	-1161.6	40.6	96.74	112.4	241.1	
	-24.160	35.7	0.909	-3.371	-1089.3	99.0	90.71	79.5	268.7	
	-25.160	33.2	0.609	-2.654	-972.5	130.4	80.99	53.2	296.2	
	-26.160	30.7	0.376	-2.026	-835.3	141.0	69.57	32.8	323.7	
	-26.391	18.5	0.330	-1.894	-802.7	141.1	66.85	15.6	203.4	
	-27.160	16.3	0.200	-1.495	-695.5	137.3	57.92	9.4	206.6	
	-28.160	13.5	0.073	-1.059	-562.3	128.6	46.83	3.5	210.8	
	-28.160	13.5	0.073	-1.059	-562.3	128.6	53.25	3.5	210.8	
	-29.160	10.7	-0.012	-0.664	-439.0	117.8	41.57	0.0	215.0	
	-30.160	7.9	-0.062	-0.363	-326.8	106.6	30.95	0.0	219.2	
	-31.160	5.1	-0.087	-0.146	-225.4	96.5	21.35	0.0	223.4	
	-31.291	13.7	-0.089	-0.123	-212.8	95.3	20.16	0.0	509.1	
	-32.160	10.9	-0.094	-0.003	-139.5	73.8	13.21	0.0	534.3	
	-33.160	7.8	-0.090	0.081	-76.9	52.0	7.28	0.0	563.4	
	-34.160	4.6	-0.079	0.123	-34.1	34.3	3.23	0.0	592.4	
	-35.160	1.5	-0.066	0.139	-6.6	21.5	0.62	0.0	621.4	
	-35.632	0.0	-0.059	0.139	2.5	17.1	0.23	0.0	635.1	
	-36.160	0.0	-0.052	0.137	10.5	13.2	0.99	0.0	650.5	
	-36.861	0.0	-0.043	0.128	18.1	8.7	1.71	0.0	670.8	
	-37.160	0.0	-0.039	0.124	20.4	7.1	1.93	0.0	679.5	

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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
	-38.160	0.0	-0.028	0.106	25.1	2.6	2.38	0.0	708.5	
	-39.160	0.0	-0.018	0.085	26.1	-0.5	2.47	0.0	737.5	
	-40.160	0.0	-0.011	0.065	24.6	-2.4	2.33	0.0	766.6	
	-40.991	0.0	-0.006	0.050	22.2	-3.2	2.11	0.0	855.3	
	-41.160	0.0	-0.005	0.047	21.7	-3.4	2.05	0.0	860.5	
	-42.160	0.0	-0.001	0.031	17.9	-4.0	1.69	0.0	890.9	
	-43.160	0.0	0.001	0.019	13.9	-4.0	1.31	0.3	921.4	
	-44.160	0.0	0.003	0.009	10.1	-3.5	0.96	0.6	951.8	
	-45.160	0.0	0.003	0.003	6.9	-2.9	0.65	0.7	982.3	
	-46.160	0.0	0.003	-0.002	4.4	-2.2	0.41	0.7	1012.7	
	-47.160	0.0	0.003	-0.004	2.5	-1.5	0.24	0.6	1043.2	
	-48.160	0.0	0.003	-0.006	1.2	-1.0	0.12	0.5	1073.7	
	-49.160	0.0	0.002	-0.007	0.5	-0.5	0.05	0.4	1104.1	
	-49.315	0.0	0.002	-0.007	0.4	-0.5	0.04	0.4	1108.8	
	-50.160	0.0	0.001	-0.007	0.1	-0.2	0.01	0.2	1137.0	
	-50.591	0.0	0.001	-0.007	0.1	-0.1	0.01	0.2	689.4	
	-51.160	0.0	0.001	-0.007	0.0	0.0	0.00	0.1	694.5	
	-52.160	0.0	0.000	-0.007	0.0	0.0	0.00	0.0	703.5	

*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	-2.743	13.157	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.085	13.157	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.085	13.157	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.427	13.157	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.112	13.159	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.205	13.170	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.864	13.184	-46.1	-45.7	4.37	0.0	0.0	
578.4										
	+1.340	30.2	1.864	13.184	-46.1	532.7	4.37	0.0	0.0	
	+0.840	35.2	2.522	13.151	216.2	516.3	20.48	0.0	0.0	
	-0.160	45.2	3.822	12.781	713.3	476.2	67.55	0.0	0.0	
	-1.160	55.2	5.066	12.037	1165.2	426.0	110.35	0.0	0.0	
	-1.660	60.1	5.656	11.536	1371.1	397.2	129.85	0.0	0.0	
	-2.160	65.1	6.218	10.957	1562.0	365.9	147.92	0.0	0.0	
	-2.660	70.1	6.750	10.305	1736.6	332.0	164.46	0.0	0.0	
	-3.160	70.1	7.248	9.588	1893.8	297.0	179.35	0.0	0.0	
	-3.160	70.1	7.248	9.588	1893.8	297.0	179.35	0.0	0.0	
	-4.160	70.1	8.128	7.986	2155.8	226.9	204.15	0.0	0.0	
	-4.660	70.1	8.506	7.114	2260.4	191.8	214.07	0.0	0.0	
	-5.091	70.0	8.796	6.332	2336.6	161.6	221.28	0.0	0.0	
	-5.160	70.2	8.839	6.204	2347.6	156.8	222.32	0.0	0.0	
	-6.160	72.6	9.365	4.299	2468.9	85.4	233.81	0.0	0.0	
	-7.160	75.0	9.696	2.326	2517.6	11.6	238.42	0.0	0.0	
	-8.060	77.2	9.825	0.542	2497.4	-56.9	236.51	0.0	0.0	
	-8.160	77.5	9.830	0.345	2491.3	-64.6	235.93	0.0	0.0	
	-9.160	79.9	9.767	-1.585	2387.6	-143.3	226.11	0.0	0.0	
	-10.160	82.3	9.517	-3.402	2203.9	-224.4	208.72	0.0	0.0	
	-11.160	84.7	9.093	-5.042	1938.0	-307.9	183.53	0.0	0.0	
	-12.060	86.9	8.580	-6.312	1626.2	-385.2	154.01	0.0	0.0	
	-12.160	87.2	8.516	-6.439	1587.6	-393.9	150.34	0.0	0.0	
	-12.160	87.2	8.516	-6.439	1587.6	-393.9	132.21	0.0	0.0	
	-13.060	89.4	7.896	-7.312	1224.3	-473.3	101.96	0.0	0.0	
108.2										
	-13.060	89.4	7.896	-7.312	1224.3	-365.1	101.96	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
	-13.160	89.6	7.822	-7.394	1182.2	-374.1	98.45	0.0	0.0	
	-14.160	92.0	7.047	-8.059	741.0	-464.9	61.71	0.0	0.0	
	-14.560	77.0	6.721	-8.238	547.6	-501.9	45.61	77.5	103.4	
	-15.160	76.1	6.221	-8.404	246.3	-503.1	20.51	71.7	117.2	
	-15.991	74.8	5.520	-8.425	-174.0	-509.5	14.49	63.6	136.3	
	-15.991	73.4	5.520	-8.425	-174.0	-509.5	14.49	181.5	181.5	*
	-16.060	73.2	5.462	-8.416	-208.9	-502.0	17.40	183.6	183.6	*
	-16.160	73.0	5.378	-8.399	-258.6	-490.8	21.53	186.6	186.6	*
	-17.160	70.5	4.552	-8.064	-687.2	-361.1	57.23	216.3	216.3	*
	-17.317	70.1	4.426	-7.986	-742.0	-337.9	61.79	221.0	221.0	*
	-17.317	70.1	4.426	-7.986	-742.0	-337.9	61.79	221.2	221.0	
	-18.160	68.1	3.773	-7.478	-976.8	-223.5	81.35	188.6	246.0	
	-19.160	65.6	3.062	-6.736	-1145.7	-119.8	95.42	153.0	275.8	
	-20.160	63.2	2.429	-5.908	-1226.9	-47.4	102.18	121.4	305.5	
	-20.291	30.9	2.352	-5.796	-1232.6	-40.0	102.65	110.8	174.9	
	-21.160	28.5	1.881	-5.048	-1239.8	20.6	103.25	88.6	178.6	
	-22.160	25.7	1.419	-4.201	-1192.5	70.9	99.31	66.8	182.8	
	-22.591	55.1	1.246	-3.850	-1158.3	87.1	96.47	108.9	353.4	
	-23.160	53.7	1.039	-3.403	-1101.0	112.9	91.69	90.9	369.1	
	-24.160	51.2	0.736	-2.682	-973.8	137.6	81.09	64.4	396.7	
	-25.160	48.7	0.500	-2.055	-832.8	141.2	69.36	43.7	424.2	
	-26.160	46.2	0.322	-1.525	-696.4	129.4	58.00	28.1	451.7	
	-26.391	17.9	0.288	-1.415	-667.0	124.9	55.55	13.6	203.8	
	-27.160	15.7	0.192	-1.085	-572.5	120.6	47.68	9.0	207.0	
	-28.160	12.9	0.102	-0.728	-455.5	113.1	37.94	4.8	211.2	
	-28.160	12.9	0.102	-0.728	-455.5	113.1	43.14	4.8	211.2	
	-29.160	10.1	0.046	-0.412	-346.6	104.9	32.82	2.1	215.4	
	-30.160	7.3	0.017	-0.179	-245.4	97.6	23.24	0.8	219.6	
	-31.160	4.5	0.007	-0.023	-150.7	92.2	14.27	0.3	223.8	
	-31.291	29.6	0.007	-0.008	-138.7	91.7	13.13	0.9	646.7	
	-32.160	26.8	0.010	0.062	-69.5	68.1	6.58	1.3	671.9	
	-33.160	23.7	0.018	0.093	-13.5	44.6	1.28	2.4	700.9	
	-34.160	20.5	0.027	0.089	21.3	25.5	2.01	3.6	729.9	
	-35.160	17.4	0.035	0.064	39.1	10.8	3.70	4.7	759.0	
	-36.160	14.2	0.040	0.030	44.2	0.0	4.18	5.3	788.0	
	-37.160	11.1	0.041	-0.003	40.3	-7.2	3.82	5.5	817.0	

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
	-38.160	7.9	0.039	-0.032	30.9	-11.3	2.92	5.3	846.0	
	-39.160	4.8	0.035	-0.051	18.7	-12.6	1.77	4.7	875.1	
	-40.160	1.6	0.029	-0.061	6.5	-11.5	0.61	3.9	904.1	
	-40.668	0.0	0.026	-0.063	1.0	-10.0	0.10	3.5	918.8	
	-40.991	0.6	0.024	-0.063	-2.0	-8.9	0.19	4.8	1003.2	
	-41.132	0.0	0.023	-0.062	-3.3	-8.3	0.31	4.6	1007.5	
	-41.160	0.0	0.023	-0.062	-3.5	-8.2	0.33	4.6	1008.4	
	-42.160	0.0	0.017	-0.057	-9.6	-4.2	0.90	3.4	1038.8	
	-42.366	0.0	0.016	-0.055	-10.3	-3.5	0.98	3.2	1045.1	
	-43.160	0.0	0.012	-0.048	-12.2	-1.3	1.16	2.3	1069.3	
	-44.160	0.0	0.007	-0.038	-12.5	0.6	1.18	1.5	1099.8	
	-45.160	0.0	0.004	-0.029	-11.3	1.7	1.07	0.8	1130.2	
	-46.160	0.0	0.001	-0.021	-9.4	2.2	0.89	0.3	1160.7	
	-47.160	0.0	0.000	-0.014	-7.1	2.3	0.67	0.0	1191.1	
	-48.160	0.0	-0.001	-0.009	-4.8	2.1	0.46	0.0	1221.6	
	-49.160	0.0	-0.002	-0.006	-2.9	1.8	0.27	0.0	1252.0	
	-50.160	0.0	-0.003	-0.005	-1.3	1.3	0.13	0.0	1282.5	
	-50.591	0.0	-0.003	-0.004	-0.8	1.0	0.08	0.0	690.4	
	-51.160	0.0	-0.003	-0.004	-0.3	0.7	0.03	0.0	695.5	
	-52.160	0.0	-0.004	-0.004	0.0	0.0	0.00	0.0	704.5	

*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	-2.813	13.346	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.146	13.346	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.146	13.346	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.478	13.346	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.144	13.348	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.192	13.360	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.860	13.374	-46.1	-45.7	4.37	0.0	0.0	
559.7										
	+1.340	30.2	1.860	13.374	-46.1	514.0	4.37	0.0	0.0	
	+0.840	35.2	2.528	13.342	206.9	497.6	19.59	0.0	0.0	
	-0.160	45.2	3.848	12.987	685.2	457.4	64.89	0.0	0.0	
	-1.160	55.2	5.114	12.272	1118.4	407.3	105.92	0.0	0.0	
	-1.660	60.1	5.715	11.791	1315.0	378.5	124.53	0.0	0.0	
81.6										
	-1.660	60.1	5.715	11.791	1315.0	460.0	124.53	0.0	0.0	
	-2.160	65.1	6.291	11.228	1537.3	428.7	145.58	0.0	0.0	
	-3.160	75.1	7.348	9.855	1931.7	358.6	182.94	0.0	0.0	
	-3.160	75.1	7.348	9.855	1931.7	358.6	182.94	0.0	0.0	
	-4.160	85.1	8.253	8.199	2251.1	278.5	213.18	0.0	0.0	
	-4.660	90.1	8.640	7.285	2379.5	234.7	225.34	0.0	0.0	
	-5.091	94.3	8.936	6.459	2472.2	195.0	234.12	0.0	0.0	
	-5.160	95.2	8.981	6.324	2485.4	188.4	235.37	0.0	0.0	
	-6.160	107.6	9.513	4.301	2624.2	87.0	248.51	0.0	0.0	
	-7.160	120.0	9.838	2.210	2655.3	-26.8	251.46	0.0	0.0	
	-8.060	131.2	9.953	0.345	2581.1	-139.8	244.43	0.0	0.0	
	-8.160	132.5	9.956	0.142	2566.5	-153.0	243.05	0.0	0.0	
	-9.160	144.9	9.871	-1.805	2345.2	-291.7	222.09	0.0	0.0	
	-10.160	157.3	9.602	-3.522	1979.0	-442.8	187.41	0.0	0.0	
	-11.160	169.7	9.178	-4.888	1455.4	-606.3	137.83	0.0	0.0	
	-12.060	180.9	8.698	-5.711	839.5	-764.1	79.50	0.0	0.0	
	-12.160	182.2	8.641	-5.774	765.2	-782.3	72.47	0.0	0.0	
	-12.160	182.2	8.641	-5.774	765.2	-782.3	63.73	0.0	0.0	
	-13.060	193.4	8.106	-6.015	286.0	-951.2	23.82	0.0	0.0	
1212.5										

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
	-13.060	193.4	8.106	-6.015	286.0	261.3	23.82	0.0	0.0	
	-13.160	194.6	8.046	-6.015	253.6	241.9	21.12	0.0	0.0	
	-14.160	207.0	7.442	-6.081	150.5	41.1	12.54	0.0	0.0	
	-14.560	196.0	7.198	-6.124	150.3	-42.7	12.52	83.0	103.4	
	-15.160	195.1	6.829	-6.178	104.1	-111.5	8.67	78.7	117.2	
	-15.991	193.8	6.314	-6.204	-29.3	-210.2	2.44	72.8	136.3	
	-15.991	192.4	6.314	-6.204	-29.3	-210.2	2.44	181.5	181.5	*
	-16.060	192.2	6.271	-6.202	-43.8	-210.9	3.65	183.6	183.6	*
	-16.160	192.0	6.209	-6.198	-65.0	-211.6	5.41	186.6	186.6	*
	-17.160	189.5	5.594	-6.080	-273.9	-200.9	22.81	216.3	216.3	*
	-18.160	187.1	4.998	-5.824	-456.0	-158.0	37.97	246.0	246.0	*
	-18.223	186.9	4.961	-5.804	-465.9	-154.2	38.80	247.9	247.9	*
	-18.223	186.9	4.961	-5.804	-465.9	-154.2	38.80	248.0	247.9	
	-19.160	184.6	4.433	-5.459	-587.1	-108.4	48.89	221.6	275.8	
	-20.160	182.2	3.909	-5.018	-681.1	-83.6	56.73	195.4	305.5	
	-20.291	181.9	3.843	-4.955	-692.0	-82.1	57.63	192.1	309.4	
	-20.291	102.3	3.843	-4.955	-692.0	-82.1	57.63	127.3	127.3	*
	-21.160	99.9	3.431	-4.519	-753.1	-57.7	62.72	131.0	131.0	*
	-22.160	97.1	3.006	-3.980	-794.1	-23.2	66.14	135.2	135.2	*
	-22.445	96.3	2.895	-3.822	-799.1	-12.0	66.55	136.3	136.3	*
	-22.445	96.3	2.895	-3.822	-799.1	-12.0	66.55	136.4	136.3	
	-22.591	174.1	2.840	-3.741	-800.5	-6.3	66.67	248.4	353.4	
	-23.160	172.7	2.636	-3.426	-793.0	31.2	66.04	230.5	369.1	
	-24.160	170.2	2.320	-2.892	-737.2	76.1	61.40	202.9	396.7	
	-25.160	167.7	2.056	-2.410	-648.3	98.2	53.99	179.8	424.2	
	-26.160	165.2	1.836	-1.995	-547.0	101.7	45.55	160.6	451.7	
	-26.391	89.3	1.791	-1.909	-523.6	100.3	43.61	84.4	156.2	
	-27.160	87.1	1.654	-1.650	-448.4	94.8	37.34	77.9	159.4	
	-28.160	84.3	1.504	-1.371	-359.0	83.3	29.90	70.8	163.6	
	-28.160	84.3	1.504	-1.371	-359.0	83.3	34.00	70.8	163.6	
	-29.160	81.5	1.380	-1.118	-282.9	68.2	26.79	65.0	167.8	
	-30.160	78.7	1.279	-0.920	-223.3	50.7	21.15	60.2	172.0	
	-31.160	75.9	1.195	-0.761	-182.1	31.6	17.24	56.3	176.2	
	-31.291	148.6	1.185	-0.742	-178.1	29.0	16.87	159.4	646.7	
	-32.160	145.8	1.125	-0.630	-149.5	36.1	14.16	151.4	671.9	
	-33.160	142.7	1.068	-0.526	-111.5	39.3	10.56	143.7	700.9	

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
	-34.160	139.5	1.019	-0.454	-72.3	38.5	6.85	137.1	729.9	
	-35.160	136.4	0.976	-0.412	-35.5	34.7	3.36	131.3	759.0	
	-36.160	133.2	0.936	-0.397	-3.7	28.6	0.35	125.9	788.0	
	-37.160	130.1	0.896	-0.404	20.9	20.2	1.98	120.6	817.0	
	-38.160	126.9	0.855	-0.427	36.0	9.5	3.41	115.0	846.0	
	-39.160	123.8	0.810	-0.457	39.1	-3.8	3.70	109.1	875.1	
	-40.160	120.6	0.763	-0.485	27.5	-20.0	2.60	102.7	904.1	
	-40.991	119.6	0.722	-0.496	4.3	-36.1	0.41	145.8	1003.2	
	-41.160	118.9	0.714	-0.496	-1.4	-31.7	0.13	144.1	1008.4	
	-42.160	114.8	0.665	-0.486	-21.5	-9.5	2.04	134.2	1038.8	
	-43.160	110.8	0.617	-0.467	-22.3	7.1	2.11	124.6	1069.3	
	-44.160	106.7	0.571	-0.454	-9.2	18.2	0.87	115.3	1099.8	
	-45.160	102.7	0.526	-0.455	12.4	24.2	1.18	106.1	1130.2	
	-46.160	98.6	0.480	-0.475	37.5	25.1	3.55	96.8	1160.7	
	-47.160	94.6	0.430	-0.514	60.7	20.4	5.75	86.8	1191.1	
	-48.160	90.5	0.376	-0.568	76.1	9.3	7.21	75.9	1221.6	
	-49.160	86.5	0.316	-0.630	76.9	-9.2	7.28	63.8	1252.0	
	-50.160	82.4	0.250	-0.684	54.9	-36.3	5.20	50.6	1282.5	
	-50.591	5.2	0.221	-0.699	36.2	-50.9	3.43	44.5	600.8	
	-51.108	0.0	0.184	-0.710	15.0	-31.1	1.42	37.2	600.3	
	-51.160	0.0	0.181	-0.710	13.4	-29.2	1.27	36.4	600.2	
	-52.112	0.0	0.113	-0.714	0.0	-1.1	0.00	22.7	599.2	
	-52.160	0.0	0.109	-0.714	0.0	0.0	0.00	22.0	599.2	

*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	-2.813	13.346	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.146	13.346	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.146	13.346	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.478	13.346	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.144	13.348	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.192	13.360	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.860	13.374	-46.1	-45.7	4.37	0.0	0.0	
559.7										
	+1.340	30.2	1.860	13.374	-46.1	514.0	4.37	0.0	0.0	
	+0.840	35.2	2.528	13.342	206.9	497.6	19.59	0.0	0.0	
	-0.160	45.2	3.848	12.987	685.2	457.4	64.89	0.0	0.0	
	-1.160	55.2	5.114	12.272	1118.4	407.3	105.92	0.0	0.0	
	-1.660	60.1	5.715	11.791	1315.0	378.5	124.53	0.0	0.0	
81.6										
	-1.660	60.1	5.715	11.791	1315.0	460.0	124.53	0.0	0.0	
	-2.160	65.1	6.291	11.228	1537.3	428.7	145.58	0.0	0.0	
	-3.160	75.1	7.348	9.855	1931.7	358.6	182.94	0.0	0.0	
	-3.160	75.1	7.348	9.855	1931.7	358.6	182.94	0.0	0.0	
	-4.160	85.1	8.253	8.199	2251.1	278.5	213.18	0.0	0.0	
	-4.660	90.1	8.640	7.285	2379.5	234.7	225.34	0.0	0.0	
0.0										
	-4.660	90.1	8.640	7.285	2379.5	234.7	225.34	0.0	0.0	
	-5.091	94.3	8.936	6.459	2472.2	195.0	234.12	0.0	0.0	
	-5.160	95.2	8.981	6.324	2485.4	188.4	235.37	0.0	0.0	
	-6.160	107.6	9.513	4.301	2624.2	87.0	248.51	0.0	0.0	
	-7.160	120.0	9.838	2.210	2655.3	-26.8	251.46	0.0	0.0	
	-8.060	131.2	9.953	0.345	2581.1	-139.8	244.43	0.0	0.0	
	-8.160	132.5	9.956	0.142	2566.5	-153.0	243.05	0.0	0.0	
	-9.160	144.9	9.871	-1.805	2345.2	-291.7	222.09	0.0	0.0	
	-10.160	157.3	9.602	-3.522	1979.0	-442.8	187.41	0.0	0.0	
	-11.160	169.7	9.178	-4.888	1455.4	-606.3	137.83	0.0	0.0	
	-12.060	180.9	8.698	-5.711	839.5	-764.1	79.50	0.0	0.0	
	-12.160	182.2	8.641	-5.774	765.2	-782.3	72.47	0.0	0.0	
	-12.160	182.2	8.641	-5.774	765.2	-782.3	63.73	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
	-13.060	193.4	8.106	-6.015	286.0	-951.3	23.82	0.0	0.0	
1212.5										
	-13.060	193.4	8.106	-6.015	286.0	261.3	23.82	0.0	0.0	
	-13.160	194.6	8.046	-6.015	253.6	241.9	21.12	0.0	0.0	
	-14.160	207.0	7.442	-6.081	150.5	41.1	12.54	0.0	0.0	
	-14.560	196.0	7.198	-6.124	150.3	-42.7	12.52	83.0	103.4	
	-15.160	195.1	6.829	-6.178	104.1	-111.5	8.67	78.7	117.2	
	-15.991	193.8	6.314	-6.204	-29.3	-210.2	2.44	72.8	136.3	
	-15.991	192.4	6.314	-6.204	-29.3	-210.2	2.44	181.5	181.5	*
	-16.060	192.2	6.271	-6.202	-43.8	-210.9	3.65	183.6	183.6	*
	-16.160	192.0	6.209	-6.198	-65.0	-211.6	5.41	186.6	186.6	*
	-17.160	189.5	5.594	-6.080	-273.9	-200.9	22.81	216.3	216.3	*
	-18.160	187.1	4.998	-5.824	-456.0	-158.0	37.97	246.0	246.0	*
	-18.234	186.9	4.955	-5.801	-467.5	-153.6	38.93	248.2	248.2	*
	-18.234	186.9	4.955	-5.801	-467.5	-153.6	38.93	247.7	248.2	
	-19.160	184.6	4.433	-5.459	-587.1	-108.4	48.90	221.6	275.8	
	-20.160	182.2	3.909	-5.018	-681.1	-83.6	56.73	195.4	305.5	
	-20.291	181.9	3.843	-4.955	-692.0	-82.1	57.63	192.1	309.4	
	-20.291	102.3	3.843	-4.955	-692.0	-82.1	57.63	127.3	127.3	*
	-21.160	99.9	3.431	-4.519	-753.1	-57.7	62.72	131.0	131.0	*
	-22.160	97.1	3.006	-3.980	-794.1	-23.2	66.14	135.2	135.2	*
	-22.445	96.3	2.895	-3.822	-799.2	-12.0	66.55	136.4	136.4	*
	-22.445	96.3	2.895	-3.822	-799.2	-12.0	66.55	136.4	136.4	
	-22.591	174.1	2.840	-3.741	-800.5	-6.3	66.67	248.4	353.4	
	-23.160	172.7	2.636	-3.426	-793.0	31.2	66.04	230.5	369.1	
	-24.160	170.2	2.320	-2.892	-737.2	76.1	61.40	202.9	396.7	
	-25.160	167.7	2.056	-2.410	-648.3	98.2	53.99	179.8	424.2	
	-26.160	165.2	1.836	-1.995	-547.0	101.7	45.55	160.6	451.7	
	-26.391	89.3	1.791	-1.909	-523.6	100.3	43.61	84.4	156.2	
	-27.160	87.1	1.654	-1.650	-448.4	94.8	37.34	77.9	159.4	
	-28.160	84.3	1.504	-1.371	-359.0	83.3	29.90	70.8	163.6	
	-28.160	84.3	1.504	-1.371	-359.0	83.3	34.00	70.8	163.6	
	-29.160	81.5	1.380	-1.118	-282.9	68.2	26.79	65.0	167.8	
	-30.160	78.7	1.279	-0.920	-223.3	50.7	21.15	60.2	172.0	
	-31.160	75.9	1.195	-0.761	-182.1	31.6	17.24	56.3	176.2	
	-31.291	148.6	1.185	-0.742	-178.1	29.0	16.87	159.4	646.7	

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
	-32.160	145.8	1.125	-0.630	-149.5	36.1	14.16	151.4	671.9	
	-33.160	142.7	1.068	-0.526	-111.5	39.3	10.56	143.7	700.9	
	-34.160	139.5	1.019	-0.454	-72.3	38.5	6.85	137.1	729.9	
	-35.160	136.4	0.976	-0.412	-35.5	34.7	3.36	131.3	759.0	
	-36.160	133.2	0.936	-0.397	-3.7	28.6	0.35	125.9	788.0	
	-37.160	130.1	0.896	-0.404	20.9	20.2	1.98	120.6	817.0	
	-38.160	126.9	0.855	-0.427	36.0	9.5	3.41	115.0	846.0	
	-39.160	123.8	0.810	-0.457	39.1	-3.8	3.70	109.1	875.1	
	-40.160	120.6	0.763	-0.485	27.5	-20.0	2.60	102.7	904.1	
	-40.991	119.6	0.722	-0.496	4.3	-36.1	0.41	145.8	1003.2	
	-41.160	118.9	0.714	-0.496	-1.4	-31.7	0.13	144.1	1008.4	
	-42.160	114.8	0.665	-0.486	-21.5	-9.5	2.04	134.2	1038.8	
	-43.160	110.8	0.617	-0.467	-22.3	7.1	2.11	124.6	1069.3	
	-44.160	106.7	0.571	-0.454	-9.2	18.2	0.87	115.3	1099.8	
	-45.160	102.7	0.526	-0.455	12.4	24.2	1.18	106.1	1130.2	
	-46.160	98.6	0.480	-0.475	37.5	25.1	3.55	96.8	1160.7	
	-47.160	94.6	0.430	-0.514	60.7	20.4	5.75	86.8	1191.1	
	-48.160	90.5	0.376	-0.568	76.1	9.3	7.21	75.9	1221.6	
	-49.160	86.5	0.316	-0.630	76.9	-9.2	7.28	63.8	1252.0	
	-50.160	82.4	0.250	-0.684	54.9	-36.3	5.20	50.6	1282.5	
	-50.591	5.2	0.221	-0.699	36.2	-50.9	3.43	44.5	600.8	
	-51.108	0.0	0.184	-0.710	15.0	-31.1	1.42	37.2	600.3	
	-51.160	0.0	0.181	-0.710	13.4	-29.2	1.27	36.4	600.2	
	-52.112	0.0	0.113	-0.714	0.0	-1.1	0.00	22.7	599.2	
	-52.160	0.0	0.109	-0.714	0.0	0.0	0.00	22.0	599.2	

*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	-2.812	13.345	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.145	13.345	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.145	13.345	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.478	13.345	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.143	13.347	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.192	13.359	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.860	13.373	-46.1	-45.7	4.37	0.0	0.0	
561.0										
	+1.340	30.2	1.860	13.373	-46.1	515.3	4.37	0.0	0.0	
	+0.840	35.2	2.528	13.341	207.5	499.0	19.66	0.0	0.0	
	-0.160	45.2	3.848	12.985	687.2	458.8	65.08	0.0	0.0	
	-1.160	55.2	5.113	12.268	1121.8	408.6	106.23	0.0	0.0	
	-1.660	60.1	5.715	11.786	1319.0	379.8	124.91	0.0	0.0	
80.9										
	-1.660	60.1	5.715	11.786	1319.0	460.7	124.91	0.0	0.0	
	-2.160	65.1	6.290	11.221	1541.6	429.4	145.99	0.0	0.0	
	-3.160	75.1	7.346	9.844	1936.8	359.3	183.41	0.0	0.0	
	-3.160	75.1	7.346	9.844	1936.8	359.3	183.41	0.0	0.0	
	-4.160	85.1	8.250	8.184	2256.8	279.2	213.72	0.0	0.0	
	-4.660	90.1	8.636	7.267	2385.6	235.4	225.92	0.0	0.0	
0.0										
	-4.660	90.1	8.636	7.267	2385.6	235.4	225.92	0.0	0.0	
	-5.091	94.3	8.932	6.439	2478.5	195.6	234.72	0.0	0.0	
	-5.160	95.2	8.976	6.304	2491.8	189.1	235.97	0.0	0.0	
	-6.160	107.6	9.506	4.276	2631.2	87.7	249.18	0.0	0.0	
	-7.160	120.0	9.829	2.179	2663.0	-26.1	252.19	0.0	0.0	
	-8.060	995439.9	9.940	0.308	2589.4	-139.2	245.22	0.0	0.0	
	-8.160	995684.4	9.942	0.104	2568.4	-281.4	243.23	0.0	0.0	
	-9.160	987232.6	9.856	-1.802	2319.3	-254.7	219.64	0.0	0.0	
	-10.160	960368.6	9.589	-3.488	1974.1	-412.0	186.95	0.0	0.0	
	-11.160	917990.7	9.169	-4.839	1464.8	-550.2	138.72	0.0	0.0	
	-12.060	180.9	8.693	-5.667	851.5	-761.8	80.64	0.0	0.0	
	-12.160	182.2	8.636	-5.731	777.5	-780.0	73.63	0.0	0.0	
	-12.160	182.2	8.636	-5.731	777.5	-780.0	64.75	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
	-13.060	193.4	8.106	-5.980	299.3	-949.0	24.93	0.0	0.0	
1208.5										
	-13.060	193.4	8.106	-5.980	299.3	259.5	24.93	0.0	0.0	
	-13.160	194.6	8.046	-5.981	266.9	240.1	22.23	0.0	0.0	
	-14.160	207.0	7.445	-6.056	162.9	39.3	13.57	0.0	0.0	
	-14.560	196.0	7.202	-6.102	161.9	-44.5	13.49	83.0	103.4	
	-15.160	195.1	6.834	-6.161	114.7	-113.3	9.55	78.8	117.2	
	-15.991	193.8	6.320	-6.193	-20.2	-211.9	1.68	72.9	136.3	
	-15.991	192.4	6.320	-6.193	-20.2	-211.9	1.68	181.5	181.5	*
	-16.060	192.2	6.277	-6.191	-34.8	-212.6	2.90	183.6	183.6	*
	-16.160	192.0	6.215	-6.188	-56.1	-213.3	4.67	186.6	186.6	*
	-17.160	189.5	5.601	-6.075	-266.7	-202.6	22.21	216.3	216.3	*
	-18.160	187.1	5.005	-5.824	-450.5	-159.7	37.52	246.0	246.0	*
	-18.228	186.9	4.965	-5.802	-461.3	-155.6	38.42	248.1	248.1	*
	-18.228	186.9	4.965	-5.802	-461.3	-155.6	38.42	248.1	248.1	
	-19.160	184.6	4.440	-5.463	-583.2	-109.8	48.57	221.9	275.8	
	-20.160	182.2	3.915	-5.023	-678.4	-84.7	56.50	195.7	305.5	
	-20.291	181.9	3.849	-4.961	-689.4	-83.1	57.42	192.4	309.4	
	-20.291	102.3	3.849	-4.961	-689.4	-83.1	57.42	127.3	127.3	*
	-21.160	99.9	3.437	-4.526	-751.4	-58.7	62.58	131.0	131.0	*
	-22.160	97.1	3.011	-3.987	-793.5	-24.2	66.08	135.2	135.2	*
	-22.451	96.3	2.897	-3.827	-798.9	-12.8	66.53	136.4	136.4	*
	-22.451	96.3	2.897	-3.827	-798.9	-12.8	66.53	136.5	136.4	
	-22.591	174.1	2.844	-3.749	-800.3	-7.3	66.65	248.8	353.4	
	-23.160	172.7	2.640	-3.434	-793.3	30.4	66.06	230.9	369.1	
	-24.160	170.2	2.324	-2.900	-738.1	75.7	61.47	203.2	396.7	
	-25.160	167.7	2.058	-2.417	-649.6	98.0	54.10	180.0	424.2	
	-26.160	165.2	1.838	-2.001	-548.3	101.7	45.66	160.8	451.7	
	-26.391	89.3	1.793	-1.915	-525.0	100.3	43.72	84.4	156.2	
	-27.160	87.1	1.656	-1.655	-449.7	94.8	37.46	78.0	159.4	
	-28.160	84.3	1.505	-1.375	-360.2	83.4	30.00	70.9	163.6	
	-28.160	84.3	1.505	-1.375	-360.2	83.4	34.12	70.9	163.6	
	-29.160	81.5	1.381	-1.121	-284.1	68.4	26.90	65.0	167.8	
	-30.160	78.7	1.279	-0.922	-224.3	50.8	21.24	60.2	172.0	
	-31.160	75.9	1.195	-0.762	-182.9	31.7	17.32	56.3	176.2	
	-31.291	148.6	1.185	-0.744	-178.9	29.2	16.94	159.4	646.7	

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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
	-32.160	145.8	1.125	-0.631	-150.2	36.2	14.22	151.4	671.9	
	-33.160	142.7	1.068	-0.527	-112.0	39.4	10.60	143.7	700.9	
	-34.160	139.5	1.019	-0.454	-72.7	38.6	6.88	137.1	729.9	
	-35.160	136.4	0.976	-0.412	-35.7	34.8	3.38	131.3	759.0	
	-36.160	133.2	0.936	-0.396	-3.8	28.7	0.36	125.9	788.0	
	-37.160	130.1	0.896	-0.404	20.8	20.3	1.97	120.6	817.0	
	-38.160	126.9	0.855	-0.427	35.9	9.6	3.40	115.0	846.0	
	-39.160	123.8	0.810	-0.457	39.1	-3.7	3.70	109.0	875.1	
	-40.160	120.6	0.763	-0.485	27.5	-20.0	2.60	102.7	904.1	
	-40.991	119.6	0.722	-0.496	4.4	-36.1	0.41	145.8	1003.2	
	-41.160	118.9	0.714	-0.496	-1.4	-31.7	0.13	144.1	1008.4	
	-42.160	114.8	0.665	-0.485	-21.5	-9.5	2.03	134.2	1038.8	
	-43.160	110.8	0.617	-0.467	-22.2	7.1	2.10	124.6	1069.3	
	-44.160	106.7	0.571	-0.454	-9.2	18.2	0.87	115.3	1099.8	
	-45.160	102.7	0.526	-0.455	12.5	24.2	1.18	106.1	1130.2	
	-46.160	98.6	0.480	-0.475	37.5	25.1	3.56	96.8	1160.7	
	-47.160	94.6	0.430	-0.514	60.7	20.4	5.75	86.8	1191.1	
	-48.160	90.5	0.376	-0.568	76.1	9.3	7.21	75.9	1221.6	
	-49.160	86.5	0.316	-0.630	76.9	-9.2	7.28	63.8	1252.0	
	-50.160	82.4	0.250	-0.684	54.9	-36.3	5.20	50.6	1282.5	
	-50.591	5.2	0.221	-0.699	36.2	-50.9	3.43	44.5	600.8	
	-51.108	0.0	0.184	-0.710	15.0	-31.1	1.42	37.2	600.3	
	-51.160	0.0	0.181	-0.710	13.4	-29.2	1.27	36.4	600.2	
	-52.112	0.0	0.113	-0.714	0.0	-1.1	0.00	22.7	599.2	
	-52.160	0.0	0.109	-0.714	0.0	0.0	0.00	22.0	599.2	

*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	-0.168	5.727	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	0.118	5.727	0.0	0.0	0.00	0.0	0.0	
218.5										
	+4.340	0.3	0.118	5.727	0.0	218.5	0.00	0.0	0.0	
	+3.840	5.3	0.404	5.705	109.0	217.1	10.32	0.0	0.0	
	+2.840	15.2	0.968	5.535	321.9	206.9	30.48	0.0	0.0	
	+1.840	25.2	1.506	5.201	519.4	186.7	49.19	0.0	0.0	
	+1.340	30.2	1.760	4.978	609.4	172.8	57.71	0.0	0.0	
	+0.840	35.2	2.003	4.721	691.8	156.4	65.52	0.0	0.0	
	+0.340	40.2	2.232	4.434	765.4	137.6	72.49	0.0	0.0	
	-0.160	40.2	2.446	4.119	829.2	117.5	78.53	0.0	0.0	
	-1.160	40.2	2.824	3.423	926.6	77.3	87.75	0.0	0.0	
	-1.660	40.1	2.985	3.050	960.3	57.3	90.94	0.0	0.0	
	-2.160	40.1	3.128	2.667	983.9	37.2	93.18	0.0	0.0	
	-3.160	40.1	3.356	1.881	1001.1	-2.9	94.80	0.0	0.0	
	-3.160	40.1	3.356	1.881	1001.1	-2.9	94.80	0.0	0.0	
	-4.160	40.1	3.505	1.097	978.1	-43.0	92.63	0.0	0.0	
	-4.660	40.1	3.550	0.716	951.6	-63.1	90.12	0.0	0.0	
	-5.091	40.1	3.574	0.397	920.7	-80.3	87.19	0.0	0.0	
	-5.091	40.0	3.574	0.397	920.7	-80.3	87.19	0.0	0.0	*
	-5.160	39.9	3.576	0.347	915.0	-83.0	86.66	1.6	1.6	*
	-6.160	38.4	3.576	-0.338	817.0	-109.1	77.37	24.6	24.6	*
	-6.860	37.4	3.537	-0.768	738.6	-112.7	69.95	40.8	40.8	*
	-6.860	37.4	3.537	-0.768	738.6	-112.7	69.95	40.8	40.8	
	-7.160	36.9	3.512	-0.938	705.0	-111.7	66.76	40.5	47.7	
	-8.060	35.6	3.406	-1.404	606.0	-108.3	57.39	39.3	68.4	
	-8.160	35.4	3.392	-1.451	595.2	-108.0	56.36	39.1	70.7	
	-9.160	33.9	3.224	-1.879	489.0	-104.5	46.31	37.2	93.8	
	-10.160	32.5	3.019	-2.224	386.0	-101.6	36.55	34.8	116.8	
	-11.160	31.0	2.782	-2.489	285.3	-99.9	27.02	32.1	139.8	
	-12.060	29.6	2.550	-2.659	195.7	-99.5	18.53	29.4	160.6	
	-12.160	29.5	2.523	-2.674	185.7	-99.5	17.59	29.1	162.9	
	-12.160	29.5	2.523	-2.674	185.7	-99.5	15.47	29.1	162.9	
	-13.060	28.1	2.278	-2.762	95.8	-100.5	7.98	26.3	183.6	
	-13.160	28.0	2.251	-2.769	85.8	-100.7	7.14	26.0	185.9	

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
	-14.160	26.5	1.972	-2.793	-16.2	-103.6	1.35	22.7	209.0	
	-15.160	25.0	1.695	-2.745	-122.0	-108.2	10.16	19.5	232.0	
	-15.991	24.8	1.470	-2.649	-214.0	-113.4	17.82	73.5	335.6	
	-16.060	24.6	1.452	-2.638	-221.7	-110.0	18.46	72.6	337.6	
	-16.160	24.4	1.426	-2.622	-232.5	-105.3	19.36	71.2	340.6	
	-17.160	22.1	1.172	-2.430	-316.1	-63.7	26.32	58.6	370.5	
	-18.160	19.8	0.941	-2.192	-363.1	-31.9	30.24	47.0	400.3	
	-19.160	17.5	0.735	-1.932	-382.7	-8.7	31.87	36.7	430.2	
	-20.160	15.2	0.555	-1.665	-383.0	7.1	31.90	27.7	460.1	
	-20.291	13.4	0.533	-1.631	-382.0	8.7	31.81	25.1	198.4	
	-21.160	11.2	0.402	-1.403	-370.5	17.1	30.86	18.9	202.3	
	-22.160	8.7	0.274	-1.153	-350.2	23.0	29.16	12.9	206.8	
	-22.591	7.0	0.226	-1.050	-339.9	24.5	28.31	19.8	497.6	
	-23.160	5.6	0.170	-0.918	-324.1	30.8	26.99	14.9	513.4	
	-24.160	3.3	0.089	-0.705	-289.6	37.5	24.12	7.8	541.0	
	-24.799	1.8	0.048	-0.582	-264.8	39.7	22.05	4.2	558.7	
	-25.160	0.9	0.029	-0.518	-250.3	40.4	20.85	2.5	568.7	
	-25.556	0.0	0.009	-0.451	-234.3	40.9	19.51	0.8	579.7	
	-26.160	0.0	-0.015	-0.358	-209.5	40.7	17.45	0.0	596.4	
	-26.391	1.6	-0.023	-0.325	-200.2	40.3	16.67	0.0	228.7	
	-27.046	0.0	-0.041	-0.240	-174.3	38.8	14.51	0.0	231.6	
	-27.160	0.0	-0.044	-0.226	-169.9	38.6	14.15	0.0	232.4	
	-28.160	0.0	-0.061	-0.122	-132.5	36.1	11.03	0.0	239.4	
	-28.160	0.0	-0.061	-0.122	-132.5	36.1	12.55	0.0	239.4	
	-29.160	0.0	-0.069	-0.031	-97.9	33.0	9.28	0.0	246.4	
	-30.160	0.0	-0.068	0.034	-66.6	29.7	6.31	0.0	253.4	
	-31.160	0.0	-0.063	0.075	-38.5	26.6	3.64	0.0	260.4	
	-31.291	0.0	-0.062	0.079	-35.0	26.2	3.31	0.0	803.3	
	-32.160	0.0	-0.054	0.096	-15.2	19.5	1.44	0.0	828.7	
	-33.160	0.0	-0.044	0.101	0.9	12.9	0.08	0.0	858.0	
	-34.160	0.0	-0.034	0.096	11.0	7.6	1.04	0.0	887.2	
	-35.160	0.0	-0.025	0.085	16.6	3.7	1.57	0.0	916.4	
	-36.160	0.0	-0.017	0.071	18.7	0.9	1.77	0.0	945.7	
	-36.538	0.0	-0.015	0.065	18.9	0.0	1.79	0.0	956.7	
	-37.160	0.0	-0.011	0.056	18.6	-1.0	1.76	0.0	974.9	
	-38.160	0.0	-0.006	0.042	17.0	-2.1	1.61	0.0	1004.2	

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
	-38.790	0.0	-0.004	0.034	15.5	-2.5	1.47	0.0	1022.6	
	-39.160	0.0	-0.002	0.029	14.5	-2.7	1.37	0.0	1034.1	
	-40.160	0.0	0.000	0.019	11.7	-2.9	1.11	0.0	1065.1	
	-40.991	0.0	0.001	0.012	9.3	-2.8	0.89	0.2	1176.3	
	-41.160	0.0	0.001	0.011	8.9	-2.7	0.84	0.3	1181.9	
	-42.160	0.0	0.002	0.005	6.3	-2.4	0.60	0.4	1215.3	
	-43.160	0.0	0.002	0.001	4.1	-1.9	0.39	0.5	1248.7	
	-44.160	0.0	0.002	-0.002	2.5	-1.4	0.23	0.5	1282.1	
	-45.160	0.0	0.002	-0.003	1.3	-1.0	0.12	0.4	1315.5	
	-46.160	0.0	0.002	-0.004	0.5	-0.6	0.04	0.3	1348.9	
	-47.160	0.0	0.001	-0.004	0.0	-0.3	0.00	0.3	1382.3	
	-48.160	0.0	0.001	-0.004	-0.2	-0.1	0.02	0.2	1415.7	
	-49.160	0.0	0.000	-0.004	-0.2	0.0	0.02	0.1	1449.1	
	-50.160	0.0	0.000	-0.004	-0.1	0.1	0.01	0.0	1482.5	
	-50.591	0.0	0.000	-0.004	-0.1	0.1	0.01	0.0	755.7	
	-51.160	0.0	0.000	-0.004	0.0	0.1	0.00	0.0	760.8	
	-52.160	0.0	-0.001	-0.004	0.0	0.0	0.00	0.0	769.8	

*showing plastic

(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/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	+4.840	0.0	-1.990	10.977	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-1.441	10.977	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-1.441	10.977	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-0.892	10.977	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	0.206	10.979	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.304	10.990	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.854	11.004	-46.1	-45.7	4.37	0.0	0.0	
446.4										
	+1.340	30.2	1.854	11.004	-46.1	400.7	4.37	0.0	0.0	
	+0.840	35.2	2.404	10.984	150.2	384.4	14.23	0.0	0.0	
	+0.340	40.2	2.951	10.887	337.8	365.5	31.99	0.0	0.0	
	-0.160	40.2	3.492	10.718	515.5	345.4	48.82	0.0	0.0	
	-1.160	40.2	4.539	10.180	840.9	305.3	79.63	0.0	0.0	
	-1.660	40.1	5.039	9.819	988.5	285.2	93.61	0.0	0.0	
	-2.160	40.1	5.520	9.402	1126.1	265.1	106.64	0.0	0.0	
	-3.160	40.1	6.412	8.414	1371.1	225.0	129.85	0.0	0.0	
	-3.160	40.1	6.412	8.414	1371.1	225.0	129.85	0.0	0.0	
	-4.160	40.1	7.196	7.248	1576.1	184.9	149.25	0.0	0.0	
	-4.660	40.1	7.543	6.609	1663.5	164.9	157.53	0.0	0.0	
	-5.091	40.0	7.815	6.031	1730.8	147.6	163.91	0.0	0.0	
	-5.160	40.2	7.857	5.937	1740.9	144.8	164.87	0.0	0.0	
	-6.160	42.6	8.380	4.511	1865.2	103.4	176.64	0.0	0.0	
	-7.160	45.0	8.756	3.004	1947.0	59.6	184.38	0.0	0.0	
	-8.060	47.2	8.964	1.606	1982.1	18.1	187.71	0.0	0.0	
	-8.160	47.5	8.979	1.450	1983.7	13.4	187.86	0.0	0.0	
	-9.160	49.9	9.046	-0.115	1972.9	-35.3	186.84	0.0	0.0	
	-10.160	52.3	8.957	-1.651	1912.3	-86.4	181.10	0.0	0.0	
	-11.160	54.7	8.718	-3.119	1799.3	-139.9	170.40	0.0	0.0	
	-12.060	56.9	8.381	-4.347	1651.0	-190.2	156.35	0.0	0.0	
	-12.160	57.2	8.337	-4.477	1631.7	-195.9	154.52	0.0	0.0	
	-12.160	57.2	8.337	-4.477	1631.7	-195.9	135.89	0.0	0.0	
	-13.060	59.4	7.890	-5.436	1431.9	-248.3	119.25	0.0	0.0	
	-13.160	59.6	7.835	-5.534	1406.8	-254.2	117.16	0.0	0.0	
	-14.160	62.0	7.236	-6.415	1122.3	-315.1	93.47	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
	-14.560	63.0	6.973	-6.709	991.3	-340.1	82.56	0.0	0.0	
	-14.560	63.0	6.973	-6.709	991.3	-340.1	82.56	0.0	0.0	*
	-15.160	62.1	6.559	-7.078	776.8	-373.4	64.70	13.8	13.8	*
	-15.991	57.5	5.955	-7.434	452.2	-405.1	37.66	44.1	44.1	*
	-16.060	57.4	5.904	-7.455	424.2	-406.0	35.33	46.1	46.1	*
	-16.160	57.2	5.829	-7.483	383.5	-406.9	31.94	49.1	49.1	*
	-17.160	54.8	5.072	-7.608	-22.0	-398.9	1.84	79.0	79.0	*
	-18.160	52.5	4.317	-7.458	-403.5	-358.7	33.60	108.8	108.8	*
	-19.160	50.2	3.589	-7.061	-728.6	-286.3	60.68	138.7	138.7	*
	-19.784	48.8	3.159	-6.709	-888.8	-224.7	74.02	157.4	157.4	*
	-19.784	48.8	3.159	-6.709	-888.8	-224.7	74.02	157.9	157.4	
	-20.160	47.9	2.911	-6.467	-965.8	-185.9	80.43	145.5	168.6	
	-20.291	32.4	2.827	-6.378	-989.3	-173.4	82.39	133.1	175.3	
	-21.160	30.2	2.300	-5.743	-1104.9	-95.9	92.02	108.3	179.2	
	-22.160	27.7	1.765	-4.951	-1165.6	-29.4	97.08	83.1	183.7	
	-22.591	40.8	1.559	-4.601	-1173.4	-7.4	97.72	136.4	226.6	
	-23.160	39.5	1.310	-4.139	-1163.3	41.1	96.88	114.6	242.4	
	-24.160	37.1	0.936	-3.354	-1090.0	100.5	90.78	81.9	270.1	
	-25.160	34.8	0.637	-2.636	-971.4	132.8	80.90	55.7	297.7	
	-26.160	32.4	0.406	-2.010	-831.3	144.4	69.23	35.5	325.4	
	-26.391	20.6	0.361	-1.880	-797.9	144.7	66.45	17.0	205.6	
	-27.160	18.7	0.232	-1.483	-688.1	140.2	57.31	10.9	209.0	
	-28.160	16.2	0.106	-1.053	-552.4	130.6	46.01	5.0	213.5	
	-28.160	16.2	0.106	-1.053	-552.4	130.6	52.32	5.0	213.5	
	-29.160	13.7	0.021	-0.667	-427.8	118.5	40.51	1.0	218.0	
	-30.160	11.2	-0.031	-0.375	-315.7	105.7	29.90	0.0	222.4	
	-31.160	8.6	-0.057	-0.166	-216.1	93.7	20.46	0.0	226.9	
	-31.291	16.4	-0.059	-0.144	-203.9	92.2	19.31	0.0	511.8	
	-32.160	13.8	-0.066	-0.030	-132.8	71.7	12.58	0.0	537.2	
	-33.160	10.9	-0.065	0.050	-72.0	50.4	6.82	0.0	566.5	
	-34.160	8.0	-0.058	0.089	-30.8	32.7	2.92	0.0	595.7	
	-35.160	5.0	-0.048	0.103	-5.3	19.1	0.50	0.0	625.0	
	-35.632	3.6	-0.043	0.103	2.6	14.2	0.24	0.0	638.7	
	-36.160	2.1	-0.037	0.101	8.9	9.8	0.84	0.0	654.2	
	-36.861	0.0	-0.031	0.094	14.3	5.9	1.35	0.0	674.7	
	-37.160	0.0	-0.028	0.091	15.8	4.7	1.50	0.0	683.4	

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	-0.020	0.077	18.9	1.6	1.79	0.0	712.7	
	-39.160	0.0	-0.013	0.061	19.3	-0.6	1.83	0.0	741.9	
	-40.160	0.0	-0.007	0.047	18.0	-1.9	1.71	0.0	771.1	
	-40.991	0.0	-0.004	0.035	16.2	-2.5	1.53	0.0	859.9	
	-41.160	0.0	-0.003	0.033	15.7	-2.6	1.49	0.0	865.1	
	-42.160	0.0	-0.001	0.022	12.9	-3.0	1.22	0.0	895.9	
	-43.160	0.0	0.001	0.013	9.9	-2.9	0.94	0.2	926.6	
	-44.160	0.0	0.002	0.006	7.2	-2.6	0.68	0.4	957.4	
	-45.160	0.0	0.003	0.001	4.9	-2.1	0.46	0.5	988.1	
	-46.160	0.0	0.002	-0.002	3.0	-1.6	0.29	0.5	1018.9	
	-47.160	0.0	0.002	-0.003	1.7	-1.1	0.16	0.4	1049.7	
	-48.160	0.0	0.002	-0.004	0.8	-0.7	0.08	0.4	1080.4	
	-49.160	0.0	0.001	-0.005	0.3	-0.4	0.03	0.3	1111.2	
	-49.315	0.0	0.001	-0.005	0.3	-0.3	0.02	0.3	1115.9	
	-50.160	0.0	0.001	-0.005	0.1	-0.1	0.01	0.2	1141.9	
	-50.591	0.0	0.001	-0.005	0.0	-0.1	0.00	0.1	689.4	
	-51.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.1	694.5	
	-52.160	0.0	0.000	-0.005	0.0	0.0	0.00	0.0	703.5	

*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	-2.730	13.171	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.071	13.171	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.071	13.171	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.413	13.171	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.095	13.173	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.222	13.185	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.882	13.199	-46.1	-45.7	4.37	0.0	0.0	
578.7										
	+1.340	30.2	1.882	13.199	-46.1	533.0	4.37	0.0	0.0	
	+0.840	35.2	2.541	13.165	216.4	516.6	20.49	0.0	0.0	
	-0.160	45.2	3.843	12.795	713.8	476.4	67.59	0.0	0.0	
	-1.160	55.2	5.088	12.050	1166.0	426.3	110.42	0.0	0.0	
	-1.660	60.1	5.678	11.549	1372.0	397.5	129.93	0.0	0.0	
	-2.160	65.1	6.241	10.970	1563.0	366.1	148.02	0.0	0.0	
	-2.660	70.1	6.774	10.318	1737.7	332.3	164.57	0.0	0.0	
	-3.160	70.1	7.272	9.600	1895.1	297.3	179.47	0.0	0.0	
	-3.160	70.1	7.272	9.600	1895.1	297.3	179.47	0.0	0.0	
	-4.160	70.1	8.154	7.997	2157.3	227.2	204.30	0.0	0.0	
	-4.660	70.1	8.532	7.124	2262.2	192.1	214.23	0.0	0.0	
	-5.091	70.0	8.822	6.341	2338.5	161.9	221.46	0.0	0.0	
	-5.160	70.2	8.866	6.214	2349.5	157.1	222.50	0.0	0.0	
	-6.160	72.6	9.392	4.307	2471.1	85.7	234.02	0.0	0.0	
	-7.160	75.0	9.725	2.333	2520.1	11.9	238.66	0.0	0.0	
	-8.060	77.2	9.854	0.546	2500.1	-56.6	236.77	0.0	0.0	
	-8.160	77.5	9.859	0.349	2494.1	-64.3	236.19	0.0	0.0	
	-9.160	79.9	9.796	-1.584	2390.6	-143.0	226.39	0.0	0.0	
	-10.160	82.3	9.546	-3.403	2207.3	-224.1	209.03	0.0	0.0	
	-11.160	84.7	9.121	-5.046	1941.6	-307.6	183.87	0.0	0.0	
	-12.060	86.9	8.608	-6.318	1630.1	-384.9	154.37	0.0	0.0	
	-12.160	87.2	8.545	-6.445	1591.5	-393.6	150.71	0.0	0.0	
	-12.160	87.2	8.545	-6.445	1591.5	-393.6	132.54	0.0	0.0	
	-13.060	89.4	7.923	-7.321	1227.8	-473.0	102.25	0.0	0.0	
105.8										
	-13.060	89.4	7.923	-7.321	1227.8	-367.2	102.25	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/mm²)	subgrade reaction (kN/m²)	passive earth pressure (kN/m²)	plastic
	-13.160	89.6	7.850	-7.403	1185.6	-376.2	98.74	0.0	0.0	
	-14.160	92.0	7.074	-8.070	742.8	-467.0	61.86	0.0	0.0	
	-14.560	77.0	6.747	-8.250	548.7	-504.0	45.69	77.8	103.4	
	-15.160	76.1	6.246	-8.415	246.1	-505.0	20.50	72.0	117.2	
	-15.991	74.9	5.544	-8.436	-175.7	-511.2	14.63	63.9	136.4	
	-15.991	73.4	5.544	-8.436	-175.7	-511.2	14.63	181.6	181.6	*
	-16.060	73.3	5.486	-8.427	-210.7	-503.7	17.55	183.7	183.7	*
	-16.160	73.0	5.402	-8.410	-260.5	-492.5	21.70	186.6	186.6	*
	-17.160	70.7	4.575	-8.073	-690.9	-362.8	57.54	216.5	216.5	*
	-17.330	70.3	4.439	-7.988	-750.4	-337.5	62.49	221.6	221.6	*
	-17.330	70.3	4.439	-7.988	-750.4	-337.5	62.49	221.9	221.6	
	-18.160	68.4	3.796	-7.484	-981.9	-224.5	81.77	189.7	246.4	
	-19.160	66.1	3.084	-6.738	-1151.4	-120.1	95.89	154.1	276.3	
	-20.160	63.8	2.451	-5.906	-1232.6	-47.1	102.65	122.5	306.1	
	-20.291	31.8	2.375	-5.794	-1238.3	-39.7	103.12	111.8	175.7	
	-21.160	29.6	1.904	-5.043	-1245.1	21.0	103.69	89.7	179.6	
	-22.160	27.1	1.442	-4.192	-1197.4	71.1	99.72	67.9	184.1	
	-22.591	56.3	1.269	-3.839	-1163.2	87.2	96.87	111.0	354.6	
	-23.160	54.9	1.064	-3.390	-1105.7	113.5	92.08	93.0	370.4	
	-24.160	52.5	0.761	-2.666	-977.4	139.1	81.40	66.6	398.0	
	-25.160	50.2	0.527	-2.037	-834.5	143.6	69.50	46.1	425.7	
	-26.160	47.8	0.351	-1.507	-695.3	132.6	57.91	30.7	453.4	
	-26.391	20.0	0.317	-1.398	-665.2	128.4	55.40	14.9	206.0	
	-27.160	18.1	0.223	-1.069	-568.3	123.4	47.33	10.5	209.4	
	-28.160	15.6	0.134	-0.716	-449.0	114.8	37.40	6.3	213.9	
	-28.160	15.6	0.134	-0.716	-449.0	114.8	42.52	6.3	213.9	
	-29.160	13.1	0.079	-0.406	-339.0	105.3	32.10	3.7	218.4	
	-30.160	10.6	0.050	-0.179	-238.1	96.5	22.55	2.4	222.8	
	-31.160	8.0	0.040	-0.028	-145.5	89.3	13.77	1.9	227.3	
	-31.291	32.3	0.040	-0.014	-133.8	88.5	12.67	5.4	649.4	
	-32.160	29.7	0.042	0.054	-66.8	66.3	6.32	5.7	674.8	
	-33.160	26.8	0.049	0.084	-11.9	44.1	1.12	6.6	704.0	
	-34.160	23.8	0.058	0.078	22.9	26.0	2.17	7.8	733.3	
	-35.160	20.9	0.064	0.052	41.5	11.9	3.93	8.7	762.5	
	-36.160	17.9	0.068	0.016	47.9	1.4	4.54	9.1	791.7	
	-37.160	15.0	0.067	-0.022	45.4	-5.9	4.30	9.1	821.0	

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
	-38.160	12.1	0.064	-0.054	36.9	-10.6	3.50	8.5	850.2	
	-39.160	9.1	0.057	-0.079	24.9	-13.1	2.36	7.6	879.4	
	-40.160	6.2	0.048	-0.093	11.4	-13.7	1.08	6.5	908.7	
	-40.668	4.7	0.043	-0.096	4.5	-13.3	0.43	5.8	923.5	
	-40.991	5.2	0.040	-0.097	0.3	-12.8	0.03	8.1	1007.8	
	-41.132	4.6	0.039	-0.097	-1.5	-12.4	0.14	7.8	1012.2	
	-41.160	4.5	0.038	-0.097	-1.8	-12.3	0.17	7.8	1013.0	
	-42.160	0.8	0.029	-0.091	-12.2	-8.2	1.16	5.9	1043.8	
	-42.366	0.0	0.027	-0.089	-13.8	-7.1	1.31	5.5	1050.1	
	-43.160	0.0	0.020	-0.079	-17.8	-3.3	1.69	4.1	1074.5	
	-44.160	0.0	0.013	-0.064	-19.3	0.1	1.82	2.7	1105.3	
	-45.160	0.0	0.008	-0.049	-18.0	2.2	1.71	1.5	1136.1	
	-46.160	0.0	0.003	-0.036	-15.2	3.3	1.44	0.7	1166.8	
	-47.160	0.0	0.000	-0.026	-11.7	3.6	1.11	0.1	1197.6	
	-48.160	0.0	-0.002	-0.018	-8.1	3.5	0.77	0.0	1228.3	
	-49.160	0.0	-0.003	-0.013	-4.9	2.9	0.46	0.0	1259.1	
	-50.160	0.0	-0.004	-0.010	-2.3	2.2	0.22	0.0	1289.8	
	-50.591	0.0	-0.005	-0.009	-1.4	1.8	0.14	0.0	690.4	
	-51.160	0.0	-0.005	-0.009	-0.6	1.2	0.06	0.0	695.5	
	-52.160	0.0	-0.006	-0.009	0.0	0.0	0.00	0.0	704.5	

*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	-2.823	13.420	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.152	13.420	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.152	13.420	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.481	13.420	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.139	13.421	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.204	13.433	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.876	13.447	-46.1	-45.7	4.37	0.0	0.0	
550.1										
	+1.340	30.2	1.876	13.447	-46.1	504.4	4.37	0.0	0.0	
	+0.840	35.2	2.548	13.416	202.1	488.1	19.14	0.0	0.0	
	-0.160	45.2	3.875	13.069	670.9	447.9	63.53	0.0	0.0	
	-1.160	55.2	5.150	12.369	1094.5	397.7	103.65	0.0	0.0	
	-1.660	60.1	5.757	11.899	1286.3	368.9	121.81	0.0	0.0	
99.0										
	-1.660	60.1	5.757	11.899	1286.3	467.9	121.81	0.0	0.0	
	-2.160	65.1	6.338	11.346	1512.5	436.6	143.24	0.0	0.0	
	-3.160	75.1	7.408	9.989	1914.9	366.5	181.34	0.0	0.0	
	-3.160	75.1	7.408	9.989	1914.9	366.5	181.34	0.0	0.0	
	-4.160	85.1	8.327	8.344	2242.1	286.4	212.33	0.0	0.0	
	-4.660	90.1	8.721	7.432	2374.5	242.6	224.87	0.0	0.0	
	-5.091	94.3	9.024	6.608	2470.5	202.8	233.96	0.0	0.0	
	-5.160	95.2	9.069	6.473	2484.3	196.3	235.27	0.0	0.0	
	-6.160	107.6	9.616	4.448	2630.9	94.9	249.15	0.0	0.0	
	-7.160	120.0	9.956	2.348	2670.0	-18.9	252.85	0.0	0.0	
	-8.060	131.2	10.083	0.470	2602.9	-132.0	246.49	0.0	0.0	
	-8.160	132.5	10.086	0.265	2589.0	-145.1	245.18	0.0	0.0	
	-9.160	144.9	10.013	-1.703	2375.6	-283.8	224.97	0.0	0.0	
	-10.160	157.3	9.753	-3.446	2017.3	-434.9	191.04	0.0	0.0	
	-11.160	169.7	9.335	-4.846	1501.6	-598.4	142.21	0.0	0.0	
	-12.060	180.9	8.857	-5.704	892.8	-756.2	84.55	0.0	0.0	
	-12.160	182.2	8.800	-5.772	819.2	-774.4	77.58	0.0	0.0	
	-12.160	182.2	8.800	-5.772	819.2	-774.4	68.23	0.0	0.0	
	-13.060	193.4	8.264	-6.048	341.8	-943.4	28.46	0.0	0.0	
1191.0										

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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
	-13.060	193.4	8.264	-6.048	341.8	247.7	28.46	0.0	0.0	
	-13.160	194.6	8.204	-6.052	309.0	228.3	25.73	0.0	0.0	
	-14.160	207.0	7.594	-6.156	196.7	27.5	16.38	0.0	0.0	
	-14.560	196.0	7.347	-6.210	191.0	-56.4	15.91	84.7	103.4	
	-15.160	195.1	6.972	-6.280	137.0	-124.2	11.41	80.4	117.2	
	-15.991	193.9	6.448	-6.322	-6.4	-221.5	0.53	74.4	136.4	
	-15.991	192.4	6.448	-6.322	-6.4	-221.5	0.53	181.6	181.6	*
	-16.060	192.3	6.404	-6.321	-21.7	-222.2	1.81	183.7	183.7	*
	-16.160	192.0	6.341	-6.319	-43.9	-222.9	3.66	186.6	186.6	*
	-17.160	189.7	5.713	-6.211	-264.1	-212.2	22.00	216.5	216.5	*
	-18.160	187.4	5.104	-5.958	-457.5	-169.3	38.10	246.4	246.4	*
	-18.306	187.1	5.017	-5.911	-481.5	-160.4	40.10	250.7	250.7	*
	-18.306	187.1	5.017	-5.911	-481.5	-160.4	40.10	250.8	250.7	
	-19.160	185.1	4.525	-5.589	-598.1	-115.7	49.81	226.2	276.3	
	-20.160	182.8	3.989	-5.138	-697.5	-87.1	58.09	199.3	306.1	
	-20.291	182.5	3.922	-5.074	-708.7	-85.1	59.03	196.0	310.0	
	-20.291	103.2	3.922	-5.074	-708.7	-85.1	59.03	128.1	128.1	*
	-21.160	101.0	3.500	-4.626	-772.5	-60.8	64.34	132.0	132.0	*
	-22.160	98.5	3.065	-4.072	-816.6	-26.2	68.01	136.5	136.5	*
	-22.496	97.6	2.931	-3.881	-823.3	-13.0	68.56	138.0	138.0	*
	-22.496	97.6	2.931	-3.881	-823.3	-13.0	68.56	138.0	138.0	
	-22.591	175.3	2.895	-3.827	-824.3	-9.3	68.65	253.2	354.6	
	-23.160	173.9	2.686	-3.502	-817.9	30.2	68.12	234.9	370.4	
	-24.160	171.5	2.364	-2.951	-761.8	77.9	63.44	206.7	398.0	
	-25.160	169.2	2.094	-2.453	-670.0	102.1	55.80	183.2	425.7	
	-26.160	166.8	1.871	-2.024	-564.0	107.2	46.97	163.6	453.4	
	-26.391	91.4	1.825	-1.936	-539.3	106.0	44.92	86.0	158.4	
	-27.160	89.5	1.687	-1.669	-459.9	100.0	38.30	79.4	161.8	
	-28.160	87.0	1.535	-1.383	-365.8	87.5	30.46	72.3	166.3	
	-28.160	87.0	1.535	-1.383	-365.8	87.5	34.64	72.3	166.3	
	-29.160	84.5	1.410	-1.127	-286.3	71.0	27.11	66.4	170.8	
	-30.160	82.0	1.307	-0.927	-224.8	51.7	21.29	61.6	175.2	
	-31.160	79.4	1.223	-0.767	-183.6	30.5	17.39	57.6	179.7	
	-31.291	151.3	1.213	-0.748	-179.8	27.6	17.03	163.2	649.4	
	-32.160	148.7	1.153	-0.634	-152.0	35.5	14.40	155.2	674.8	
	-33.160	145.8	1.095	-0.529	-114.2	39.4	10.81	147.4	704.0	

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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
	-34.160	142.8	1.046	-0.454	-74.7	39.1	7.07	140.8	733.3	
	-35.160	139.9	1.003	-0.410	-37.1	35.5	3.52	135.0	762.5	
	-36.160	136.9	0.963	-0.394	-4.5	29.4	0.42	129.6	791.7	
	-37.160	134.0	0.924	-0.401	20.9	20.9	1.98	124.3	821.0	
	-38.160	131.1	0.882	-0.425	36.5	9.9	3.46	118.7	850.2	
	-39.160	128.1	0.838	-0.456	39.7	-3.9	3.76	112.8	879.4	
	-40.160	125.2	0.791	-0.484	27.7	-20.8	2.62	106.5	908.7	
	-40.991	124.2	0.751	-0.495	3.6	-37.6	0.34	151.5	1007.8	
	-41.160	123.5	0.742	-0.495	-2.4	-33.1	0.23	149.8	1013.0	
	-42.160	119.8	0.693	-0.483	-23.4	-9.9	2.21	139.9	1043.8	
	-43.160	116.0	0.646	-0.463	-24.2	7.3	2.29	130.4	1074.5	
	-44.160	112.3	0.600	-0.449	-10.6	18.9	1.00	121.2	1105.3	
	-45.160	108.5	0.556	-0.449	11.9	25.2	1.13	112.2	1136.1	
	-46.160	104.8	0.510	-0.468	38.1	26.2	3.61	103.0	1166.8	
	-47.160	101.0	0.461	-0.508	62.4	21.4	5.91	93.1	1197.6	
	-48.160	97.3	0.408	-0.565	78.8	10.1	7.46	82.3	1228.3	
	-49.160	93.5	0.348	-0.629	80.0	-8.9	7.58	70.3	1259.1	
	-50.160	89.8	0.282	-0.685	58.0	-36.8	5.49	57.0	1289.8	
	-50.591	13.7	0.252	-0.702	38.9	-51.9	3.69	51.0	609.3	
	-51.108	9.0	0.216	-0.713	17.0	-33.3	1.61	43.6	609.3	
	-51.160	8.6	0.212	-0.713	15.3	-31.5	1.45	42.8	609.3	
	-52.112	0.0	0.144	-0.717	0.0	-1.4	0.00	29.1	609.3	
	-52.160	0.0	0.141	-0.717	0.0	0.0	0.00	28.4	609.3	

*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	-2.823	13.420	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.152	13.420	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.152	13.420	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.481	13.420	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.139	13.421	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.204	13.433	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.876	13.447	-46.1	-45.7	4.37	0.0	0.0	
550.1										
	+1.340	30.2	1.876	13.447	-46.1	504.4	4.37	0.0	0.0	
	+0.840	35.2	2.548	13.416	202.1	488.1	19.14	0.0	0.0	
	-0.160	45.2	3.875	13.069	670.9	447.9	63.53	0.0	0.0	
	-1.160	55.2	5.150	12.369	1094.5	397.7	103.65	0.0	0.0	
	-1.660	60.1	5.757	11.899	1286.3	368.9	121.81	0.0	0.0	
99.0										
	-1.660	60.1	5.757	11.899	1286.3	467.9	121.81	0.0	0.0	
	-2.160	65.1	6.338	11.346	1512.5	436.6	143.24	0.0	0.0	
	-3.160	75.1	7.408	9.989	1914.9	366.5	181.34	0.0	0.0	
	-3.160	75.1	7.408	9.989	1914.9	366.5	181.34	0.0	0.0	
	-4.160	85.1	8.327	8.344	2242.1	286.4	212.33	0.0	0.0	
	-4.660	90.1	8.721	7.432	2374.5	242.6	224.87	0.0	0.0	
0.0										
	-4.660	90.1	8.721	7.432	2374.5	242.6	224.87	0.0	0.0	
	-5.091	94.3	9.024	6.608	2470.5	202.8	233.96	0.0	0.0	
	-5.160	95.2	9.069	6.473	2484.3	196.3	235.27	0.0	0.0	
	-6.160	107.6	9.616	4.448	2630.9	94.9	249.15	0.0	0.0	
	-7.160	120.0	9.956	2.348	2670.0	-18.9	252.85	0.0	0.0	
	-8.060	131.2	10.083	0.470	2602.9	-132.0	246.49	0.0	0.0	
	-8.160	132.5	10.086	0.265	2589.0	-145.1	245.18	0.0	0.0	
	-9.160	144.9	10.013	-1.703	2375.6	-283.8	224.97	0.0	0.0	
	-10.160	157.3	9.753	-3.446	2017.3	-434.9	191.04	0.0	0.0	
	-11.160	169.7	9.335	-4.846	1501.6	-598.4	142.21	0.0	0.0	
	-12.060	180.9	8.857	-5.704	892.8	-756.2	84.55	0.0	0.0	
	-12.160	182.2	8.800	-5.772	819.2	-774.4	77.58	0.0	0.0	
	-12.160	182.2	8.800	-5.772	819.2	-774.4	68.23	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
	-13.060	193.4	8.264	-6.048	341.8	-943.4	28.46	0.0	0.0	
1191.0										
	-13.060	193.4	8.264	-6.048	341.8	247.7	28.46	0.0	0.0	
	-13.160	194.6	8.204	-6.052	309.0	228.3	25.73	0.0	0.0	
	-14.160	207.0	7.594	-6.156	196.7	27.5	16.38	0.0	0.0	
	-14.560	196.0	7.347	-6.210	191.0	-56.4	15.91	84.7	103.4	
	-15.160	195.1	6.972	-6.280	137.0	-124.2	11.41	80.4	117.2	
	-15.991	193.9	6.448	-6.322	-6.4	-221.5	0.53	74.4	136.4	
	-15.991	192.4	6.448	-6.322	-6.4	-221.5	0.53	181.6	181.6	*
	-16.060	192.3	6.404	-6.321	-21.7	-222.2	1.81	183.7	183.7	*
	-16.160	192.0	6.341	-6.319	-43.9	-222.9	3.66	186.6	186.6	*
	-17.160	189.7	5.713	-6.211	-264.1	-212.2	22.00	216.5	216.5	*
	-18.160	187.4	5.104	-5.958	-457.5	-169.3	38.10	246.4	246.4	*
	-18.306	187.1	5.017	-5.911	-481.6	-160.3	40.11	250.7	250.7	*
	-18.306	187.1	5.017	-5.911	-481.6	-160.3	40.11	250.7	250.7	
	-19.160	185.1	4.525	-5.589	-598.1	-115.7	49.81	226.2	276.3	
	-20.160	182.8	3.989	-5.138	-697.5	-87.1	58.09	199.3	306.1	
	-20.291	182.5	3.922	-5.074	-708.7	-85.1	59.03	196.0	310.0	
	-20.291	103.2	3.922	-5.074	-708.7	-85.1	59.03	128.1	128.1	*
	-21.160	101.0	3.500	-4.626	-772.5	-60.8	64.34	132.0	132.0	*
	-22.160	98.5	3.065	-4.072	-816.6	-26.2	68.01	136.5	136.5	*
	-22.497	97.6	2.931	-3.881	-823.3	-13.0	68.56	138.0	138.0	*
	-22.497	97.6	2.931	-3.881	-823.3	-13.0	68.56	138.0	138.0	
	-22.591	175.3	2.895	-3.827	-824.3	-9.3	68.65	253.2	354.6	
	-23.160	173.9	2.686	-3.502	-817.9	30.2	68.12	234.9	370.4	
	-24.160	171.5	2.364	-2.951	-761.8	77.9	63.44	206.7	398.0	
	-25.160	169.2	2.094	-2.453	-670.0	102.1	55.80	183.2	425.7	
	-26.160	166.8	1.871	-2.024	-564.0	107.2	46.97	163.6	453.4	
	-26.391	91.4	1.825	-1.936	-539.3	106.0	44.92	86.0	158.4	
	-27.160	89.5	1.687	-1.669	-459.9	100.0	38.30	79.4	161.8	
	-28.160	87.0	1.535	-1.383	-365.8	87.5	30.46	72.3	166.3	
	-28.160	87.0	1.535	-1.383	-365.8	87.5	34.64	72.3	166.3	
	-29.160	84.5	1.410	-1.127	-286.3	71.0	27.11	66.4	170.8	
	-30.160	82.0	1.307	-0.927	-224.8	51.7	21.29	61.6	175.2	
	-31.160	79.4	1.223	-0.767	-183.6	30.5	17.39	57.6	179.7	
	-31.291	151.3	1.213	-0.748	-179.8	27.6	17.03	163.2	649.4	

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
	-32.160	148.7	1.153	-0.634	-152.0	35.5	14.40	155.2	674.8	
	-33.160	145.8	1.095	-0.529	-114.2	39.4	10.81	147.4	704.0	
	-34.160	142.8	1.046	-0.454	-74.7	39.1	7.07	140.8	733.3	
	-35.160	139.9	1.003	-0.410	-37.1	35.5	3.52	135.0	762.5	
	-36.160	136.9	0.963	-0.394	-4.5	29.4	0.42	129.6	791.7	
	-37.160	134.0	0.924	-0.401	20.9	20.9	1.98	124.3	821.0	
	-38.160	131.1	0.882	-0.425	36.5	9.9	3.46	118.7	850.2	
	-39.160	128.1	0.838	-0.456	39.7	-3.9	3.76	112.8	879.4	
	-40.160	125.2	0.791	-0.484	27.7	-20.8	2.62	106.5	908.7	
	-40.991	124.2	0.751	-0.495	3.6	-37.6	0.34	151.5	1007.8	
	-41.160	123.5	0.742	-0.495	-2.4	-33.1	0.23	149.8	1013.0	
	-42.160	119.8	0.693	-0.483	-23.4	-9.9	2.21	139.9	1043.8	
	-43.160	116.0	0.646	-0.463	-24.2	7.3	2.29	130.4	1074.5	
	-44.160	112.3	0.600	-0.449	-10.6	18.9	1.00	121.2	1105.3	
	-45.160	108.5	0.556	-0.449	11.9	25.2	1.13	112.2	1136.1	
	-46.160	104.8	0.510	-0.468	38.1	26.2	3.61	103.0	1166.8	
	-47.160	101.0	0.461	-0.508	62.4	21.4	5.91	93.1	1197.6	
	-48.160	97.3	0.408	-0.565	78.8	10.1	7.46	82.3	1228.3	
	-49.160	93.5	0.348	-0.629	80.0	-8.9	7.58	70.3	1259.1	
	-50.160	89.8	0.282	-0.685	58.0	-36.8	5.49	57.0	1289.8	
	-50.591	13.7	0.252	-0.702	38.9	-51.9	3.69	51.0	609.3	
	-51.108	9.0	0.216	-0.713	17.0	-33.3	1.61	43.6	609.3	
	-51.160	8.6	0.212	-0.713	15.3	-31.5	1.45	42.8	609.3	
	-52.112	0.0	0.144	-0.717	0.0	-1.4	0.00	29.1	609.3	
	-52.160	0.0	0.141	-0.717	0.0	0.0	0.00	28.4	609.3	

*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	-2.822	13.419	0.0	0.0	0.00	0.0	0.0	
	+4.340	0.3	-2.151	13.419	0.0	0.0	0.00	0.0	0.0	
0.0										
	+4.340	0.3	-2.151	13.419	0.0	0.0	0.00	0.0	0.0	
	+3.840	5.3	-1.480	13.419	-0.2	-1.4	0.02	0.0	0.0	
	+2.840	15.2	-0.138	13.420	-5.9	-11.6	0.56	0.0	0.0	
	+1.840	25.2	1.204	13.432	-26.8	-31.9	2.54	0.0	0.0	
	+1.340	30.2	1.876	13.446	-46.1	-45.7	4.37	0.0	0.0	
551.4										
	+1.340	30.2	1.876	13.446	-46.1	505.7	4.37	0.0	0.0	
	+0.840	35.2	2.548	13.415	202.8	489.4	19.20	0.0	0.0	
	-0.160	45.2	3.875	13.067	672.9	449.2	63.72	0.0	0.0	
	-1.160	55.2	5.150	12.365	1097.8	399.0	103.96	0.0	0.0	
	-1.660	60.1	5.756	11.893	1290.2	370.2	122.19	0.0	0.0	
98.4										
	-1.660	60.1	5.756	11.893	1290.2	468.6	122.19	0.0	0.0	
	-2.160	65.1	6.338	11.339	1516.8	437.3	143.65	0.0	0.0	
	-3.160	75.1	7.406	9.978	1919.9	367.2	181.82	0.0	0.0	
	-3.160	75.1	7.406	9.978	1919.9	367.2	181.82	0.0	0.0	
	-4.160	85.1	8.324	8.328	2247.9	287.1	212.88	0.0	0.0	
	-4.660	90.1	8.717	7.414	2380.6	243.3	225.45	0.0	0.0	
0.0										
	-4.660	90.1	8.717	7.414	2380.6	243.3	225.45	0.0	0.0	
	-5.091	94.3	9.019	6.588	2477.0	203.6	234.58	0.0	0.0	
	-5.160	95.2	9.064	6.453	2490.8	197.0	235.88	0.0	0.0	
	-6.160	107.6	9.609	4.422	2638.2	95.6	249.84	0.0	0.0	
	-7.160	120.0	9.946	2.317	2678.0	-18.2	253.61	0.0	0.0	
	-8.060	1008383.4 10.070								
	-8.160	1008752.1	10.073	0.227	2591.2	-274.7	245.40	0.0	0.0	
	-9.160	1001434.4	9.998	-1.700	2349.8	-247.1	222.53	0.0	0.0	
	-10.160	975464.5	9.740	-3.413	2012.4	-404.6	190.58	0.0	0.0	
	-11.160	933678.3	9.326	-4.797	1511.3	-541.6	143.12	0.0	0.0	
	-12.060	180.9	8.852	-5.660	905.1	-754.5	85.72	0.0	0.0	
	-12.160	182.2	8.795	-5.729	831.7	-772.7	78.77	0.0	0.0	
	-12.160	182.2	8.795	-5.729	831.7	-772.7	69.27	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
	-13.060	193.4	8.263	-6.014	355.0	-941.7	29.56	0.0	0.0	
1187.6										
	-13.060	193.4	8.263	-6.014	355.0	245.9	29.56	0.0	0.0	
	-13.160	194.6	8.203	-6.019	322.2	226.6	26.83	0.0	0.0	
	-14.160	207.0	7.596	-6.131	208.9	25.7	17.39	0.0	0.0	
	-14.560	196.0	7.350	-6.189	202.5	-58.1	16.86	84.8	103.4	
	-15.160	195.1	6.976	-6.263	147.4	-125.8	12.28	80.5	117.2	
	-15.991	193.9	6.453	-6.310	2.7	-223.1	0.22	74.4	136.4	
	-15.991	192.4	6.453	-6.310	2.7	-223.1	0.22	181.6	181.6	*
	-16.060	192.3	6.410	-6.310	-12.7	-223.8	1.06	183.7	183.7	*
	-16.160	192.0	6.347	-6.308	-35.2	-224.5	2.93	186.6	186.6	*
	-17.160	189.7	5.719	-6.206	-257.0	-213.8	21.40	216.5	216.5	*
	-18.160	187.4	5.110	-5.958	-452.1	-170.9	37.65	246.4	246.4	*
	-18.311	187.1	5.021	-5.909	-477.1	-161.7	39.73	250.9	250.9	*
	-18.311	187.1	5.021	-5.909	-477.1	-161.7	39.73	250.9	250.9	
	-19.160	185.1	4.532	-5.592	-594.1	-117.1	49.48	226.5	276.3	
	-20.160	182.8	3.995	-5.143	-694.7	-88.2	57.86	199.6	306.1	
	-20.291	182.5	3.928	-5.079	-706.1	-86.2	58.81	196.3	310.0	
	-20.291	103.2	3.928	-5.079	-706.1	-86.2	58.81	128.1	128.1	*
	-21.160	101.0	3.505	-4.633	-770.8	-61.8	64.19	132.0	132.0	*
	-22.160	98.5	3.069	-4.080	-815.9	-27.2	67.95	136.5	136.5	*
	-22.500	97.6	2.934	-3.886	-822.9	-13.9	68.54	138.0	138.0	*
	-22.500	97.6	2.934	-3.886	-822.9	-13.9	68.54	138.2	138.0	
	-22.591	175.3	2.899	-3.835	-824.0	-10.3	68.63	253.5	354.6	
	-23.160	173.9	2.690	-3.510	-818.1	29.4	68.14	235.3	370.4	
	-24.160	171.5	2.367	-2.958	-762.6	77.4	63.51	207.0	398.0	
	-25.160	169.2	2.097	-2.459	-671.2	101.9	55.90	183.4	425.7	
	-26.160	166.8	1.873	-2.030	-565.3	107.1	47.08	163.8	453.4	
	-26.391	91.4	1.827	-1.941	-540.7	106.0	45.03	86.0	158.4	
	-27.160	89.5	1.688	-1.674	-461.2	100.0	38.41	79.5	161.8	
	-28.160	87.0	1.536	-1.387	-367.0	87.6	30.57	72.3	166.3	
	-28.160	87.0	1.536	-1.387	-367.0	87.6	34.76	72.3	166.3	
	-29.160	84.5	1.410	-1.130	-287.4	71.1	27.22	66.4	170.8	
	-30.160	82.0	1.308	-0.929	-225.8	51.8	21.38	61.6	175.2	
	-31.160	79.4	1.223	-0.769	-184.4	30.6	17.46	57.6	179.7	
	-31.291	151.3	1.213	-0.750	-180.6	27.8	17.10	163.2	649.4	

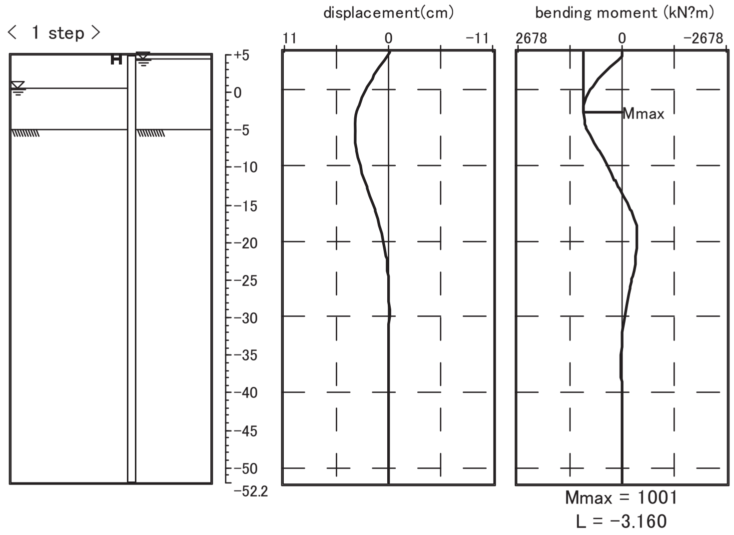
support point reaction (kN)	elevation (m)	active side pressure (kN/m)	Del. (cm)	Theta (mrad)	M (kN.m)	S (kN)	Sig. (N/mm^2)	subgrade reaction (kN/m^2)	passive earth pressure (kN/m^2)	plastic
	-32.160	148.7	1.153	-0.635	-152.7	35.7	14.46	155.2	674.8	
	-33.160	145.8	1.095	-0.529	-114.7	39.5	10.86	147.3	704.0	
	-34.160	142.8	1.046	-0.455	-75.0	39.2	7.10	140.8	733.3	
	-35.160	139.9	1.003	-0.410	-37.4	35.6	3.54	135.0	762.5	
	-36.160	136.9	0.963	-0.394	-4.6	29.5	0.44	129.6	791.7	
	-37.160	134.0	0.924	-0.401	20.8	20.9	1.97	124.3	821.0	
	-38.160	131.1	0.882	-0.425	36.5	9.9	3.45	118.7	850.2	
	-39.160	128.1	0.838	-0.456	39.8	-3.9	3.77	112.8	879.4	
	-40.160	125.2	0.791	-0.483	27.7	-20.8	2.62	106.5	908.7	
	-40.991	124.2	0.751	-0.494	3.6	-37.6	0.34	151.5	1007.8	
	-41.160	123.5	0.742	-0.494	-2.4	-33.1	0.22	149.8	1013.0	
	-42.160	119.8	0.693	-0.483	-23.3	-9.9	2.21	139.9	1043.8	
	-43.160	116.0	0.646	-0.463	-24.1	7.3	2.29	130.4	1074.5	
	-44.160	112.3	0.600	-0.448	-10.5	18.9	1.00	121.2	1105.3	
	-45.160	108.5	0.556	-0.449	12.0	25.2	1.13	112.2	1136.1	
	-46.160	104.8	0.510	-0.468	38.1	26.2	3.61	103.0	1166.8	
	-47.160	101.0	0.461	-0.508	62.4	21.4	5.91	93.1	1197.6	
	-48.160	97.3	0.408	-0.565	78.8	10.1	7.46	82.3	1228.3	
	-49.160	93.5	0.348	-0.629	80.0	-8.9	7.58	70.3	1259.1	
	-50.160	89.8	0.282	-0.685	58.0	-36.8	5.49	57.0	1289.8	
	-50.591	13.7	0.252	-0.702	38.9	-51.9	3.69	51.0	609.3	
	-51.108	9.0	0.216	-0.713	17.0	-33.3	1.61	43.6	609.3	
	-51.160	8.6	0.212	-0.713	15.3	-31.5	1.45	42.8	609.3	
	-52.112	0.0	0.144	-0.717	0.0	-1.4	0.00	29.1	609.3	
	-52.160	0.0	0.141	-0.717	0.0	0.0	0.00	28.4	609.3	

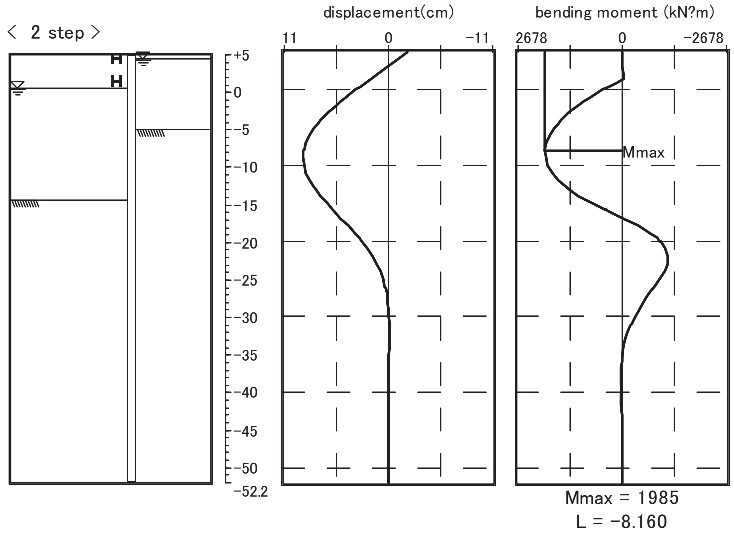
*showing plastic

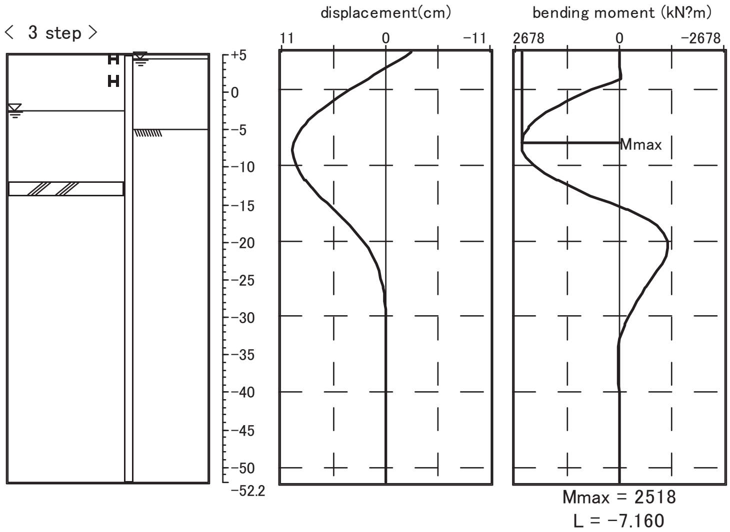
bending moment at support of footing concrete is reduced value

2.11 displacement / member force diagram

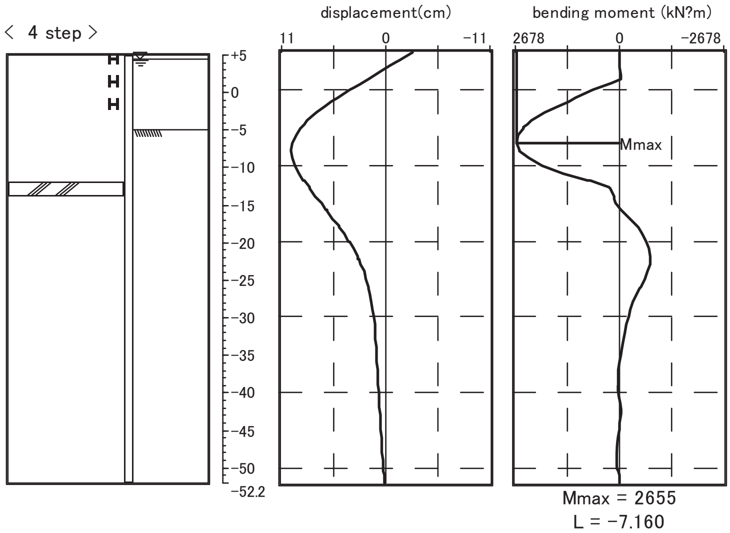
bridge axis direction



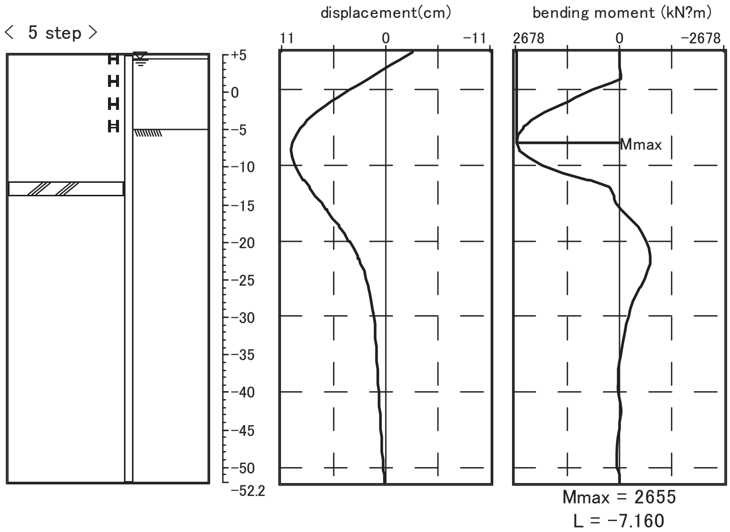


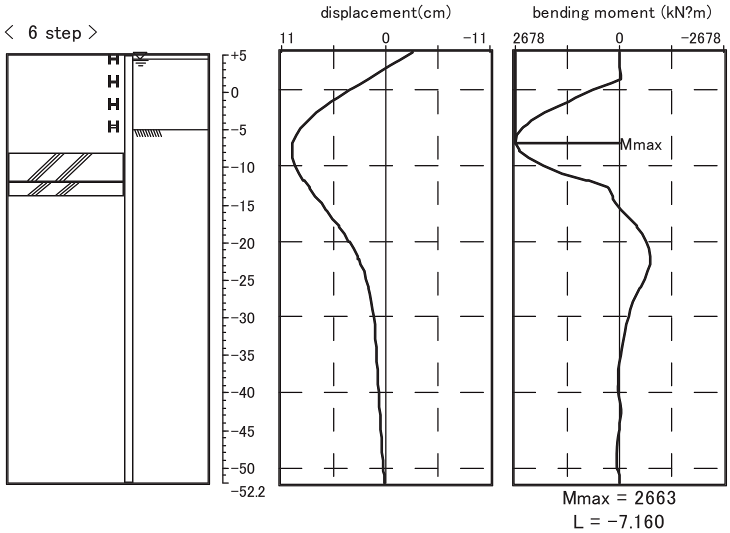


< 3 step >
displacement(cm)
11
0
−11
bending moment (kN?m)
2678
0
−2678
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−52.2
Mmax
Mmax = 2518
L = −7.160

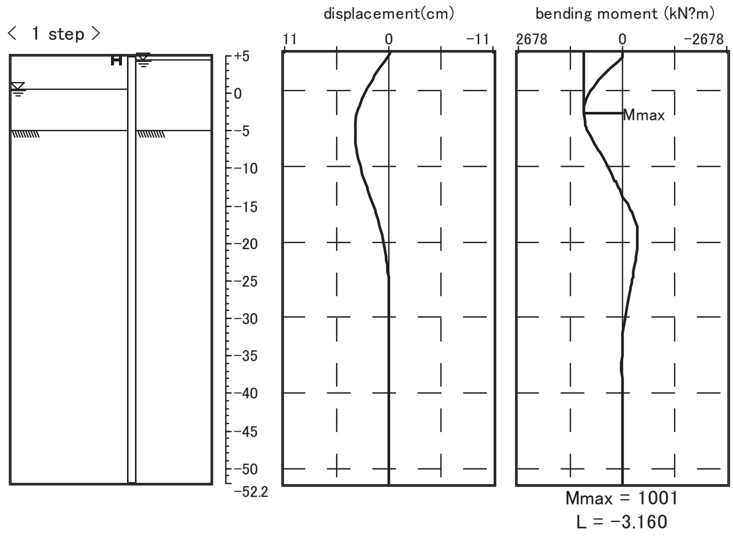


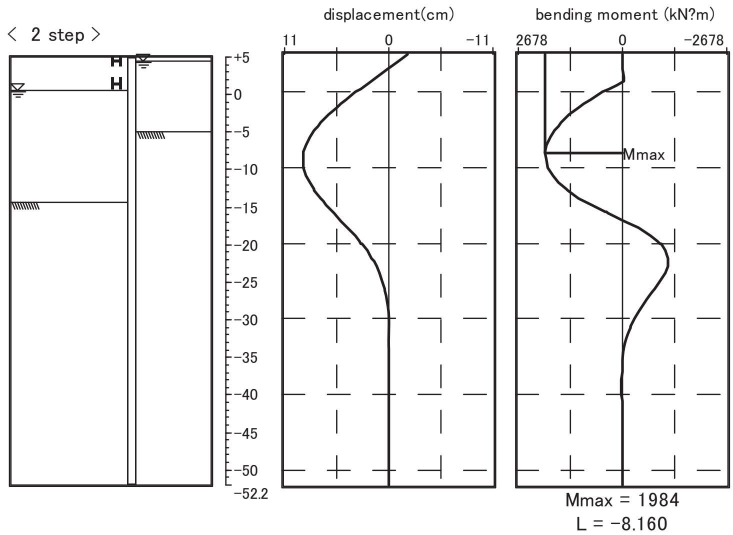
< 4 step >
displacement(cm)
11
0
−11
bending moment (kN?m)
2678
0
−2678
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−52.2
Mmax
Mmax = 2655
L = −7.160

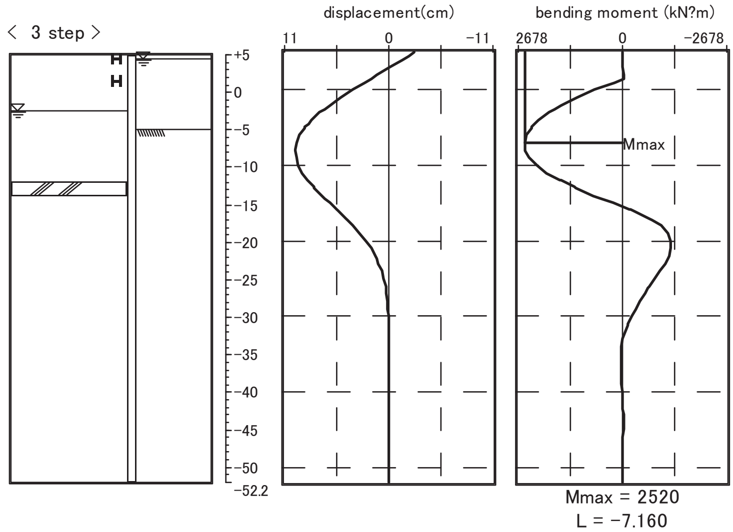

〈 5 step 〉
displacement(cm)
11 0 −11
bending moment (kN?m)
2678 0 −2678
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−52.2
Mmax
Mmax = 2655
L = −7.160

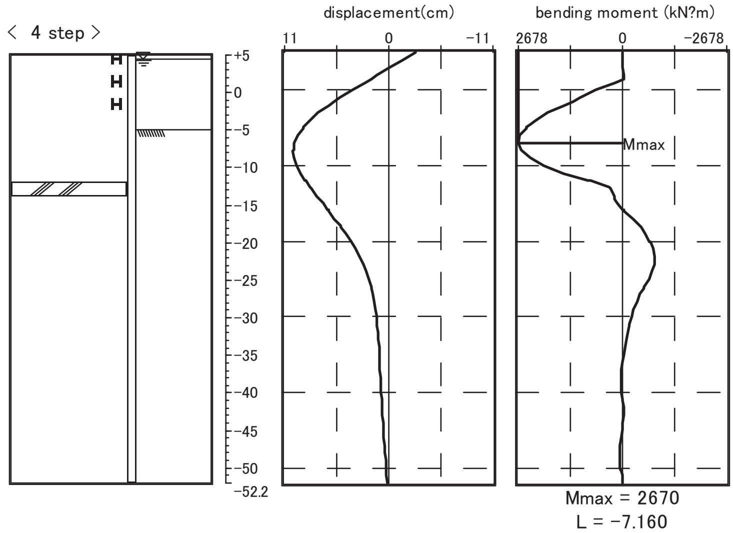

〈 6 step 〉
displacement(cm)
11 0 −11
bending moment (kN?m)
2678 0 −2678
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−52.2
Mmax
Mmax = 2663
L = −7.160

perpendicular direction

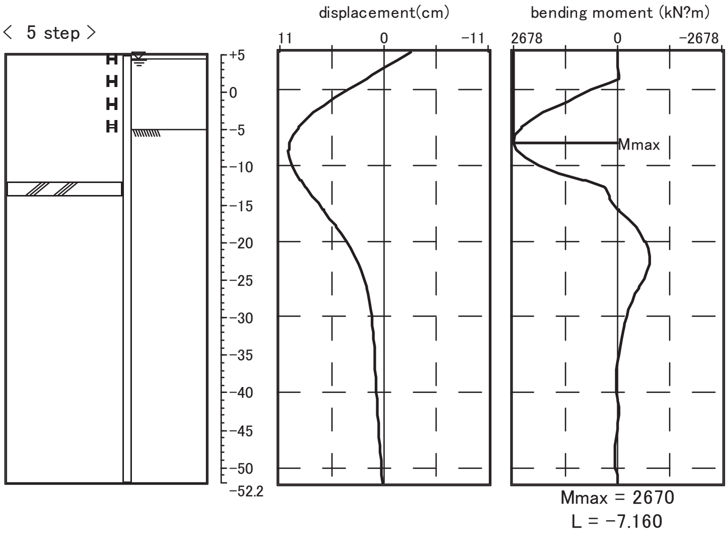




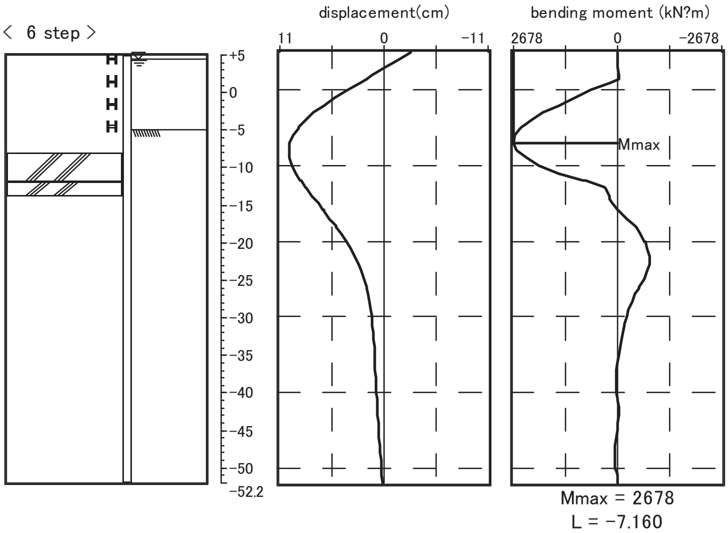

< 3 step >
displacement(cm)
bending moment (kN?m)
11
0
-11
2678
0
-2678
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-52.2
Mmax
Mmax = 2520
L = -7.160


< 4 step >
displacement(cm)
bending moment (kN?m)
11
0
-11
2678
0
-2678
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-52.2
Mmax
Mmax = 2670
L = -7.160

< 5 step >


displacement(cm)
11
0
−11
bending moment (kN?m)
2678
0
−2678
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−52.2
Mmax
Mmax = 2670
L = −7.160

< 6 step >


displacement(cm)
11
0
−11
bending moment (kN?m)
2678
0
−2678
+5
0
−5
−10
−15
−20
−25
−30
−35
−40
−45
−50
−52.2
Mmax
Mmax = 2678
L = −7.160

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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	40.0	40.0	218.70	46.54	66600	3330	17.50	10.10
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	218.51	H-350*350*12*19	218.51
2	2H-400*400*13*21	289.21	2H-400*400*13*21	289.35

row	bridge axis direction (linear)		perpendicular direction(arc)	
	section	Rmax	section	Rmax
3	H-300*300*10*15	81.58	H-300*300*10*15	99.03
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	431.16	39800	1986.21	218.51	OK
2	2H-400*400*13*21	428.66	66600	3382.15	289.35	OK
3	H-300*300*10*15	433.66	20200	990.74	99.03	OK
4	H-300*300*10*15	433.66	20200	990.74	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.

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

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	218.51	218.51	431.16
2	2H-400*400*13*21	218.70	3330	289.35	289.21	428.66
3	H-300*300*10*15	118.40	1350	99.03	81.58	433.66
4	H-300*300*10*15	118.40	1350	0.00	0.00	433.66

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	942.1	81.2	132.7	148.66	210.00	OK
2	2.700	1240.3	106.3	175.7	141.41	210.00	OK
3	2.700	429.5	37.2	49.6	100.57	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)

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

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

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) = $\dfrac{1,200,000}{\left(\dfrac{L4}{ry}\right)^2}$

L4 : effective buckling length about strong axis (mm)

ry : section second radius about strong axis (mm)

a)stability check1

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

N = R1max*r + Del.N

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

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

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

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	431.16	4.000	1.300	2.700	2.700	2.700	2.700
2	2H-400*400*13*21	218.70	3330	428.66	4.000	1.300	2.700	2.700	2.700	2.700
3	H-300*300*10*15	118.40	1350	433.66	4.000	1.300	2.700	2.700	2.700	2.700
4	H-300*300*10*15	118.40	1350	433.66	4.000	1.300	2.700	2.700	2.700	2.700

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	30.37	194.78	7.71	198.43	17.76	3803.13
2	26.73	199.26	6.75	201.90	15.43	5041.15
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	218.51	218.51	1092.14	199.12	63.53	87.33
2	289.35	289.21	1390.33	263.54	63.57	79.14
3	99.03	81.58	579.47	74.34	48.94	55.06
4	0.00	0.00	150.00	0.00	12.67	0.00

row	Alp.	Beta	Alp.+Beta	judgement
1	0.326	0.448	0.774	OK
2	0.319	0.397	0.716	OK
3	0.260	0.289	0.549	OK
4	0.067	0.000	0.067	OK

b)stability check2

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

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

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	63.53	87.33	3803.13	88.82	152.35	210.00	OK
2	63.57	79.14	5041.15	80.15	143.72	210.00	OK
3	48.94	55.06	2824.86	56.03	104.98	210.00	OK
4	12.67	0.00	2824.86	0.00	12.67	210.00	OK

c) check of shear stress

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

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

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	218.51	2.700	294.99	37.44	78.79	120.00	OK
2	289.21	2.700	390.43	46.54	83.89	120.00	OK
3	81.58	2.700	110.13	27.00	40.79	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	5.673	8.273	8.273	5.673
2	2H-400*400*13*21	218.70	3330	4.000	5.573	8.173	8.173	5.573
3	H-300*300*10*15	118.40	1350	4.000	5.773	8.373	8.373	5.773
4	H-300*300*10*15	118.40	1350	4.000	5.773	8.373	8.373	5.773

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
1	63.81	153.65	16.21	167.85	54.43	405.08
2	55.18	164.27	13.93	176.04	46.70	550.17

row	L5/rz	Sig.caz (N/mm^2)	L2/b	Sig.bagy (N/mm^2)	L4/ry (m)	Sig.eay (N/mm^2)
3	76.46	138.09	19.24	156.92	63.92	293.74
4	76.46	138.09	19.24	156.92	63.92	293.74

row	R1max (kN/m)	R2max (kN/m)	N (kN)	M (kN.m)	Sig.c (N/mm2)	Sig.bcy (N/mm2)
1	218.51	218.51	1024.06	42.78	59.57	18.76
2	289.35	289.21	1306.82	41.75	59.75	12.54
3	99.03	81.58	476.30	43.82	40.23	32.46
4	0.00	0.00	150.00	43.82	12.67	32.46

row	Alp.	Beta	Alp.+Beta	judgement
1	0.388	0.131	0.519	OK
2	0.364	0.080	0.444	OK
3	0.291	0.240	0.531	OK
4	0.092	0.216	0.308	OK

b)stability check2

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

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

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	59.57	18.76	405.08	22.00	81.57	210.00	OK
2	59.75	12.54	550.17	14.06	73.82	210.00	OK
3	40.23	32.46	293.74	37.61	77.84	210.00	OK
4	12.67	32.46	293.74	33.92	46.59	210.00	OK

c) check of shear stress

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

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

row	L3 (m)	Smax (kN)	Aw (cm2)	Tau.s (N/mm2)	Tau.sa (N/mm2)	judgement
1	8.273	20.68	37.44	5.52	120.00	OK
2	8.173	20.43	46.54	4.39	120.00	OK
3	8.373	20.93	27.00	7.75	120.00	OK
4	8.373	20.93	27.00	7.75	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-400*400*13*21	218.70	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	218.51	417.18	24.27	206.70	OK
2	18.20	289.21	552.15	25.25	209.75	OK
3	24.35	81.58	155.74	13.15	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 -5.091 (m)
riverside water table elevation +4.340 (m)
steel pipe sheet pile length 57.000 (m)

(1)final excavation time (5 step)
observing strut elevation = -4.660 (m)
coffered landside excavation area elevation = -14.560 (m)
coffered landside water table elevation = -14.560 (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 -5.091	0.431	------- -------	0.00 0.00	90.00 94.31
2	-5.091 -14.560	9.469	------- -------	0.00 26.28	94.31 189.00
3	-14.560 -15.991	1.431	0.00 32.99	26.28 30.26	189.00 0.00
4	-15.991 -20.291	4.300	38.83 155.52	25.71 35.85	0.00 0.00
5	-20.291 -22.591	2.300	129.85 147.10	37.60 54.85	0.00 0.00
6	-22.591 -26.391	3.800	205.36 304.30	42.66 52.00	0.00 0.00
7	-26.391 -28.680	2.289	177.50 194.67	85.25 102.42	0.00 0.00

active earth pressure /water pressure Pa = 3513.6 (kN/m)
ya = 11.525 (m)
Ma = 40495 (kN.m/m)
passive earth pressure Pp = 2154.3 (kN/m)
yp = 18.798 (m)
Mp = 40495 (kN.m/m)
balanced depth Z = 14.120 (m) (elevation = -28.680 (m))
embedment length D = 16.944 (m) (elevation = -31.504 (m))
required sheet pile length L = 36.344 (m)

(2)before installation of the lower strut (4 step)
observing strut elevation = -1.660 (m)
coffered landside excavation area elevation = -14.560 (m)
coffered landside water table elevation = -14.560 (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 -5.091	3.431	------- -------	0.00 0.00	60.00 94.31
2	-5.091 -14.560	9.469	------- -------	0.00 26.28	94.31 189.00
3	-14.560 -15.991	1.431	0.00 32.99	26.28 30.26	189.00 7.32
4	-15.991 -20.291	4.300	38.83 155.52	25.71 35.85	7.32 5.31
5	-20.291 -22.591	2.300	129.85 147.10	37.60 54.85	5.31 4.23
6	-22.591 -26.391	3.800	205.36 304.30	42.66 52.00	4.23 2.46
7	-26.391 -31.291	4.900	177.50 214.25	85.25 122.00	2.46 0.17
8	-31.291 -31.653	0.362	441.82 451.65	60.73 61.58	0.17 0.00

active earth pressure /water pressure Pa = 4334.7 (kN/m)
ya = 15.437 (m)
Ma = 66914 (kN.m/m)
passive earth pressure Pp = 2849.9 (kN/m)
yp = 23.479 (m)
Mp = 66914 (kN.m/m)
balanced depth Z = 17.093 (m) (elevation = -31.653 (m))
embedment length D = 20.512 (m) (elevation = -35.072 (m))
required sheet pile length L = 39.912 (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)	-22.591	32.83	66.67	99.49	140.00
2	Oridinary(low tide)	-22.591	34.06	66.67	100.73	140.00
3	Ord+Temp(high tide)	-22.591	52.57	66.67	119.24	161.00
4	Ord+Temp(low tide)	-22.591	53.81	66.67	120.48	161.00
5	Wind+Temp	-22.591	52.74	66.67	119.40	189.00
6	Wind+Temp	-22.591	51.27	66.67	117.94	189.00
7	Ord+Collision	-22.591	46.70	66.67	113.37	210.00
8	Ord+Collision(scour)	-22.591	45.23	66.67	111.90	210.00
9	Earthquake	-22.160	118.65	66.14	184.78	210.00
10	Earthquake(scour)	-22.160	119.45	66.14	185.59	210.00

2) material :SKY490

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)	-12.060	37.33	79.50	116.83	185.00
2	Oridinary(low tide)	-12.060	38.74	79.50	118.24	185.00
3	Ord+Temp(high tide)	-12.060	59.78	79.50	139.28	212.75
4	Ord+Temp(low tide)	-12.060	61.18	79.50	140.69	212.75
5	Wind+Temp	-12.060	59.94	79.50	139.44	249.75
6	Wind+Temp	-12.060	58.27	79.50	137.77	249.75
7	Ord+Collision	-12.060	50.90	79.50	130.41	277.50
8	Ord+Collision(scour)	-12.060	49.23	79.50	128.73	277.50
9	Earthquake	-12.060	119.27	79.50	198.78	277.50
10	Earthquake(scour)	-12.060	118.80	79.50	198.31	277.50

(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)	-22.591	32.83	68.65	101.48	140.00
2	Oridinary(low tide)	-22.591	34.06	68.65	102.71	140.00
3	Wind	-22.591	40.72	68.65	109.37	175.00
4	Ord+Collision	-22.591	61.72	68.65	130.37	210.00
5	Ord+Collision(scour)	-22.591	60.23	68.65	128.88	210.00
6	Earthquake	-22.591	113.07	68.65	181.72	210.00
7	Earthquake(scour)	-22.591	111.90	68.65	180.55	210.00

2) material :SKY490

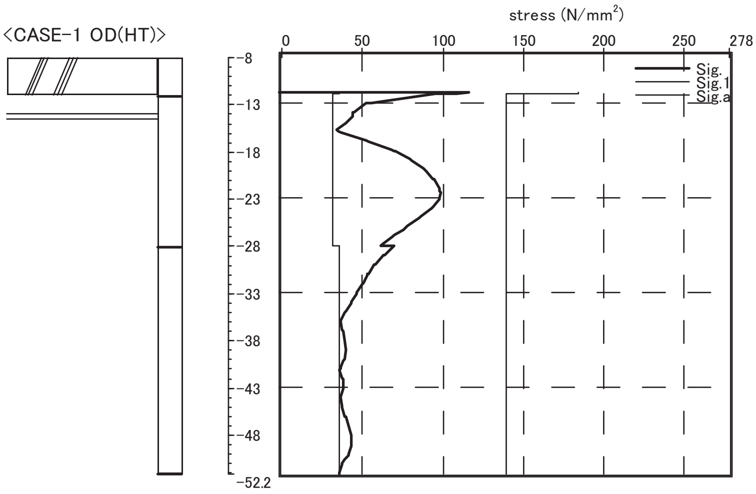
Case	load name	accrue location(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	Sig.a(N/mm²)
1	Oridinary(high tide)	-12.060	37.33	84.55	121.88	185.00
2	Oridinary(low tide)	-12.060	38.74	84.55	123.29	185.00
3	Wind	-12.060	45.68	84.55	130.23	231.25
4	Ord+Collision	-12.060	63.19	84.55	147.74	277.50
5	Ord+Collision(scour)	-12.060	61.49	84.55	146.04	277.50
6	Earthquake	-12.060	111.77	84.55	196.32	277.50
7	Earthquake(scour)	-12.060	110.22	84.55	194.77	277.50

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

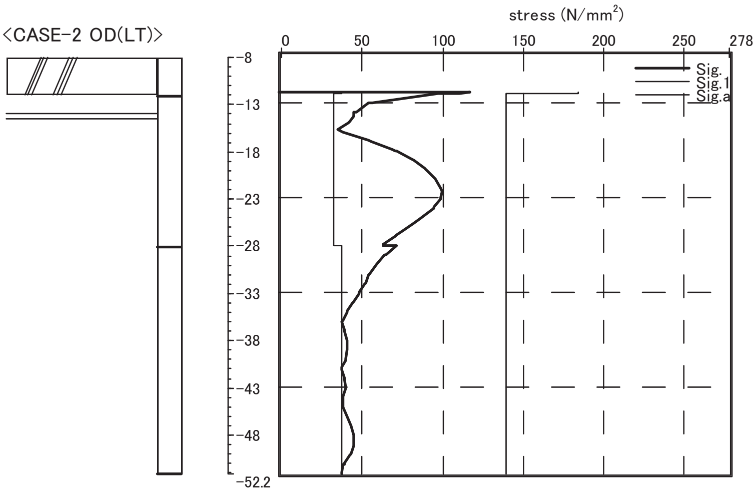
3.2 stress distribution diagram

(1)bridge axis direction

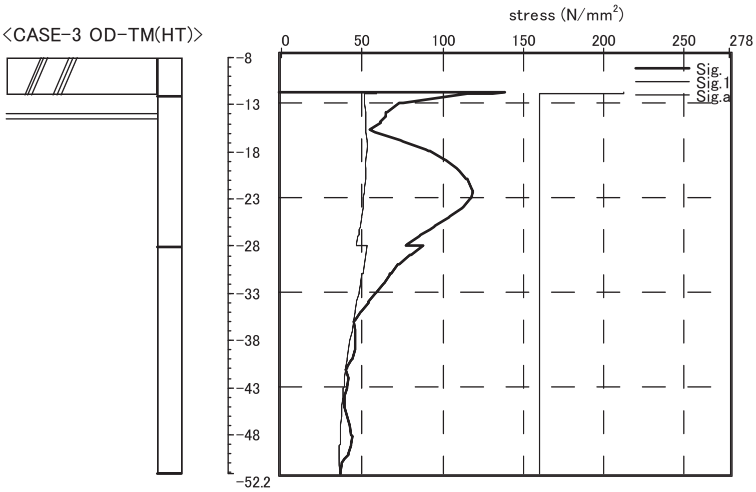
<CASE-1 OD(HT)>



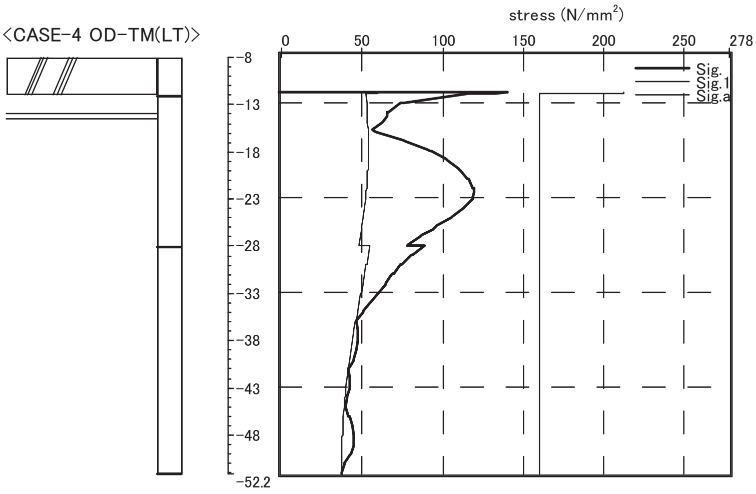
<CASE-2 OD(LT)>



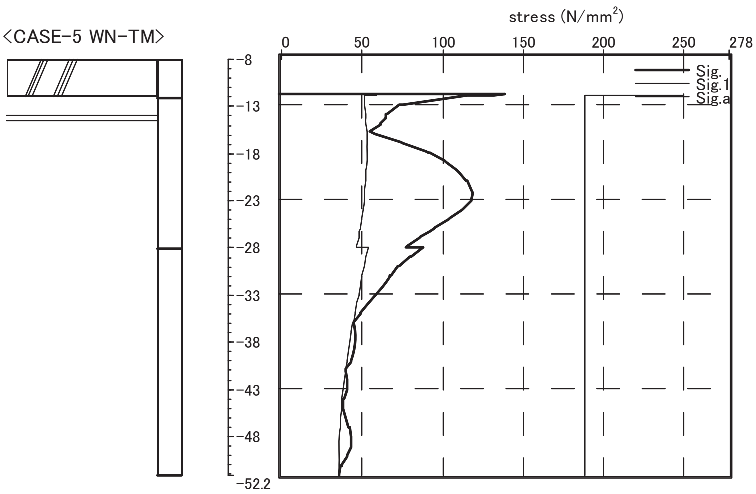
<CASE-3 OD-TM(HT)>



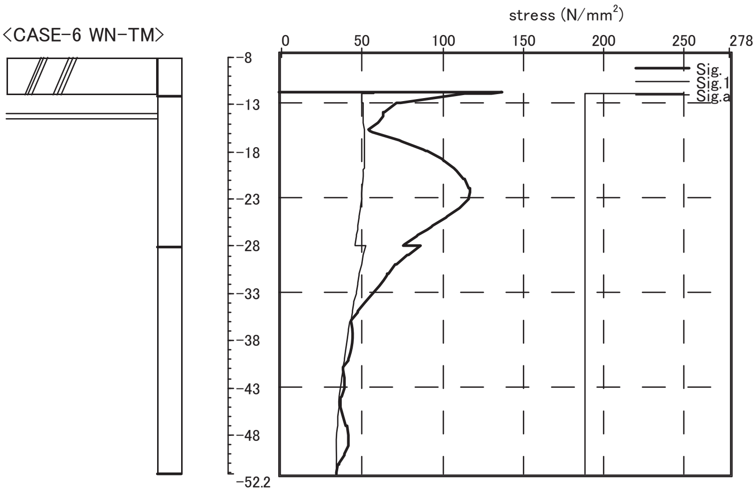
<CASE-4 OD-TM(LT)>



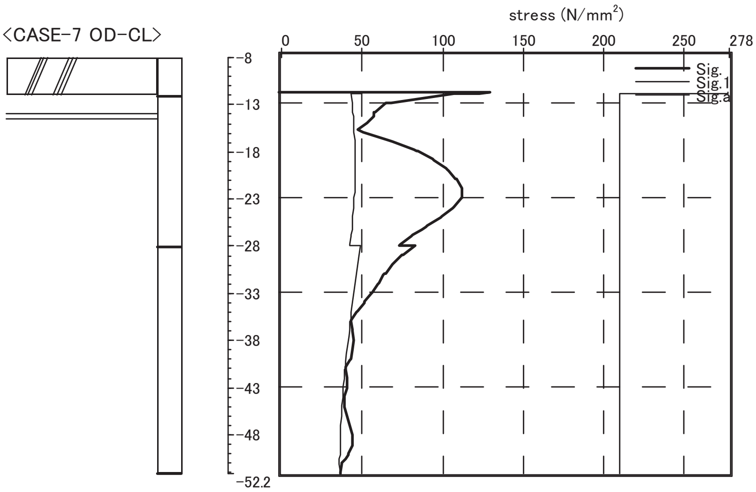
<CASE-5 WN-TM>



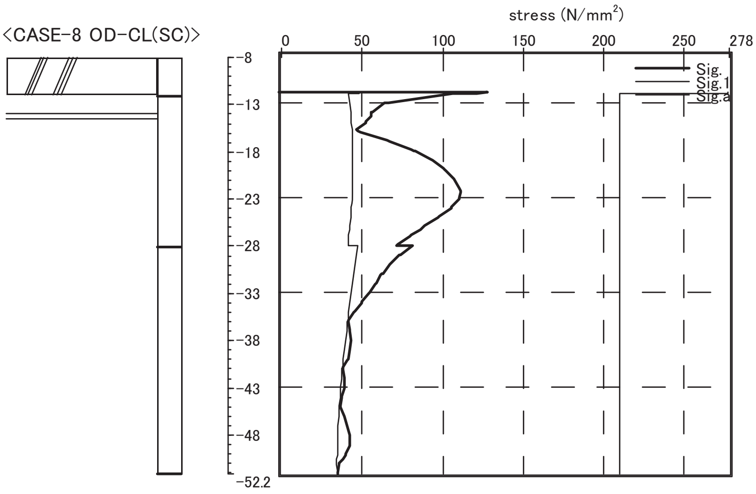
<CASE-6 WN-TM>



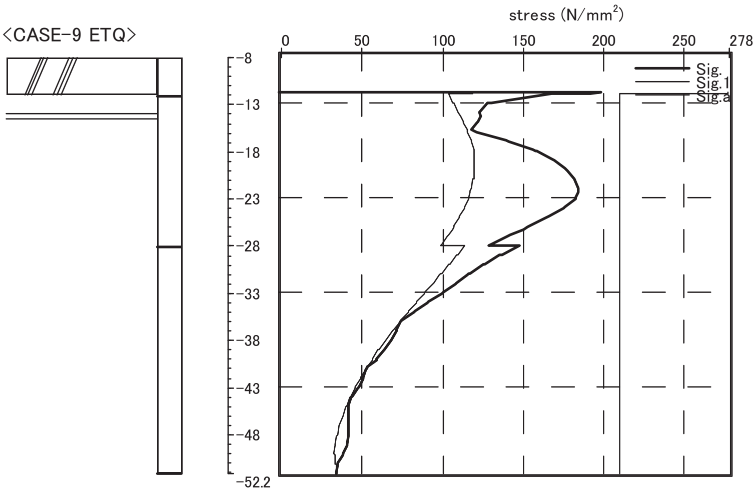
<CASE-7 OD-CL>

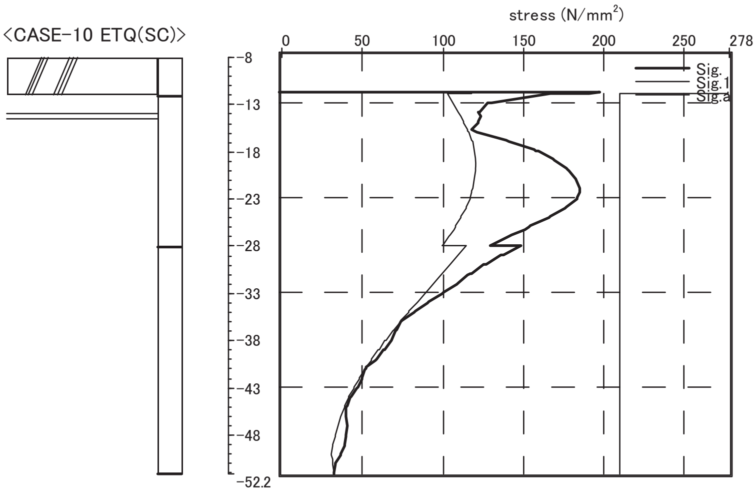


<CASE-8 OD-CL(SC)>

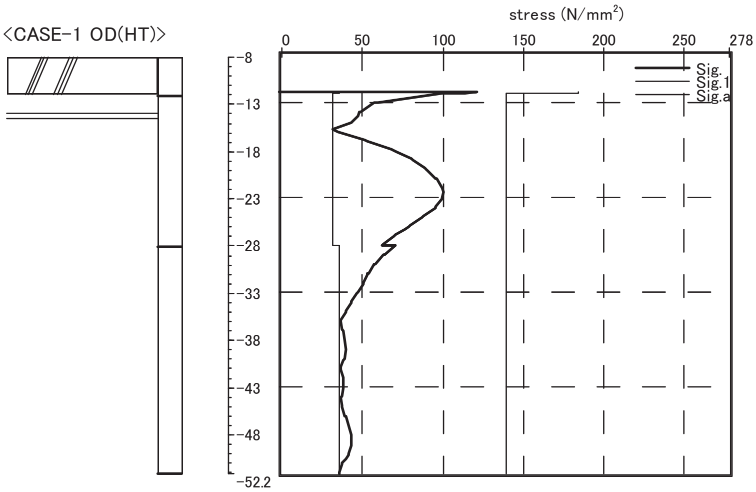


<CASE-9 ETQ>

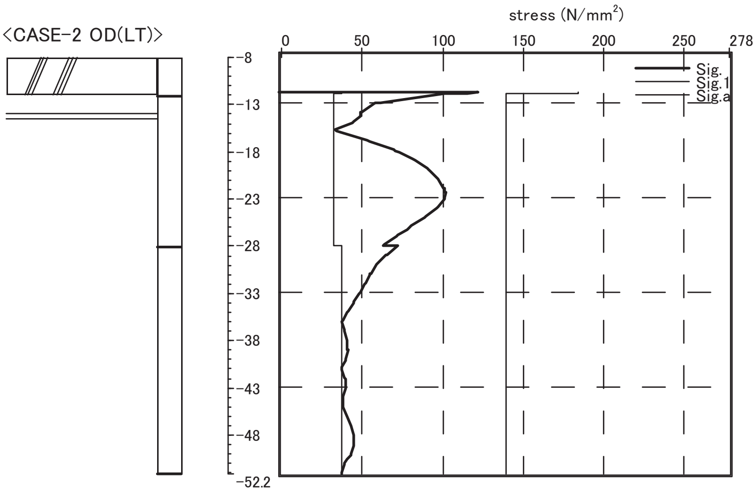




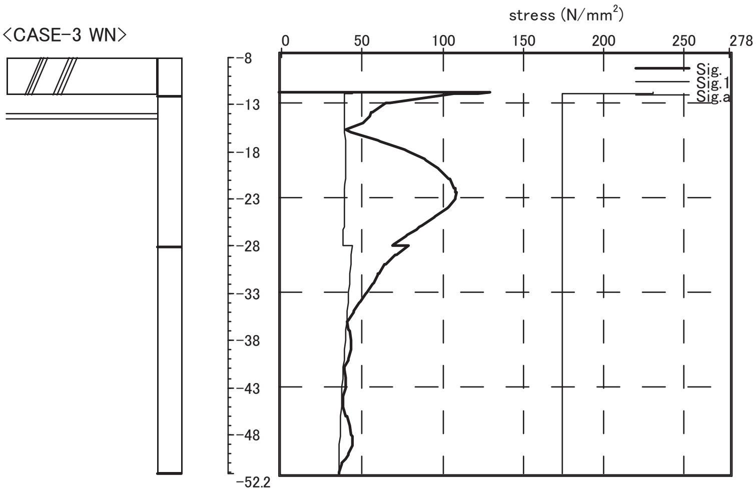
(2)perpendicular direction



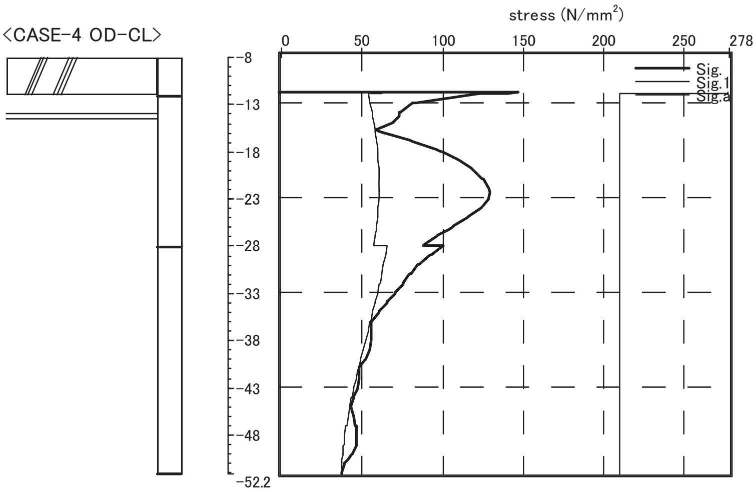
<CASE-2 OD(LT)>



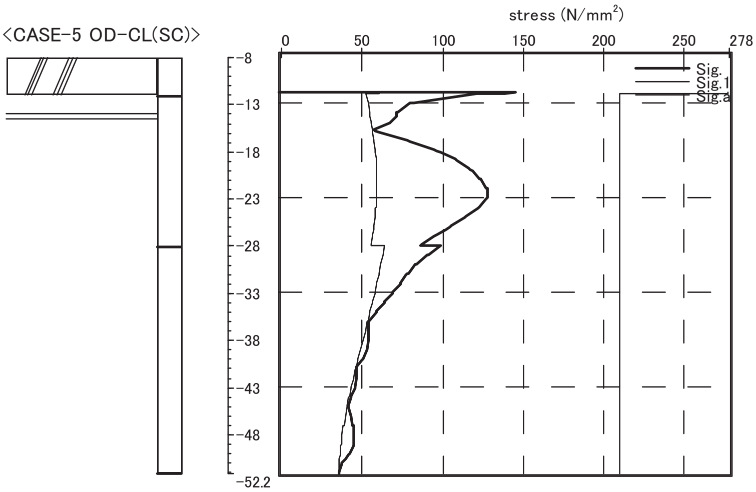
<CASE-3 WN>



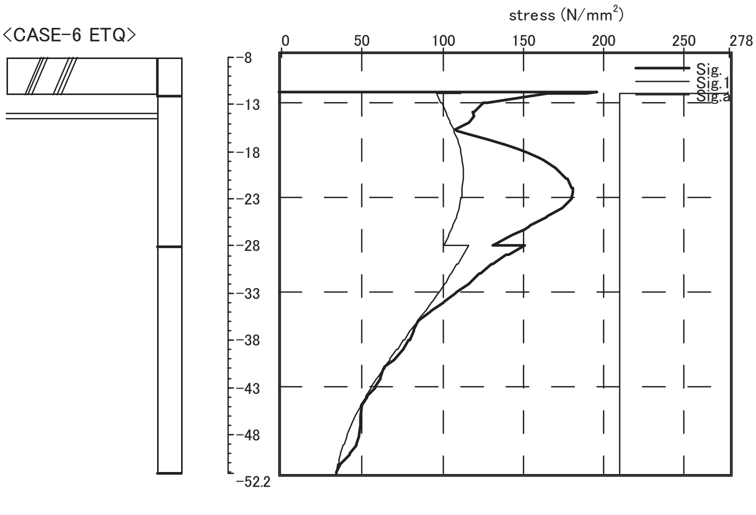
<CASE-4 OD-CL>



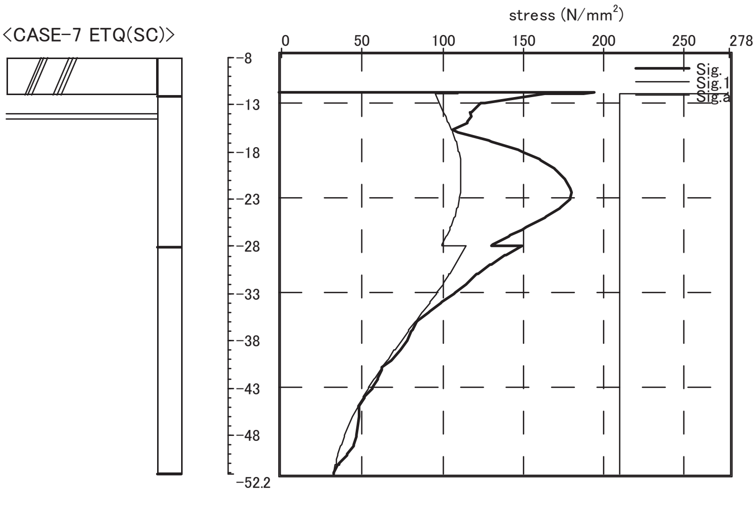
<CASE-5 OD-CL(SC)>



<CASE-6 ETQ>



<CASE-7 ETQ(SC)>



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)	
-12.060	37.33	79.50	116.83	
-12.160	37.33	72.47	109.80	
-12.160	32.83	63.73	96.55	
-13.060	32.83	23.82	56.64	
-13.160	32.83	21.12	53.94	
-14.060	32.83	13.40	46.22	
-14.160	32.83	12.54	45.36	
-14.560	32.83	12.52	45.34	
-15.060	32.83	9.31	42.14	
-15.160	32.83	8.67	41.49	
-15.991	32.83	2.44	35.27	
-16.060	32.83	3.65	36.48	
-16.160	32.83	5.41	38.24	
-17.060	32.83	21.07	53.89	
-17.160	32.83	22.81	55.63	
-18.060	32.83	36.46	69.28	
-18.160	32.83	37.97	70.80	
-18.234	32.83	38.93	71.76	
-19.060	32.83	47.82	80.64	
-19.160	32.83	48.90	81.72	
-20.060	32.83	55.94	88.77	
-20.160	32.83	56.73	89.55	
-20.291	32.83	57.63	90.46	
-21.060	32.83	62.13	94.96	
-21.160	32.83	62.72	95.54	
-22.060	32.83	65.79	98.62	
-22.160	32.83	66.14	98.96	
-22.445	32.83	66.55	99.38	
-22.591	32.83	66.67	99.49	**
-23.060	32.83	66.15	98.98	
-23.160	32.83	66.04	98.87	
-24.060	32.83	61.86	94.69	
-24.160	32.83	61.40	94.22	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-25.060	32.83	54.73	87.56	
-25.160	32.83	53.99	86.82	
-26.060	32.83	46.40	79.22	
-26.160	32.83	45.55	78.38	
-26.391	32.83	43.61	76.43	
-27.060	32.83	38.16	70.98	
-27.160	32.83	37.34	70.17	
-28.060	32.83	30.64	63.47	
-28.160	32.83	29.90	62.72	
-28.160	37.33	34.00	71.33	
-29.060	37.33	27.51	64.84	
-29.160	37.33	26.79	64.12	
-30.060	37.33	21.71	59.04	
-30.160	37.33	21.15	58.48	
-31.060	37.33	17.63	54.97	
-31.160	37.33	17.24	54.57	
-31.291	37.33	16.87	54.20	
-32.060	37.33	14.47	51.80	
-32.160	37.33	14.16	51.49	
-33.060	37.33	10.92	48.25	
-33.160	37.33	10.56	47.89	
-34.060	37.33	7.22	44.55	
-34.160	37.33	6.85	44.18	
-35.060	37.33	3.71	41.04	
-35.160	37.33	3.36	40.69	
-36.060	37.33	0.65	37.98	
-36.160	37.33	0.35	37.68	
-37.060	37.33	1.82	39.15	
-37.160	37.33	1.98	39.31	
-38.060	37.33	3.26	40.59	
-38.160	37.33	3.41	40.74	
-39.060	37.33	3.67	41.00	
-39.160	37.33	3.70	41.03	
-40.060	37.33	2.71	40.04	
-40.160	37.33	2.60	39.93	
-40.991	37.33	0.41	37.74	
-41.060	37.33	0.30	37.63	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-41.160	37.33	0.13	37.46	
-42.060	37.33	1.85	39.18	
-42.160	37.33	2.04	39.37	
-43.060	37.33	2.10	39.43	
-43.160	37.33	2.11	39.44	
-44.060	37.33	1.00	38.33	
-44.160	37.33	0.87	38.20	
-45.060	37.33	1.15	38.48	
-45.160	37.33	1.18	38.51	
-46.060	37.33	3.32	40.65	
-46.160	37.33	3.55	40.88	
-47.060	37.33	5.53	42.86	
-47.160	37.33	5.75	43.08	
-48.060	37.33	7.06	44.39	
-48.160	37.33	7.21	44.54	
-49.060	37.33	7.27	44.60	
-49.160	37.33	7.28	44.61	
-50.060	37.33	5.41	42.74	
-50.160	37.33	5.20	42.53	
-50.591	37.33	3.43	40.76	
-51.060	37.33	1.61	38.94	
-51.108	37.33	1.42	38.75	
-51.160	37.33	1.27	38.60	
-52.060	37.33	0.07	37.40	
-52.112	37.33	0.00	37.33	
-52.160	37.33	0.00	37.33	

* :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)	
-12.060	38.74	79.50	118.24	
-12.160	38.74	72.47	111.20	
-12.160	34.06	63.73	97.79	
-13.060	34.06	23.82	57.88	
-13.160	34.06	21.12	55.18	
-14.060	34.06	13.40	47.46	
-14.160	34.06	12.54	46.60	
-14.560	34.06	12.52	46.58	
-15.060	34.06	9.31	43.37	
-15.160	34.06	8.67	42.73	
-15.991	34.06	2.44	36.50	
-16.060	34.06	3.65	37.71	
-16.160	34.06	5.41	39.47	
-17.060	34.06	21.07	55.13	
-17.160	34.06	22.81	56.87	
-18.060	34.06	36.46	70.52	
-18.160	34.06	37.97	72.04	
-18.234	34.06	38.93	72.99	
-19.060	34.06	47.82	81.88	
-19.160	34.06	48.90	82.96	
-20.060	34.06	55.94	90.01	
-20.160	34.06	56.73	90.79	
-20.291	34.06	57.63	91.69	
-21.060	34.06	62.13	96.20	
-21.160	34.06	62.72	96.78	
-22.060	34.06	65.79	99.86	
-22.160	34.06	66.14	100.20	
-22.445	34.06	66.55	100.62	
-22.591	34.06	66.67	100.73	**
-23.060	34.06	66.15	100.21	
-23.160	34.06	66.04	100.10	
-24.060	34.06	61.86	95.92	
-24.160	34.06	61.40	95.46	
-25.060	34.06	54.73	88.80	
-25.160	34.06	53.99	88.06	
-26.060	34.06	46.40	80.46	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	34.06	45.55	79.61	
-26.391	34.06	43.61	77.67	
-27.060	34.06	38.16	72.22	
-27.160	34.06	37.34	71.40	
-28.060	34.06	30.64	64.70	
-28.160	34.06	29.90	63.96	
-28.160	38.74	34.00	72.73	
-29.060	38.74	27.51	66.25	
-29.160	38.74	26.79	65.53	
-30.060	38.74	21.71	60.45	
-30.160	38.74	21.15	59.88	
-31.060	38.74	17.63	56.37	
-31.160	38.74	17.24	55.98	
-31.291	38.74	16.87	55.61	
-32.060	38.74	14.47	53.21	
-32.160	38.74	14.16	52.90	
-33.060	38.74	10.92	49.66	
-33.160	38.74	10.56	49.30	
-34.060	38.74	7.22	45.96	
-34.160	38.74	6.85	45.59	
-35.060	38.74	3.71	42.45	
-35.160	38.74	3.36	42.10	
-36.060	38.74	0.65	39.39	
-36.160	38.74	0.35	39.08	
-37.060	38.74	1.82	40.55	
-37.160	38.74	1.98	40.72	
-38.060	38.74	3.26	42.00	
-38.160	38.74	3.41	42.14	
-39.060	38.74	3.67	42.41	
-39.160	38.74	3.70	42.44	
-40.060	38.74	2.71	41.45	
-40.160	38.74	2.60	41.34	
-40.991	38.74	0.41	39.14	
-41.060	38.74	0.30	39.03	
-41.160	38.74	0.13	38.87	
-42.060	38.74	1.85	40.59	
-42.160	38.74	2.04	40.78	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	38.74	2.10	40.84	
-43.160	38.74	2.11	40.85	
-44.060	38.74	1.00	39.73	
-44.160	38.74	0.87	39.61	
-45.060	38.74	1.15	39.88	
-45.160	38.74	1.18	39.91	
-46.060	38.74	3.32	42.05	
-46.160	38.74	3.55	42.29	
-47.060	38.74	5.53	44.27	
-47.160	38.74	5.75	44.49	
-48.060	38.74	7.06	45.80	
-48.160	38.74	7.21	45.95	
-49.060	38.74	7.27	46.01	
-49.160	38.74	7.28	46.02	
-50.060	38.74	5.41	44.14	
-50.160	38.74	5.20	43.94	
-50.591	38.74	3.43	42.16	
-51.060	38.74	1.61	40.34	
-51.108	38.74	1.42	40.16	
-51.160	38.74	1.27	40.01	
-52.060	38.74	0.07	38.81	
-52.112	38.74	0.00	38.74	
-52.160	38.74	0.00	38.74	

* :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)	
-12.060	59.78	79.50	139.28	
-12.160	59.83	72.47	132.30	
-12.160	52.44	63.73	116.16	
-13.060	52.84	23.82	76.66	
-13.160	52.88	21.12	74.00	
-14.060	53.24	13.40	66.64	
-14.160	53.28	12.54	65.82	
-14.560	53.42	12.52	65.94	
-15.060	53.59	9.31	62.90	
-15.160	53.62	8.67	62.29	
-15.991	53.87	2.44	56.31	
-16.060	53.89	3.65	57.54	
-16.160	53.91	5.41	59.32	
-17.060	54.07	21.07	75.13	
-17.160	54.07	22.81	76.88	
-18.060	54.08	36.46	90.54	
-18.160	54.07	37.97	92.04	
-18.234	54.06	38.93	92.99	
-19.060	53.95	47.82	101.77	
-19.160	53.92	48.90	102.82	
-20.060	53.69	55.94	109.63	
-20.160	53.65	56.73	110.38	
-20.291	53.61	57.63	111.24	
-21.060	53.32	62.13	115.45	
-21.160	53.27	62.72	115.99	
-22.060	52.85	65.79	118.65	
-22.160	52.80	66.14	118.93	
-22.445	52.65	66.55	119.20	
-22.591	52.57	66.67	119.24	**
-23.060	52.30	66.15	118.45	
-23.160	52.24	66.04	118.28	
-24.060	51.64	61.86	113.50	
-24.160	51.56	61.40	112.96	
-25.060	50.87	54.73	105.61	
-25.160	50.79	53.99	104.78	
-26.060	50.02	46.40	96.42	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	49.93	45.55	95.48	
-26.391	49.73	43.61	93.33	
-27.060	49.11	38.16	87.27	
-27.160	49.02	37.34	86.36	
-28.060	48.17	30.64	78.81	
-28.160	48.07	29.90	77.97	
-28.160	54.83	34.00	88.82	
-29.060	53.83	27.51	81.35	
-29.160	53.72	26.79	80.52	
-30.060	52.72	21.71	74.43	
-30.160	52.60	21.15	73.75	
-31.060	51.59	17.63	69.22	
-31.160	51.47	17.24	68.72	
-31.291	51.33	16.87	68.19	
-32.060	50.45	14.47	64.93	
-32.160	50.34	14.16	64.50	
-33.060	49.33	10.92	60.25	
-33.160	49.22	10.56	59.77	
-34.060	48.22	7.22	55.44	
-34.160	48.11	6.85	54.96	
-35.060	47.13	3.71	50.84	
-35.160	47.02	3.36	50.39	
-36.060	46.08	0.65	46.73	
-36.160	45.98	0.35	46.32	
-37.060	45.06	1.82	46.88	
-37.160	44.97	1.98	46.95	
-38.060	44.10	3.26	47.36	
-38.160	44.01	3.41	47.41	
-39.060	43.18	3.67	46.85	
-39.160	43.09	3.70	46.79	
-40.060	42.31	2.71	45.02	
-40.160	42.23	2.60	44.83	
-40.991	41.54	0.41	41.95	
-41.060	41.49	0.30	41.79	
-41.160	41.42	0.13	41.55	
-42.060	40.74	1.85	42.59	
-42.160	40.67	2.04	42.71	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	40.07	2.10	42.17	
-43.160	40.01	2.11	42.11	
-44.060	39.47	1.00	40.46	
-44.160	39.42	0.87	40.29	
-45.060	38.94	1.15	40.09	
-45.160	38.90	1.18	40.08	
-46.060	38.49	3.32	41.81	
-46.160	38.45	3.55	42.01	
-47.060	38.11	5.53	43.64	
-47.160	38.08	5.75	43.83	
-48.060	37.79	7.06	44.86	
-48.160	37.77	7.21	44.98	
-49.060	37.54	7.27	44.81	
-49.160	37.52	7.28	44.80	
-50.060	37.34	5.41	42.75	
-50.160	37.35	5.20	42.55	
-50.591	37.40	3.43	40.83	
-51.060	37.46	1.61	39.07	
-51.108	37.47	1.42	38.89	
-51.160	37.47	1.27	38.74	
-52.060	37.56	0.07	37.63	
-52.112	37.56	0.00	37.56	
-52.160	37.56	0.00	37.56	

*   :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)	
-12.060	61.18	79.50	140.69	
-12.160	61.24	72.47	133.71	
-12.160	53.67	63.73	117.40	
-13.060	54.08	23.82	77.90	
-13.160	54.12	21.12	75.24	
-14.060	54.48	13.40	67.87	
-14.160	54.51	12.54	67.05	
-14.560	54.66	12.52	67.17	
-15.060	54.83	9.31	64.14	
-15.160	54.86	8.67	63.52	
-15.991	55.10	2.44	57.55	
-16.060	55.12	3.65	58.78	
-16.160	55.14	5.41	60.55	
-17.060	55.30	21.07	76.37	
-17.160	55.30	22.81	78.11	
-18.060	55.32	36.46	91.77	
-18.160	55.30	37.97	93.28	
-18.234	55.29	38.93	94.22	
-19.060	55.18	47.82	103.00	
-19.160	55.16	48.90	104.05	
-20.060	54.92	55.94	110.87	
-20.160	54.89	56.73	111.62	
-20.291	54.85	57.63	112.48	
-21.060	54.55	62.13	116.69	
-21.160	54.51	62.72	117.23	
-22.060	54.09	65.79	119.88	
-22.160	54.04	66.14	120.17	
-22.445	53.89	66.55	120.44	
-22.591	53.81	66.67	120.48	**
-23.060	53.54	66.15	119.69	
-23.160	53.47	66.04	119.51	
-24.060	52.88	61.86	114.74	
-24.160	52.80	61.40	114.20	
-25.060	52.11	54.73	106.84	
-25.160	52.02	53.99	106.02	
-26.060	51.26	46.40	97.65	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	51.17	45.55	96.72	
-26.391	50.96	43.61	94.57	
-27.060	50.35	38.16	88.50	
-27.160	50.25	37.34	87.60	
-28.060	49.41	30.64	80.05	
-28.160	49.31	29.90	79.21	
-28.160	56.23	34.00	90.23	
-29.060	55.24	27.51	82.76	
-29.160	55.13	26.79	81.92	
-30.060	54.12	21.71	75.83	
-30.160	54.01	21.15	75.16	
-31.060	52.99	17.63	70.63	
-31.160	52.88	17.24	70.12	
-31.291	52.73	16.87	69.60	
-32.060	51.86	14.47	66.33	
-32.160	51.75	14.16	65.91	
-33.060	50.73	10.92	61.65	
-33.160	50.62	10.56	61.18	
-34.060	49.62	7.22	56.84	
-34.160	49.51	6.85	56.36	
-35.060	48.54	3.71	52.25	
-35.160	48.43	3.36	51.79	
-36.060	47.48	0.65	48.13	
-36.160	47.38	0.35	47.73	
-37.060	46.47	1.82	48.29	
-37.160	46.37	1.98	48.35	
-38.060	45.50	3.26	48.77	
-38.160	45.41	3.41	48.82	
-39.060	44.58	3.67	48.26	
-39.160	44.50	3.70	48.20	
-40.060	43.71	2.71	46.42	
-40.160	43.63	2.60	46.23	
-40.991	42.95	0.41	43.36	
-41.060	42.90	0.30	43.19	
-41.160	42.82	0.13	42.96	
-42.060	42.15	1.85	43.99	
-42.160	42.08	2.04	44.12	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	41.47	2.10	43.57	
-43.160	41.41	2.11	43.52	
-44.060	40.87	1.00	41.87	
-44.160	40.82	0.87	41.69	
-45.060	40.35	1.15	41.50	
-45.160	40.31	1.18	41.48	
-46.060	39.90	3.32	43.22	
-46.160	39.86	3.55	43.41	
-47.060	39.52	5.53	45.05	
-47.160	39.48	5.75	45.24	
-48.060	39.20	7.06	46.26	
-48.160	39.17	7.21	46.38	
-49.060	38.94	7.27	46.22	
-49.160	38.92	7.28	46.20	
-50.060	38.75	5.41	44.15	
-50.160	38.76	5.20	43.96	
-50.591	38.81	3.43	42.24	
-51.060	38.87	1.61	40.48	
-51.108	38.87	1.42	40.29	
-51.160	38.88	1.27	40.15	
-52.060	38.96	0.07	39.03	
-52.112	38.97	0.00	38.97	
-52.160	38.97	0.00	38.97	

* :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)	
-12.060	59.94	79.50	139.44	
-12.160	60.00	72.47	132.47	
-12.160	52.58	63.73	116.30	
-13.060	53.00	23.82	76.82	
-13.160	53.04	21.12	74.16	
-14.060	53.41	13.40	66.81	
-14.160	53.45	12.54	65.99	
-14.560	53.60	12.52	66.11	
-15.060	53.77	9.31	63.08	
-15.160	53.80	8.67	62.47	
-15.991	54.06	2.44	56.50	
-16.060	54.08	3.65	57.73	
-16.160	54.10	5.41	59.51	
-17.060	54.27	21.07	75.33	
-17.160	54.27	22.81	77.08	
-18.060	54.28	36.46	90.74	
-18.160	54.27	37.97	92.24	
-18.234	54.26	38.93	93.19	
-19.060	54.15	47.82	101.97	
-19.160	54.12	48.90	103.02	
-20.060	53.88	55.94	109.82	
-20.160	53.85	56.73	110.57	
-20.291	53.80	57.63	111.43	
-21.060	53.50	62.13	115.63	
-21.160	53.45	62.72	116.17	
-22.060	53.03	65.79	118.82	
-22.160	52.97	66.14	119.11	
-22.445	52.82	66.55	119.37	
-22.591	52.74	66.67	119.40	**
-23.060	52.46	66.15	118.61	
-23.160	52.39	66.04	118.43	
-24.060	51.78	61.86	113.64	
-24.160	51.70	61.40	113.10	
-25.060	50.99	54.73	105.73	
-25.160	50.91	53.99	104.90	
-26.060	50.12	46.40	96.51	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	50.03	45.55	95.58	
-26.391	49.81	43.61	93.42	
-27.060	49.18	38.16	87.34	
-27.160	49.08	37.34	86.43	
-28.060	48.21	30.64	78.85	
-28.160	48.12	29.90	78.01	
-28.160	54.88	34.00	88.88	
-29.060	53.86	27.51	81.37	
-29.160	53.74	26.79	80.54	
-30.060	52.71	21.71	74.42	
-30.160	52.59	21.15	73.74	
-31.060	51.55	17.63	69.18	
-31.160	51.43	17.24	68.67	
-31.291	51.28	16.87	68.15	
-32.060	50.38	14.47	64.85	
-32.160	50.27	14.16	64.43	
-33.060	49.22	10.92	60.14	
-33.160	49.11	10.56	59.67	
-34.060	48.08	7.22	55.30	
-34.160	47.97	6.85	54.82	
-35.060	46.96	3.71	50.67	
-35.160	46.85	3.36	50.22	
-36.060	45.88	0.65	46.53	
-36.160	45.77	0.35	46.12	
-37.060	44.84	1.82	46.65	
-37.160	44.74	1.98	46.72	
-38.060	43.84	3.26	47.10	
-38.160	43.75	3.41	47.15	
-39.060	42.89	3.67	46.57	
-39.160	42.81	3.70	46.51	
-40.060	42.00	2.71	44.71	
-40.160	41.92	2.60	44.52	
-40.991	41.21	0.41	41.62	
-41.060	41.16	0.30	41.45	
-41.160	41.08	0.13	41.21	
-42.060	40.38	1.85	42.23	
-42.160	40.32	2.04	42.35	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	39.69	2.10	41.79	
-43.160	39.63	2.11	41.74	
-44.060	39.08	1.00	40.07	
-44.160	39.02	0.87	39.89	
-45.060	38.54	1.15	39.68	
-45.160	38.49	1.18	39.67	
-46.060	38.07	3.32	41.39	
-46.160	38.03	3.55	41.59	
-47.060	37.68	5.53	43.21	
-47.160	37.64	5.75	43.40	
-48.060	37.35	7.06	44.41	
-48.160	37.32	7.21	44.53	
-49.060	37.09	7.27	44.36	
-49.160	37.07	7.28	44.35	
-50.060	36.88	5.41	42.29	
-50.160	36.90	5.20	42.10	
-50.591	36.95	3.43	40.37	
-51.060	37.01	1.61	38.62	
-51.108	37.01	1.42	38.43	
-51.160	37.02	1.27	38.29	
-52.060	37.10	0.07	37.18	
-52.112	37.11	0.00	37.11	
-52.160	37.11	0.00	37.11	

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

6)Wind+Temp

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	58.27	79.50	137.77	
-12.160	58.33	72.47	130.80	
-12.160	51.11	63.73	114.84	
-13.060	51.53	23.82	75.35	
-13.160	51.57	21.12	72.69	
-14.060	51.94	13.40	65.34	
-14.160	51.98	12.54	64.52	
-14.560	52.13	12.52	64.64	
-15.060	52.30	9.31	61.61	
-15.160	52.33	8.67	61.00	
-15.991	52.59	2.44	55.03	
-16.060	52.61	3.65	56.26	
-16.160	52.63	5.41	58.04	
-17.060	52.80	21.07	73.86	
-17.160	52.80	22.81	75.61	
-18.060	52.81	36.46	89.27	
-18.160	52.80	37.97	90.77	
-18.234	52.79	38.93	91.72	
-19.060	52.68	47.82	100.50	
-19.160	52.65	48.90	101.55	
-20.060	52.41	55.94	108.36	
-20.160	52.38	56.73	109.10	
-20.291	52.33	57.63	109.96	
-21.060	52.03	62.13	114.17	
-21.160	51.98	62.72	114.70	
-22.060	51.56	65.79	117.35	
-22.160	51.50	66.14	117.64	
-22.445	51.35	66.55	117.90	
-22.591	51.27	66.67	117.94	**
-23.060	50.99	66.15	117.14	
-23.160	50.92	66.04	116.96	
-24.060	50.31	61.86	112.17	
-24.160	50.23	61.40	111.63	
-25.060	49.52	54.73	104.26	
-25.160	49.44	53.99	103.43	
-26.060	48.65	46.40	95.04	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	48.56	45.55	94.11	
-26.391	48.34	43.61	91.95	
-27.060	47.71	38.16	85.87	
-27.160	47.62	37.34	84.96	
-28.060	46.74	30.64	77.39	
-28.160	46.65	29.90	76.54	
-28.160	53.21	34.00	87.21	
-29.060	52.19	27.51	79.70	
-29.160	52.07	26.79	78.87	
-30.060	51.04	21.71	72.75	
-30.160	50.92	21.15	72.07	
-31.060	49.88	17.63	67.51	
-31.160	49.76	17.24	67.00	
-31.291	49.61	16.87	66.48	
-32.060	48.71	14.47	63.18	
-32.160	48.60	14.16	62.76	
-33.060	47.55	10.92	58.47	
-33.160	47.44	10.56	58.00	
-34.060	46.41	7.22	53.63	
-34.160	46.30	6.85	53.15	
-35.060	45.29	3.71	49.00	
-35.160	45.18	3.36	48.54	
-36.060	44.21	0.65	44.86	
-36.160	44.10	0.35	44.45	
-37.060	43.17	1.82	44.98	
-37.160	43.07	1.98	45.05	
-38.060	42.17	3.26	45.43	
-38.160	42.08	3.41	45.48	
-39.060	41.22	3.67	44.89	
-39.160	41.13	3.70	44.83	
-40.060	40.33	2.71	43.04	
-40.160	40.24	2.60	42.84	
-40.991	39.54	0.41	39.95	
-41.060	39.49	0.30	39.78	
-41.160	39.41	0.13	39.54	
-42.060	38.71	1.85	40.56	
-42.160	38.64	2.04	40.68	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	38.02	2.10	40.12	
-43.160	37.96	2.11	40.07	
-44.060	37.40	1.00	38.40	
-44.160	37.35	0.87	38.22	
-45.060	36.87	1.15	38.01	
-45.160	36.82	1.18	38.00	
-46.060	36.40	3.32	39.72	
-46.160	36.36	3.55	39.91	
-47.060	36.01	5.53	41.54	
-47.160	35.97	5.75	41.72	
-48.060	35.68	7.06	42.74	
-48.160	35.65	7.21	42.86	
-49.060	35.42	7.27	42.69	
-49.160	35.40	7.28	42.68	
-50.060	35.21	5.41	40.62	
-50.160	35.22	5.20	40.42	
-50.591	35.28	3.43	38.70	
-51.060	35.34	1.61	36.95	
-51.108	35.34	1.42	36.76	
-51.160	35.35	1.27	36.62	
-52.060	35.43	0.07	35.50	
-52.112	35.44	0.00	35.44	
-52.160	35.44	0.00	35.44	

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

7)Ord+Collision

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	50.90	79.50	130.41	
-12.160	50.97	72.47	123.43	
-12.160	44.71	63.73	108.44	
-13.060	45.19	23.82	69.01	
-13.160	45.24	21.12	66.36	
-14.060	45.69	13.40	59.08	
-14.160	45.73	12.54	58.27	
-14.560	45.92	12.52	58.44	
-15.060	46.14	9.31	55.45	
-15.160	46.18	8.67	54.85	
-15.991	46.53	2.44	48.97	
-16.060	46.56	3.65	50.21	
-16.160	46.59	5.41	52.00	
-17.060	46.88	21.07	67.95	
-17.160	46.90	22.81	69.71	
-18.060	47.08	36.46	83.54	
-18.160	47.09	37.97	85.06	
-18.234	47.09	38.93	86.02	
-19.060	47.16	47.82	94.98	
-19.160	47.15	48.90	96.05	
-20.060	47.13	55.94	103.08	
-20.160	47.12	56.73	103.85	
-20.291	47.11	57.63	104.74	
-21.060	47.02	62.13	109.15	
-21.160	47.00	62.72	109.72	
-22.060	46.83	65.79	112.62	
-22.160	46.80	66.14	112.94	
-22.445	46.73	66.55	113.29	
-22.591	46.70	66.67	113.37	**
-23.060	46.57	66.15	112.72	
-23.160	46.53	66.04	112.57	
-24.060	46.21	61.86	108.07	
-24.160	46.16	61.40	107.56	
-25.060	45.76	54.73	100.49	
-25.160	45.71	53.99	99.70	
-26.060	45.24	46.40	91.63	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	45.18	45.55	90.73	
-26.391	45.05	43.61	88.66	
-27.060	44.66	38.16	82.82	
-27.160	44.60	37.34	81.94	
-28.060	44.05	30.64	74.70	
-28.160	43.99	29.90	73.89	
-28.160	50.14	34.00	84.14	
-29.060	49.50	27.51	77.01	
-29.160	49.42	26.79	76.22	
-30.060	48.76	21.71	70.47	
-30.160	48.68	21.15	69.83	
-31.060	48.01	17.63	65.64	
-31.160	47.93	17.24	65.18	
-31.291	47.84	16.87	64.70	
-32.060	47.25	14.47	61.72	
-32.160	47.17	14.16	61.33	
-33.060	46.48	10.92	57.40	
-33.160	46.40	10.56	56.96	
-34.060	45.71	7.22	52.93	
-34.160	45.63	6.85	52.48	
-35.060	44.94	3.71	48.66	
-35.160	44.87	3.36	48.23	
-36.060	44.20	0.65	44.84	
-36.160	44.12	0.35	44.47	
-37.060	43.47	1.82	45.28	
-37.160	43.40	1.98	45.38	
-38.060	42.76	3.26	46.03	
-38.160	42.70	3.41	46.10	
-39.060	42.09	3.67	45.76	
-39.160	42.02	3.70	45.72	
-40.060	41.44	2.71	44.16	
-40.160	41.38	2.60	43.98	
-40.991	40.87	0.41	41.28	
-41.060	40.83	0.30	41.13	
-41.160	40.78	0.13	40.91	
-42.060	40.27	1.85	42.12	
-42.160	40.22	2.04	42.25	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	39.75	2.10	41.86	
-43.160	39.71	2.11	41.82	
-44.060	39.29	1.00	40.29	
-44.160	39.25	0.87	40.12	
-45.060	38.88	1.15	40.03	
-45.160	38.85	1.18	40.02	
-46.060	38.52	3.32	41.84	
-46.160	38.49	3.55	42.05	
-47.060	38.22	5.53	43.75	
-47.160	38.19	5.75	43.94	
-48.060	37.96	7.06	45.02	
-48.160	37.94	7.21	45.15	
-49.060	37.75	7.27	45.02	
-49.160	37.73	7.28	45.01	
-50.060	37.58	5.41	42.99	
-50.160	37.57	5.20	42.77	
-50.591	37.52	3.43	40.94	
-51.060	37.52	1.61	39.13	
-51.108	37.53	1.42	38.95	
-51.160	37.53	1.27	38.80	
-52.060	37.60	0.07	37.67	
-52.112	37.61	0.00	37.61	
-52.160	37.61	0.00	37.61	

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

8)Ord+Collision(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	49.23	79.50	128.73	
-12.160	49.30	72.47	121.76	
-12.160	43.24	63.73	106.97	
-13.060	43.72	23.82	67.54	
-13.160	43.77	21.12	64.89	
-14.060	44.22	13.40	57.61	
-14.160	44.27	12.54	56.80	
-14.560	44.45	12.52	56.97	
-15.060	44.67	9.31	53.98	
-15.160	44.72	8.67	53.38	
-15.991	45.06	2.44	47.51	
-16.060	45.09	3.65	48.74	
-16.160	45.12	5.41	50.53	
-17.060	45.42	21.07	66.48	
-17.160	45.43	22.81	68.24	
-18.060	45.61	36.46	82.07	
-18.160	45.62	37.97	83.59	
-18.234	45.62	38.93	84.55	
-19.060	45.69	47.82	93.51	
-19.160	45.69	48.90	94.58	
-20.060	45.66	55.94	101.61	
-20.160	45.65	56.73	102.38	
-20.291	45.64	57.63	103.27	
-21.060	45.55	62.13	107.68	
-21.160	45.53	62.72	108.25	
-22.060	45.36	65.79	111.15	
-22.160	45.33	66.14	111.47	
-22.445	45.27	66.55	111.82	
-22.591	45.23	66.67	111.90	**
-23.060	45.10	66.15	111.25	
-23.160	45.06	66.04	111.10	
-24.060	44.74	61.86	106.60	
-24.160	44.69	61.40	106.09	
-25.060	44.29	54.73	99.02	
-25.160	44.24	53.99	98.23	
-26.060	43.77	46.40	90.16	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	43.71	45.55	89.26	
-26.391	43.58	43.61	87.19	
-27.060	43.19	38.16	81.35	
-27.160	43.13	37.34	80.47	
-28.060	42.59	30.64	73.23	
-28.160	42.52	29.90	72.42	
-28.160	48.47	34.00	82.47	
-29.060	47.82	27.51	75.34	
-29.160	47.75	26.79	74.55	
-30.060	47.09	21.71	68.80	
-30.160	47.01	21.15	68.16	
-31.060	46.34	17.63	63.97	
-31.160	46.26	17.24	63.51	
-31.291	46.16	16.87	63.03	
-32.060	45.58	14.47	60.05	
-32.160	45.50	14.16	59.66	
-33.060	44.81	10.92	55.73	
-33.160	44.73	10.56	55.29	
-34.060	44.04	7.22	51.26	
-34.160	43.96	6.85	50.81	
-35.060	43.27	3.71	46.98	
-35.160	43.20	3.36	46.56	
-36.060	42.52	0.65	43.17	
-36.160	42.45	0.35	42.80	
-37.060	41.80	1.82	43.61	
-37.160	41.73	1.98	43.70	
-38.060	41.09	3.26	44.36	
-38.160	41.02	3.41	44.43	
-39.060	40.42	3.67	44.09	
-39.160	40.35	3.70	44.05	
-40.060	39.77	2.71	42.48	
-40.160	39.71	2.60	42.31	
-40.991	39.20	0.41	39.61	
-41.060	39.16	0.30	39.46	
-41.160	39.11	0.13	39.24	
-42.060	38.60	1.85	40.44	
-42.160	38.54	2.04	40.58	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	38.08	2.10	40.18	
-43.160	38.04	2.11	40.14	
-44.060	37.62	1.00	38.62	
-44.160	37.58	0.87	38.45	
-45.060	37.21	1.15	38.36	
-45.160	37.18	1.18	38.35	
-46.060	36.85	3.32	40.17	
-46.160	36.82	3.55	40.38	
-47.060	36.55	5.53	42.08	
-47.160	36.52	5.75	42.27	
-48.060	36.29	7.06	43.35	
-48.160	36.27	7.21	43.48	
-49.060	36.08	7.27	43.35	
-49.160	36.06	7.28	43.34	
-50.060	35.91	5.41	41.32	
-50.160	35.90	5.20	41.10	
-50.591	35.84	3.43	39.27	
-51.060	35.85	1.61	37.46	
-51.108	35.86	1.42	37.28	
-51.160	35.86	1.27	37.13	
-52.060	35.93	0.07	36.00	
-52.112	35.93	0.00	35.94	
-52.160	35.94	0.00	35.94	

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*** :SKY490 maximum stress accrue location

9)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	119.27	79.50	198.78	
-12.160	119.65	72.47	192.11	
-12.160	104.53	63.73	168.26	
-13.060	107.41	23.82	131.23	
-13.160	107.72	21.12	128.84	
-14.060	110.51	13.40	123.91	
-14.160	110.81	12.54	123.35	
-14.560	112.03	12.52	124.54	
-15.060	113.52	9.31	122.83	
-15.160	113.81	8.67	122.48	
-15.991	116.24	2.44	118.68	
-16.060	116.44	3.65	120.09	
-16.160	116.67	5.41	122.08	
-17.060	118.77	21.07	139.84	
-17.160	118.91	22.81	141.72	
-18.060	120.20	36.46	156.66	
-18.160	120.26	37.97	158.24	
-18.234	120.31	38.93	159.24	
-19.060	120.83	47.82	168.64	
-19.160	120.82	48.90	169.71	
-20.060	120.74	55.94	176.68	
-20.160	120.69	56.73	177.41	
-20.291	120.62	57.63	178.25	
-21.060	120.03	62.13	182.16	
-21.160	119.91	62.72	182.63	
-22.060	118.80	65.79	184.60	
-22.160	118.65	66.14	184.78	**
-22.445	118.20	66.55	184.75	
-22.591	117.97	66.67	184.63	
-23.060	117.09	66.15	183.24	
-23.160	116.85	66.04	182.89	
-24.060	114.72	61.86	176.58	
-24.160	114.42	61.40	175.82	
-25.060	111.75	54.73	166.48	
-25.160	111.40	53.99	165.40	
-26.060	108.28	46.40	154.67	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	107.90	45.55	153.45	
-26.391	107.04	43.61	150.64	
-27.060	104.44	38.16	142.60	
-27.160	104.04	37.34	141.38	
-28.060	100.41	30.64	131.05	
-28.160	100.00	29.90	129.90	
-28.160	114.45	34.00	148.45	
-29.060	110.15	27.51	137.66	
-29.160	109.66	26.79	136.46	
-30.060	105.27	21.71	126.98	
-30.160	104.77	21.15	125.92	
-31.060	100.31	17.63	117.94	
-31.160	99.81	17.24	117.05	
-31.291	99.16	16.87	116.03	
-32.060	95.29	14.47	109.76	
-32.160	94.79	14.16	108.95	
-33.060	90.23	10.92	101.15	
-33.160	89.73	10.56	100.28	
-34.060	85.19	7.22	92.41	
-34.160	84.69	6.85	91.54	
-35.060	80.22	3.71	83.93	
-35.160	79.73	3.36	83.10	
-36.060	75.37	0.65	76.02	
-36.160	74.90	0.35	75.25	
-37.060	70.68	1.82	72.49	
-37.160	70.22	1.98	72.20	
-38.060	66.16	3.26	69.43	
-38.160	65.73	3.41	69.14	
-39.060	61.85	3.67	65.52	
-39.160	61.44	3.70	65.14	
-40.060	57.76	2.71	60.47	
-40.160	57.37	2.60	59.97	
-40.991	54.15	0.41	54.56	
-41.060	53.89	0.30	54.19	
-41.160	53.54	0.13	53.67	
-42.060	50.32	1.85	52.17	
-42.160	50.00	2.04	52.04	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	47.10	2.10	49.20	
-43.160	46.81	2.11	48.92	
-44.060	44.22	1.00	45.21	
-44.160	43.96	0.87	44.83	
-45.060	41.67	1.15	42.82	
-45.160	41.45	1.18	42.63	
-46.060	39.44	3.32	42.76	
-46.160	39.25	3.55	42.81	
-47.060	37.53	5.53	43.06	
-47.160	37.37	5.75	43.12	
-48.060	35.91	7.06	42.97	
-48.160	35.77	7.21	42.98	
-49.060	34.56	7.27	41.83	
-49.160	34.52	7.28	41.80	
-50.060	34.18	5.41	39.59	
-50.160	34.27	5.20	39.47	
-50.591	34.65	3.43	38.08	
-51.060	35.02	1.61	36.62	
-51.108	35.05	1.42	36.47	
-51.160	35.08	1.27	36.35	
-52.060	35.63	0.07	35.70	
-52.112	35.66	0.00	35.66	
-52.160	35.68	0.00	35.68	

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

10)Earthquake(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	118.80	79.50	198.31	
-12.160	119.20	72.47	191.66	
-12.160	104.13	63.73	167.85	
-13.060	107.15	23.82	130.97	
-13.160	107.48	21.12	128.60	
-14.060	110.42	13.40	123.82	
-14.160	110.74	12.54	123.28	
-14.560	112.02	12.52	124.53	
-15.060	113.59	9.31	122.90	
-15.160	113.90	8.67	122.57	
-15.991	116.46	2.44	118.90	
-16.060	116.67	3.65	120.32	
-16.160	116.92	5.41	122.33	
-17.060	119.15	21.07	140.22	
-17.160	119.30	22.81	142.11	
-18.060	120.70	36.46	157.16	
-18.160	120.77	37.97	158.75	
-18.234	120.83	38.93	159.76	
-19.060	121.43	47.82	169.25	
-19.160	121.43	48.90	170.32	
-20.060	121.42	55.94	177.37	
-20.160	121.38	56.73	178.11	
-20.291	121.33	57.63	178.96	
-21.060	120.78	62.13	182.92	
-21.160	120.66	62.72	183.38	
-22.060	119.61	65.79	185.40	
-22.160	119.45	66.14	185.59	**
-22.445	119.01	66.55	185.57	
-22.591	118.79	66.67	185.45	
-23.060	117.93	66.15	184.08	
-23.160	117.69	66.04	183.73	
-24.060	115.57	61.86	177.43	
-24.160	115.27	61.40	176.67	
-25.060	112.59	54.73	167.32	
-25.160	112.24	53.99	166.23	
-26.060	109.09	46.40	155.48	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-26.160	108.71	45.55	154.26	
-26.391	107.83	43.61	151.44	
-27.060	105.20	38.16	143.36	
-27.160	104.79	37.34	142.13	
-28.060	101.12	30.64	131.76	
-28.160	100.70	29.90	130.60	
-28.160	115.27	34.00	149.27	
-29.060	110.90	27.51	138.42	
-29.160	110.41	26.79	137.20	
-30.060	105.94	21.71	127.66	
-30.160	105.44	21.15	126.59	
-31.060	100.90	17.63	118.54	
-31.160	100.39	17.24	117.64	
-31.291	99.73	16.87	116.60	
-32.060	95.79	14.47	110.26	
-32.160	95.27	14.16	109.44	
-33.060	90.62	10.92	101.54	
-33.160	90.11	10.56	100.67	
-34.060	85.47	7.22	92.69	
-34.160	84.96	6.85	91.81	
-35.060	80.38	3.71	84.09	
-35.160	79.88	3.36	83.24	
-36.060	75.40	0.65	76.05	
-36.160	74.92	0.35	75.26	
-37.060	70.57	1.82	72.39	
-37.160	70.11	1.98	72.09	
-38.060	65.92	3.26	69.19	
-38.160	65.48	3.41	68.88	
-39.060	61.48	3.67	65.15	
-39.160	61.06	3.70	64.76	
-40.060	57.25	2.71	59.96	
-40.160	56.85	2.60	59.45	
-40.991	53.52	0.41	53.93	
-41.060	53.25	0.30	53.55	
-41.160	52.88	0.13	53.01	
-42.060	49.55	1.85	51.40	
-42.160	49.21	2.04	51.25	

elevation(m)	Sig.1(N/mm^2)	Sig.2(N/mm^2)	Sig.max(N/mm^2)	
-43.060	46.20	2.10	48.30	
-43.160	45.90	2.11	48.01	
-44.060	43.20	1.00	44.19	
-44.160	42.93	0.87	43.80	
-45.060	40.54	1.15	41.69	
-45.160	40.31	1.18	41.48	
-46.060	38.21	3.32	41.52	
-46.160	38.01	3.55	41.56	
-47.060	36.20	5.53	41.73	
-47.160	36.03	5.75	41.78	
-48.060	34.49	7.06	41.55	
-48.160	34.35	7.21	41.56	
-49.060	33.07	7.27	40.34	
-49.160	33.00	7.28	40.28	
-50.060	32.39	5.41	37.80	
-50.160	32.49	5.20	37.69	
-50.591	32.90	3.43	36.33	
-51.060	33.29	1.61	34.90	
-51.108	33.32	1.42	34.74	
-51.160	33.35	1.27	34.63	
-52.060	33.94	0.07	34.02	
-52.112	33.97	0.00	33.97	
-52.160	34.00	0.00	34.00	

*   :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)	
-12.060	37.33	84.55	121.88	
-12.160	37.33	77.58	114.91	
-12.160	32.83	68.23	101.05	
-13.060	32.83	28.46	61.29	
-13.160	32.83	25.73	58.56	
-14.060	32.83	17.32	50.14	
-14.160	32.83	16.38	49.21	
-14.560	32.83	15.91	48.73	
-15.060	32.83	12.16	44.98	
-15.160	32.83	11.41	44.23	
-15.991	32.83	0.53	33.36	
-16.060	32.83	1.81	34.63	
-16.160	32.83	3.66	36.48	
-17.060	32.83	20.16	52.99	
-17.160	32.83	22.00	54.82	
-18.060	32.83	36.49	69.32	
-18.160	32.83	38.10	70.93	
-18.306	32.83	40.11	72.93	
-19.060	32.83	48.67	81.50	
-19.160	32.83	49.81	82.64	
-20.060	32.83	57.26	90.08	
-20.160	32.83	58.09	90.91	
-20.291	32.83	59.03	91.85	
-21.060	32.83	63.73	96.55	
-21.160	32.83	64.34	97.16	
-22.060	32.83	67.64	100.47	
-22.160	32.83	68.01	100.84	
-22.497	32.83	68.56	101.39	
-22.591	32.83	68.65	101.48	**
-23.060	32.83	68.21	101.04	
-23.160	32.83	68.12	100.94	
-24.060	32.83	63.91	96.73	
-24.160	32.83	63.44	96.27	
-25.060	32.83	56.56	89.39	
-25.160	32.83	55.80	88.62	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.060	32.83	47.85	80.68	
-26.160	32.83	46.97	79.79	
-26.391	32.83	44.92	77.74	
-27.060	32.83	39.16	71.99	
-27.160	32.83	38.30	71.13	
-28.060	32.83	31.25	64.07	
-28.160	32.83	30.46	63.29	
-28.160	37.33	34.64	71.97	
-29.060	37.33	27.87	65.20	
-29.160	37.33	27.11	64.44	
-30.060	37.33	21.87	59.20	
-30.160	37.33	21.29	58.62	
-31.060	37.33	17.78	55.11	
-31.160	37.33	17.39	54.72	
-31.291	37.33	17.03	54.36	
-32.060	37.33	14.70	52.03	
-32.160	37.33	14.40	51.73	
-33.060	37.33	11.17	48.50	
-33.160	37.33	10.81	48.14	
-34.060	37.33	7.45	44.78	
-34.160	37.33	7.07	44.40	
-35.060	37.33	3.87	41.20	
-35.160	37.33	3.52	40.85	
-36.060	37.33	0.73	38.06	
-36.160	37.33	0.42	37.75	
-37.060	37.33	1.82	39.15	
-37.160	37.33	1.98	39.31	
-38.060	37.33	3.31	40.64	
-38.160	37.33	3.46	40.79	
-39.060	37.33	3.73	41.06	
-39.160	37.33	3.76	41.09	
-40.060	37.33	2.73	40.06	
-40.160	37.33	2.62	39.95	
-40.991	37.33	0.34	37.67	
-41.060	37.33	0.29	37.62	
-41.160	37.33	0.23	37.56	
-42.060	37.33	2.02	39.35	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-42.160	37.33	2.21	39.54	
-43.060	37.33	2.28	39.61	
-43.160	37.33	2.29	39.62	
-44.060	37.33	1.13	38.46	
-44.160	37.33	1.00	38.33	
-45.060	37.33	1.12	38.45	
-45.160	37.33	1.13	38.46	
-46.060	37.33	3.36	40.69	
-46.160	37.33	3.61	40.94	
-47.060	37.33	5.68	43.01	
-47.160	37.33	5.91	43.24	
-48.060	37.33	7.30	44.63	
-48.160	37.33	7.46	44.79	
-49.060	37.33	7.57	44.90	
-49.160	37.33	7.58	44.91	
-50.060	37.33	5.70	43.03	
-50.160	37.33	5.49	42.82	
-50.591	37.33	3.69	41.02	
-51.060	37.33	1.80	39.13	
-51.108	37.33	1.61	38.94	
-51.160	37.33	1.45	38.78	
-52.060	37.33	0.08	37.41	
-52.112	37.33	0.00	37.33	
-52.160	37.33	0.00	37.33	

* :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)	
-12.060	38.74	84.55	123.29	
-12.160	38.74	77.58	116.32	
-12.160	34.06	68.23	102.29	
-13.060	34.06	28.46	62.53	
-13.160	34.06	25.73	59.80	
-14.060	34.06	17.32	51.38	
-14.160	34.06	16.38	50.45	
-14.560	34.06	15.91	49.97	
-15.060	34.06	12.16	46.22	
-15.160	34.06	11.41	45.47	
-15.991	34.06	0.53	34.59	
-16.060	34.06	1.81	35.87	
-16.160	34.06	3.66	37.72	
-17.060	34.06	20.16	54.22	
-17.160	34.06	22.00	56.06	
-18.060	34.06	36.49	70.55	
-18.160	34.06	38.10	72.17	
-18.306	34.06	40.11	74.17	
-19.060	34.06	48.67	82.74	
-19.160	34.06	49.81	83.87	
-20.060	34.06	57.26	91.32	
-20.160	34.06	58.09	92.15	
-20.291	34.06	59.03	93.09	
-21.060	34.06	63.73	97.79	
-21.160	34.06	64.34	98.40	
-22.060	34.06	67.64	101.70	
-22.160	34.06	68.01	102.07	
-22.497	34.06	68.56	102.62	
-22.591	34.06	68.65	102.71	**
-23.060	34.06	68.21	102.27	
-23.160	34.06	68.12	102.18	
-24.060	34.06	63.91	97.97	
-24.160	34.06	63.44	97.50	
-25.060	34.06	56.56	90.63	
-25.160	34.06	55.80	89.86	
-26.060	34.06	47.85	81.91	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	34.06	46.97	81.03	
-26.391	34.06	44.92	78.98	
-27.060	34.06	39.16	73.22	
-27.160	34.06	38.30	72.36	
-28.060	34.06	31.25	65.31	
-28.160	34.06	30.46	64.53	
-28.160	38.74	34.64	73.38	
-29.060	38.74	27.87	66.60	
-29.160	38.74	27.11	65.85	
-30.060	38.74	21.87	60.61	
-30.160	38.74	21.29	60.03	
-31.060	38.74	17.78	56.51	
-31.160	38.74	17.39	56.12	
-31.291	38.74	17.03	55.76	
-32.060	38.74	14.70	53.44	
-32.160	38.74	14.40	53.13	
-33.060	38.74	11.17	49.91	
-33.160	38.74	10.81	49.55	
-34.060	38.74	7.45	46.18	
-34.160	38.74	7.07	45.81	
-35.060	38.74	3.87	42.61	
-35.160	38.74	3.52	42.25	
-36.060	38.74	0.73	39.47	
-36.160	38.74	0.42	39.16	
-37.060	38.74	1.82	40.56	
-37.160	38.74	1.98	40.71	
-38.060	38.74	3.31	42.04	
-38.160	38.74	3.46	42.19	
-39.060	38.74	3.73	42.47	
-39.160	38.74	3.76	42.50	
-40.060	38.74	2.73	41.47	
-40.160	38.74	2.62	41.36	
-40.991	38.74	0.34	39.07	
-41.060	38.74	0.29	39.03	
-41.160	38.74	0.23	38.97	
-42.060	38.74	2.02	40.75	
-42.160	38.74	2.21	40.95	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	38.74	2.28	41.02	
-43.160	38.74	2.29	41.03	
-44.060	38.74	1.13	39.87	
-44.160	38.74	1.00	39.74	
-45.060	38.74	1.12	39.86	
-45.160	38.74	1.13	39.87	
-46.060	38.74	3.36	42.10	
-46.160	38.74	3.61	42.35	
-47.060	38.74	5.68	44.42	
-47.160	38.74	5.91	44.65	
-48.060	38.74	7.30	46.04	
-48.160	38.74	7.46	46.19	
-49.060	38.74	7.57	46.30	
-49.160	38.74	7.58	46.32	
-50.060	38.74	5.70	44.44	
-50.160	38.74	5.49	44.23	
-50.591	38.74	3.69	42.42	
-51.060	38.74	1.80	40.54	
-51.108	38.74	1.61	40.34	
-51.160	38.74	1.45	40.19	
-52.060	38.74	0.08	38.82	
-52.112	38.74	0.00	38.74	
-52.160	38.74	0.00	38.74	

*   :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)	
-12.060	45.68	84.55	130.23	
-12.160	45.71	77.58	123.29	
-12.160	40.07	68.23	108.30	
-13.060	40.25	28.46	68.71	
-13.160	40.27	25.73	66.00	
-14.060	40.43	17.32	57.75	
-14.160	40.45	16.38	56.83	
-14.560	40.52	15.91	56.42	
-15.060	40.60	12.16	52.75	
-15.160	40.61	11.41	52.02	
-15.991	40.74	0.53	41.27	
-16.060	40.75	1.81	42.55	
-16.160	40.76	3.66	44.42	
-17.060	40.87	20.16	61.03	
-17.160	40.87	22.00	62.87	
-18.060	40.93	36.49	77.42	
-18.160	40.93	38.10	79.04	
-18.306	40.94	40.11	81.04	
-19.060	40.95	48.67	89.63	
-19.160	40.95	49.81	90.76	
-20.060	40.93	57.26	98.19	
-20.160	40.93	58.09	99.01	
-20.291	40.92	59.03	99.95	
-21.060	40.87	63.73	104.60	
-21.160	40.87	64.34	105.20	
-22.060	40.78	67.64	108.43	
-22.160	40.77	68.01	108.78	
-22.497	40.73	68.56	109.30	
-22.591	40.72	68.65	109.37	**
-23.060	40.66	68.21	108.87	
-23.160	40.65	68.12	108.76	
-24.060	40.50	63.91	104.41	
-24.160	40.48	63.44	103.92	
-25.060	40.29	56.56	96.85	
-25.160	40.27	55.80	96.06	
-26.060	40.04	47.85	87.90	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	40.02	46.97	86.99	
-26.391	39.96	44.92	84.87	
-27.060	39.77	39.16	78.93	
-27.160	39.74	38.30	78.04	
-28.060	39.48	31.25	70.73	
-28.160	39.45	30.46	69.92	
-28.160	44.99	34.64	79.63	
-29.060	44.68	27.87	72.54	
-29.160	44.64	27.11	71.75	
-30.060	44.32	21.87	66.19	
-30.160	44.28	21.29	65.57	
-31.060	43.94	17.78	61.72	
-31.160	43.91	17.39	61.29	
-31.291	43.86	17.03	60.88	
-32.060	43.56	14.70	58.26	
-32.160	43.52	14.40	57.92	
-33.060	43.16	11.17	54.33	
-33.160	43.12	10.81	53.93	
-34.060	42.75	7.45	50.20	
-34.160	42.71	7.07	49.78	
-35.060	42.33	3.87	46.20	
-35.160	42.29	3.52	45.80	
-36.060	41.90	0.73	42.64	
-36.160	41.86	0.42	42.28	
-37.060	41.48	1.82	43.30	
-37.160	41.44	1.98	43.41	
-38.060	41.06	3.31	44.36	
-38.160	41.01	3.46	44.47	
-39.060	40.64	3.73	44.37	
-39.160	40.60	3.76	44.36	
-40.060	40.23	2.73	42.96	
-40.160	40.19	2.62	42.81	
-40.991	39.86	0.34	40.19	
-41.060	39.83	0.29	40.12	
-41.160	39.79	0.23	40.02	
-42.060	39.44	2.02	41.46	
-42.160	39.41	2.21	41.62	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	39.08	2.28	41.36	
-43.160	39.05	2.29	41.34	
-44.060	38.74	1.13	39.87	
-44.160	38.71	1.00	39.71	
-45.060	38.43	1.12	39.54	
-45.160	38.40	1.13	39.53	
-46.060	38.14	3.36	41.50	
-46.160	38.11	3.61	41.72	
-47.060	37.88	5.68	43.56	
-47.160	37.86	5.91	43.77	
-48.060	37.65	7.30	44.95	
-48.160	37.63	7.46	45.09	
-49.060	37.45	7.57	45.02	
-49.160	37.44	7.58	45.02	
-50.060	37.29	5.70	42.99	
-50.160	37.28	5.49	42.77	
-50.591	37.22	3.69	40.91	
-51.060	37.17	1.80	38.97	
-51.108	37.16	1.61	38.77	
-51.160	37.16	1.45	38.61	
-52.060	37.07	0.08	37.16	
-52.112	37.07	0.00	37.07	
-52.160	37.07	0.00	37.07	

*   :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)	
-12.060	63.19	84.55	147.74	
-12.160	63.33	77.58	140.91	
-12.160	55.34	68.23	123.56	
-13.060	56.37	28.46	84.84	
-13.160	56.48	25.73	82.21	
-14.060	57.46	17.32	74.78	
-14.160	57.57	16.38	73.95	
-14.560	57.99	15.91	73.89	
-15.060	58.49	12.16	70.65	
-15.160	58.59	11.41	70.00	
-15.991	59.41	0.53	59.94	
-16.060	59.47	1.81	61.28	
-16.160	59.56	3.66	63.21	
-17.060	60.31	20.16	80.47	
-17.160	60.37	22.00	82.37	
-18.060	60.94	36.49	97.43	
-18.160	60.98	38.10	99.09	
-18.306	61.05	40.11	101.15	
-19.060	61.38	48.67	110.06	
-19.160	61.41	49.81	111.22	
-20.060	61.66	57.26	118.92	
-20.160	61.68	58.09	119.76	
-20.291	61.70	59.03	120.73	
-21.060	61.78	63.73	125.51	
-21.160	61.78	64.34	126.12	
-22.060	61.77	67.64	129.42	
-22.160	61.76	68.01	129.77	
-22.497	61.73	68.56	130.29	
-22.591	61.72	68.65	130.37	**
-23.060	61.63	68.21	129.84	
-23.160	61.60	68.12	129.72	
-24.060	61.30	63.91	125.21	
-24.160	61.25	63.44	124.69	
-25.060	60.79	56.56	117.35	
-25.160	60.72	55.80	116.52	
-26.060	60.12	47.85	107.97	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	60.04	46.97	107.01	
-26.391	59.87	44.92	104.78	
-27.060	59.32	39.16	98.48	
-27.160	59.23	38.30	97.53	
-28.060	58.45	31.25	89.70	
-28.160	58.36	30.46	88.82	
-28.160	66.82	34.64	101.46	
-29.060	65.85	27.87	93.72	
-29.160	65.74	27.11	92.85	
-30.060	64.73	21.87	86.60	
-30.160	64.61	21.29	85.90	
-31.060	63.55	17.78	81.33	
-31.160	63.43	17.39	80.82	
-31.291	63.27	17.03	80.30	
-32.060	62.31	14.70	77.01	
-32.160	62.18	14.40	76.58	
-33.060	60.99	11.17	72.16	
-33.160	60.85	10.81	71.66	
-34.060	59.59	7.45	67.04	
-34.160	59.44	7.07	66.52	
-35.060	58.14	3.87	62.01	
-35.160	57.99	3.52	61.51	
-36.060	56.65	0.73	57.38	
-36.160	56.50	0.42	56.92	
-37.060	55.14	1.82	56.96	
-37.160	54.98	1.98	56.96	
-38.060	53.62	3.31	56.92	
-38.160	53.46	3.46	56.92	
-39.060	52.10	3.73	55.83	
-39.160	51.95	3.76	55.71	
-40.060	50.60	2.73	53.33	
-40.160	50.45	2.62	53.07	
-40.991	49.22	0.34	49.56	
-41.060	49.12	0.29	49.42	
-41.160	48.98	0.23	49.21	
-42.060	47.69	2.02	49.71	
-42.160	47.56	2.21	49.77	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	46.33	2.28	48.61	
-43.160	46.20	2.29	48.49	
-44.060	45.03	1.13	46.17	
-44.160	44.91	1.00	45.92	
-45.060	43.83	1.12	44.95	
-45.160	43.72	1.13	44.85	
-46.060	42.72	3.36	46.08	
-46.160	42.62	3.61	46.23	
-47.060	41.72	5.68	47.40	
-47.160	41.63	5.91	47.54	
-48.060	40.83	7.30	48.13	
-48.160	40.75	7.46	48.21	
-49.060	40.06	7.57	47.63	
-49.160	40.00	7.58	47.58	
-50.060	39.42	5.70	45.12	
-50.160	39.37	5.49	44.86	
-50.591	39.13	3.69	42.82	
-51.060	38.92	1.80	40.72	
-51.108	38.90	1.61	40.50	
-51.160	38.88	1.45	40.33	
-52.060	38.55	0.08	38.64	
-52.112	38.54	0.00	38.54	
-52.160	38.53	0.00	38.53	

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

5)Ord+Collision(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	61.49	84.55	146.04	
-12.160	61.63	77.58	139.21	
-12.160	53.84	68.23	122.07	
-13.060	54.88	28.46	83.34	
-13.160	54.99	25.73	80.72	
-14.060	55.97	17.32	73.29	
-14.160	56.07	16.38	72.46	
-14.560	56.49	15.91	72.40	
-15.060	57.00	12.16	69.16	
-15.160	57.10	11.41	68.51	
-15.991	57.91	0.53	58.45	
-16.060	57.98	1.81	59.79	
-16.160	58.06	3.66	61.72	
-17.060	58.81	20.16	78.98	
-17.160	58.88	22.00	80.87	
-18.060	59.45	36.49	95.94	
-18.160	59.49	38.10	97.59	
-18.306	59.56	40.11	99.66	
-19.060	59.89	48.67	108.57	
-19.160	59.92	49.81	109.73	
-20.060	60.17	57.26	117.43	
-20.160	60.19	58.09	118.27	
-20.291	60.21	59.03	119.24	
-21.060	60.29	63.73	124.02	
-21.160	60.29	64.34	124.63	
-22.060	60.28	67.64	127.93	
-22.160	60.27	68.01	128.28	
-22.497	60.24	68.56	128.80	
-22.591	60.23	68.65	128.88	**
-23.060	60.14	68.21	128.35	
-23.160	60.11	68.12	128.23	
-24.060	59.81	63.91	123.72	
-24.160	59.76	63.44	123.20	
-25.060	59.30	56.56	115.87	
-25.160	59.24	55.80	115.04	
-26.060	58.63	47.85	106.48	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	58.56	46.97	105.52	
-26.391	58.38	44.92	103.29	
-27.060	57.83	39.16	97.00	
-27.160	57.75	38.30	96.05	
-28.060	56.97	31.25	88.21	
-28.160	56.88	30.46	87.34	
-28.160	65.13	34.64	99.77	
-29.060	64.17	27.87	92.03	
-29.160	64.05	27.11	91.17	
-30.060	63.04	21.87	84.91	
-30.160	62.92	21.29	84.21	
-31.060	61.86	17.78	79.64	
-31.160	61.74	17.39	79.13	
-31.291	61.59	17.03	78.61	
-32.060	60.63	14.70	75.33	
-32.160	60.50	14.40	74.89	
-33.060	59.30	11.17	70.48	
-33.160	59.16	10.81	69.98	
-34.060	57.91	7.45	65.35	
-34.160	57.76	7.07	64.83	
-35.060	56.46	3.87	60.33	
-35.160	56.31	3.52	59.82	
-36.060	54.97	0.73	55.70	
-36.160	54.82	0.42	55.24	
-37.060	53.46	1.82	55.28	
-37.160	53.30	1.98	55.28	
-38.060	51.94	3.31	55.24	
-38.160	51.79	3.46	55.24	
-39.060	50.42	3.73	54.15	
-39.160	50.27	3.76	54.04	
-40.060	48.92	2.73	51.66	
-40.160	48.77	2.62	51.39	
-40.991	47.55	0.34	47.88	
-41.060	47.45	0.29	47.74	
-41.160	47.30	0.23	47.53	
-42.060	46.02	2.02	48.03	
-42.160	45.88	2.21	48.09	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	44.65	2.28	46.93	
-43.160	44.52	2.29	46.81	
-44.060	43.36	1.13	44.49	
-44.160	43.24	1.00	44.24	
-45.060	42.16	1.12	43.28	
-45.160	42.05	1.13	43.18	
-46.060	41.05	3.36	44.41	
-46.160	40.95	3.61	44.56	
-47.060	40.05	5.68	45.73	
-47.160	39.96	5.91	45.87	
-48.060	39.16	7.30	46.46	
-48.160	39.08	7.46	46.54	
-49.060	38.39	7.57	45.96	
-49.160	38.32	7.58	45.90	
-50.060	37.75	5.70	43.45	
-50.160	37.69	5.49	43.19	
-50.591	37.46	3.69	41.15	
-51.060	37.24	1.80	39.05	
-51.108	37.23	1.61	38.83	
-51.160	37.21	1.45	38.66	
-52.060	36.88	0.08	36.96	
-52.112	36.87	0.00	36.87	
-52.160	36.85	0.00	36.85	

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

6)Earthquake

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	111.77	84.55	196.32	
-12.160	112.10	77.58	189.69	
-12.160	97.52	68.23	165.74	
-13.060	100.06	28.46	128.53	
-13.160	100.34	25.73	126.08	
-14.060	102.83	17.32	120.15	
-14.160	103.10	16.38	119.49	
-14.560	104.19	15.91	120.10	
-15.060	105.54	12.16	117.69	
-15.160	105.80	11.41	117.21	
-15.991	108.00	0.53	108.53	
-16.060	108.18	1.81	109.99	
-16.160	108.41	3.66	112.07	
-17.060	110.43	20.16	130.59	
-17.160	110.59	22.00	132.59	
-18.060	112.05	36.49	148.54	
-18.160	112.16	38.10	150.26	
-18.306	112.31	40.11	152.42	
-19.060	113.10	48.67	161.78	
-19.160	113.16	49.81	162.97	
-20.060	113.64	57.26	170.90	
-20.160	113.66	58.09	171.75	
-20.291	113.69	59.03	172.72	
-21.060	113.71	63.73	177.44	
-21.160	113.68	64.34	178.02	
-22.060	113.39	67.64	181.03	
-22.160	113.33	68.01	181.34	
-22.497	113.12	68.56	181.69	
-22.591	113.07	68.65	181.72	**
-23.060	112.67	68.21	180.88	
-23.160	112.55	68.12	180.67	
-24.060	111.41	63.91	175.32	
-24.160	111.23	63.44	174.67	
-25.060	109.63	56.56	166.19	
-25.160	109.41	55.80	165.21	
-26.060	107.39	47.85	155.24	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	107.14	46.97	154.11	
-26.391	106.56	44.92	151.48	
-27.060	104.80	39.16	143.96	
-27.160	104.52	38.30	142.82	
-28.060	102.01	31.25	133.26	
-28.160	101.72	30.46	132.18	
-28.160	116.96	34.64	151.60	
-29.060	113.89	27.87	141.76	
-29.160	113.53	27.11	140.65	
-30.060	110.34	21.87	132.21	
-30.160	109.97	21.29	131.26	
-31.060	106.67	17.78	124.45	
-31.160	106.30	17.39	123.68	
-31.291	105.81	17.03	122.83	
-32.060	102.85	14.70	117.56	
-32.160	102.45	14.40	116.85	
-33.060	98.83	11.17	110.00	
-33.160	98.41	10.81	109.23	
-34.060	94.65	7.45	102.10	
-34.160	94.23	7.07	101.30	
-35.060	90.37	3.87	94.25	
-35.160	89.94	3.52	93.46	
-36.060	86.04	0.73	86.77	
-36.160	85.60	0.42	86.02	
-37.060	81.68	1.82	83.50	
-37.160	81.25	1.98	83.23	
-38.060	77.35	3.31	80.65	
-38.160	76.92	3.46	80.37	
-39.060	73.06	3.73	76.80	
-39.160	72.64	3.76	76.41	
-40.060	68.86	2.73	71.59	
-40.160	68.45	2.62	71.07	
-40.991	65.03	0.34	65.37	
-41.060	64.75	0.29	65.04	
-41.160	64.36	0.23	64.59	
-42.060	60.80	2.02	62.82	
-42.160	60.43	2.21	62.65	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	57.07	2.28	59.35	
-43.160	56.72	2.29	59.01	
-44.060	53.56	1.13	54.69	
-44.160	53.23	1.00	54.24	
-45.060	50.30	1.12	51.42	
-45.160	50.00	1.13	51.14	
-46.060	47.31	3.36	50.68	
-46.160	47.04	3.61	50.65	
-47.060	44.60	5.68	50.28	
-47.160	44.36	5.91	50.27	
-48.060	42.19	7.30	49.49	
-48.160	41.97	7.46	49.43	
-49.060	40.07	7.57	47.64	
-49.160	39.89	7.58	47.47	
-50.060	38.27	5.70	43.97	
-50.160	38.11	5.49	43.61	
-50.591	37.44	3.69	41.13	
-51.060	36.79	1.80	38.59	
-51.108	36.73	1.61	38.34	
-51.160	36.67	1.45	38.12	
-52.060	35.64	0.08	35.72	
-52.112	35.59	0.00	35.59	
-52.160	35.54	0.00	35.54	

* :location unable to weld in site

** :SKY400 maximum stress accrue location

*** :SKY490 maximum stress accrue location

7)Earthquake(scour)

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-12.060	110.22	84.55	194.77	
-12.160	110.55	77.58	188.14	
-12.160	96.15	68.23	164.38	
-13.060	98.72	28.46	127.19	
-13.160	99.00	25.73	124.74	
-14.060	101.51	17.32	118.83	
-14.160	101.79	16.38	118.17	
-14.560	102.88	15.91	118.79	
-15.060	104.24	12.16	116.40	
-15.160	104.51	11.41	115.92	
-15.991	106.73	0.53	107.26	
-16.060	106.91	1.81	108.72	
-16.160	107.14	3.66	110.80	
-17.060	109.18	20.16	129.35	
-17.160	109.35	22.00	131.34	
-18.060	110.83	36.49	147.32	
-18.160	110.93	38.10	149.04	
-18.306	111.09	40.11	151.19	
-19.060	111.90	48.67	160.57	
-19.160	111.95	49.81	161.76	
-20.060	112.45	57.26	169.70	
-20.160	112.47	58.09	170.56	
-20.291	112.50	59.03	171.53	
-21.060	112.53	63.73	176.26	
-21.160	112.50	64.34	176.84	
-22.060	112.22	67.64	179.86	
-22.160	112.16	68.01	180.17	
-22.497	111.96	68.56	180.52	
-22.591	111.90	68.65	180.55	**
-23.060	111.51	68.21	179.73	
-23.160	111.39	68.12	179.51	
-24.060	110.26	63.91	174.17	
-24.160	110.08	63.44	173.52	
-25.060	108.48	56.56	165.05	
-25.160	108.26	55.80	164.06	
-26.060	106.25	47.85	154.10	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-26.160	106.00	46.97	152.96	
-26.391	105.42	44.92	150.33	
-27.060	103.65	39.16	142.81	
-27.160	103.37	38.30	141.67	
-28.060	100.86	31.25	132.11	
-28.160	100.57	30.46	131.03	
-28.160	115.66	34.64	150.30	
-29.060	112.58	27.87	140.45	
-29.160	112.23	27.11	139.34	
-30.060	109.03	21.87	130.90	
-30.160	108.66	21.29	129.95	
-31.060	105.35	17.78	123.13	
-31.160	104.98	17.39	122.37	
-31.291	104.49	17.03	121.52	
-32.060	101.53	14.70	116.23	
-32.160	101.13	14.40	115.53	
-33.060	97.50	11.17	108.67	
-33.160	97.08	10.81	107.89	
-34.060	93.31	7.45	100.76	
-34.160	92.88	7.07	99.95	
-35.060	89.02	3.87	92.89	
-35.160	88.58	3.52	92.10	
-36.060	84.66	0.73	85.40	
-36.160	84.23	0.42	84.65	
-37.060	80.29	1.82	82.12	
-37.160	79.86	1.98	81.84	
-38.060	75.94	3.31	79.25	
-38.160	75.51	3.46	78.97	
-39.060	71.64	3.73	75.37	
-39.160	71.22	3.76	74.98	
-40.060	67.42	2.73	70.15	
-40.160	67.00	2.62	69.62	
-40.991	63.57	0.34	63.91	
-41.060	63.29	0.29	63.58	
-41.160	62.90	0.23	63.12	
-42.060	59.33	2.02	61.34	
-42.160	58.95	2.21	61.17	

elevation(m)	Sig.1(N/mm²)	Sig.2(N/mm²)	Sig.max(N/mm²)	
-43.060	55.57	2.28	57.85	
-43.160	55.22	2.29	57.51	
-44.060	52.04	1.13	53.18	
-44.160	51.72	1.00	52.72	
-45.060	48.77	1.12	49.89	
-45.160	48.47	1.13	49.60	
-46.060	45.76	3.36	49.12	
-46.160	45.49	3.61	49.10	
-47.060	43.04	5.68	48.72	
-47.160	42.79	5.91	48.70	
-48.060	40.60	7.30	47.91	
-48.160	40.39	7.46	47.85	
-49.060	38.47	7.57	46.04	
-49.160	38.29	7.58	45.87	
-50.060	36.66	5.70	42.36	
-50.160	36.50	5.49	42.00	
-50.591	35.83	3.69	39.52	
-51.060	35.17	1.80	36.97	
-51.108	35.11	1.61	36.72	
-51.160	35.05	1.45	36.50	
-52.060	34.01	0.08	34.09	
-52.112	33.96	0.00	33.96	
-52.160	33.91	0.00	33.91	

*   :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)
1.4478 (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	OD(HT)	-5.091	3.180	81.75
2	OD(LT)	-5.091	-2.390	81.75
3	OD-TM(HT)	-5.091	3.180	81.75
4	OD-TM(LT)	-5.091	-2.390	81.75
5	WN-TM	-5.091	4.990	81.75
6	WN-TM	-7.970	4.990	58.72
7	OD-CL	-5.091	2.530	81.75
8	OD-CL(SC)	-7.970	2.530	58.72
9	ETQ	-5.091	0.290	81.75
10	ETQ(SC)	-7.970	0.290	58.72

2)perpendicular direction

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m²)
1	OD(HT)	-5.091	3.180	81.75
2	OD(LT)	-5.091	-2.390	81.75
3	WN	-5.091	4.990	81.75
4	OD-CL	-5.091	2.530	81.75
5	OD-CL(SC)	-7.970	2.530	58.72
6	ETQ	-5.091	0.290	81.75

No	abbreviation	embankment height (m)	water table height (m)	w(kN/m^2)
7	ETQ(SC)	-7.970	0.290	58.72

note: backfilling soil height , water table height is shown in elevation(crest of pile cap elevation = -8.060m)

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)

= 8.973^2*Pai/4 + 8.973*(14.764- 8.973) = 115.205 (m^2)

(2)area of backfilling soil

A2 = A1 - Ap = 74.635 (m^2)

where, Ap:leg column cross sectional area = 40.57 (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)	51100.0	0.0	0.0	0.0	0.0
2	OD(LT)	51100.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	51100.0	3100.0	67000.0	12400.0	79400.0
4	OD-TM(LT)	51100.0	3100.0	67000.0	12400.0	79400.0
5	WN-TM	51100.0	3200.0	68800.0	12800.0	81600.0
6	WN-TM	51100.0	3200.0	68800.0	12800.0	81600.0
7	OD-CL	51100.0	3100.0	35400.0	12400.0	47800.0
8	OD-CL(SC)	51100.0	3100.0	35400.0	12400.0	47800.0
9	ETQ	44300.0	14900.0	237500.0	59600.0	297100.0
10	ETQ(SC)	44300.0	15600.0	238900.0	62400.0	301300.0

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)	51100.0	0.0	0.0	0.0	0.0
2	OD(LT)	51100.0	0.0	0.0	0.0	0.0
3	WN	51100.0	1200.0	28100.0	4800.0	32900.0
4	OD-CL	51100.0	6300.0	71400.0	25200.0	96600.0
5	OD-CL(SC)	51100.0	6300.0	71300.0	25200.0	96500.0
6	ETQ	44300.0	13490.0	233800.0	53960.0	287760.0
7	ETQ(SC)	44300.0	13600.0	233800.0	54400.0	288200.0

(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) = 17.0 (kN/m^3)

Gam.sat: unit weight of backfilling soil(saturated) = 18.0 (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)	11.240	2.969	6681.88	1772.73	4560.07	3894.54
2	OD(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
3	OD-TM(HT)	11.240	2.969	6681.88	1772.73	4560.07	3894.54
4	OD-TM(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
5	WN-TM	13.050	2.969	6681.88	1772.73	5294.39	3160.23
6	WN-TM	13.050	0.090	6681.88	53.74	5294.39	1441.24
7	OD-CL	10.590	2.969	6681.88	1772.73	4296.36	4158.25
8	OD-CL(SC)	10.590	0.090	6681.88	53.74	4296.36	2439.26
9	ETQ	8.350	2.969	6681.88	1772.73	3387.60	5067.02
10	ETQ(SC)	8.350	0.090	6681.88	53.74	3387.60	3348.03

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	WN-TM	0.00	0.000	0.00
7	OD-CL	0.00	0.000	0.00
8	OD-CL(SC)	0.00	0.000	0.00
9	ETQ	0.00	0.000	0.00
10	ETQ(SC)	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)	11.240	2.969	6681.88	1772.73	4560.07	3894.54

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
2	OD(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
3	WN	13.050	2.969	6681.88	1772.73	5294.39	3160.23
4	OD-CL	10.590	2.969	6681.88	1772.73	4296.36	4158.25
5	OD-CL(SC)	10.590	0.090	6681.88	53.74	4296.36	2439.26
6	ETQ	8.350	2.969	6681.88	1772.73	3387.60	5067.02
7	ETQ(SC)	8.350	0.090	6681.88	53.74	3387.60	3348.03

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	OD-CL(SC)	0.00	0.000	0.00
6	ETQ	0.00	0.000	0.00
7	ETQ(SC)	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	54994.5	0.0	0.0
2	OD(LT)	0.0	57254.3	0.0	0.0
3	OD-TM(HT)	0.0	54994.5	3100.0	79400.0
4	OD-TM(LT)	0.0	57254.3	3100.0	79400.0
5	WN-TM	0.0	54260.2	3200.0	81600.0

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
6	WN-TM	0.0	52541.2	3200.0	81600.0
7	OD-CL	0.0	55258.2	3100.0	47800.0
8	OD-CL(SC)	0.0	53539.2	3100.0	47800.0
9	ETQ	0.0	49367.0	14900.0	297100.0
10	ETQ(SC)	0.0	47648.0	15600.0	301300.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	54994.5	0.0	0.0
2	OD(LT)	0.0	57254.3	0.0	0.0
3	WN	0.0	54260.2	1200.0	32900.0
4	OD-CL	0.0	55258.2	6300.0	96600.0
5	OD-CL(SC)	0.0	53539.2	6300.0	96500.0
6	ETQ	0.0	49367.0	13490.0	287760.0
7	ETQ(SC)	0.0	47648.0	13600.0	288200.0

(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	IBi (m^2) perpendicular direction
periphery sheet pile(1)	30	0.04464	491.60	903.99
separation wall sheet pile(2)	6	0.04464	36.96	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)	1528	1528	1.00

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
2	OD(LT)	1590	1590	1.00
3	OD-TM(HT)	2292	764	1.15
4	OD-TM(LT)	2355	826	1.15
5	WN-TM	2293	722	1.35
6	WN-TM	2245	674	1.35
7	OD-CL	1995	1075	1.50
8	OD-CL(SC)	1947	1027	1.50
9	ETQ	4230	-1488	1.50
10	ETQ(SC)	4223	-1576	1.50

2)perpendicular direction

No	abbreviation	max reaction(kN/number)	min reaction(kN/number)	increment coefficient
1	OD(HT)	1528	1528	1.00
2	OD(LT)	1590	1590	1.00
3	WN	1796	1219	1.25
4	OD-CL	2382	688	1.50
5	OD-CL(SC)	2334	641	1.50
6	ETQ	3896	-1153	1.50
7	ETQ(SC)	3852	-1205	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 = 11.3732 (m) (bridge axis direction)
Bx = 17.1644 (m) (perpendicular direction)
periphery steel pipe pile body diameter Do = 1.2000 (m)
leg column shape : oval
leg column dimension : 4.000 (m) (bridge axis direction)
11.000 (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 = 30 (number)
n2 : number of separation wall steel pipe sheet pile = 6 (number)
n3 : number of intermediate driven single pile = 0 (number)
Ao1 : pure cross sectional area of periphery steel pipe sheet pile = 0.04464 (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	491.60	903.99
separation wall steel pipe sheet pile	IB2	36.96	0.00
intermediate driven single pile	IB3	0.00	0.00

1)bridge axis direction

1. check location

X1 = 5.0866 (m)
X2 = -5.0866 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Oridinary(high tide)	54994.5	0.0	1.00
2	Oridinary(low tide)	57254.3	0.0	1.00
3	Ord+Temp(high tide)	54994.5	79400.0	1.15
4	Ord+Temp(low tide)	57254.3	79400.0	1.15
5	Wind+Temp	54260.2	81600.0	1.35
6	Wind+Temp	52541.2	81600.0	1.35
7	Ord+Collision	55258.2	47800.0	1.50

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
8	Ord+Collision(scour)	53539.2	47800.0	1.50
9	Earthquake	49367.0	297100.0	1.50
10	Earthquake(scour)	47648.0	301300.0	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	5.0866	-5.0866
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Oridinary(high tide)	1527.6	1527.6
2	Oridinary(low tide)	1590.4	1590.4
3	Ord+Temp(high tide)	2291.7	763.5
4	Ord+Temp(low tide)	2354.5	826.3
5	Wind+Temp	2292.5	721.9
6	Wind+Temp	2244.8	674.2
7	Ord+Collision	1995.0	1074.9
8	Ord+Collision(scour)	1947.2	1027.2
9	Earthquake	4230.5	-1487.8
10	Earthquake(scour)	4223.1	-1576.0

4.separation wall steel pipe sheet pile reaction

coordinated system of center of figure		
pile No	number	Xi (m)
1	1	3.6333
2	1	2.1800

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	1527.6	1527.6	1590.4	1590.4	2073.4	981.8	2136.2	1044.6
2	1527.6	1527.6	1590.4	1590.4	1855.1	1200.2	1917.9	1262.9

abbreviation	[5] WN-TM		[6] WN-TM		[7] OD-CL		[8] OD-CL(SC)	
pile No	R1	R2	R1	R2	R1	R2	R1	R2
1	2068.1	946.3	2020.4	898.6	1863.5	1206.4	1815.8	1158.6
2	1843.8	1170.7	1796.0	1122.9	1732.1	1337.8	1684.3	1290.1

abbreviation	[9] ETQ		[10] ETQ(SC)	
pile No	R1	R2	R1	R2
1	3413.6	-670.9	3394.7	-747.6
2	2596.7	146.0	2566.2	80.9

2)perpendicular direction

1. check location

   Y1 = 7.9822 (m)

   Y2 = -7.9822 (m)

2. bottom of pile cap working force

No	load abbreviation	Vo (kN)	Mo (kN.m)	increment coefficient
1	Oridinary(high tide)	54994.5	0.0	1.00
2	Oridinary(low tide)	57254.3	0.0	1.00
3	Wind	54260.2	32900.0	1.25
4	Ord+Collision	55258.2	96600.0	1.50
5	Ord+Collision(scour)	53539.2	96500.0	1.50
6	Earthquake	49367.0	287760.0	1.50
7	Earthquake(scour)	47648.0	288200.0	1.50

3.periphery steel pipe sheet pile reaction

No	at farthest sheet pile location Xi(m)	7.9822	-7.9822
	load abbreviation	R1 (kN/number)	R2 (kN/number)
1	Oridinary(high tide)	1527.6	1527.6
2	Oridinary(low tide)	1590.4	1590.4
3	Wind	1797.7	1216.7

No	at farthest sheet pile location Xi(m)	7.9822	-7.9822
	load abbreviation	R1 (kN/number)	R2 (kN/number)
4	Ord+Collision	2387.9	682.0
5	Ord+Collision(scour)	2339.3	635.1
6	Earthquake	3912.2	-1169.6
7	Earthquake(scour)	3868.4	-1221.3

(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 = 2.4866 (m)(bridge axis direction)
= 2.2822 (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)
= 1.4478 (m) (perpendicular direction)

d : effective height of pile cap = 3.6338 (m) (bridge axis direction)
= 3.7023 (m) (perpendicular direction)

ai : Do + d

		bridge axis direction	perpendicular direction
separation wall steel pipe sheet pile	ai	4.8338	4.9023

(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)	3577	3577	1055	1015
2	Oridinary(low tide)	3734	3734	1098	1059
3	Ord+Temp(high tide)	5403	1751	1583	1543
4	Ord+Temp(low tide)	5560	1909	1626	1586
5	Wind+Temp	5402	1650	1583	1544
6	Wind+Temp	5354	1601	1550	1522
7	Ord+Collision	4695	2496	1378	1338
8	Ord+Collision(scour)	4646	2448	1345	1316
9	Earthquake	10016	-3646	2922	2882
10	Earthquake(scour)	10064	-3791	2917	2888

2)perpendicular direction

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
1	Oridinary(high tide)	2828	2828	1055	1032
2	Oridinary(low tide)	2953	2953	1098	1075
3	Wind	3366	2209	1242	1219
4	Ord+Collision	4541	1145	1649	1626

No	load name	MA (kN.m/m)	MA' (kN.m/m)	QB (kN/m)	QB1 (kN/m)
5	Ord+Collision(scour)	4504	1111	1616	1599
6	Earthquake	7575	-2541	2702	2679
7	Earthquake(scour)	7548	-2584	2672	2655

4.1.4 stress calculation

(1)bridge axis direction

b = 100.0 (cm)   h = 400.0 (cm)

rebar in use

lower tensile (As = 165.549 (cm^2))

1 row   cover 300 (mm)   D51 @ 183

2 row   cover 500 (mm)   D51 @ 370

upper tensile (As = 61.092 (cm^2))

1 row   cover 150 (mm)   D32 @ 260

2 row   cover 300 (mm)   D32 @ 260

			unit	OD(HT)	OD(LT)	OD-TM(HT)
bottom side ten sile	bending moment	MA	kN.m	3577.0	3734.0	5403.0
	required rebar amount	Asr	cm^2	67.617	70.706	89.765
	neutral axis	x	cm	111.8	111.8	111.8
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.96 67.93	2.05 70.92	2.96 102.60
	tensile resultant force required rebar amount	T As	kN cm^2	1589.8 99.364	1659.8 103.735	2401.2 130.501
top side ten sile	bending moment	MA'	kN.m	3577.0	3734.0	1751.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	13.1	13.1	13.1
	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	9.20 184.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1055.0 0.29 0.98	1098.0 0.30 0.98	1583.0 0.44 1.13
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1015.0 0.28 0.98	1059.0 0.29 0.98	1543.0 0.42 1.13
shear force to share by concrete		SC a	kN	3560.0	3560.0	4094.0
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	----	0.274	0.274	0.274
	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 = 363.38 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.156 : tensile rebar percentage pt = 0.456 (%)
3) for shear span ratio increment coefficient Cdc = 5.515 : shear span a = 2.487 (m)

			unit	OD-TM(LT)	WN-TM	WN-TM
bottom side ten sile	bending moment	MA	kN.m	5560.0	5402.0	5354.0
	required rebar amount	Asr	cm^2	92.492	75.965	75.261
	neutral axis	x	cm	111.8	111.8	111.8
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	3.05 105.59	2.96 102.59	2.93 101.67
	tensile resultant force required rebar amount	T As	kN cm^2	2471.2 134.302	2401.0 111.156	2379.4 110.158
top side ten sile	bending moment	MA'	kN.m	1909.0	1650.0	1601.0
	required rebar amount	Asr	cm^2	0.000	0.000	0.000
	neutral axis	x	cm	13.1	13.1	13.1
	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	9.20 184.00	10.80 216.00	10.80 216.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1626.0 0.45 1.13	1583.0 0.44 1.32	1550.0 0.43 1.32
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1586.0 0.44 1.13	1544.0 0.42 1.32	1522.0 0.42 1.32
shear force to share by concrete		SC a	kN	4094.0	4806.0	4806.0
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	----	0.274	0.274	0.274
	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 = 363.38 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.156 : tensile rebar percentage pt = 0.456 (%)
3) for shear span ratio increment coefficient Cdc = 5.515 : shear span a = 2.487 (m)

			unit	OD-CL	OD-CL(SC)	ETQ
bottom side ten sile	bending moment	MA	kN.m	4695.0	4646.0	10016.0
	required rebar amount	Asr	cm^2	46.751	46.258	102.638
	neutral axis	x	cm	111.8	111.8	111.8
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.57 89.15	2.55 88.23	5.49 190.21
	tensile resultant force required rebar amount	T As	kN cm^2	2086.4 69.548	2064.9 68.830	4451.7 148.391
top side ten sile	bending moment	MA'	kN.m	2496.0	2448.0	-3646.0
	required rebar amount	Asr	cm^2	0.000	0.000	34.699
	neutral axis	x	cm	13.1	13.1	74.6
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	2.77 173.30
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	1620.4 54.015
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	12.00 300.00	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1378.0 0.38 1.49	1345.0 0.37 1.49	2922.0 0.80 1.49
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1338.0 0.37 1.49	1316.0 0.36 1.49	2882.0 0.79 1.49
shear force to share by concrete		SC a	kN	5417.0	5417.0	5417.0
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	----	0.274	0.274	0.274
	allowable tensile stress	Sig.sa	N/mm^2	200.00	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 = 363.38 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.156 : tensile rebar percentage pt = 0.456 (%)
3) for shear span ratio increment coefficient Cdc = 5.515 : shear span a = 2.487 (m)

			unit	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	10064.0
	required rebar amount	Asr	cm^2	103.153
	neutral axis	x	cm	111.8
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	5.51 191.13
	tensile resultant force required rebar amount	T As	kN cm^2	4473.1 149.103
top side ten sile	bending moment	MA'	kN.m	-3791.0
	required rebar amount	Asr	cm^2	36.118
	neutral axis	x	cm	74.6
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.89 180.20
	tensile resultant force required rebar amount	T As	kN cm^2	1684.9 56.164
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	2917.0 0.80 1.49
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2888.0 0.79 1.49
shear force to share by concrete		SC a	kN	5417.0
rebar	shear force to share	Sh'	kN	0.0
	member axial direction spacing	s	cm	100.0
	reduction coefficient	Cds	----	0.274
	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 = 363.38 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.156 : tensile rebar percentage pt = 0.456 (%)
3) for shear span ratio increment coefficient Cdc = 5.515 : shear span a = 2.487 (m)

```
(2)perpendicular direction
   b =  100.0 (cm)      h =  400.0 (cm)
    rebar in use
         lower tensile ( As = 146.667 (cm²) )
                     1 row    cover  230 (mm)   D51 @ 209
                     2 row    cover  430 (mm)   D51 @ 408
         upper tensile ( As =  57.466 (cm²) )
                     1 row    cover  118 (mm)   D32 @ 209
                     2 row    cover  268 (mm)   D32 @ 408
```


			unit	OD(HT)	OD(LT)	WN
bottom side tensile	bending moment	MA	kN.m	2828.0	2953.0	3366.0
	required rebar amount	Asr	cm²	51.983	54.361	49.418
	neutral axis	x	cm	107.5	107.5	107.5
	stress	Sig.c Sig.s	N/mm² N/mm²	1.57 59.10	1.64 61.72	1.87 70.34
	tensile resultant force required rebar amount	T As	kN cm²	1257.0 78.562	1312.5 82.033	1496.0 74.799
top side tensile	bending moment	MA'	kN.m	2828.0	2953.0	2209.0
	required rebar amount	Asr	cm²	0.000	0.000	0.000
	neutral axis	x	cm	10.5	10.5	10.5
	stress	Sig.c Sig.s	N/mm² N/mm²	0.00 0.00	0.00 0.00	0.00 0.00
	tensile resultant force required rebar amount	T As	kN cm²	0.0 0.000	0.0 0.000	0.0 0.000
allowable stress		Sig.ca Sig.sa	N/mm² N/mm²	8.00 160.00	8.00 160.00	10.00 200.00
average shear force		QB Tau.m Tau.a1'	kN N/mm² N/mm²	1055.0 0.28 0.98	1098.0 0.30 0.98	1242.0 0.34 1.22
average shear force		S Tau.m Tau.a1'	kN N/mm² N/mm²	1032.0 0.28 0.98	1075.0 0.29 0.98	1219.0 0.33 1.22
shear force to share by concrete		SC a	kN	3625.0	3625.0	4531.0
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	----	0.247	0.247	0.247
	allowable tensile stress	Sig.sa	N/mm²	160.00	160.00	160.00
	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  = 0.665  : effective height          d  =  370.23 (cm)
  2) correction coefficient about tensile rebar percentage  Cpt = 1.096  : tensile rebar percentage  pt = 0.396   (%)
  3) for shear span ratio increment coefficient            Cdc = 5.841  : shear span                a  = 2.282   (m)
```

			unit	OD-CL	OD-CL(SC)	ETQ
bottom side ten sile	bending moment	MA	kN.m	4541.0	4504.0	7575.0
	required rebar amount	Asr	cm^2	44.297	43.927	75.211
	neutral axis	x	cm	107.5	107.5	107.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	2.52 94.89	2.50 94.12	4.21 158.31
	tensile resultant force required rebar amount	T As	kN cm^2	2018.2 67.272	2001.8 66.726	3366.8 112.228
top side ten sile	bending moment	MA'	kN.m	1145.0	1111.0	-2541.0
	required rebar amount	Asr	cm^2	0.000	0.000	23.426
	neutral axis	x	cm	10.5	10.5	73.1
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	0.00 0.00	0.00 0.00	1.94 125.24
	tensile resultant force required rebar amount	T As	kN cm^2	0.0 0.000	0.0 0.000	1129.5 37.649
allowable stress		Sig.ca Sig.sa	N/mm^2 N/mm^2	12.00 300.00	12.00 300.00	12.00 300.00
average shear force		QB Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1649.0 0.45 1.49	1616.0 0.44 1.49	2702.0 0.73 1.49
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	1626.0 0.44 1.49	1599.0 0.43 1.49	2679.0 0.72 1.49
shear force to share by concrete		SC a	kN	5516.0	5516.0	5516.0
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	----	0.247	0.247	0.247
	allowable tensile stress	Sig.sa	N/mm^2	200.00	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 = 370.23 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.096 : tensile rebar percentage pt = 0.396 (%)
3) for shear span ratio increment coefficient Cdc = 5.841 : shear span a = 2.282 (m)

			unit	ETQ(SC)
bottom side ten sile	bending moment	MA	kN.m	7548.0
	required rebar amount	Asr	cm^2	74.933
	neutral axis	x	cm	107.5
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	4.19 157.74
	tensile resultant force required rebar amount	T As	kN cm^2	3354.7 111.823
top side ten sile	bending moment	MA'	kN.m	-2584.0
	required rebar amount	Asr	cm^2	23.829
	neutral axis	x	cm	73.1
	stress	Sig.c Sig.s	N/mm^2 N/mm^2	1.97 127.35
	tensile resultant force required rebar amount	T As	kN cm^2	1148.5 38.283
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	2672.0 0.72 1.49
average shear force		S Tau.m Tau.a1'	kN N/mm^2 N/mm^2	2655.0 0.72 1.49
shear force to share by concrete		SC a	kN	5516.0
rebar	shear force to share	Sh'	kN	0.0
	member axial direction spacing	s	cm	100.0
	reduction coefficient	Cds	----	0.247
	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 = 0.665 : effective height d = 370.23 (cm)
2) correction coefficient about tensile rebar percentage Cpt = 1.096 : tensile rebar percentage pt = 0.396 (%)
3) for shear span ratio increment coefficient Cdc = 5.841 : shear span a = 2.282 (m)

(3) required thickness of pile cap

$$h >= 1.94*\sqrt[3]{\frac{kp*Lambda^4}{E}} = 1.216 \text{ (m)}$$

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) = 2.6444E+005

Kv2(separation wall steel pipe sheet pile) = 2.6444E+005

Kv3(intermediate driven single pile) = 0.0000E+000

n1 : number of periphery steel pipe sheet pile = 30

n2 : number of separation wall steel pipe sheet pile = 6

n3 : number of intermediate driven single pile = 0

A : area of pile cap (m^2) = 140.2

E : Young's modulus of pile cap (kN/m^2) = $2.50 * 10^7$

Lambda : protrusion length of pile cap (m) = 3.09

(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	19933	5103	17110	16555	OK
	upper tensile	7845	5103	6445	6109	OK
perpendicular direction	lower tensile	18089	5103	12878	14667	OK
	upper tensile	7497	5103	4393	5747	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 :SKY490
(5) diameter of steel material main body :D = 1200.0 (mm)
(6) section coefficient of steel pipe pile body :Z = 13081.0 (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: $A1 = B^2 = PI /4 + B * (L-B)$

$= 8.973^2 * Pai/4 + 8.973*(14.764- 8.973) = 115.205$ (m^2)

(2)area of backfilling soil

A2 = A1 - Ap = 74.635 (m^2)

where, Ap:leg column cross sectional area = 40.57 (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)	51100.0	0.0	0.0	0.0	0.0
2	OD(LT)	51100.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	51100.0	3100.0	67000.0	12400.0	79400.0
4	OD-TM(LT)	51100.0	3100.0	67000.0	12400.0	79400.0
5	WN-TM	51100.0	3200.0	68800.0	12800.0	81600.0
6	WN-TM	51100.0	3200.0	68800.0	12800.0	81600.0
7	OD-CL	51100.0	3100.0	35400.0	12400.0	47800.0
8	OD-CL(SC)	51100.0	3100.0	35400.0	12400.0	47800.0

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
9	ETQ	44300.0	14900.0	237500.0	59600.0	297100.0
10	ETQ(SC)	44300.0	15600.0	238900.0	62400.0	301300.0

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)	51100.0	0.0	0.0	0.0	0.0
2	OD(LT)	51100.0	0.0	0.0	0.0	0.0
3	WN	51100.0	1200.0	28100.0	4800.0	32900.0
4	OD-CL	51100.0	6300.0	71400.0	25200.0	96600.0
5	OD-CL(SC)	51100.0	6300.0	71300.0	25200.0	96500.0
6	ETQ	44300.0	13490.0	233800.0	53960.0	287760.0
7	ETQ(SC)	44300.0	13600.0	233800.0	54400.0	288200.0

(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) = 17.0 (kN/m³)
Gam.sat: unit weight of backfilling soil(saturated) = 18.0 (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)	11.240	2.969	6681.88	1772.73	4560.07	3894.54
2	OD(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
3	OD-TM(HT)	11.240	2.969	6681.88	1772.73	4560.07	3894.54
4	OD-TM(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
5	WN-TM	13.050	2.969	6681.88	1772.73	5294.39	3160.23
6	WN-TM	13.050	0.090	6681.88	53.74	5294.39	1441.24
7	OD-CL	10.590	2.969	6681.88	1772.73	4296.36	4158.25
8	OD-CL(SC)	10.590	0.090	6681.88	53.74	4296.36	2439.26
9	ETQ	8.350	2.969	6681.88	1772.73	3387.60	5067.02
10	ETQ(SC)	8.350	0.090	6681.88	53.74	3387.60	3348.03

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	WN-TM	0.00	0.000	0.00
7	OD-CL	0.00	0.000	0.00
8	OD-CL(SC)	0.00	0.000	0.00
9	ETQ	0.00	0.000	0.00
10	ETQ(SC)	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)	11.240	2.969	6681.88	1772.73	4560.07	3894.54

No	abbreviation	hw(m)	h'(m)	V1(kN)	V2(kN)	V3(kN)	Sum.V(kN)
2	OD(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
3	WN	13.050	2.969	6681.88	1772.73	5294.39	3160.23
4	OD-CL	10.590	2.969	6681.88	1772.73	4296.36	4158.25
5	OD-CL(SC)	10.590	0.090	6681.88	53.74	4296.36	2439.26
6	ETQ	8.350	2.969	6681.88	1772.73	3387.60	5067.02
7	ETQ(SC)	8.350	0.090	6681.88	53.74	3387.60	3348.03

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	OD-CL(SC)	0.00	0.000	0.00
6	ETQ	0.00	0.000	0.00
7	ETQ(SC)	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	54994.5	0.0	0.0
2	OD(LT)	0.0	57254.3	0.0	0.0
3	OD-TM(HT)	0.0	54994.5	3100.0	79400.0
4	OD-TM(LT)	0.0	57254.3	3100.0	79400.0
5	WN-TM	0.0	54260.2	3200.0	81600.0

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
6	WN-TM	0.0	52541.2	3200.0	81600.0
7	OD-CL	0.0	55258.2	3100.0	47800.0
8	OD-CL(SC)	0.0	53539.2	3100.0	47800.0
9	ETQ	0.0	49367.0	14900.0	297100.0
10	ETQ(SC)	0.0	47648.0	15600.0	301300.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	54994.5	0.0	0.0
2	OD(LT)	0.0	57254.3	0.0	0.0
3	WN	0.0	54260.2	1200.0	32900.0
4	OD-CL	0.0	55258.2	6300.0	96600.0
5	OD-CL(SC)	0.0	53539.2	6300.0	96500.0
6	ETQ	0.0	49367.0	13490.0	287760.0
7	ETQ(SC)	0.0	47648.0	13600.0	288200.0

(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)	30	0.04464	491.60	903.99
separation wall sheet pile(2)	6	0.04464	36.96	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)	1528	0	1.00
2	OD(LT)	1590	0	1.00
3	OD-TM(HT)	2292	103	1.15
4	OD-TM(LT)	2355	103	1.15
5	WN-TM	2293	107	1.35
6	WN-TM	2245	107	1.35
7	OD-CL	1995	103	1.50
8	OD-CL(SC)	1947	103	1.50
9	ETQ	4230	497	1.50
10	ETQ(SC)	4223	520	1.50

2)perpendicular direction

No	abbreviation	vertical reaction(kN/num)	horizontal react (kN/num)	increment coefficient
1	OD(HT)	1528	0	1.00
2	OD(LT)	1590	0	1.00
3	WN	1796	40	1.25
4	OD-CL	2382	210	1.50
5	OD-CL(SC)	2334	210	1.50
6	ETQ	3896	450	1.50
7	ETQ(SC)	3852	453	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)	1528	0	1.00
2	Oridinary(low tide)	1590	0	1.00
3	Ord+Temp(high tide)	2292	103	1.15

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
4	Ord+Temp(low tide)	2355	103	1.15
5	Wind+Temp	2293	107	1.35
6	Wind+Temp	2245	107	1.35
7	Ord+Collision	1995	103	1.50
8	Ord+Collision(scour)	1947	103	1.50
9	Earthquake	4230	497	1.50
10	Earthquake(scour)	4223	520	1.50

(2)perpendicular direction

No	load name	vertical reaction (kN/number)	horizontal reaction (kN/number)	increment coefficient
1	Oridinary(high tide)	1528	0	1.00
2	Oridinary(low tide)	1590	0	1.00
3	Wind	1796	40	1.25
4	Ord+Collision	2382	210	1.50
5	Ord+Collision(scour)	2334	210	1.50
6	Earthquake	3896	450	1.50
7	Earthquake(scour)	3852	453	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) = 185.00 (N/mm^2)

Zo : section coefficient of steel pipe pile body (m^3) = 13081.0 (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) = 2600.00
Sig.s1: moment rebar tensile stress (N/mm^2)
nb : number of moment rebar (number/ row) = 20
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 = 72
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)	1528.0	917	2420	2420	930.8	0.0
2	OD(LT)	1590.0	954	2420	2420	930.8	0.0
3	OD-TM(HT)	2292.0	1375	2783	2783	1070.4	103.0
4	OD-TM(LT)	2355.0	1413	2783	2783	1070.4	103.0
5	WN-TM	2293.0	1376	3267	3267	1256.5	107.0
6	WN-TM	2245.0	1347	3267	3267	1256.5	107.0
7	OD-CL	1995.0	1197	3630	3630	1396.1	103.0
8	OD-CL(SC)	1947.0	1168	3630	3630	1396.1	103.0
9	ETQ	4230.0	2538	3630	3630	1396.1	497.0
10	ETQ(SC)	4223.0	2534	3630	3630	1396.1	520.0

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	120.22	0.00	120.22	160.00	20 >= 16	54.82	96.00	72 >= 42
2	120.22	0.00	120.22	160.00	20 >= 16	57.05	96.00	72 >= 43
3	138.26	6.65	144.91	184.00	20 >= 16	82.24	110.40	72 >= 54

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)
4	138.26	6.65	144.91	184.00	20 >= 16	84.50	110.40	72 >= 56
5	162.30	6.91	169.21	216.00	20 >= 16	82.27	129.60	72 >= 46
6	162.30	6.91	169.21	216.00	20 >= 16	80.55	129.60	72 >= 45
7	180.33	6.65	186.99	300.00	20 >= 13	71.58	180.00	72 >= 29
8	180.33	6.65	186.99	300.00	20 >= 13	69.86	180.00	72 >= 28
9	180.33	32.10	212.43	300.00	20 >= 15	151.77	180.00	72 >= 61
10	180.33	33.58	213.92	300.00	20 >= 15	151.52	180.00	72 >= 61

perpendicular direction

No	load name abbreviation	Rp (kN)	Me (kN.m)	MFix (kN.m)	M (kN.m)	T1 (kN)	T2 (kN)
1	OD(HT)	1528.0	917	2420	2420	930.8	0.0
2	OD(LT)	1590.0	954	2420	2420	930.8	0.0
3	WN	1796.0	1078	3025	3025	1163.5	40.0
4	OD-CL	2382.0	1429	3630	3630	1396.1	210.0
5	OD-CL(SC)	2334.0	1400	3630	3630	1396.1	210.0
6	ETQ	3896.0	2338	3630	3630	1396.1	450.0
7	ETQ(SC)	3852.0	2311	3630	3630	1396.1	453.0

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	120.22	0.00	120.22	160.00	20 >= 16	54.82	96.00	72 >= 42
2	120.22	0.00	120.22	160.00	20 >= 16	57.05	96.00	72 >= 43
3	150.28	2.58	152.86	200.00	20 >= 16	64.44	120.00	72 >= 39
4	180.33	13.56	193.90	300.00	20 >= 13	85.46	180.00	72 >= 35
5	180.33	13.56	193.90	300.00	20 >= 13	83.74	180.00	72 >= 34
6	180.33	29.06	209.40	300.00	20 >= 14	139.79	180.00	72 >= 56
7	180.33	29.26	209.59	300.00	20 >= 14	138.21	180.00	72 >= 56

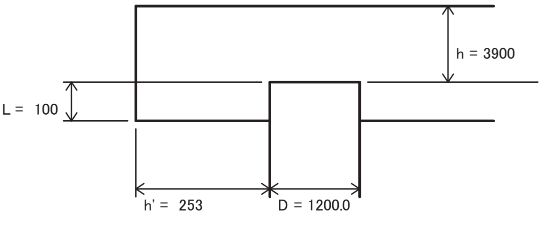
4.3 calculation of pile head joint part

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	1528	1528	0	0
2	Oridinary(low tide)	1.00	1590	1590	0	0
3	Ord+Temp(high tide)	1.15	2073	982	86	88
4	Ord+Temp(low tide)	1.15	2136	1045	86	88
5	Wind+Temp	1.35	2068	946	89	91
6	Wind+Temp	1.35	2020	899	89	91
7	Ord+Collision	1.50	1864	1206	86	53
8	Ord+Collision(scour)	1.50	1816	1159	86	53
9	Earthquake	1.50	3414	-671	414	330
10	Earthquake(scour)	1.50	3395	-748	433	335

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	1528	1528	0	0
2	Oridinary(low tide)	1.00	1590	1590	0	0
3	Wind	1.25	1507	1507	33	37
4	Ord+Collision	1.50	1535	1535	175	107
5	Ord+Collision(scour)	1.50	1487	1487	175	107
6	Earthquake	1.50	1371	1371	375	320
7	Earthquake(scour)	1.50	1324	1324	378	320

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

$= 8.973^2 * Pai/4 + 8.973 * (14.764 - 8.973) = 115.205$ (m²)

(2)area of backfilling soil

$A2 = A1 - Ap = 74.635$ (m²)

where, Ap:leg column cross sectional area = 40.57 (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)	51100.0	0.0	0.0	0.0	0.0
2	OD(LT)	51100.0	0.0	0.0	0.0	0.0
3	OD-TM(HT)	51100.0	3100.0	67000.0	12400.0	79400.0
4	OD-TM(LT)	51100.0	3100.0	67000.0	12400.0	79400.0
5	WN-TM	51100.0	3200.0	68800.0	12800.0	81600.0
6	WN-TM	51100.0	3200.0	68800.0	12800.0	81600.0

No	abbreviation	V(kN)	H(kN)	M(kN.m)	H*y(kN.m)	Sum.M(kN.m)
7	OD-CL	51100.0	3100.0	35400.0	12400.0	47800.0
8	OD-CL(SC)	51100.0	3100.0	35400.0	12400.0	47800.0
9	ETQ	44300.0	14900.0	237500.0	59600.0	297100.0
10	ETQ(SC)	44300.0	15600.0	238900.0	62400.0	301300.0

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)	51100.0	0.0	0.0	0.0	0.0
2	OD(LT)	51100.0	0.0	0.0	0.0	0.0
3	WN	51100.0	1200.0	28100.0	4800.0	32900.0
4	OD-CL	51100.0	6300.0	71400.0	25200.0	96600.0
5	OD-CL(SC)	51100.0	6300.0	71300.0	25200.0	96500.0
6	ETQ	44300.0	13490.0	233800.0	53960.0	287760.0
7	ETQ(SC)	44300.0	13600.0	233800.0	54400.0	288200.0

(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) = 17.0 (kN/m³)

Gam.sat: unit weight of backfilling soil(saturated) = 18.0 (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)	11.240	2.969	6681.88	1772.73	4560.07	3894.54
2	OD(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
3	OD-TM(HT)	11.240	2.969	6681.88	1772.73	4560.07	3894.54
4	OD-TM(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
5	WN-TM	13.050	2.969	6681.88	1772.73	5294.39	3160.23
6	WN-TM	13.050	0.090	6681.88	53.74	5294.39	1441.24
7	OD-CL	10.590	2.969	6681.88	1772.73	4296.36	4158.25
8	OD-CL(SC)	10.590	0.090	6681.88	53.74	4296.36	2439.26
9	ETQ	8.350	2.969	6681.88	1772.73	3387.60	5067.02
10	ETQ(SC)	8.350	0.090	6681.88	53.74	3387.60	3348.03

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	WN-TM	0.00	0.000	0.00
7	OD-CL	0.00	0.000	0.00
8	OD-CL(SC)	0.00	0.000	0.00
9	ETQ	0.00	0.000	0.00
10	ETQ(SC)	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)	11.240	2.969	6681.88	1772.73	4560.07	3894.54
2	OD(LT)	5.670	2.969	6681.88	1772.73	2300.32	6154.29
3	WN	13.050	2.969	6681.88	1772.73	5294.39	3160.23
4	OD-CL	10.590	2.969	6681.88	1772.73	4296.36	4158.25
5	OD-CL(SC)	10.590	0.090	6681.88	53.74	4296.36	2439.26
6	ETQ	8.350	2.969	6681.88	1772.73	3387.60	5067.02
7	ETQ(SC)	8.350	0.090	6681.88	53.74	3387.60	3348.03

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	OD-CL(SC)	0.00	0.000	0.00

No	abbreviation	H1(kN)	y(m)	H1*y(kN.m)
6	ETQ	0.00	0.000	0.00
7	ETQ(SC)	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	54994.5	0.0	0.0
2	OD(LT)	0.0	57254.3	0.0	0.0
3	OD-TM(HT)	0.0	54994.5	3100.0	79400.0
4	OD-TM(LT)	0.0	57254.3	3100.0	79400.0
5	WN-TM	0.0	54260.2	3200.0	81600.0
6	WN-TM	0.0	52541.2	3200.0	81600.0
7	OD-CL	0.0	55258.2	3100.0	47800.0
8	OD-CL(SC)	0.0	53539.2	3100.0	47800.0
9	ETQ	0.0	49367.0	14900.0	297100.0
10	ETQ(SC)	0.0	47648.0	15600.0	301300.0

2)perpendicular direction

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
1	OD(HT)	0.0	54994.5	0.0	0.0
2	OD(LT)	0.0	57254.3	0.0	0.0
3	WN	0.0	54260.2	1200.0	32900.0
4	OD-CL	0.0	55258.2	6300.0	96600.0
5	OD-CL(SC)	0.0	53539.2	6300.0	96500.0
6	ETQ	0.0	49367.0	13490.0	287760.0

No	abbreviation	V4(kN)	Vo(kN)	Ho(kN)	Mo(kN.m)
7	ETQ(SC)	0.0	47648.0	13600.0	288200.0

(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)	30	0.04464	491.60	903.99
separation wall sheet pile(2)	6	0.04464	36.96	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)	1528	1528	0	1.00
2	OD(LT)	1590	1590	0	1.00
3	OD-TM(HT)	2073	982	86	1.15
4	OD-TM(LT)	2136	1045	86	1.15
5	WN-TM	2068	946	89	1.35
6	WN-TM	2020	899	89	1.35
7	OD-CL	1864	1206	86	1.50
8	OD-CL(SC)	1816	1159	86	1.50
9	ETQ	3414	-671	414	1.50
10	ETQ(SC)	3395	-748	433	1.50

2)perpendicular direction

No	abbreviation	max vertical force (kN)	min vertical force (kN)	horizontal force(kN)	increment coefficient
1	OD(HT)	1528	1528	0	1.00
2	OD(LT)	1590	1590	0	1.00

No	abbreviation	max vertical force (kN)	min vertical force (kN)	horizontal force(kN)	increment coefficient
3	WN	1507	1507	33	1.25
4	OD-CL	1535	1535	175	1.50
5	OD-CL(SC)	1487	1487	175	1.50
6	ETQ	1371	1371	375	1.50
7	ETQ(SC)	1324	1324	378	1.50

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/m²)	Alp.*Eo (kN/m²)	dyna.het.coef ED(kN/m)	dyna.pois.rate NyuD
1	sandy	7.931	3.0	4800	9600	44339	0.50
2	sandy	4.300	13.0	20800	41600	117855	0.50
3	clay	2.300	7.0	19600	39200	125458	0.50
4	sandy	3.800	13.0	36400	72800	117855	0.50
5	clay	4.900	7.0	19600	39200	125458	0.50
6	sandy	9.700	20.0	56000	112000	157052	0.50
7	sandy	9.600	30.0	84000	168000	205805	0.50
8	clay	1.569	30.0	84000	168000	301510	0.50

(2)modulus of subgrade reaction

1) foundation bottom spring

	vertical direction kv(kN/m³)	horizontal direction shear ks(kN/m³)
periphery sheet pile	355333	106600
separation wall sheet pile	355333	106600
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 = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	1283	385	1114	557
2	-12.060 - -15.991	1283	385	1114	557
3	-15.991 - -20.291	5562	1669	4828	2414
4	-20.291 - -22.591	5241	1572	4550	2275
5	-22.591 - -26.391	9733	2920	8450	4225
6	-26.391 - -31.291	5241	1572	4550	2275
7	-31.291 - -40.991	14974	4492	12999	6500
8	-40.991 - -45.378	22461	6738	19499	9749
9	-45.378 - -50.591	22461	13476	19499	19499
10	-50.591 - -52.160	22461	13476	19499	19499

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	1857	557	770	385
2	-12.060 - -15.991	1857	557	770	385
3	-15.991 - -20.291	8047	2414	3337	1669
4	-20.291 - -22.591	7583	2275	3145	1572
5	-22.591 - -26.391	14083	4225	5840	2920
6	-26.391 - -31.291	7583	2275	3145	1572
7	-31.291 - -40.991	21666	6500	8984	4492
8	-40.991 - -45.378	32498	9749	13476	6738
9	-45.378 - -50.591	32498	19499	13476	13476
10	-50.591 - -52.160	32498	19499	13476	13476

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -45.378(m) evaluated as sum of modulus of subgrade reaction both in external periphery and internal periphery

earthquake time

1.bridge axis direction(Be = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	855	256	742	371
2	-12.060 - -15.991	855	256	742	371
3	-15.991 - -20.291	11123	3337	9657	4828
4	-20.291 - -22.591	10482	3145	9100	4550
5	-22.591 - -26.391	19466	5840	16899	8450
6	-26.391 - -31.291	10482	3145	9100	4550
7	-31.291 - -40.991	29948	8984	25999	12999
8	-40.991 - -45.378	44921	13476	38998	19499
9	-45.378 - -50.591	44921	26953	38998	38998
10	-50.591 - -52.160	44921	26953	38998	38998

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	1237	371	513	256
2	-12.060 - -15.991	1237	371	513	256
3	-15.991 - -20.291	16094	4828	6674	3337
4	-20.291 - -22.591	15166	4550	6289	3145
5	-22.591 - -26.391	28165	8450	11680	5840
6	-26.391 - -31.291	15166	4550	6289	3145
7	-31.291 - -40.991	43331	12999	17969	8984
8	-40.991 - -45.378	64997	19499	26953	13476
9	-45.378 - -50.591	64997	38998	26953	26953
10	-50.591 - -52.160	64997	38998	26953	26953

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -45.378(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 = 14.88977, De = 9.09857)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	11856	3557	10292	5146
2	-12.060 - -15.991	11856	3557	10292	5146
3	-15.991 - -20.291	31513	9454	27358	13679
4	-20.291 - -22.591	33546	10064	29123	14561
5	-22.591 - -26.391	31513	9454	27358	13679
6	-26.391 - -31.291	33546	10064	29123	14561
7	-31.291 - -40.991	41994	12598	36457	18228
8	-40.991 - -45.378	55030	16509	47774	23887
9	-45.378 - -50.591	55030	33018	47774	47774
10	-50.591 - -52.160	80621	48372	69990	69990

2.perpendicular direction(Be = 9.09857, De = 14.88977)

layer No	elevation(m)	front (kN/m^3)		side (kN/m^3)	
		kH	kSVB	kSHD	kSVD
1	-8.060 - -12.060	17154	5146	7113	3557
2	-12.060 - -15.991	17154	5146	7113	3557
3	-15.991 - -20.291	45596	13679	18908	9454
4	-20.291 - -22.591	48538	14561	20128	10064
5	-22.591 - -26.391	45596	13679	18908	9454
6	-26.391 - -31.291	48538	14561	20128	10064
7	-31.291 - -40.991	60761	18228	25196	12598
8	-40.991 - -45.378	79623	23887	33018	16509
9	-45.378 - -50.591	79623	47774	33018	33018
10	-50.591 - -52.160	116649	69990	48372	48372

as for kSVB and kSVD, because resistance in internal periphery deeper than elevation -45.378(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

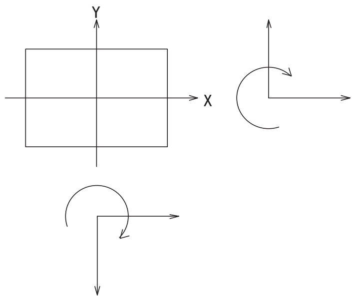
item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	1.1632E-001	9.4061E-002
ThetaoH	mrad	5.0980E-003	3.4286E-003
Del.oM	mm	5.0980E-002	3.4286E-002
ThetaoM	mrad	4.2349E-003	2.7517E-003
Ass	kN/m	1.8199E+006	1.9478E+006
Asr	kN/rad	-2.1907E+007	-2.4269E+007
Ars	kN.m/m	-2.1907E+007	-2.4269E+007
Arr	kN.m/rad	4.9986E+008	6.6580E+008

earthquake time

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	9.7659E-002	7.6806E-002
ThetaoH	mrad	4.6378E-003	2.9827E-003
Del.oM	mm	4.6378E-002	2.9827E-002
ThetaoM	mrad	4.0506E-003	2.5462E-003
Ass	kN/m	2.2443E+006	2.3887E+006
Asr	kN/rad	-2.5696E+007	-2.7983E+007
Ars	kN.m/m	-2.5696E+007	-2.7983E+007
Arr	kN.m/rad	5.4109E+008	7.2055E+008

to estimate natural period

item	unit	bridge axis direction	perpendicular direction
Ho	kN		100.00
Mo	kN.m		1000.00
Del.oH	mm	3.0445E-002	2.4860E-002
ThetaoH	mrad	1.9342E-003	1.2956E-003
Del.oM	mm	1.9342E-002	1.2956E-002
ThetaoM	mrad	2.3986E-003	1.5554E-003
Ass	kN/m	6.7346E+006	7.1081E+006
Asr	kN/rad	-5.4306E+007	-5.9208E+007
Ars	kN.m/m	-5.4306E+007	-5.9208E+007
Arr	kN.m/rad	8.5481E+008	1.1361E+009



Y direction: bridge axis direction
X direction:perpendicular direction

CHAPTER 4. RC PIER SUBSTRUCTURE DESIGN

4.1 SUMMARY OF DESIGN OF RC PIER COLUMN

1) Design Section

A verification of the sections of pier column will be made at the section A-A against bending moment and shear force in each bridge axis and axis perpendicular direction as shown in the figure below.

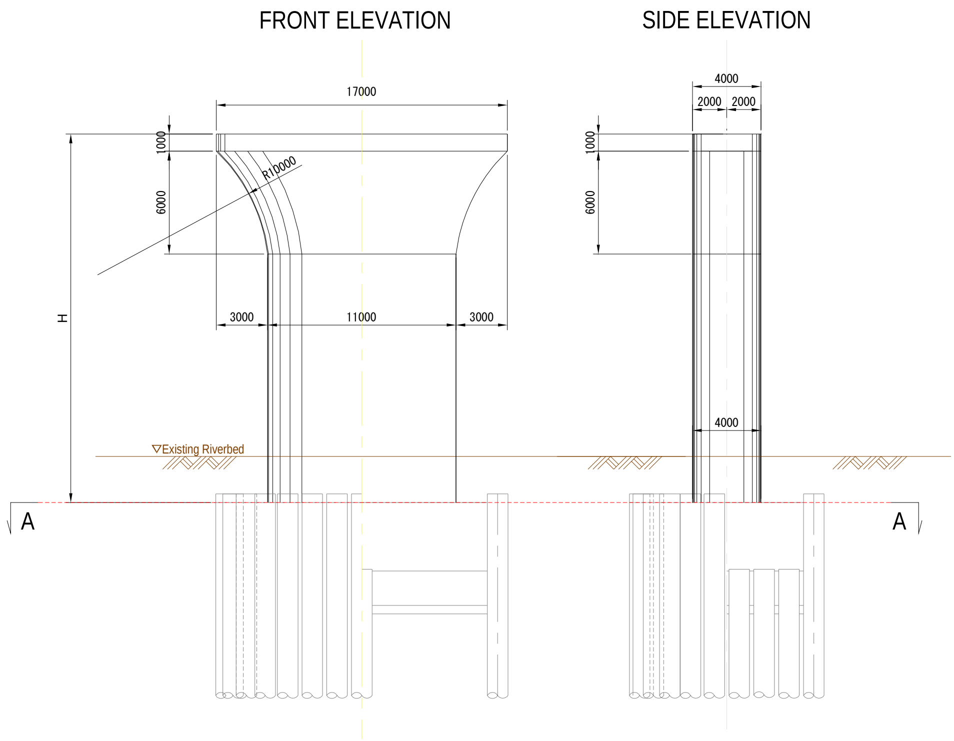


Figure Design Section of Pier Column

2) Design Condition

- Applied reinforcement bar: SD345 for shear reinforcement, SD390 for 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 Sectional Force in Earthquake Condition

Load Direction		V (kN)	S (kN)	M (kN.m)
P14	Bridge axis direction	48,500	15,700	243,600
	Bridge axis perpendicular direction	48,500	14,800	266,700
P15	Bridge axis direction	44,300	15,600	239,300
	Bridge axis perpendicular direction	44,300	13,600	235,300
P16	Bridge axis direction	45,200	15,800	241,500
	Bridge axis perpendicular direction	45,200	13,800	238,300
P17	Bridge axis direction	44,500	15,900	239,900
	Bridge axis perpendicular direction	44,500	13,600	230,900
P18	Bridge axis direction	43,700	16,000	239,700
	Bridge axis perpendicular direction	43,700	13,400	224,400
P19	Bridge axis direction	45,800	16,200	241,500
	Bridge axis perpendicular direction	45,800	14,000	236,300

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.

P14-P19

Cover (mm)	Straight Section		Arc Section	
	Diameter	Arrangement	Diameter	Arrangement
150	D38	56@125	D38	2 x 32@182
250	D38	56@125	-	-

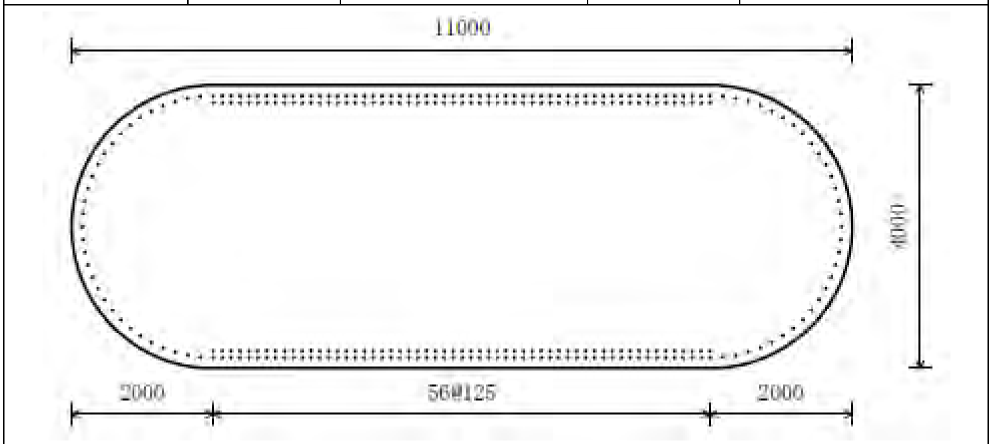


Figure Rebar Arrangement (Main Reinforcement)

b) Shear Reinforcement

- Lateral tie to avoid the column from buckling due to shear force: D22, double reinforcement, 150 mm pitch through the column
- Intermediate hoop to avoid the lateral tie from jutting outside: 8 nos. for bridge axis direction and 4 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}	
P14	12.1<	15.0	330.6<	345.0	0.40<	0.28,2.85	3871.0>	747.7	OK
P15	11.9<	15.0	333.5<	345.0	0.40<	0.28,2.85	3871.0>	733.8	OK
P16	12.0<	15.0	335.2<	345.0	0.40<	0.27,2.85	3871.0>	766.5	OK
P17	11.9<	15.0	334.0<	345.0	0.41<	0.28,2.85	3871.0>	779.0	OK
P18	11.9<	15.0	335.8<	345.0	0.41<	0.28,2.85	3871.0>	796.2	OK
P19	12.0<	15.0	333.6<	345.0	0.42<	0.28,2.85	3871.0>	828.8	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}	
P14	7.1<	15.0	142.8<	345.0	0.37<	0.21,2.85	2322.6>	359.0	OK
P15	6.2<	15.0	121.1<	345.0	0.34<	0.21,2.85	2322.6>	293.5	OK
P16	6.3<	15.0	121.5<	345.0	0.35<	0.21,2.85	2322.6>	305.1	OK
P17	6.1<	15.0	115.5<	345.0	0.34<	0.21,2.85	2322.6>	293.0	OK
P18	5.9<	15.0	110.8<	345.0	0.34<	0.21,2.85	2322.6>	282.6	OK
P19	6.3<	15.0	117.4<	345.0	0.35<	0.21,2.85	2322.6>	316.2	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 PIER COLUMN DESIGN

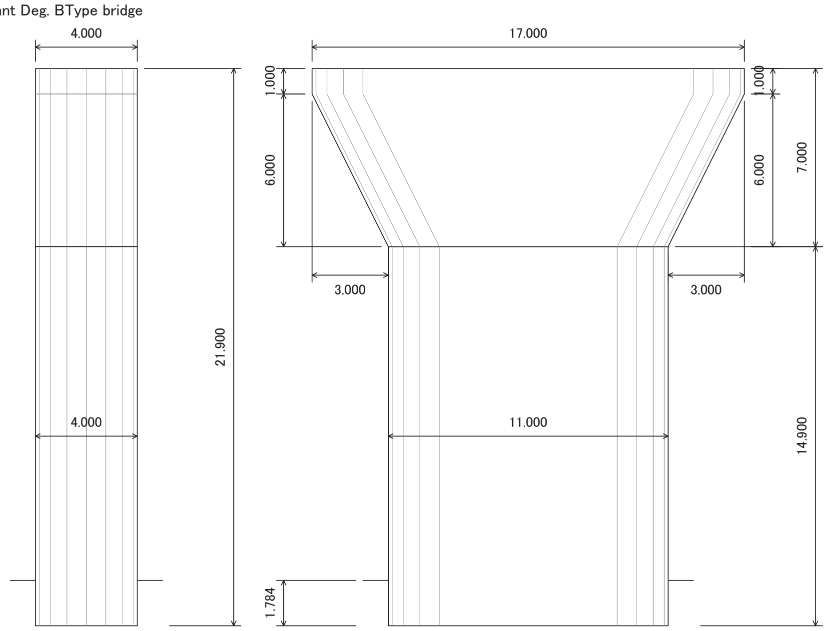
Detail calculation sheet of pier column design of Pier No.14 and No.15 is attached from next page.

Contents

1 Design condition

1.1 Shape dimension

Type RCOval column pier (new consider)
Beam shape type Beam type (oval)
foundation type Spread foundation
Division of important Deg. BType 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	14.900 4.000 11.000
Surface (from column lower edge)	h_G	1.784

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 24300.00 (kN)

bridge axial	bridge axial	right angle
operated position of super structural inertia force h_I (m)	0.000	2.830

1.2.2 Allowable stress check 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)	7000.00 7000.00	7000.00 7300.00

1.2.3 Dynamic bearing capacity 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 check 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 Dynamic bearing capacity method

Bridge axial direction

	Design seismic coefficient type1. sharing weight				Design seismic coefficient type2. 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 type1. sharing weight				Design seismic coefficient type2. 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 $2.00\text{x}10^5$(N/mm^2)
Young's modulus ratio of section design 15
Unit weight of reinforcement concrete Gam.c 24.50(kN/m^3)
Water unit weight Gam.w 9.80(kN/m^3)
Unit weight of sediment (backfill) Gam.t 18.00(kN/m^3)
Water unit weight on sediment buoyancy calculation Gam.w 9.00(kN/m^3)

1.5 Column

1.5.1 Material of use

Design standard strength of concrete Sig.ck 30.0(N/mm^2)
Young's modulus of concrete Ec $2.80\text{x}10^4$(N/mm^2)
Main reinforcement material SD390
Striped reinforcement material SD345

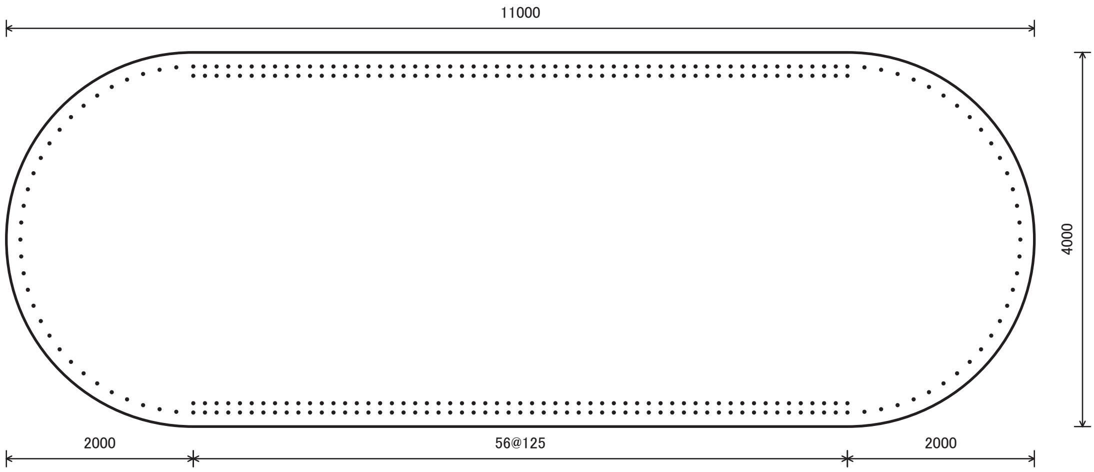
Tensile stress of column reinforcement uses basic value as the member in water.
Not consider correction coefficient cN to allowable shear stress Tau.a1of column.

1.5.2 Rebar

(1) Base main reinforcement

Cover (mm)	Straight linear part		Circular arc	
	Diameter	Bar Arrangement	Diameter	One side Number
150 250	D38 D38	2000+56@125+2000 2000+56@125+2000	D38 ----	31 ----

Note : Reinforcement amount total 330600.0mm^2,
*Satisfy more than [reinforcement amount of 500mm^2 / m (13283.2mm^2)]Do.
*Satisfy no more than [reinforcement amount (40566370.6mm^2) to be 6% of section area (2433982.2mm^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) Middle striped reinforcement

Middle striped reinforcement arrangement

reinforcement diameter D22

Bridge axial direction 8 number / step

Perpendicular direction 4 number / step

Consider middle striped reinforcement 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	57	57	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 Alp.Beta.

Section correction factor	Bridge axial	Perpendicular
Alpha	0.20	1.00
Beta	0.40	1.00

1.6 Shape of earth surface

surface type :Horizontal

1.7 Allowable stress check 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 : 5.670m high water level : 11.240m sediment height: 1.784m (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	24300.00
Live load reaction R_L	7000.00
Total	31300.00

horizontal force R_H(kN)	operated position h_l(m)	moment (kN.m)		
		R_H*h_l	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 : 5.670m high water level : 11.240m sediment height: 1.784m (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	24300.00
Live load reaction R_L	7000.00
Total	31300.00

horizontal force R_H(kN)	operated position h_l(m)	moment (kN.m)		
		R_H*h_l	R_M	total
5400.00	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 : SeismicLevel1(abbreviation : Seismic) load condition : Lv1 E.Q(increasing coefficient of allowable stress 1.50)
low water level : 8.350m high water level : 8.350m 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	24300.00
Total	24300.00

horizontal force R_H(kN)	operated position h_l(m)	moment (kN.m)		
		R_H*h_l	R_M	total
7000.00	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 : 11.240m high water level : 11.240m sediment height: 1.784m (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	24300.00
Live load reaction R_L	7000.00
Total	31300.00

horizontal force R_H(kN)	operated position h_l(m)	moment (kN.m)		
		R_H*h_l	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

Load directly operated to frame body
Impact load load bridge axial direction
Height from column lower edge 12.040 (m)
Load strength 3700.00 (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 : 5.670m high water level : 11.240m sediment height: 1.784m (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	24300.00
Live load reaction R_L	7000.00
Total	31300.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	2.830	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

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 : SeismicLevel1(abbreviation : Seismic) load condition : Lv1E.Q(increasing coefficient of allowable stress 1.50)
low water level : 8.350m high water level : 8.350m 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	24300.00
Total	24300.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
7300.00	2.830	20659.00	0.00	20659.00

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 : VesselCollision(abbreviation : Collision) load condition : Vessel Collision(increasing coefficient of allowable stress 1.50)
low water level : 11.240m high water level : 11.240m 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	24300.00
Live load reaction R_L	7000.00
Total	31300.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	2.830	0.00	0.00	0.00

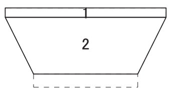
Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Do not consider
Load directly operated to frame body
Impact load Load to bridge axial perpendicular direction
Height from column lower edge 12.040 (m)
Load strength 7300.00 (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 check 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	4.000	4.000	4.000	4.000	17.000	64.56637
2	Drawn parts	6.000	6.000	4.000	4.000	4.000	4.000	17.000	315.39822

No	volume V(m^3)	Xg (m)	Yg (m)	Zg (m)	V*Xg (m^4)	V*Yg (m^4)	V*Zg (m^4)
1	64.56637	0.0000	6.5000	0.0000	0.0000	419.6814	0.0000
2	315.39822	0.0000	3.2283	0.0000	0.0000	1018.1947	0.0000
Sum	379.96459	------	------	------	0.0000	1437.8761	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 = 14.900 from column base to beam lower edge (m)
W = Sum V *Gam.c = 379.96459*24.50 = 9309.13(kN)
Y = Sum (V*Yg)/Sum V + PH = 18.684(m)
Xc = Sum (V*Xg)/Sum 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	11.000	11.000	4.000	4.000	14.900	604.43892

No	volume V(m^3)	Xg (m)	Yg (m)	Zg (m)	V*Xg (m^4)	V*Yg (m^4)	V*Zg (m^4)
1	604.43892	0.0000	7.4500	0.0000	0.0000	4503.0700	0.0000
Sum	604.43892	------	------	------	0.0000	4503.0700	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 = Sum V *Gam.c = 604.43892*24.50 = 14808.75(kN)
Y = Sum(V*Yg)/Sum V = 7.450(m)

Xc = Sum(V*Xg)/Sum V = 0.000(m)

(3) Weight total

Sum W = 24117.89(kN)

(4) Center of gravity position

$$Y = \frac{\text{Sum W*Y}}{\text{Sum W}} = 11.786(m)$$

$$Xc = \frac{\text{Sum W*Xc}}{\text{Sum W}} = 0.000(m)$$

2.1.2 Dynamic water pressure in seismic condition

(1) Axial direction

1) Case : SeismicLevel1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{11.000}{4.000} * \left(1 - \frac{11.000}{4 * 8.350}\right)$$

$$= 1377.51 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

2) Case : SeismicLevel1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{11.000}{4.000} * \left(1 - \frac{11.000}{4 * 8.350}\right)$$

$$= 1377.51 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

(2) Axial perpendicular direction

1) Case : SeismicLevel1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{4.000}{11.000} * \left(1 - \frac{4.000}{4 * 8.350}\right)$$

$$= 239.07 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

2) Case : SeismicLevel1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{4.000}{11.000} * \left(1 - \frac{4.000}{4 * 8.350}\right)$$

$$= 239.07 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

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 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	31300.00	0.00	21.900	0.00	0.00
Frame body	24117.89	0.00	11.786	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	55417.89	0.00	――――――	――――――	0.00
High water level	55417.89	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	31300.00	5400.00	21.900	0.00	118260.00
Frame body	24117.89	0.00	11.786	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	55417.89	5400.00	――――――	――――――	118260.00
High water level	55417.89	5400.00	――――――	――――――	118260.00

Case:SeismicLevel1

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	24300.00	7000.00	21.900	0.00	153300.00
Frame body	24117.89	7235.37	11.786	0.00	85277.78
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	――――――	1377.51	3.579	――――――	4929.53
Dynamic water pressure in seismic condition High water level	――――――	1377.51	3.579	――――――	4929.53
Total Low water level	48417.89	15612.88	――――――	――――――	243507.30
High water level	48417.89	15612.88	――――――	――――――	243507.30

Case:Vessel Collision

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	31300.00	0.00	21.900	0.00	0.00
Frame body	24117.89	0.00	11.786	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	3700.00	12.040	----------	44548.00
Spread load operated to column	0.00	0.00	0.000	----------	0.00
Total Low water level	55417.89	3700.00	-------	----------	44548.00
High water level	55417.89	3700.00	-------	----------	44548.00

2.1.4 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	31300.00	0.00	21.900	0.00	0.00
Frame body	24117.89	0.00	11.786	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	55417.89	0.00	-------	----------	0.00
High water level	55417.89	0.00	-------	----------	0.00

Case:SeismicLevel1

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	24300.00	7300.00	21.900	20659.00	180529.00
Frame body	24117.89	7235.37	11.786	0.00	85277.78
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	------	239.07	3.579	----------	855.54
Dynamic water pressure in seismic condition High water level	------	239.07	3.579	----------	855.54
Total Low water level	48417.89	14774.44	-------	----------	266662.31
High water level	48417.89	14774.44	-------	----------	266662.31

Case:VesselCollision

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	31300.00	0.00	21.900	0.00	0.00
Frame body	24117.89	0.00	11.786	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	7300.00	12.040	----------	87892.00
Spread load operated to column	0.00	0.00	0.000	----------	0.00
Total Low water level	55417.89	7300.00	-------	----------	87892.00
High water level	55417.89	7300.00	-------	----------	87892.00

2.1.5 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	55417.89	0.00	0.00
Ordinary	Height	55417.89	0.00	0.00
Temperature	Low	55417.89	5400.00	118260.00
Temperature	Height	55417.89	5400.00	118260.00
Seismic	Low	48417.89	15612.88	243507.30
Seismic	Height	48417.89	15612.88	243507.30
Collision	Low	55417.89	3700.00	44548.00
Collision	Height	55417.89	3700.00	44548.00

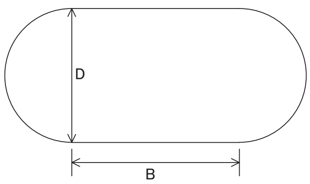
bridge axial perpendicular direction

Case	Water level	Vertical force (kN)	Horizontal force (kN)	Bending moment (kN.m)
Ordinary	Low	55417.89	0.00	0.00
Ordinary	Height	55417.89	0.00	0.00
Seismic	Low	48417.89	14774.44	266662.31
Seismic	Height	48417.89	14774.44	266662.31
Collision	Low	55417.89	7300.00	87892.00
Collision	Height	55417.89	7300.00	87892.00

2.2 Consider of column base section

2.2.1 Axial direction

(1) Section shape and reinforcement arrangement



B = 7.000 (m) D = 4.000 (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 2	150 250	D38 D38	114 114	129960.0 129960.0	D38 ----	62 ----	70680.0 ------
Total Sum As1 = 259920.0 Total Sum As2 = 70680.0							
Reinforcement amount total Sum As = 330600.0							

Total amount of rebar As = 330600.0(mm^2)

* minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (13283.2mm^2)] OK

* maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2433982.2mm^2)] OK

(2) Section check

1) Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
Load condition	------	Ordinary	Ordinary	Dead+ Live+ Temperature	Dead+ Live+ Temperature
Axial force N Bending moment M	kN kN.m	55417.89 0.00	55417.89 0.00	55417.89 118260.00	55417.89 118260.00
Compressive edge-middle axial x	mm	--------	--------	1944	1944
Compressive stress Sig.c Tensile stress Sig.s	N/mm^2 N/mm^2	1.22 −18.26	1.22 −18.26	6.01 88.39	6.01 88.39
Increasing coefficient Alp. Allowable compressive stress Sig.ca Allowable tensile stress Sig.sa	------ N/mm^2 N/mm^2	1.00 10.00 −230.00	1.00 10.00 −230.00	1.15 11.50 184.00	1.15 11.50 184.00
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 ------ ------	89488.38 290193.03 331978.10 1.7M<=Mc 42876.5 48417.89 42876.5 13534.0 OK OK	89488.38 290193.03 331978.10 1.7M<=Mc 42876.5 48417.89 42876.5 13534.0 OK OK	89488.38 290193.03 331978.10 Mc<=Mu 37283.9 48417.89 37283.9 13534.0 OK OK	89488.38 290193.03 331978.10 Mc<=Mu 37283.9 48417.89 37283.9 13534.0 OK OK

Items	Unit	Seismic LowWL	Seismic HeightWL	Collision LowWL	Collision HeightWL
Load condition	------	Lv1 E.Q	Lv1 E.Q	Vessel Collision	Vessel Collision
Axial force N	kN	48417.89	48417.89	55417.89	55417.89
Bending moment M	kN.m	243507.30	243507.30	44548.00	44548.00
Compressive edge-middle axial x	mm	1362	1362	3736	3736
Compressive stress Sig.c	N/mm^2	12.07	12.07	2.61	2.61
Tensile stress Sig.s	N/mm^2	330.52	330.52	1.19	1.19
Increasing coefficient Alp.	------	1.50	1.50	1.50	1.50
Allowable compressive stress Sig.ca	N/mm^2	15.00	15.00	15.00	15.00
Allowable tensile stress Sig.sa	N/mm^2	345.00	345.00	345.00	345.00
Crack moment Mc	kN.m	85183.11	85183.11	89488.38	89488.38
First yield moment My0	kN.m	280269.61	280269.61	290193.03	290193.03
Ultimate bending moment Mu	kN.m	320366.35	320366.35	331978.10	331978.10
Minimum rebar amount as bending member	------	Mc<=Mu	Mc<=Mu	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm^2	24973.8	24973.8	28584.3	28584.3
Axial force Nu	kN	48417.89	48417.89	48417.89	48417.89
0.008A1' (axial force Na=N)	mm^2	24973.8	24973.8	28584.3	28584.3
0.008A2' (axial force Nu)	mm^2	13534.0	13534.0	13534.0	13534.0
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

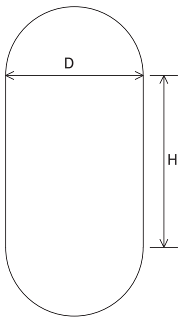
2) Consider against shear force

items	unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
condition	--------	Ordinary	Ordinary	Dead+ Live+ Temperature	Dead+ Live+ Temperature
b	mm	10545	10545	10545	10545
d	mm	3706	3706	3706	3706
S	kN	0.00	0.00	5400.00	5400.00
N	kN	55417.89	55417.89	55417.89	55417.89
M	kN.m	0.00	0.00	118260.00	118260.00
Alp.	------	1.00	1.00	1.15	1.15
pt	%	0.423	0.423	0.423	0.423
ce	------	0.665	0.665	0.665	0.665
cpt	------	1.123	1.123	1.123	1.123
CN	------	1.000	1.000	1.000	1.000
Tau.m	N/mm^2	0.000	0.000	0.138	0.138
Tau.a$_1$	N/mm^2	0.187	0.187	0.215	0.215
Tau.a$_2$	N/mm^2	1.900	1.900	2.185	2.185
Sig.sa	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	--------	Lv1 E.Q	Lv1 E.Q	Vessel Collision	Vessel Collision
b	mm	10545	10545	10545	10545
d	mm	3706	3706	3706	3706
S	kN	15612.88	15612.88	3700.00	3700.00
N	kN	48417.89	48417.89	55417.89	55417.89
M	kN.m	243507.30	243507.30	44548.00	44548.00
Alp.	------	1.50	1.50	1.50	1.50
pt	%	0.423	0.423	0.423	0.423
ce	------	0.665	0.665	0.665	0.665
cpt	------	1.123	1.123	1.123	1.123
CN	------	1.000	1.000	1.000	1.000
Tau.m	N/mm^2	0.399	0.399	0.095	0.095
Tau.a$_1$	N/mm^2	0.276	0.276	0.276	0.276
Tau.a$_2$	N/mm^2	2.850	2.850	2.850	2.850
Sig.sa	N/mm^2	300.00	300.00	------------	------------
s	mm	150	150	------------	------------
Sca	kN	10793.46	10793.46	------------	------------
Sh'	kN	4819.42	4819.42	------------	------------
AwReq	mm^2	747.69	747.69	------------	------------
Aw	mm^2	3871.00	3871.00	------------	------------

The following ;
S : Shear force
N : Axial force
M : Bending moment
b : Member section width
d : Effective height
Alp. : 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
Tau.m : 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
Sig.sa : 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.mShear supplemental barAmount
Aw : Shear supplemental barAmount

2.2.2 Axial perpendicular direction
(1) Section shape and reinforcement arrangement



H = 7.000 (m) D = 4.000 (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	114	129960.0	D38	62	70680.0
2	250	D38	114	129960.0	----	----	------
Total Sum As1 = 259920.0 Total Sum As2 = 70680.0							
Reinforcement amount total Sum As = 330600.0							

Total amount of rebar As = 330600.0(mm^2)
* minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (13283.2mm^2)] OK
* maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2433982.2mm^2)] OK

(2) Section check

1) Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Seismic LowWL	Seismic HeightWL
Load condition	------	Ordinary	Ordinary	Lv1 E.Q	Lv1 E.Q
Axial force N	kN	55417.89	55417.89	48417.89	48417.89
Bending moment M	kN.m	0.00	0.00	266662.31	266662.31
Compressive edge-middle axial x	mm	--------	--------	4639	4639
Compressive stress Sig.c	N/mm^2	1.22	1.22	7.11	7.11
Tensile stress Sig.s	N/mm^2	-18.26	-18.26	142.82	142.82
Increasing coefficient Alp.	------	1.00	1.00	1.50	1.50
Allowable compressive stress Sig.ca	N/mm^2	10.00	10.00	15.00	15.00
Allowable tensile stress Sig.sa	N/mm^2	-230.00	-230.00	345.00	345.00
Crack moment Mc	kN.m	231836.04	231836.04	220682.46	220682.46
First yield moment My0	kN.m	528483.30	528483.30	504918.54	504918.54
Ultimate bending moment Mu	kN.m	801331.15	801331.15	777145.99	777145.99
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc	Mc<=Mu	Mc<=Mu
Minimum rebar amount axial force member	mm^2	42876.5	42876.5	24973.8	24973.8
Axial force Nu	kN	48417.89	48417.89	48417.89	48417.89
0.008A1' (axial force Na=N)	mm^2	42876.5	42876.5	24973.8	24973.8
0.008A2' (axial force Nu)	mm^2	13534.0	13534.0	13534.0	13534.0
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	55417.89	55417.89
Bending moment M	kN.m	87892.00	87892.00
Compressive edge-middle axial x	mm	10983	10983
Compressive stress Sig.c	N/mm^2	2.44	2.44
Tensile stress Sig.s	N/mm^2	-0.44	-0.44
Increasing coefficient Alp.	------	1.50	1.50
Allowable compressive stress Sig.ca	N/mm^2	15.00	15.00
Allowable tensile stress Sig.sa	N/mm^2	-345.00	-345.00
Crack moment Mc	kN.m	231836.04	231836.04
First yield moment My0	kN.m	528483.30	528483.30
Ultimate bending moment Mu	kN.m	801331.15	801331.15
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm^2	28584.3	28584.3
Axial force Nu	kN	48417.89	48417.89
0.008A1' (axial force Na=N)	mm^2	28584.3	28584.3
0.008A2' (axial force Nu)	mm^2	13534.0	13534.0
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 E.Q	Lv1 E.Q
b	mm	3847	3847	3847	3847
d	mm	10437	10437	10437	10437
S	kN	0.00	0.00	14774.44	14774.44
N	kN	55417.89	55417.89	48417.89	48417.89
M	kN.m	0.00	0.00	266662.31	266662.31
Alp.	------	1.00	1.00	1.50	1.50
pt	%	0.412	0.412	0.412	0.412
ce	------	0.500	0.500	0.500	0.500
cpt	------	1.112	1.112	1.112	1.112
CN	------	1.000	1.000	1.000	1.000
Tau.m	N/mm^2	0.000	0.000	0.368	0.368
Tau.a_1	N/mm^2	0.139	0.139	0.206	0.206
Tau.a_2	N/mm^2	1.900	1.900	2.850	2.850
Sig.sa	N/mm^2	------------	------------	300.00	300.00
s	mm	------------	------------	150	150
Sca	kN	------------	------------	8257.49	8257.49
Sh'	kN	------------	------------	6516.95	6516.95
AwReq	mm^2	------------	------------	359.05	359.05
Aw	mm^2	------------	------------	2322.60	2322.60

items	unit	Collision LowWL	Collision HeightWL
condition	--------	Vessel Collision	Vessel Collision
b	mm	3847	3847
d	mm	10437	10437
S	kN	7300.00	7300.00
N	kN	55417.89	55417.89
M	kN.m	87892.00	87892.00
Alp.	------	1.50	1.50
pt	%	0.412	0.412
ce	------	0.500	0.500
cpt	------	1.112	1.112
CN	------	1.000	1.000
Tau.m	N/mm^2	0.182	0.182
Tau.a_1	N/mm^2	0.206	0.206
Tau.a_2	N/mm^2	2.850	2.850
Sig.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

Alp. : 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

Tau.m : 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

Sig.sa : 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.mShear supplemental barAmount

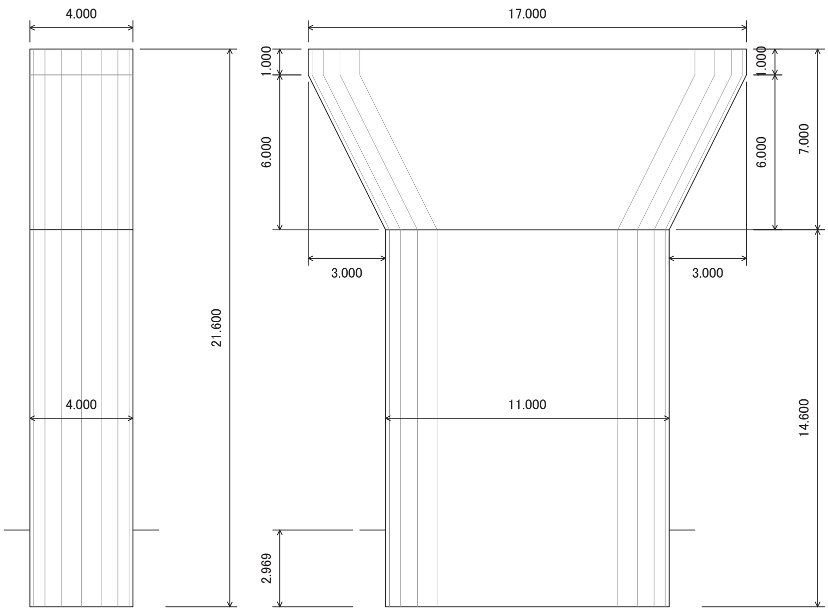
Aw : Shear supplemental barAmount

Contents

1 Design condition

1.1 Shape dimension

Type RCOval column pier (new consider)
Beam shape type Beam type (oval)
foundation type Spread foundation
Division of important Deg. BType 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	14.600 4.000 11.000
Surface (from column lower edge)	h_G	2.969

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 20400.00 (kN)

bridge axial	bridge axial	right angle
operated position of super structural inertia force h_I (m)	0.000	2.800

1.2.2 Allowable stress check 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)	6800.00 7000.00	6800.00 6200.00

1.2.3 Dynamic bearing capacity 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 check 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 Dynamic bearing capacity method

Bridge axial direction

	Design seismic coefficient type1. sharing weight				Design seismic coefficient type2. 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 type1. sharing weight				Design seismic coefficient type2. 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 Gam.c 24.50(kN/m^3)
Water unit weight Gam.w 9.80(kN/m^3)
Unit weight of sediment (backfill) Gam.t 18.00(kN/m^3)
Water unit weight on sediment buoyancy calculation Gam.w 9.00(kN/m^3)

1.5 Column

1.5.1 Material of use

Design standard strength of concrete Sig.ck 30.0(N/mm^2)
Young's modulus of concrete Ec 2.80×10^4(N/mm^2)
Main reinforcement material SD390
Striped reinforcement material SD345

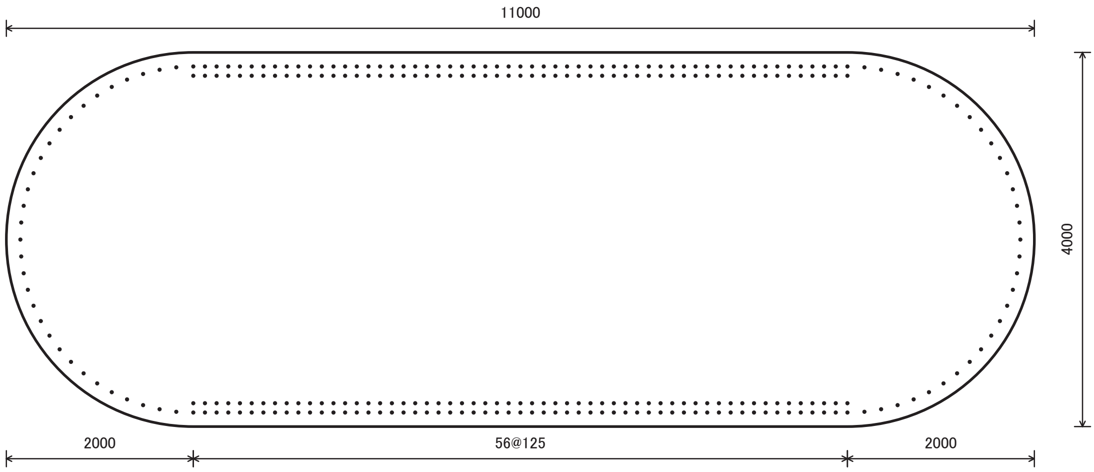
Tensile stress of column reinforcement uses basic value as the member in water.
Not consider correction coefficient cN to allowable shear stress Tau.a1of column.

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	2000+56@125+2000 2000+56@125+2000	D38 ----	31 ----

Note : Reinforcement amount total 330600.0mm^2,
*Satisfy more than [reinforcement amount of 500mm^2 / m (13283.2mm^2)]Do.
*Satisfy no more than [reinforcement amount (40566370.6mm^2) to be 6% of section area (2433982.2mm^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) Middle striped reinforcement
Middle striped reinforcement arrangement

reinforcement diameter D22
Bridge axial direction 8 number / step
Perpendicular direction 4 number / step
Not consider middle striped reinforcement 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	57	57	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 Alp.Beta.

Section correction factor	Bridge axial	Perpendicular
Alpha	0.20	1.00
Beta	0.40	1.00

1.6 Shape of earth surface
surface type :Horizontal

1.7 Allowable stress check 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 : 5.670m high water level : 11.240m sediment height: 2.969m (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	20400.00
Live load reaction R_L	6800.00
Total	27200.00

horizontal force R_H(kN)	operated position h_l(m)	moment (kN.m)		
		R_H*h_l	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(abbreviation : Temperature) load condition : Dead+ Live+ Temperature(increasing coefficient of allowable stress 1.15)

low water level : 5.670m high water level : 11.240m sediment height: 2.969m (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	20400.00
Live load reaction R_L	6800.00
Total	27200.00

horizontal force R_H(kN)	operated position h_l(m)	moment (kN.m)		
		R_H*h_l	R_M	total
3100.00	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 : SeismicLevel1(abbreviation : Seismic) load condition : Lv1 E.Q(increasing coefficient of allowable stress 1.50)
low water level : 8.350m high water level : 8.350m 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	20400.00
Total	20400.00

horizontal force R_H(kN)	operated position h_i(m)	moment (kN.m)		
		R_H*h_i	R_M	total
7000.00	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 : VesselCollision(abbreviation : Collision) load condition : Vessel Collision(increasing coefficient of allowable stress 1.50)
low water level : 10.590m high water level : 10.590m sediment height: 2.969m (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	20400.00
Live load reaction R_L	6800.00
Total	27200.00

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

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 11.390 (m)
Load strength 3100.00 (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 : 5.670m high water level : 11.240m sediment height: 2.969m (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	20400.00
Live load reaction R_L	6800.00
Total	27200.00

horizontal force R_H(kN)	operated position h_i(m)	moment (kN.m)		
		R_H*h_i	R_M	total
0.00	2.800	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
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 : SeismicLevel1(abbreviation : Seismic) load condition : Lv1 E,Q(increasing coefficient of allowable stress 1.50)
low water level : 8.350m high water level : 8.350m 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	20400.00
Total	20400.00

horizontal force R_H(kN)	operated position h_i(m)	moment (kN.m)		
		R_H*h_i	R_M	total
6200.00	2.800	17360.00	0.00	17360.00

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 : VesselCollision(abbreviation : Collision) load condition : Vessel Collision(increasing coefficient of allowable stress 1.50)
low water level : 10.590m high water level : 10.590m sediment height: 2.969m (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	20400.00
Live load reaction R_L	6800.00
Total	27200.00

horizontal force R_H(kN)	operated position h_i(m)	moment (kN.m)		
		R_H*h_i	R_M	total
0.00	2.800	0.00	0.00	0.00

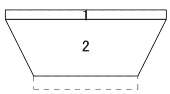
Moment by horizontal force from pier top edge to warking pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Do not consider
Load directly operated to frame body
Flowing water pressure Bridge axial perpendicular rightward direction
Flow velocity 1.190 (m/sec)
Impact load Load to bridge axial perpendicular direction
Height from column lower edge 11.390 (m)
Load strength 6200.00 (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 check 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	4.000	4.000	4.000	4.000	17.000	64.56637
2	Drawn parts	6.000	6.000	4.000	4.000	4.000	4.000	17.000	315.39822

No	volume V(m^3)	Xg (m)	Yg (m)	Zg (m)	V*Xg (m^4)	V*Yg (m^4)	V*Zg (m^4)
1	64.56637	0.0000	6.5000	0.0000	0.0000	419.6814	0.0000
2	315.39822	0.0000	3.2283	0.0000	0.0000	1018.1947	0.0000
Sum	379.96459	------	------	------	0.0000	1437.8761	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 = 14.600 from column base to beam lower edge (m)
W = Sum V *Gam.c = 379.96459*24.50 = 9309.13(kN)
Y = Sum (V*Yg)/Sum V + PH = 18.384(m)
Xc = Sum (V*Xg)/Sum 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	11.000	11.000	4.000	4.000	14.600	592.26901

No	volume V(m^3)	Xg (m)	Yg (m)	Zg (m)	V*Xg (m^4)	V*Yg (m^4)	V*Zg (m^4)
1	592.26901	0.0000	7.3000	0.0000	0.0000	4323.5638	0.0000
Sum	592.26901	------	------	------	0.0000	4323.5638	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 = Sum V *Gam.c = 592.26901*24.50 = 14510.59(kN)
Y = Sum(V*Yg)/Sum V = 7.300(m)

Xc = Sum(V*Xg)/Sum V = 0.000(m)

(3) Weight total

Sum W = 23819.72(kN)

(4) Center of gravity position

$$Y = \frac{\text{Sum } W*Y}{\text{Sum } W} = 11.632(\text{m})$$

$$Xc = \frac{\text{Sum } W*Xc}{\text{Sum } W} = 0.000(\text{m})$$

2.1.2 Dynamic water pressure in seismic condition

(1) Axial direction

1) Case : SeismicLevel1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{11.000}{4.000} * \left(1 - \frac{11.000}{4 * 8.350}\right)$$

$$= 1377.51 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

2) Case : SeismicLevel1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{11.000}{4.000} * \left(1 - \frac{11.000}{4 * 8.350}\right)$$

$$= 1377.51 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

(2) Axial perpendicular direction

1) Case : SeismicLevel1(Low water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{4.000}{11.000} * \left(1 - \frac{4.000}{4 * 8.350}\right)$$

$$= 239.07 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

2) Case : SeismicLevel1(High water level), Load plus direction (Upper load sediment height 0.000(m), water level 8.350(m))

$$P = \frac{3}{4} * k_h * w_0 * A_0 * h \cdot \frac{b}{a} * \left(1 - \frac{b}{4h}\right)$$

$$= \frac{3}{4} * 0.30 * 9.80 * 40.566 * 8.350 * \frac{4.000}{11.000} * \left(1 - \frac{4.000}{4 * 8.350}\right)$$

$$= 239.07 \text{ (kN)}$$

$$h_g = \frac{3}{7} * h = 3.579 \text{ (m)}$$

$$h_{g0} = h_g + h_s = 3.579 \text{ (m)}$$

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 : VesselCollision(Low water level), Load plus direction (Upper load sediment height 2.969(m), water level 10.590(m))

$P = K * v^2 * A$

$= 0.4 * 1.190^2 * 30.484$

$= 17.27$ (kN)

$h_{g0} = 0.6 * h + h_s$

$= 0.6 * 7.621 + 2.969$

$= 7.542$ (m)

＊Vertical projection area (column)

No	Height from column base (m)	Lower side column width (m)	Upper side column width (m)	Vertical projection area (m^2)
1	2.969 – 10.590	4.000	4.000	30.484

2) Case : VesselCollision(High water level), Load plus direction (Upper load sediment height 2.969(m), water level 10.590(m))

$P = K * v^2 * A$

$= 0.4 * 1.190^2 * 30.484$

$= 17.27$ (kN)

$h_{g0} = 0.6 * h + h_s$

$= 0.6 * 7.621 + 2.969$

$= 7.542$ (m)

＊Vertical projection area (column)

No	Height from column base (m)	Lower side column width (m)	Upper side column width (m)	Vertical projection area (m^2)
1	2.969 – 10.590	4.000	4.000	30.484

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} : The distance from column base to total force operated point of flowing water pressure (m)

2.1.4 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	27200.00	0.00	21.600	0.00	0.00
Frame body	23819.72	0.00	11.632	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	51019.72	0.00	-------	----------	0.00
High water level	51019.72	0.00	-------	----------	0.00

Case:Temperature

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	27200.00	3100.00	21.600	0.00	66960.00
Frame body	23819.72	0.00	11.632	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	51019.72	3100.00	-------	----------	66960.00
High water level	51019.72	3100.00	-------	----------	66960.00

Case:SeismicLevel1

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	20400.00	7000.00	21.600	0.00	151200.00
Frame body	23819.72	7145.92	11.632	0.00	83120.58
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	------	1377.51	3.579	----------	4929.53
Dynamic water pressure in seismic condition High water level	------	1377.51	3.579	----------	4929.53
Total Low water level	44219.72	15523.43	-------	----------	239250.11
High water level	44219.72	15523.43	-------	----------	239250.11

Case:VesselCollision

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	27200.00	0.00	21.600	0.00	0.00
Frame body	23819.72	0.00	11.632	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	3100.00	11.390	----------	35309.00
Spread load operated to column	0.00	0.00	0.000	----------	0.00
Total Low water level	51019.72	3100.00	-------	----------	35309.00
High water level	51019.72	3100.00	-------	----------	35309.00

2.1.5 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	27200.00	0.00	21.600	0.00	0.00
Frame body	23819.72	0.00	11.632	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	51019.72	0.00	-------	----------	0.00
High water level	51019.72	0.00	-------	----------	0.00

Case:SeismicLevel1

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	20400.00	6200.00	21.600	17360.00	151280.00
Frame body	23819.72	7145.92	11.632	0.00	83120.58
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	------	239.07	3.579	----------	855.54
Dynamic water pressure in seismic condition High water level	------	239.07	3.579	----------	855.54
Total Low water level	44219.72	13584.99	-------	----------	235256.12
High water level	44219.72	13584.99	-------	----------	235256.12

Case:VesselCollision

	V force (kN)	H force (kN)	Operated height (m)	Eccentric moment (kN.m)	Bending moment (kN.m)
Super structural reaction force	27200.00	0.00	21.600	0.00	0.00
Frame body	23819.72	0.00	11.632	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	6200.00	11.390	----------	70618.00
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	------	17.27	7.542	----------	130.22
Total Low water level	51019.72	6217.27	-------	----------	70748.22
High water level	51019.72	6217.27	-------	----------	70748.22

2.1.6 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	51019.72	0.00	0.00
Ordinary	Height	51019.72	0.00	0.00
Temperature	Low	51019.72	3100.00	66960.00
Temperature	Height	51019.72	3100.00	66960.00
Seismic	Low	44219.72	15523.43	239250.11
Seismic	Height	44219.72	15523.43	239250.11
Collision	Low	51019.72	3100.00	35309.00
Collision	Height	51019.72	3100.00	35309.00

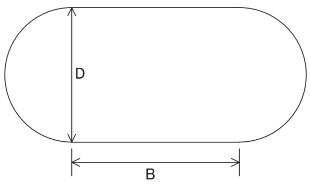
bridge axial perpendicular direction

Case	Water level	Vertical force (kN)	Horizontal force (kN)	Bending moment (kN.m)
Ordinary	Low	51019.72	0.00	0.00
Ordinary	Height	51019.72	0.00	0.00
Seismic	Low	44219.72	13584.99	235256.12
Seismic	Height	44219.72	13584.99	235256.12
Collision	Low	51019.72	6217.27	70748.22
Collision	Height	51019.72	6217.27	70748.22

2.2 Consider of column base section

2.2.1 Axial direction

(1) Section shape and reinforcement arrangement



B = 7.000 (m) D = 4.000 (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	114	129960.0	D38	62	70680.0
2	250	D38	114	129960.0	----	----	------
Total Sum As1 = 259920.0 Total Sum As2 = 70680.0							
Reinforcement amount total Sum As = 330600.0							

Total amount of rebar As = 330600.0(mm^2)

＊ minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (13283.2mm^2)] OK

＊ maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2433982.2mm^2)] OK

(2) Section check

1) Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
Load condition	------	Ordinary	Ordinary	Dead+ Live+ Temperature	Dead+ Live+ Temperature
Axial force N	kN	51019.72	51019.72	51019.72	51019.72
Bending moment M	kN.m	0.00	0.00	66960.00	66960.00
Compressive edge-middle axial x	mm	--------	--------	2706	2706
Compressive stress Sig.c	N/mm^2	1.12	1.12	3.46	3.46
Tensile stress Sig.s	N/mm^2	-16.81	-16.81	21.94	21.94
Increasing coefficient Alp.	------	1.00	1.00	1.15	1.15
Allowable compressive stress Sig.ca	N/mm^2	10.00	10.00	11.50	11.50
Allowable tensile stress Sig.sa	N/mm^2	-230.00	-230.00	184.00	184.00
Crack moment Mc	kN.m	86783.34	86783.34	86783.34	86783.34
First yield moment My0	kN.m	283970.09	283970.09	283970.09	283970.09
Ultimate bending moment Mu	kN.m	324698.33	324698.33	324698.33	324698.33
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc	Mc<=Mu	Mc<=Mu
Minimum rebar amount axial force member	mm^2	39473.7	39473.7	34324.9	34324.9
Axial force Nu	kN	44219.72	44219.72	44219.72	44219.72
0.008A1' (axial force Na=N)	mm^2	39473.7	39473.7	34324.9	34324.9
0.008A2' (axial force Nu)	mm^2	12360.5	12360.5	12360.5	12360.5
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	------	Lv1 E.Q	Lv1 E.Q	Vessel Collision	Vessel Collision
Axial force N	kN	44219.72	44219.72	51019.72	51019.72
Bending moment M	kN.m	239250.11	239250.11	35309.00	35309.00
Compressive edge-middle axial x	mm	1337	1337	4041	4041
Compressive stress Sig.c	N/mm^2	11.82	11.82	2.22	2.22
Tensile stress Sig.s	N/mm^2	333.41	333.41	−1.57	−1.57
Increasing coefficient Alp.	------	1.50	1.50	1.50	1.50
Allowable compressive stress Sig.ca	N/mm^2	15.00	15.00	15.00	15.00
Allowable tensile stress Sig.sa	N/mm^2	345.00	345.00	−345.00	−345.00
Crack moment Mc	kN.m	82601.08	82601.08	86783.34	86783.34
First yield moment My0	kN.m	274264.03	274264.03	283970.09	283970.09
Ultimate bending moment Mu	kN.m	313340.63	313340.63	324698.33	324698.33
Minimum rebar amount as bending member	------	Mc<=Mu	Mc<=Mu	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm^2	22808.4	22808.4	26315.8	26315.8
Axial force Nu	kN	44219.72	44219.72	44219.72	44219.72
0.008A1' (axial force Na=N)	mm^2	22808.4	22808.4	26315.8	26315.8
0.008A2' (axial force Nu)	mm^2	12360.5	12360.5	12360.5	12360.5
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

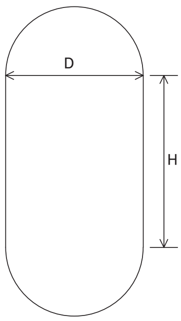
2) Consider against shear force

items	unit	Ordinary LowWL	Ordinary HeightWL	Temperature LowWL	Temperature HeightWL
condition	--------	Ordinary	Ordinary	Dead+ Live+ Temperature	Dead+ Live+ Temperature
b	mm	10545	10545	10545	10545
d	mm	3706	3706	3706	3706
S	kN	0.00	0.00	3100.00	3100.00
N	kN	51019.72	51019.72	51019.72	51019.72
M	kN.m	0.00	0.00	66960.00	66960.00
Alp.	------	1.00	1.00	1.15	1.15
pt	%	0.423	0.423	0.423	0.423
ce	------	0.665	0.665	0.665	0.665
cpt	------	1.123	1.123	1.123	1.123
CN	------	1.000	1.000	1.000	1.000
Tau.m	N/mm^2	0.000	0.000	0.079	0.079
$Tau.a_1$	N/mm^2	0.187	0.187	0.215	0.215
$Tau.a_2$	N/mm^2	1.900	1.900	2.185	2.185
Sig.sa	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	--------	Lv1 E.Q	Lv1 E.Q	Vessel Collision	Vessel Collision
b	mm	10545	10545	10545	10545
d	mm	3706	3706	3706	3706
S	kN	15523.43	15523.43	3100.00	3100.00
N	kN	44219.72	44219.72	51019.72	51019.72
M	kN.m	239250.11	239250.11	35309.00	35309.00
Alp.	------	1.50	1.50	1.50	1.50
pt	%	0.423	0.423	0.423	0.423
ce	------	0.665	0.665	0.665	0.665
cpt	------	1.123	1.123	1.123	1.123
CN	------	1.000	1.000	1.000	1.000
Tau.m	N/mm^2	0.397	0.397	0.079	0.079
$Tau.a_1$	N/mm^2	0.276	0.276	0.276	0.276
$Tau.a_2$	N/mm^2	2.850	2.850	2.850	2.850
Sig.sa	N/mm^2	300.00	300.00	----------	----------
s	mm	150	150	----------	----------
Sca	kN	10793.46	10793.46	----------	----------
Sh'	kN	4729.97	4729.97	----------	----------
AwReq	mm^2	733.82	733.82	----------	----------
Aw	mm^2	3871.00	3871.00	----------	----------

The following ;
S : Shear force
N : Axial force
M : Bending moment
b : Member section width
d : Effective height
Alp. : 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
Tau.m : 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
Sig.sa : 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.mShear supplemental barAmount
Aw : Shear supplemental barAmount

2.2.2 Axial perpendicular direction
(1) Section shape and reinforcement arrangement



H = 7.000 (m) D = 4.000 (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 2	150 250	D38 D38	114 114	129960.0 129960.0	D38 ----	62 ----	70680.0 ------
Total Sum As1 = 259920.0 Total Sum As2 = 70680.0							
Reinforcement amount total Sum As = 330600.0							

Total amount of rebar As = 330600.0(mm²)
* minimum reinforcement amount [all reinforcement amount As >= reinforcement amount per 500mm/ m (13283.2mm²)] OK
* maximum reinforcement amount [all reinforcement amount As <= reinforcement amount to be 6 % of section area (2433982.2mm²)] OK

(2) Section check

1) Consider against bending moment

Items	Unit	Ordinary LowWL	Ordinary HeightWL	Seismic LowWL	Seismic HeightWL
Load condition	------	Ordinary	Ordinary	Lv1 E.Q	Lv1 E.Q
Axial force N	kN	51019.72	51019.72	44219.72	44219.72
Bending moment M	kN.m	0.00	0.00	235256.12	235256.12
Compressive edge-middle axial x	mm	--------	--------	4728	4728
Compressive stress Sig.c	N/mm²	1.12	1.12	6.23	6.23
Tensile stress Sig.s	N/mm²	-16.81	-16.81	121.06	121.06
Increasing coefficient Alp.	------	1.00	1.00	1.50	1.50
Allowable compressive stress Sig.ca	N/mm²	10.00	10.00	15.00	15.00
Allowable tensile stress Sig.sa	N/mm²	-230.00	-230.00	345.00	345.00
Crack moment Mc	kN.m	224828.15	224828.15	213993.25	213993.25
First yield moment My0	kN.m	513708.08	513708.08	490664.33	490664.33
Ultimate bending moment Mu	kN.m	786191.29	786191.29	762463.26	762463.26
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc	Mc<=Mu	Mc<=Mu
Minimum rebar amount axial force member	mm²	39473.7	39473.7	22808.4	22808.4
Axial force Nu	kN	44219.72	44219.72	44219.72	44219.72
0.008A1' (axial force Na=N)	mm²	39473.7	39473.7	22808.4	22808.4
0.008A2' (axial force Nu)	mm²	12360.5	12360.5	12360.5	12360.5
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	51019.72	51019.72
Bending moment M	kN.m	70748.22	70748.22
Compressive edge-middle axial x	mm	11771	11771
Compressive stress Sig.c	N/mm²	2.10	2.10
Tensile stress Sig.s	N/mm²	-2.47	-2.47
Increasing coefficient Alp.	------	1.50	1.50
Allowable compressive stress Sig.ca	N/mm²	15.00	15.00
Allowable tensile stress Sig.sa	N/mm²	-345.00	-345.00
Crack moment Mc	kN.m	224828.15	224828.15
First yield moment My0	kN.m	513708.08	513708.08
Ultimate bending moment Mu	kN.m	786191.29	786191.29
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc
Minimum rebar amount axial force member	mm²	26315.8	26315.8
Axial force Nu	kN	44219.72	44219.72
0.008A1' (axial force Na=N)	mm²	26315.8	26315.8
0.008A2' (axial force Nu)	mm²	12360.5	12360.5
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	Lv1 E.Q	Lv1 E.Q
b	mm	3847	3847	3847	3847
d	mm	10437	10437	10437	10437
S	kN	0.00	0.00	13584.99	13584.99
N	kN	51019.72	51019.72	44219.72	44219.72
M	kN.m	0.00	0.00	235256.12	235256.12
Alp.	------	1.00	1.00	1.50	1.50
pt	%	0.412	0.412	0.412	0.412
ce	------	0.500	0.500	0.500	0.500
cpt	------	1.112	1.112	1.112	1.112
CN	------	1.000	1.000	1.000	1.000
Tau.m	N/mm^2	0.000	0.000	0.338	0.338
$Tau.a_1$	N/mm^2	0.139	0.139	0.206	0.206
$Tau.a_2$	N/mm^2	1.900	1.900	2.850	2.850
Sig.sa	N/mm^2	------------	------------	300.00	300.00
s	mm	------------	------------	150	150
Sca	kN	------------	------------	8257.49	8257.49
Sh'	kN	------------	------------	5327.50	5327.50
AwReq	mm^2	------------	------------	293.51	293.51
Aw	mm^2	------------	------------	2322.60	2322.60

items	unit	Collision LowWL	Collision HeightWL
condition	--------	Vessel Collision	Vessel Collision
b	mm	3847	3847
d	mm	10437	10437
S	kN	6217.27	6217.27
N	kN	51019.72	51019.72
M	kN.m	70748.22	70748.22
Alp.	------	1.50	1.50
pt	%	0.412	0.412
ce	------	0.500	0.500
cpt	------	1.112	1.112
CN	------	1.000	1.000
Tau.m	N/mm^2	0.155	0.155
$Tau.a_1$	N/mm^2	0.206	0.206
$Tau.a_2$	N/mm^2	2.850	2.850
Sig.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

Alp. : 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

Tau.m : 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

Sig.sa : 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.mShear supplemental barAmount

Aw : Shear supplemental barAmount

4.3 SUMMARY OF DESIGN OF BEAM AT PIER HEAD

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=7000/1548=4.5≥1.0, this kind of beam will be designed as a corbel. And, design section (A-A) is set at 400 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.

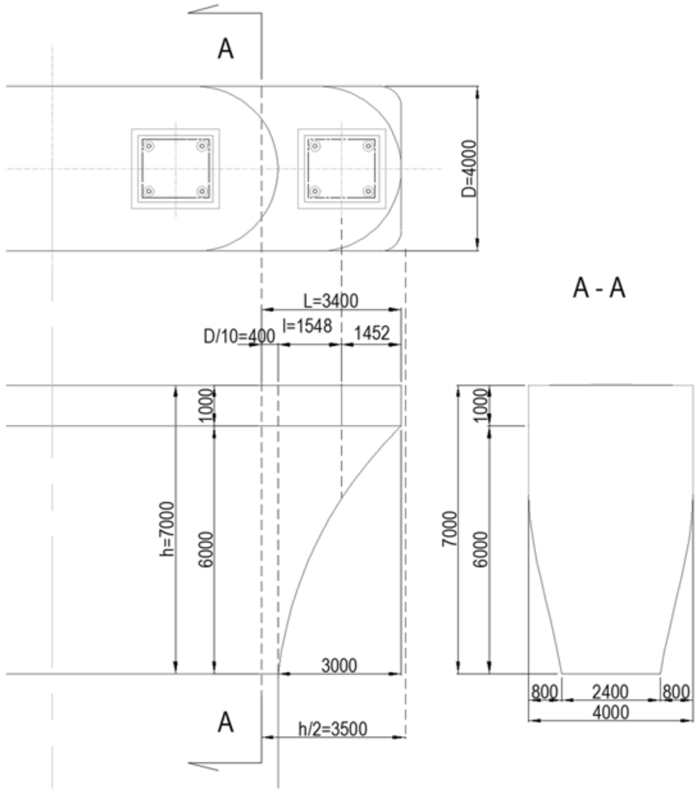


Figure Design Section of Pier Head Beam

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	P14	P15	P16	P17	P18	P19
Vertical direction							
Ordinary Condition (Dead + Live Loads)	Dead Load at G1 girder	6,100	5,100	5,500	5,400	5,200	5,800
	Live Load with Impact at G1 girder	2,100	2,000	2,100	2,100	2,000	2,000
	Weight of Beam	1,578	1,578	1,578	1,578	1,578	1,578
	Total	**9,778**	**8,678**	**9,178**	**9,078**	**8,778**	**9,378**
Earthquake Condition (Dead Load + Effect of earthquake)	Dead Load at G1 girder	6,100	5,100	5,500	5,400	5,200	5,800
	Weight of Beam	1,578	1,578	1,578	1,578	1,578	1,578
	Vertical reaction force due to earthquake from Superstructure*1	1,400	1,200	1,200	1,200	1,200	1,300
	Total	**9,078**	**7,878**	**8,278**	**8,178**	**7,978**	**8,678**
Bridge axis perpendicular direction							
Earthquake Condition	Inertia force of superstructure	**2,400**	**2,100**	**2,200**	**2,100**	**2,100**	**2,300**
Bridge axis direction							
Effect of temperature change	Horizontal force due to temperature change	**1,400**	**500**	**300**	**300**	**800**	**1,500**
Earthquake Condition	Inertia force on the beam	473	473	473	473	473	473
	Inertia force on superstructure	1,800	1,800	1,900	1,900	2,000	2,000
	Total	**2,273**	**2,273**	**2,373**	**2,373**	**2,473**	**2,473**

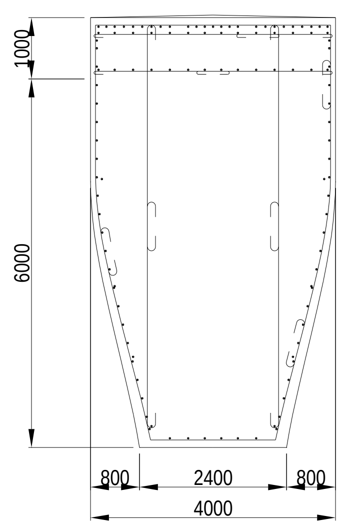
*Note: *1: It is calculated in accordance with Chapter 15.4 of Specifications for Highway Bridges Part-V 2012.*

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.



Location	Cover (mm)	Diameter	Arrangement
Upper (main reinforcement)	150	D32	24@155.8 in average
	250	D32	13@287.7 on average
Lower	150	D32	5@282 in average
Side	103	D22	(125+20@300+200) x 2 sides
Stirrup	-	D22	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

Item	Unit	Ordinary Condition (Dead Load)	Ordinary Condition (Dead and Live Loads)	Earthquake Condition
Design Tensile Force (T)	kN	2,454.8	3,161.0	5,325.6
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 30,973.80 24,547.28	Asu ≥ AsuReq OK 30,973.80 17,561.19	Asu ≥ AsuReq OK 30,973.80 17,751.95
Reinforcement at Sides Arranged Content (Ass) Required Content (AssReq*2)	mm^2	Ass ≥ AssReq OK 17,806.60 12,389.52	Ass ≥ AssReq OK 17,806.60 12,389.52	Ass ≥ AssReq OK 17,806.60 12,389.52

*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

Item	Unit	Effect of Temperature Change	Earthquake Condition
Bending Moment (M)	kN.m	2,922 (= 1,500 kN x 1.948 m)	4,597 (= 473 kN x 1.48 m + 2000 kN x 1.948 m)
Distance between edge of compressive side and neutral axis (x)	Mm	538	538
Compressive Stress σ_c Tensile Stress σ_s	N/mm^2 N/mm^2	0.86 $<\sigma_{ca}$ 80.88 $<\sigma_{sa}$	1.36 $<\sigma_{ca}$ 127.23 $<\sigma_{sa}$
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

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 774.2 mm^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	Effect of Temperature Change	Earthquake Condition
Sectional Force Shear Force (S) Bending Moment (M)	 kN kN.m	 1,500 2,922	 2,474 4,597
Effective Height (d)	mm	3,645	3,645
Shear Force considering Effective Height (Sh)*1	kN	1,500	2,474
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 0.050 0.668 0.601	1.50 0.050 0.668 0.601
τ_m τ_{a1} τ_{a2}	N/mm^2 N/mm^2 N/mm^2	0.067 < 0.115 2.185	0.111 < 0.148 2.850
Shear Reinforcement Content Aw AwReq	 mm^2 mm^2	 774.2 0.0	 774.2 0.0

Note: *1: Sh=M-M/d x (tanβ+tanγ), β and γ = zero in this case *2: pt=As/(b x d)

4.4 DETAIL CALCULATION SHEET OF PIER BEAM DESIGN

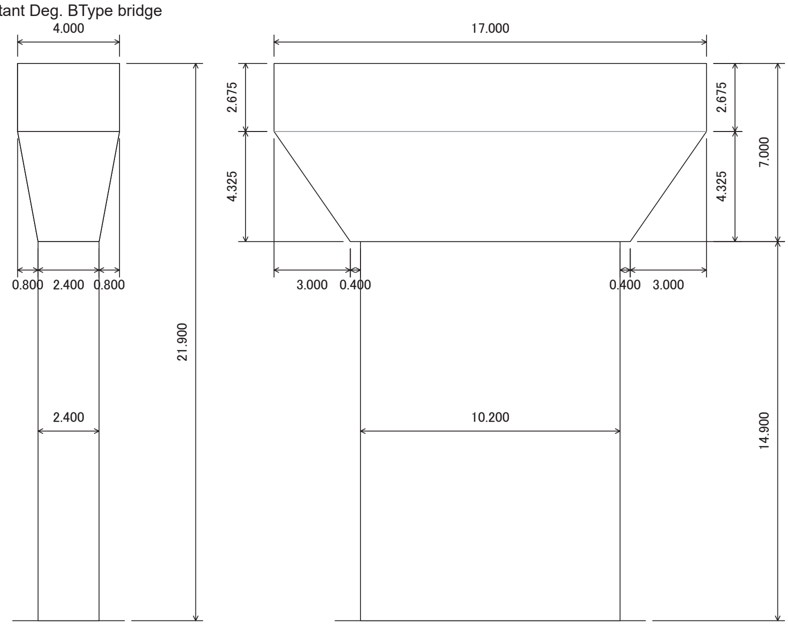
Detail calculation sheet of pier beam design (the case which is critical load condition) is attached from next page.

Contents

1 Design condition

1.1 Shape dimension

Type RCRectangle column pier (new consider)
Beam shape type Beam type (rectangle)
foundation type Spread foundation
Division of important Deg. BType bridge



(right side is back side)

Items	Symbol	Dimension(m)
Beam height	H	7.000
Bridge axial direction beam width	B_L	4.000
Bridge axial perpendicular direction beam width	B_T	17.000
Beam upper face center - horizontal distance to the column upper face center	x	0.000
Lower face both direction drawn height	H_{t2}	4.325
Lower face bridge axial direction drawn width	B_{tL2}	0.800
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	14.900
Bridge axial direction column width	B_L	2.400
Bridge axial perpendicular direction column width	B_T	10.200
Surface (from column lower edge)	h_G	0.000

1.2 Beam

1.2.1 Material of use

Design standard strength of concrete Sig.ck 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	130	130+135+6@150+300+6@135+300+6@150+135+130	130
250	D32	130	265+4@300+3@270+4@300+265	130

Lower face

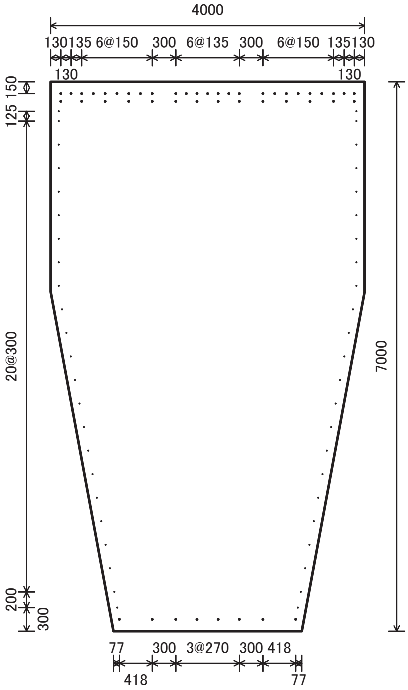
covering (mm)	diameter (mm)	left side edge	bar arrangement	right side edge (mm)
150	D32	77	418+300+3@270+300+418	77

Side face

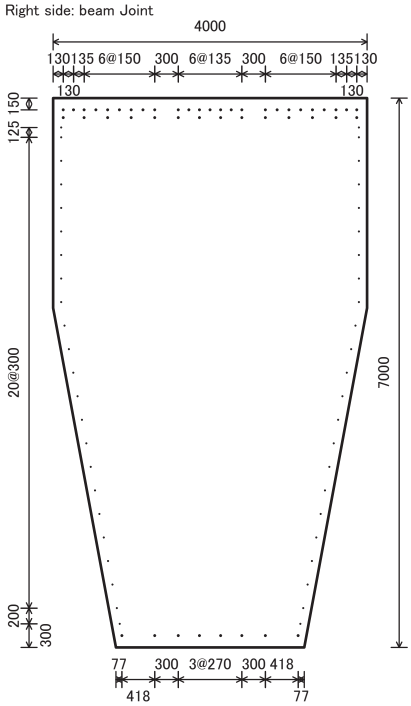
covering (mm)	diameter (mm)	upper side edge	bar arrangement	lower side edge (mm)
103	D22	375	125+20@300+200	300

4

Left side: beam Joint



Right side: beam Joint



5

(2) Stirrup

Stirrup

Reinforcement diameter D22 inner circumference group number 1.0

Effective shear stiffening bars on horizontal direction check except for stirrup

Reinforcement diameter D13 number sets 0

Input method of stirrup : detail assign

Edge	Bar arrangement	Edge
250	110@150	250

1.2.3 Left 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

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	1.948	6100.00	0.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.948 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	1.948	6100.00	2100.00	0.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.948 0.00	

3) Load case 3: SeismicLevel1

Load type Seismic Lv1

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	1.948	6100.00	1400.00

Horizontal reactions at orthogonal direction

No.	operated position Xc(m)	Horizontal Reactions H(kN)
1	1.948 2400.00	

(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 Seismic Lv1 (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	1.948	2000.00

2) Load case : Temperature

Load type Dead Load and Temperature Effect

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	1.948	1500.00

1.3 Allowable stress check method load case

Considering allowable stress method of column is calculated at the following load case.

1.3.1 Axial direction

(1) case : Ordinary (abbreviation : Ordinary) load condition : Ordinary (increasing coefficient of allowable stress 1.00)
design water level : 0.000m 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	24300.00
Live load reaction R_L	0.00
Total	24300.00

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 working pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Do not consider

(2) case : Ordinary＋Temperature(abbreviation : Ordinary+Temperatre) load condition : DeadLoad+LiveLoad+Temperature(increasing coefficient of allowable stress 1.15)
design water level : 0.000m 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	24300.00
Live load reaction R_L	0.00
Total	24300.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
3837.00	0.000	0.00	0.00	0.00

Moment by horizontal force from pier top edge to working pos. of super structural inertia force is calculated as eccentric moment.
Inertia force in seismic condition Do not consider

(3) case : SeismicLv1(with scouring)(abbreviation : Lv1 with scouring) load condition :Seismic Lv1(increasing coefficient of allowable stress 1.50)
design water level : 0.000m 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	24300.00
Total	24300.00

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 working 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)

1.3.2 Axial perpendicular direction

(1) case : Ordinary(abbreviation : Ordinary) load condition : Ordinary(increasing coefficient of allowable stress 1.00)

design water level : 0.000m 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	24300.00
Live load reaction R_L	0.00
Total	24300.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	2.830	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

(2) case : Seismic Level-1(洗掘)(abbreviation : Lv1･洗掘) load condition : Seismic Level-1(increasing coefficient of allowable stress 1.50)

design water level : 0.000m 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	24300.00
Total	24300.00

horizontal force R_H(kN)	operated position h_I(m)	moment (kN.m)		
		R_H*h_I	R_M	total
0.00	2.830	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 perpendicular direction rightward (plus direction)

Dynamic water pressure perpendicular direction rightward (plus direction)

2 Design beam (left 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	Left sideDrawn parts(Top)	2.675	2.675	4.000	4.000	4.000	4.000	3.000	32.10000
2	Left sideDrawn parts(Bottom)	0.000	4.325	4.000	4.000	4.000	2.400	3.000	22.49000
3	Left sideOver hanged part(Top)	2.675	2.675	4.000	4.000	4.000	4.000	0.400	4.28000
4	Left sideOver hanged part(Bottom)	4.325	4.325	4.000	2.400	4.000	2.400	0.400	5.53600

No	volume V(m3)	right angle center of figure Xg(m)	V*Xg (m4)
1	32.10000	-1.9000	-60.9900
2		-1.4385	-32.3510
3	22.49000	-0.2000	-0.8560
4		-0.2000	-1.1072
Su	64.40600	------	-95.3042

Note : Table's center of figure Xg is the distance from beam joint

Weight W = Sum V + Gamma c = 64.40600*24.50 = 1577.95(kN)

Moment M = |Sum (V*Xg)|* gamma c = 2334.95(kN.m)

Center of gravity $Xg = \frac{M}{W} = 1.480(m)$

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	1577.95	1.480	2334.95
Other horizontal concentrated load	--------	--------	1577.95

Tensile force by beam own weight $T_J = \frac{M}{lambda} = 403.14$ (kN)

Tensile force by horizontal reactions at axial perpendicular direction

Items	Horizontal Force H (kN)	Arm length a (m)
Dead Load	0.00 1.948	
Dead+Live Loads	0.00 1.948	
SeismicLevel1	2400.00 1.948	
Dead LoadSum Dead+Live LoadsSum SeismicLevel1Sum	0.00 0.00 2400.00	-------- -------- --------

Dead LoadTensile force $T_H = H = 0.00$ (kN)

Dead+Live LoadsTensile force $T_H = H = 0.00$ (kN)

SeismicLevel1Tensile force $T_H = H = 2400.00$ (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 $T_{HT} = \mathrm{Sum}\left(Ht*\left(1+\frac{y_i}{\mathrm{lambda}}\right)\right) = 0.00$ (kN)

Dead+Live LoadsTensile force $T_{HT} = \mathrm{Sum}\left(Ht*\left(1+\frac{y_i}{\mathrm{lambda}}\right)\right) = 0.00$ (kN)

SeismicLevel1Tensile force $T_{HT} = \mathrm{Sum}\left(Ht*\left(1+\frac{y_i}{\mathrm{lambda}}\right)\right) = 0.00$ (kN)

Tensile force by vertical reactions of super structure

Items	Vertical force Arm length P (kN)	
Dead Load	6100.00 1.948	
Dead+Live Loads	8200.00 1.948	
SeismicLevel1	7500.00 1.948	
Dead LoadSum	6100.00	--------

Items	Vertical force Arm length P (kN) a (m)	
Dead+Live LoadsSum SeismicLevel1Sum	8200.00 7500.00	-------- --------

Dead LoadTensile force $T_V = P*\frac{a}{\mathrm{lambda}} = 2051.59$ (kN)

Dead+Live LoadsTensile force $T_V = P*\frac{a}{\mathrm{lambda}} = 2757.88$ (kN)

SeismicLevel1Tensile force $T_V = P*\frac{a}{\mathrm{lambda}} = 2522.45$ (kN)

The following ;

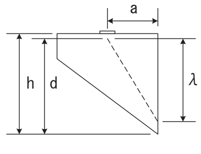
The vertical reactions of super structure: P (kN)

The truss width : a = 1948 (mm)

The truss height : lambda = 0.85×d = 5792 (mm)

The height of beam joint : h = 7000 (mm)

The effective height of beam joint : d = 6814 (mm)



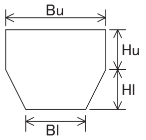
Design tensile force

Dead Load $T = T_J + T_H + T_{HT} + T_V = 2454.73$ (kN)

Dead+Live Loads $T = T_J + T_H + T_{HT} + T_V = 3161.01$ (kN)

SeismicLevel1 $T = T_J + T_H + T_{HT} + T_V = 5325.59$ (kN)

(2) Section shape and reinforcement arrangement



Bu = 4000 mm Bl = 2400 mm

Hu = 2675 mm Hl = 4325 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 2	150 250	D32 D32	25 14	19855.0 11118.8
Reinforcement amount total Sum As =				30973.8

(3) Check against Reinforcement arrangement, effective height

Effective height of beam joint : d = 6814 mm

Upper face rebar position Bottom step position hl d/4	mm	hl <= d/4 OK 250.00 1703.53
Effective height Load point position da d/2	mm	da >= d/2 OK 4582.40 3407.05
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+Live Loads	Ordinary	Seismic Level-1
Design tensile force T	kN	2454.73	3161.01	5325.59
Allowable tensile stress Sig.sa	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 30973.80 24547.28	Asu >= AsuReq OK 30973.80 17561.19	Asu >= AsuReq OK 30973.80 17751.95
Side face core rebar Amount of use Ass Necessary amount AssReq	mm^2	Ass >= AssReq OK 17806.60 12389.52	Ass >= AssReq OK 17806.60 12389.52	Ass >= AssReq OK 17806.60 12389.52

Note : AsuReq = 1000*T / sigma sa

Note : AssReq = 0.4*Asu

2.3 Design vertical direction section (Allowable Stress Check 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 1 : Dead Load

Items	Vertical force V (kN)	Arm length x (m)	Bending moment V*x (kN.m)
Beam own load	1577.95	1.480	2334.95
Super structural vertical reaction force	6100.00	1.948	11882.80
Total(design section force)	7677.95	-------	14217.75

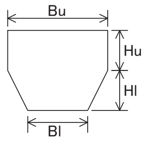
2) Case 2 : Dead+Live Loads

Items	Vertical force V (kN)	Arm length x (m)	Bending moment V*x (kN.m)
Beam own load	1577.95	1.480	2334.95
Super structural vertical reaction force	8200.00	1.948	15973.60
Total(design section force)	9777.95	-------	18308.55

3) Case 3 : SeismicLevel1

Items	Vertical force V (kN)	Arm length x (m)	Bending moment V*x (kN.m)
Beam own load	1577.95	1.480	2334.95
Super structural vertical reaction force	7500.00	1.948	14610.00
Total(design section force)	9077.95	-------	16944.95

(2) Section shape and reinforcement arrangement



Bu = 4000 mm Bl = 2400 mm

Hu = 2675 mm Hl = 4325 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	D32 D32	25 14	19855.0 11118.8
Reinforcement amount total Sum As =				30973.8

* Minimum reinforcement amount [Reinforcement amount total(30973.8mm^2) >= m: reinforcement amount of 500mm^2(2000.0mm^2)] OK

* Maximum reinforcement amount [tensile reinforcement amount (30973.8mm^2) <= balanced reinforcement amount Asb(866474.0mm^2)] OK

(3) Section check

Items	Unit	Dead Load	Dead+Live Lo ads	SeismicLevel 1
Load condition	------	Dead+Live Loads	Ordinary	Seismic Level-1
Bending moment M	kN.m	14217.75	18308.55	16944.95
Compressive edge-middle axial x	mm	1399	1399	1399
Compressive stress Sig.c Tensile stress Sig.s	N/mm 2 N/mm	1.25 72.96	1.61 93.96	1.49 86.96
Increasing coefficient Alp. Allowable compressive stress Sig.ca Allowable tensile stress Sig.sa	------ N/mm 2 N/mm	1.00 10.00 100.00	1.00 10.00 180.00	1.50 15.00 300.00
Minimum rebar amount as bending member	------	1.7M<=Mc	1.7M<=Mc	1.7M<=Mc

Crack bending moment Mc = 65040.11 (kN.m) Ultimate bending moment Mu = 71864.26 (kN.m)

2.4 Design horizontal direction section(Allowable Stress Check Method)

2.4.1 Consider against bending moment

About bending moment, considering at the position of beam joint.

(1) Section force from the beam joint

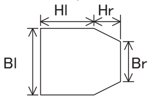
1) case SeismicLevel1

items	horizontal force H (kN)	arm length x (m)	bending moment H*x (kN.m)
Inertia force by beam own load	473.38	1.480	700.49
Super structural horizontal reaction force	2000.00	1.948	3896.00
Total (design section force)	2473.38	----------	4596.49

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	1500.00	1.948	2922.00
Total (design section force)	1500.00	----------	2922.00

(2) Section shape and reinforcement arrangement



Bl = 4000 mm Br = 2400 mm

Hl = 2675 mm Hr = 4325 mm

Main reinforcement(Position is the distance form beam side face.)

No.	Reinforcement position (mm)	Reinforcement diameter	Number sets	Reinforcement amount (mm2)
1	103	D22	9	3483.9
2	130	D32	1	794.2
3	130	D32	1	794.2
4	506	D22	14	5419.4
5	882	D32	1	794.2
		Reinforcement amount total Sum As =		11285.9

* Minimum reinforcement amount [Reinforcement amount total(11285.9mm^2) >= m: reinforcement amount of 500mm^2(3536.7mm^2)] OK

* Maximum reinforcement amount [tensile reinforcement amount (11285.9mm^2) <= balanced reinforcement amount Asb(1200726.6mm^2)] OK

(3) Section check

Items	Unit	SeismicLevel 1	Temperature
Load condition	------	Seismic Level-1	Dead Load+Temperature
Bending moment M	kN.m	4596.49	2922.00
Compressive edge-middle axial x	mm	538	538
Compressive stress Sig.c Tensile stress Sig.s	N/mm2 N/mm	1.36 127.23	0.86 80.88
Increasing coefficient Alp. Allowable compressive stress Sig.ca Allowable tensile stress Sig.sa	------ N/mm2 N/mm	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 = 33051.20 (kN.m) Ultimate bending moment Mu = 14081.67 (kN.m)

2.4.2 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)	tan beta+ tan gamma
1	0.000	6.135	4.000	0.000
2	1.948	4.566		0.000

2) Section check

Section[1] b = 6135mm h = 4000mm

Items	Unit	SeismicLevel1	Temperature
Condition	--------	Seismic Level-1	Dead Load+Temperature
S	kN	2473.38	1500.00
M	kN.m	4596.49	2922.00
d	mm	3645	3645
Sh	kN	2473.38	1500.00
Alp.	-------	1.50	1.15
pt	%	0.050	0.050
ce	-------	0.668	0.668
cpt	-------	0.601	0.601
Tau.m	N/mm^2	0.111	0.067
Tau.a1	N/mm^2	0.148	0.115
Tau.a2	N/mm^2	2.850	2.185

Section[2] b = 4566mm h = 4000mm

Items	Unit	SeismicLevel1	Temperature
Condition	--------	Seismic Level-1	Dead Load+Temperature
S	kN	2155.99	1500.00
M	kN.m	103.48	0.00
d	mm	3765	3765
Sh	kN	2155.99	1500.00
Alp.	-------	1.50	1.15
pt	%	0.048	0.048
ce	-------	0.662	0.662
cpt	-------	0.595	0.595
Tau.m	N/mm^2	0.125	0.087
Tau.a1	N/mm^2	0.146	0.113
Tau.a2	N/mm^2	2.850	2.185

Note : Sh = S- M/d*(tan Beta + tan Gam.)

Tau.m = Sh / bd

The following ;

S : Shear force

M : Bending moment

d : Effective height

tan Beta. + tan Gam. : Change of effective height

Sh : Shear force to consider the change of effective height

Alp. : 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

Tau.m : 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

4.5 BRIDGE SEAT DESIGN

(1) Seating Length at P13 and P20

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 Length

Pier No.	P13	P20
Span Length	110.8m	103.1m
Required Seating Length (SEM)	1.254m	1.216m
Seating Length	3.550m	2.150m
Judge	OK	OK

Source: JICA Study Team

(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:

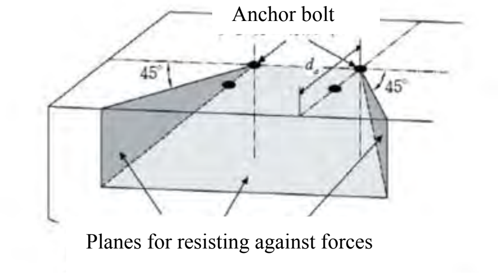
$S \geq 0.2+0.005$ x span length (m)

Table Verification of Bearing Edge Distance

Pier No.	P13	P14	P15	P16	P17	P18	P19	P20
Span Length	110.8m	112m	112m	112m	112m	112m	112m	103.1m
Minimum Edge Distance	0.754m	0.76m	0.76m	0.76m	0.76m	0.76m	0.76m	0.72m
Edge Distance (S)	1.157m	0.802m	0.802m	0.802m	0.802m	0.802m	0.802m	0.757m
Judge	OK	OK	OK	OK	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: JSBH

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 ith 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 ith reinforcement (mm^2)

The calculation results is summarized in table below.

Table Verification Result of Bridge Seat Strength

Pier No.	P19	
Girder	G1&G4	G2&G3
Design horizontal seismic force Ph (kN) *per bearing	2,000	2,000
Resistance area of concrete Ac (mm2)	5,901,000	14,771,000
Bearing stress at bottom of bearing support against vertical force σn (N/mm2)	2.50	2.53
Coefficient for determining the strength borne by concrete	0.30	0.30
Strength borne by concrete Pc (kN)	3,050	7,700
Strength borne by reinforcement Ps (kN)	2,090	3,140
Strength of bridge seat Pbs (kN)	5,140	10,840
Judge (Pbs≧Ph)	OK	OK

Detailed calculation is referred to following pages.

Detail Calculation Sheet of Bridge Seat Design for P19

*maximum load case

G1&G4 Girders

1. Force

・Horizontal Seismic Force：H

7895.1 kN/pier
2000 kN/bearing *100kN Roundup

・Dead load on Bearing：V

5745 k N／bearing@G1&G4

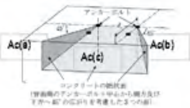
2. Strength of Bridge Seat

Strength borne by concrete：Pc

Pc=0.32・α・√ σck・Ac

Dimension of Base Plate of Bearing
1620 1420 mm

σn：	2.4973918 N/mm2			
σck：	30 N/mm2			
σn／√ σck：	0.455959			
α：	0.295701			
Ac	5,901,000 mm2	Ac(a)	=a1xa2/2=	1,887,625
		Ac(b)	=b1xb2/2=	642,978
		Ac©	=(c1+c2)x√ 2xc 3 /2=	3,371,016
		Total		5,901,618



Pc= 3,058,366 N
3050 kN > H:2000kN

Strength borne by reinforcement：Ps

Ps=Σβ(1-hi/da) σsy・Asi

β：		0.5	Diameter	
hi：	h1	0.123 m	D22	
	h2	0.274 m	D16	
	h3	0.874 m	D16	
da:		2.55 m		
σsy：		345 N/mm2		nos. *C2/150mm
Asi：	D22	387.1 mm2	x	18
	D16	198.6 mm2	x	18

Ps= 2099660.5 N
2090 kN *Shall be less than 50% of Pbs OK

Pbs=Pc+Ps=
5140 kN > H:2000kN OK

G2&G3 Girders

1. Force

・Horizontal Seismic Force：H

7895.1 kN/pier
2000 kN/bearing *100kN Roundup

・Dead load on Bearing：V

5826 k N／bearing@G2&G3

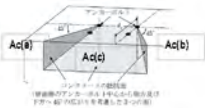
2. Strength of Bridge Seat

Strength borne by concrete：Pc

Pc=0.32・α・√ σck・Ac

Dimension of Base Plate of Bearing
1620 1420 mm

σn：	2.532603026 N/mm2			
σck：	30 N/mm2			
σn／√ σck：	0.462388			
α：	0.297756			
Ac	14,771,000 mm2	Ac(a)	=a1xa2/2=	5,521,165
		Ac(b)	=b1xb2/2=	1,887,625
		Ac©	=(c1+c2)x√ 2xc 3 /2=	7,362,776
		Total		14,771,565



Pc= 7,708,686 N
7700 kN > H:2000kN

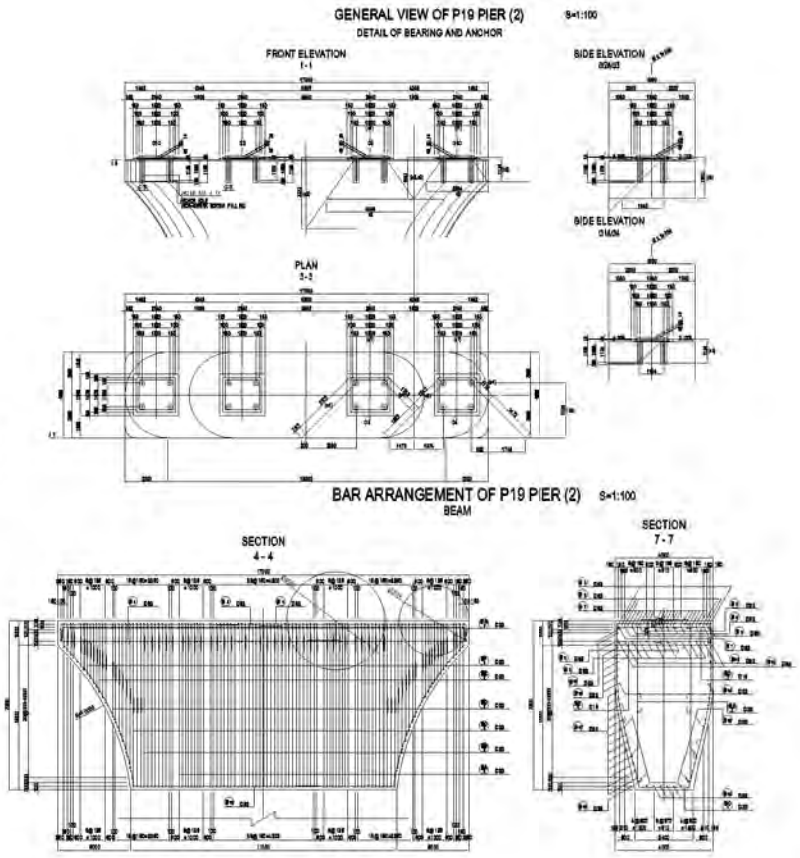
Strength borne by reinforcement：Ps

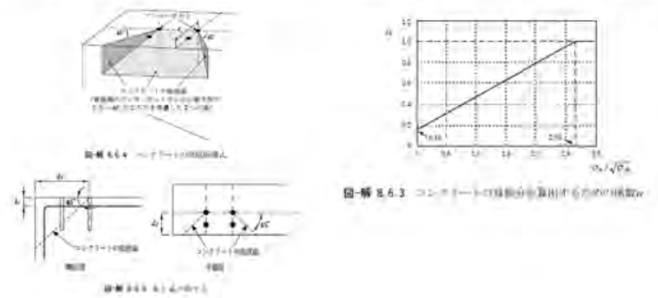
Ps=Σβ(1-hi/da) σsy・Asi

β：		0.5	Diameter	
hi：	h1	0.123 m	D22	
	h2	0.274 m	D16	
	h3	0.874 m	D16	
da:		2.55 m		
σsy：		345 N/mm2		nos. *C2/150mm
Asi：	D22	387.1 mm2	x	27
	D16	198.6 mm2	x	27

Ps= 3149490.814 N
3140 kN *Shall be less than 50% of Pbs OK

Pbs=Pc+Ps=
10840 kN > H:2000kN OK





STEEL BOX GIREDER BRIDGE
(7-SPAN)

ACCESSORIES

Design Report of Accessories of 7-Span Steel Box Girder Bridge

Contents

1.Design of Rubber Bearing from P14 to P19

Accessory

- Calculation Report of Rubber Bearing from P14 to P19-

Contents

BAGO APPROACH BRIDGE Calculation of rubber bearing part

１． Design condition

Type of super structure	Steel
Type of sub structure	Concrete sub- structure
Area Classify	A2 Area
	Cz= 1.0 CⅠz= 1.0 CⅡz= 1.0
Design Thermal variation	± 25℃
Design condition	Ordinary, Seismic Level I

Specification: Specification of highway bridge design, book V March 2012
Bridge bearing manual (April 2004)
Published by Japan Road Association

	Span length	Span length	Bearing condition		Ground Type	
	L (m)	L (m)	Longitudinal	Transverse	Longitudinal	Transverse
P14	112.0	4	F	F	TypeⅢ	TypeⅢ
P15	112.0	4	F	F	TypeⅢ	TypeⅢ
P16	112.0	4	F	F	TypeⅢ	TypeⅢ
P17	112.0	4	F	F	TypeⅢ	TypeⅢ
P18	112.0	4	F	F	TypeⅢ	TypeⅢ
P19	112.0	4	F	F	TypeⅢ	TypeⅢ

・Reaction forces from super- structure

	Max. Reaction	For Rotation	For Stress Amplitude		Dead Load		Max. Live load
	R_{max1} (kN)	R_{max2} (kN)	R_{max}' (kN)	R_{min}' (kN)	ΣR_d (kN/pier)	R_{dmax} (kN)	R_{lmax} (kN)
P14	8070	7973	8070	5655	24252	6101	0
P15	7009	6941	7009	4563	20362	5137	0
P16	7442	7134	7442	4954	21503	5332	0
P17	7360	7092	7360	4885	21287	5293	0
P18	7176	6950	7176	4726	20731	5171	0
P19	7737	7653	7737	5377	23141	5826	0

・Movement

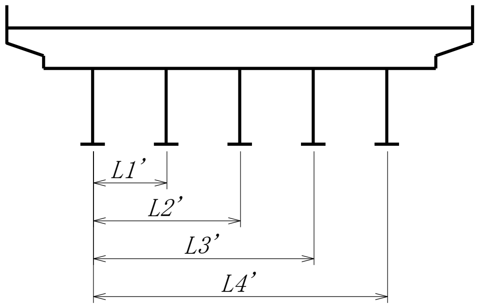
	Bridge longitudinal direction	
	Ordinary (mm)	Seismic L1 (mm)
P14	0.0	0.0
P15	0.0	0.0
P16	0.0	0.0
P17	0.0	0.0
P18	0.0	0.0
P19	0.0	0.0

・Design Horizontal reaction

	Bridge longitudinal direction		Bridge Trans Direction
	Ordinary (kN/pier)	Seismic L1 (kN/pier)	Seismic L1 (kN/pier)
P14	6395	7055	7276
P15	2794	7155	6109
P16	883	6907	6451
P17	688	6845	6387
P18	2744	7177	6220
P19	6819	7411	6943

・Calculation of vertical reaction

a) Position equilibrium of super- structure



Calculation Results

	No. Bearing n	L_1' (mm)	L_2' (mm)	L_3' (mm)	L_4' (mm)	L_5' (mm)	L_6' (mm)	L_7' (mm)	L_8' (mm)
P14	4	4048	10048	14096	-	-	-	-	-
P15	4	4048	10048	14096	-	-	-	-	-
P16	4	4048	10048	14096	-	-	-	-	-
P17	4	4048	10048	14096	-	-	-	-	-
P18	4	4048	10048	14096	-	-	-	-	-
P19	4	4048	10048	14096	-	-	-	-	-

For calculation of RL

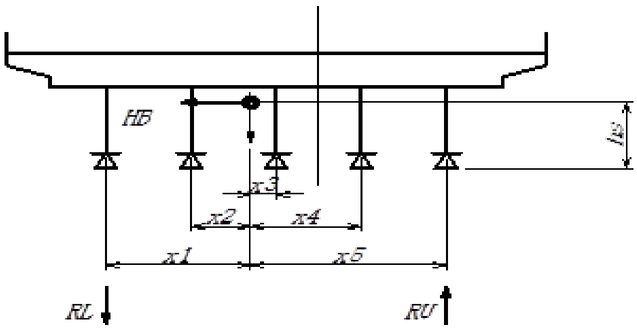
	Deadload reactions								
	R_{d1} (kN)	R_{d2} (kN)	R_{d3} (kN)	R_{d4} (kN)	R_{d5} (kN)	R_{d6} (kN)	R_{d7} (kN)	R_{d8} (kN)	R_{d9} (kN)
P14	6050	6150	6150	6050	0	0	0	0	0
P15	5050	5150	5150	5050	0	0	0	0	0
P16	5450	5350	5350	5450	0	0	0	0	0
P17	5400	5300	5300	5400	0	0	0	0	0
P18	5200	5200	5200	5200	0	0	0	0	0
P19	5750	5850	5850	5750	0	0	0	0	0

For calculation of RU

	Deadload reactions								
	R_{d1} (kN)	R_{d2} (kN)	R_{d3} (kN)	R_{d4} (kN)	R_{d5} (kN)	R_{d6} (kN)	R_{d7} (kN)	R_{d8} (kN)	R_{d9} (kN)
P14	6000	6100	6100	6000	0	0	0	0	0
P15	5000	5100	5100	5000	0	0	0	0	0
P16	5400	5300	5300	5400	0	0	0	0	0
P17	5350	5250	5250	5350	0	0	0	0	0
P18	5150	5150	5150	5150	0	0	0	0	0

b） Calculation of vertical reaction in seismic condition （R_L, R_U）

EHEQ position equilibrium



Base on section 15．2（3） of Highway Bridge Specification

$R_L = R_d + \sqrt{(R_{VEQ}^2 + R_{HEQ}^2)}$

$R_U = R_d - \sqrt{(R_{VEQ}^2 + R_{HEQ}^2)}$

$R_{VEQ} = R_d \times k_V$

(1)Vertical force due to reaction in bridge longitudinal direction

$R_L = R_d + R_{VEQ}$

$R_U = R_d - R_{VEQ}$

(2)Vertical force due to reaction in bridge transversal direction

$H_B \times h_S = \Sigma(R_{HEQi} \times x_i)$

$\Sigma R_{HEQi} = 0$

$R_{HEQi} = K \times x_i$

・ x_i distance from centroid to bearing position

・Distance yi in transversal direction from equilibrium position of RHEQi to bearing position

$y_i = X_i - X_0$

$y_1 = \Sigma L_i' / n$, $y_2 = y_1 - L_1'$, ...

・Proportionality coefficient K

$K = H_B \times h_S / \Sigma y_i^2$

	Inertial force position h_S (mm)	$\Sigma L_i'$	Σx_i^2	Ground Type		Ground type modify Factor cz	Ground type modify Factor cⅠz	Ground type modify Factor cⅡz
				Longitudinal	Transverse			
P14	3650	28192	117348608	TypeⅢ	TypeⅢ	1.0	1.0	1.0
P15	3650	28192	117348608	TypeⅢ	TypeⅢ	1.0	1.0	1.0
P16	3650	28192	117348608	TypeⅢ	TypeⅢ	1.0	1.0	1.0
P17	3650	28192	117348608	TypeⅢ	TypeⅢ	1.0	1.0	1.0
P18	3650	28192	117348608	TypeⅢ	TypeⅢ	1.0	1.0	1.0
P19	3650	28192	117348608	TypeⅢ	TypeⅢ	1.0	1.0	1.0

	y_1 (mm)	y_2 (mm)	y_3 (mm)	y_4 (mm)	y_5 (mm)	y_6 (mm)	y_7 (mm)	y_8 (mm)	y_9 (mm)
P14	7048	3000	-3000	-7048	0	0	0	0	0
P15	7048	3000	-3000	-7048	0	0	0	0	0
P16	7048	3000	-3000	-7048	0	0	0	0	0
P17	7048	3000	-3000	-7048	0	0	0	0	0
P18	7048	3000	-3000	-7048	0	0	0	0	0
P19	7048	3000	-3000	-7048	0	0	0	0	0

・Calculation results （Seismic L1）

	Longitudinal	Transverse		
	Vertical seismic coefficient k_V	Horizontal force H_B(kN)	Vertical seismic coefficient k_V	Proportionality coefficient K
P14	0.12	7276	0.12	0.23
P15	0.12	6109	0.12	0.19
P16	0.12	6451	0.12	0.20
P17	0.12	6387	0.12	0.20
P18	0.12	6220	0.12	0.19
P19	0.12	6943	0.12	0.22

longitudinal	R_{VEQ1} (kN)	R_{VEQ2} (kN)	R_{VEQ3} (kN)	R_{VEQ4} (kN)	R_{VEQ5} (kN)	R_{VEQ6} (kN)	R_{VEQ7} (kN)	R_{VEQ8} (kN)	R_{VEQ9} (kN)
P14	726	738	738	726	-	-	-	-	-
P15	606	618	618	606	-	-	-	-	-
P16	654	642	642	654	-	-	-	-	-
P17	648	636	636	648	-	-	-	-	-
P18	624	624	624	624	-	-	-	-	-
P19	690	702	702	690	-	-	-	-	-

longitudinal	R_{VEQ1} (kN)	R_{VEQ2} (kN)	R_{VEQ3} (kN)	R_{VEQ4} (kN)	R_{VEQ5} (kN)	R_{VEQ6} (kN)	R_{VEQ7} (kN)	R_{VEQ8} (kN)	R_{VEQ9} (kN)
P14	726	738	738	726	-	-	-	-	-
P15	606	618	618	606	-	-	-	-	-
P16	654	642	642	654	-	-	-	-	-
P17	648	636	636	648	-	-	-	-	-
P18	624	624	624	624	-	-	-	-	-
P19	690	702	702	690	-	-	-	-	-

	R_{HEQ1} (kN)	R_{HEQ2} (kN)	R_{HEQ3} (kN)	R_{HEQ4} (kN)	R_{HEQ5} (kN)	R_{HEQ6} (kN)	R_{HEQ7} (kN)	R_{HEQ8} (kN)	R_{HEQ9} (kN)
P14	1595	679	-679	-1595	-	-	-	-	-
P15	1339	570	-570	-1339	-	-	-	-	-
P16	1414	602	-602	-1414	-	-	-	-	-
P17	1400	596	-596	-1400	-	-	-	-	-
P18	1364	580	-580	-1364	-	-	-	-	-
P19	1522	648	-648	-1522	-	-	-	-	-

Bridge longitudinal direction

	R_{L1} (kN)	R_{L2} (kN)	R_{L3} (kN)	R_{L4} (kN)	R_{L5} (kN)	R_{L6} (kN)	R_{L7} (kN)	R_{L8} (kN)	R_{L9} (kN)
P14	6780	6890	6890	6780	-	-	-	-	-
P15	5660	5770	5770	5660	-	-	-	-	-
P16	6110	6000	6000	6110	-	-	-	-	-
P17	6050	5940	5940	6050	-	-	-	-	-
P18	5830	5830	5830	5830	-	-	-	-	-
P19	6440	6560	6560	6440	-	-	-	-	-

	R_{U1} (kN)	R_{U2} (kN)	R_{U3} (kN)	R_{U4} (kN)	R_{U5} (kN)	R_{U6} (kN)	R_{U7} (kN)	R_{U8} (kN)	R_{U9} (kN)
P14	5270	5360	5360	5270	-	-	-	-	-
P15	4390	4480	4480	4390	-	-	-	-	-
P16	4740	4650	4650	4740	-	-	-	-	-
P17	4700	4610	4610	4700	-	-	-	-	-
P18	4520	4520	4520	4520	-	-	-	-	-
P19	5010	5090	5090	5010	-	-	-	-	-

Bridge transverse direction

	R_{L1} (kN)	R_{L2} (kN)	R_{L3} (kN)	R_{L4} (kN)	R_{L5} (kN)	R_{L6} (kN)	R_{L7} (kN)	R_{L8} (kN)	R_{L9} (kN)
P14	7810	7910	7910	7810	-	-	-	-	-
P15	6520	6630	6630	6520	-	-	-	-	-
P16	7010	6910	6910	7010	-	-	-	-	-
P17	6950	6840	6840	6950	-	-	-	-	-
P18	6700	6700	6700	6700	-	-	-	-	-
P19	7430	7530	7530	7430	-	-	-	-	-

	R_{U1} (kN)	R_{U2} (kN)	R_{U3} (kN)	R_{U4} (kN)	R_{U5} (kN)	R_{U6} (kN)	R_{U7} (kN)	R_{U8} (kN)	R_{U9} (kN)
P14	4240	4340	4340	4240	-	-	-	-	-
P15	3530	3620	3620	3530	-	-	-	-	-
P16	3840	3740	3740	3840	-	-	-	-	-
P17	3800	3710	3710	3800	-	-	-	-	-
P18	3650	3650	3650	3650	-	-	-	-	-
P19	4020	4120	4120	4020	-	-	-	-	-

Summary

	Longitudinal		Transverse	
	R_L (kN)	R_U (kN)	R_L (kN)	R_U (kN)
P14	6890	5270	7910	4240
P15	5770	4390	6630	3530
P16	6110	4650	7010	3740
P17	6050	4610	6950	3710
P18	5830	4520	6700	3650
P19	6560	5010	7530	4020

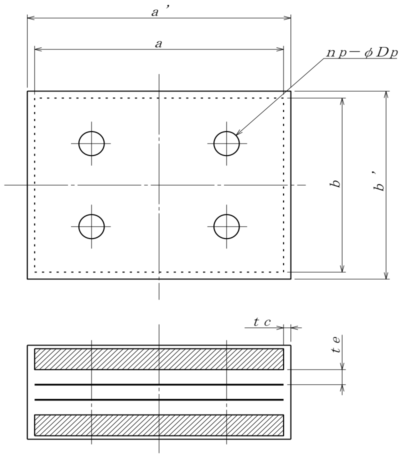
・Table of allowable value

Allowable value used in design of rubber bearing shall be listed as below,

Maximum compressive stress	$S_1 < 8$		$\sigma_{maxa} =$ 8.0 N/mm^2
	$8 \leqq S_1 < 12$		$\sigma_{maxa} = S_1$ N/mm^2
	$12 \leqq S_1$		$\sigma_{maxa} =$ 12.0 N/mm^2
Stress amplitude	$S_1 \leqq 8$		$\sigma_{maxa} =$ 5.0 N/mm^2
	$S_1 > 8$		$\sigma_{maxa} = 5.0 + 0.375(S_1 - 8.0)$ N/mm^2 however not larger than 6.5 N/mm^2
Shear deformation	Ordinary condition		$\gamma_{sa} =$ 70 %
	Wind condition		$\gamma_{wa} =$ 150 %
	Seismic Condition	Level 1	$\gamma_{ea} =$ 150 %
		Level 2	$\gamma_{ea} =$ 250 %
Local shear strain	Ordinary condition		$\gamma_{ta} = \gamma_u / f_a$: $f_a = 1.5$
Elongation at break γu	NR	G6	600 %
		G8	550 %
		G10	550 %
		G12	500 %
		G14	450 %
	HDR HDR-S	G8	650 %
		G10	600 %
		G12	550 %
Tensile stress	Wind Condition	G6	$\sigma_{ta} =$ 0.9 N/mm^2
		G8	$\sigma_{ta} =$ 1.2 N/mm^2
		G10 or above	$\sigma_{ta} =$ 1.5 N/mm^2
	Seismic COndition	G6	$\sigma_{ta} =$ 1.2 N/mm^2
		G8	$\sigma_{ta} =$ 1.6 N/mm^2
		G10 or above	$\sigma_{ta} =$ 2.0 N/mm^2

1） Properties of rubber bearing part

・Physical and Geometrical properties of rubber bearing



a ' : Length of rubber bearing in longitudinal direction (mm)
b ' : Width of rubber bearing in transversal direction (mm)
t_c : Thickness of rubber covering layers (mm)
a : Effective length (Length of steel plate) of rubber bearing (mm)
b : Effective width (width of steel plate) of rubber bearing (mm)
t_e : Thickness of a rubber layer (mm)
n : Number of rubber layers
Σt_e : Total thickness of rubber layers $(= t_e \times n)$
A_e : Area of rubber bearing excluding the side surface covering rubber (mm2) $(= a \cdot b - \pi/4 \cdot D_P^2 \cdot n_P)$

	Type of rubber	Shape of bearing	Elastic Shear Modulus Ge (N/mm^2)	Fracture deformation γ_u (%)	Dimensions of bearing Long. Dim a ' (mm)	Trans. Dim b ' (mm)	Side surface rubber t_c (mm)
P14	NR	□	0.8	550%	920	920	10
P15	NR	□	0.8	550%	920	920	10
P16	NR	□	0.8	550%	920	920	10
P17	NR	□	0.8	550%	920	920	10
P18	NR	□	0.8	550%	920	920	10
P19	NR	□	0.8	550%	920	920	10

	Effective dimensions		Design thickness of rubber layers			Surface area of bearing
	Long. Dim a (mm)	Trans. Dim b (mm)	Thickness of 1 layer t_e (mm)	No. layers n	Total thickness Σt_e (mm)	A_e (mm^2)
P14	900	900	20	4	80	810000
P15	900	900	21	4	84	810000
P16	900	900	21	4	84	810000
P17	900	900	21	4	84	810000
P18	900	900	21	4	84	810000
P19	900	900	20	4	80	810000

・Characteristics of rubber bearing

1st shape factor

In case of rectangular bearing

In case of $0.5 \leqq b/a \leqq 2.0$

$$S_1 = \frac{A_e}{2\cdot(a+b)\cdot t_e}$$

In case of circular bearing

$$S_1 = \frac{A_e}{\pi\cdot D\cdot t_e}$$

$0.5 > b/a$, $b/a > 2.0$のとき

$$S_1 = \frac{\min(a, b)}{2\cdot t_e}$$

2nd shape factor

$$S_2 = \frac{\min(a, b) \text{ or } D}{\Sigma t_e}$$

Young Modulus（Ralated in Design handbook of bridge bearing）

$$E = \alpha\cdot\beta\cdot S_1\cdot G_e$$

ここに，　α：Factor depends on type of rubber

NR	35

β：Factor depends on plane shape of bearing

Rectangular ($0.5 \leqq b/a \leqq 2$)	1.00
Rectangular ($0.5 > b/a$, $b/a > 2$)	0.50
Circular	0.75

Young Modulus（Based on theory of Hatori Takei ）

Rectangular ($0.5 \leqq b/a \leqq 2$)　$E' = (3 + 2/3\cdot\pi^2\cdot S_1^2)\cdot G_e$

Rectangular ($0.5 > b/a$, $b/a > 2$)　$E' = (4 + 1/3\cdot\pi^2\cdot S_1^2)\cdot G_e$

Circular　$E' = (3 + 1/2\cdot\pi^2\cdot S_1^2)\cdot G_e$

Vertical Rigidity

$$K_v = \frac{E \text{ or } E'\times A_e}{\Sigma t_e}$$

Where,　A_e :　Area of Inner steel plate(mm^2)

a, b, D :　Plane dimensions of steel plate (mm)

t_e :　Thickness of a rubber layer（mm)

Σt_e :　Total thickness of rubber layers（mm)

G_e :　Shear stiffness of rubber（N/mm^2)

Where, In case of $S_1 \geqq 5.0$ Use the value of E, If $S_1 < 5.0$
Use the value E' for design and calculation.

	Long.dim a (㎜)	Trans.dim b (㎜)	1 layer thickness t_e (㎜)	Total thickness Σt_e (㎜)	Bearing Area A_e ($㎜^2$)
P14	900	900	20	80	810000
P15	900	900	21	84	810000
P16	900	900	21	84	810000
P17	900	900	21	84	810000
P18	900	900	21	84	810000
P19	900	900	20	80	810000

	1st shape factor S_1	2nd shape factor S_2	Shear Stiffness G_e (N/mm^2)	Modify factors		Young Modulus E (N/mm^2)	Young Modulus E' (N/mm^2)	Vertical stiffness K_v (N/mm)
				α	β			
P14	11.25	11.25	0.80	35	1.00	315.0	668.6	3189375
P15	10.71	10.71	0.80	35	1.00	300.0	606.7	2892857
P16	10.71	10.71	0.80	35	1.00	300.0	606.7	2892857
P17	10.71	10.71	0.80	35	1.00	300.0	606.7	2892857
P18	10.71	10.71	0.80	35	1.00	300.0	606.7	2892857
P19	11.25	11.25	0.80	35	1.00	315.0	668.6	3189375

２） Calculation of ordinary movement

・Shear stiffness

$$K_B = G_e \cdot A_e / \Sigma t_e$$

Where ,　G_e : Equivalent shear modulus
A_e : Effective area (area of steel plate) (mm^2)
Σt_e : Total thickness of elastic rubber layers (mm)

・Shear stiffness　(For super damping rubber bearing)

$$K_m = 1/(1/(N \cdot K_B) + 1/K_p)$$

Where, K_p : Stiffness of sub-structure
N : Number of bearings on a bridge pier

Amount of movement of bearing

$$\delta_{st} = K_m / K_B \times \Delta Lt$$

	Span length L_m (m)	Total movement ΔL (mm)	Bearing movement δ_{st} (mm)	Shear strain γ
P14	112.000	0.0	0.0	0.0%
P15	112.000	0.0	0.0	0.0%
P16	112.000	0.0	0.0	0.0%
P17	112.000	0.0	0.0	0.0%
P18	112.000	0.0	0.0	0.0%
P19	112.000	0.0	0.0	0.0%

	Number of bearings N (pcs／pier)	Shear stiffness		Stiffness of sub-structure K_p (N/mm)	Total stiffness K_m (N/mm)
		1 bearing K_B (N/mm)	on 1 pier $N \cdot K_B$ (N/mm)		
P14	4	1.E+99	1.E+99	1.E+101	1.E+99
P15	4	1.E+99	1.E+99	1.E+101	1.E+99
P16	4	1.E+99	1.E+99	1.E+101	1.E+99
P17	4	1.E+99	1.E+99	1.E+101	1.E+99
P18	4	1.E+99	1.E+99	1.E+101	1.E+99
P19	4	1.E+99	1.E+99	1.E+101	1.E+99

２． Checking in ordinary and wind condition

（１） Effects due to vertical force

１）Maximum stress due to vertical reaction

$$\sigma_{max} = \frac{R_{max1}}{A_{cn}} \leqq \sigma_{maxa}$$

Where,

σ_{max} ： Maximum compressive stress due to vertical reaction （N/mm2)

R_{max1} ： Maximum vertical reaction (kN)

A_{cn} ： Effective area(mm^2) （$= A_e - \Delta L1 \cdot b$）

σ_{maxa} ： Allowable value (N/mm^2)

	Calculation condition					Results of calculation		
	Maximum reaction R_{max1} (kN)	Area of steel plate A_e (mm^2)	Bearing dimensions b (㎜)	Amount of movement $\Delta L1$ (㎜)	Effective Area A_{cn} (mm^2)	Calculated result σ_{max} (N/mm^2)	Allowable Value $\leqq\sigma_{maxa}$ (N/mm^2)	Conclusions
P14	8070	810000	900	0.0	810000	9.96	11.25	OK
P15	7009	810000	900	0.0	810000	8.65	10.71	OK
P16	7442	810000	900	0.0	810000	9.19	10.71	OK
P17	7360	810000	900	0.0	810000	9.09	10.71	OK
P18	7176	810000	900	0.0	810000	8.86	10.71	OK
P19	7737	810000	900	0.0	810000	9.55	11.25	OK

2） Stress amplitude

$$\Delta\sigma = \sigma_{max}' - \sigma_{min}' \leqq \Delta\sigma_a$$

Where,

$\Delta\sigma$: Stress amplitude (N/mm^2)

σ_{max}' : Maximum compressive stress used in calculation of stress amplitude (N/mm2) ($= R_{max}' / A_{cn}$)

σ_{min}' : Minimum compressive stress used in calculation of stress amplitude (N/mm2) ($= R_{min}' / A_e$)

$\Delta\sigma_a$: Allowable value (N/mm^2)

Calculation results

	Maximum compressive stress						Minimum compressive stress		
	Max. reaction R_{max}' (kN)	Surface area A_e (mm^2)	Bearing dimensions b (㎜)	Design movement ΔL1 (㎜)	Effective area A_{cn} (mm^2)	Calculated results σ_{max}' (N/mm^2)	Minimum reaction R_{min}' (kN)	Surface area A_e (㎟)	Allowable value σ_{min}' (N/mm^2)
P14	8070	810000	900	0.0	810000	9.96	5655	810000	6.98
P15	7009	810000	900	0.0	810000	8.65	4563	810000	5.63
P16	7442	810000	900	0.0	810000	9.19	4954	810000	6.12
P17	7360	810000	900	0.0	810000	9.09	4885	810000	6.03
P18	7176	810000	900	0.0	810000	8.86	4726	810000	5.83
P19	7737	810000	900	0.0	810000	9.55	5377	810000	6.64

Calculation results

	Calculated result $\Delta\sigma$ (N/mm^2)	Allowable value $\leqq\Delta\sigma$ (N/mm^2)	Conclusions
P14	2.98	6.22	OK
P15	3.02	6.02	OK
P16	3.07	6.02	OK
P17	3.06	6.02	OK
P18	3.02	6.02	OK
P19	2.91	6.22	OK

3） Buckling stability

・Ordinary condition

$\sigma_{max} \leqq \sigma_{cra}$

Where, σ_{max} : Maximum compressive stress （N/mm^2)

σ_{cra} : Allowable value of compressive stress
When considering buckling stability （N/mm2)
$(= G_e \cdot S_1 \cdot S_2 / f_{cr})$

f_{cr}

Ordinary	Wind	Seismic
2.5	2.0	1.5

Calculation results

	Shear modulus G_e (N/mm^2)	1st Shape factor S_1 -	2nd Shape factor S_2 -	factor Ordinary f_{cr} -	Allowable value Ordinary σ_{cra} (N/mm^2)
P14	0.8	11.25	11.25	2.5	40.50
P15	0.8	10.71	10.71	2.5	36.73
P16	0.8	10.71	10.71	2.5	36.73
P17	0.8	10.71	10.71	2.5	36.73
P18	0.8	10.71	10.71	2.5	36.73
P19	0.8	11.25	11.25	2.5	40.50

Calculation results

	Calculated result σ_{max} (N/mm^2)	Allowable value $\leqq \sigma_{cra}$ (N/mm^2)	Conclusions
P14	9.96	40.50	OK
P15	8.65	36.73	OK
P16	9.19	36.73	OK
P17	9.09	36.73	OK
P18	8.86	36.73	OK
P19	9.55	40.50	OK

4） Deflection of ends bearing

$$\delta_{cl} = k \cdot R_{lmax} / K_v \leqq \sigma_{cla}$$

Where,
- k : Load factor for live load
- R_{lmax} : Maximum live load at ends bearing (kN)
- K_v : Vertical rigidity (N/mm)
- σ_{cla} : Allowable value (mm) (=1.000)

	Calculation condition			Results of calculation		
	Maximum live load R_{lmax} (kN)	Load factor for live load k	Vertical stiffness K_v (N/mm)	Calculated results δ_{cl} (mm)	Allowable value $\leqq\delta_{cla}$ (mm)	Conclusions
P14	0	1/2	3189375	-	-	-
P15	0	1/2	2892857	-	-	-
P16	0	1/2	2892857	-	-	-
P17	0	1/2	2892857	-	-	-
P18	0	1/2	2892857	-	-	-
P19	0	1/2	3189375	-	-	-

（2） Displacement checking

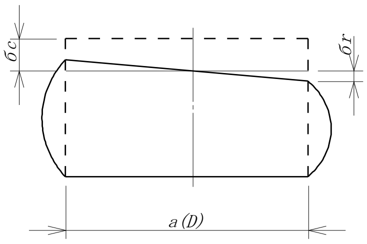
1） Checking of shear deformation

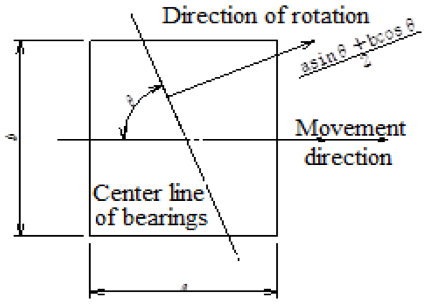
$$\gamma_s = \frac{\Delta L1}{\Sigma t_e} \leqq \gamma_{sa}$$

Where,
- γ_s : Shear deformation in ordinary condition (%)
- $\Delta L1$: Movement in ordinary condition (mm)
- Σt_e : Total thickness of rubber layers (mm)
- γ_{sa} : Allowable value (%)

	Calculating condition		Calculated results		
	Design movement $\Delta L1$ (mm)	Total thickness Σt_e (mm)	Calculated result γ_s (%)	Allowable Value $\leqq\gamma_{sa}$ (%)	Conclusions
P14	0.0	80	0.0%	70.0%	OK
P15	0.0	84	0.0%	70.0%	OK
P16	0.0	84	0.0%	70.0%	OK
P17	0.0	84	0.0%	70.0%	OK
P18	0.0	84	0.0%	70.0%	OK
P19	0.0	80	0.0%	70.0%	OK

2） Checking of rotation capacity





Checking formula

$\delta_r \leqq \delta_c / f_v$

Where, δ_r : Movement of ends bearings due to rotation of girders (mm)

In case of rectangular shape : $\delta_r = (a \cdot \sin\theta + b \cdot \cos\theta)/2 \times \Sigma\alpha_e$

Incase of circle shape : $\delta_r = D/2 \times \Sigma\alpha_e$

a : Effective length of bearing (mm)

b : Effective width of bearing (mm)

D : Effective diameter of bearing in case of circle (mm)

θ : Skew angle (deg)

(=The angle of bearing center line and movement direction)

$\Sigma\alpha_e$: Rotation angle of girder due to live load (rad)

δ_c : Compressive deflection due to vertical force (mm) $(= R_{max2} / K_v)$

R_{max2} : Vertical reaction used in calculation of rotation (kN)

K_v : Vertical stiffness (kN/mm)

f_v : Coefficient of precision and variability of vertical stiffness (=1.3)

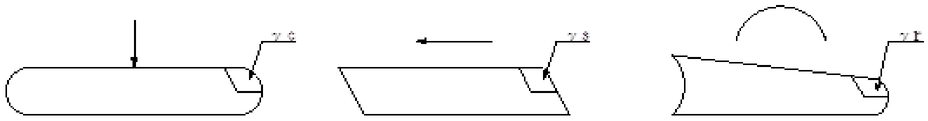
Calculating condition

	Compressive movement			Rotation angle				
	Maximum reaction R_{max2} (kN)	Vertical Stiffness K_v (N/mm)	Calculated value δ_c (mm)	Bearing length a (mm)	Bearing width b (mm)	Live load rotation angle $\Sigma\alpha_e$ (rad)	Skew angle θ (deg)	Calculated value δ_r (mm)
P14	7973	3189375	2.500	900	900	1/300	90.0	1.500
P15	6941	2892857	2.399	900	900	1/300	90.0	1.500
P16	7134	2892857	2.466	900	900	1/300	90.0	1.500
P17	7092	2892857	2.452	900	900	1/300	90.0	1.500
P18	6950	2892857	2.402	900	900	1/300	90.0	1.500
P19	7653	3189375	2.400	900	900	1/300	90.0	1.500

Calculation results

	Compressive deflection $\delta_c/1.3$ (mm)	Deflection due to rotation $\geqq \delta_r$ (mm)	Conclusions
P14	1.923	1.500	OK
P15	1.846	1.500	OK
P16	1.897	1.500	OK
P17	1.886	1.500	OK
P18	1.848	1.500	OK
P19	1.846	1.500	OK

（３） Checking of local strain



(a) Local shear strain due to vertical load　　(b) Local shear strain due to horizontal force　　(c) Local shear strain due to rotation

Checking formula

$\gamma_t \leqq \gamma_{ta}$

Where, γ_t : Local shear strain (%)

$= \gamma_c + \gamma_s + \gamma_r$

γ_c : Local shear stain due to vertical force (%)

In case of rectangular shape : $\gamma_c = 8.5 \cdot S_1 \cdot R_{max1} / E \cdot A_{cn}$

Incase of circle shape : $\gamma_c = 6.0 \cdot S_1 \cdot R_{max1} / E \cdot A_{cn}$

γ_s : Shear strain in ordinary condition (%)

γ_r: Local shear strain due to rotation of girder (%)

In case of rectangular shape : $\gamma_r = 2 \cdot (1 + a / b)^2 \cdot S_1 \cdot \alpha_e$

Incase of circle shape : $\gamma_r = 6.0 \cdot S_1^{\ 2} \cdot \alpha_e$

γ_{ta} : Allowable value of local shear strain (= γu/fa) (%)

S_1 : 1st shape factor
R_{max1} : Maximum reaction (kN)
E : Young modulus of rubber bearing (N/mm^2)
A_{cn} : Effective area considered movement in ordinary condition (mm2)
a : Effective length of bearing (mm)
b : Effective width of bearing (mm)
α_e : Rotation angle of 1 rubber layer (rad)

Calculating condition

	Local shear strain due to vertical reaction				
	1st shape factor S_1 -	Maximum reaction R_{max1} (kN)	Young modulus E (N/mm^2)	Effective area A_{cn} (㎜^{2})	Calculated value γ_c (%)
P14	11.25	8070	668.6	810000	142.5%
P15	10.71	7009	606.7	810000	129.9%
P16	10.71	7442	606.7	810000	137.9%
P17	10.71	7360	606.7	810000	136.4%
P18	10.71	7176	606.7	810000	133.0%
P19	11.25	7737	668.6	810000	136.6%

	Local shear strain due to rotation angle				
	Bearing length a (㎜)	Bearing width b (㎜)	Live load rotation angle $\Sigma\alpha_e$ (rad)	1st shape factor S_1 -	Calculated value γ_r (%)
P14	900	900	1/300	11.25	84.4%
P15	900	900	1/300	10.71	76.5%
P16	900	900	1/300	10.71	76.5%
P17	900	900	1/300	10.71	76.5%
P18	900	900	1/300	10.71	76.5%
P19	900	900	1/300	11.25	84.4%

Calculated results

	Local shear strain					Conclusions
	Due to vertical force γ_c (%)	Due to shear γ_s (%)	Due to rotation γ_r (%)	Total γ_t (%)	Allowable Value $\leqq\gamma_{ta}$ (%)	
P14	142.5%	0.0%	84.4%	226.9%	366.7%	OK
P15	129.9%	0.0%	76.5%	206.4%	366.7%	OK
P16	137.9%	0.0%	76.5%	214.5%	366.7%	OK
P17	136.4%	0.0%	76.5%	212.9%	366.7%	OK
P18	133.0%	0.0%	76.5%	209.5%	366.7%	OK
P19	136.6%	0.0%	84.4%	221.0%	366.7%	OK

3． Checking in seismic condition

1） Calculation of movement in seismic condition

・Shear stiffness

$K_B = G_e \cdot A_e / \Sigma t_e$

G(γ)：Equivalent shear modulus （$=G_e$）

Where, A_e：Surface area of bearing (mm^2)
Σt_e：Total thickness of elastic rubber layers (mm)

・Shear stiffness （For super damping rubber bearing）

$K_m = 1/(1/(N \cdot K_B) + 1/K_p)$

Where, K_p：Stiffness of sub-structure
N：Number of bearings on a bridge pier

Calculation of stiffness / Calculation of displacement

	Number of bearings N (個／脚)	Shear modulus of elasticity of lead G_e (N/mm^2)	Shear stiffness 1 bearing K_B (N/mm)	Shear stiffness on 1 pier ΣK_B (N/mm)	Stiffness of sub- K_p (N/mm)	Total stiffness K_m (N/mm)	Bearing deformation $\triangle L_e$ (mm)	Design deformation u_B (mm)	Effective value γ (%)
P14	4	0.8	1.E+99	1.E+99	1.E+101	1.E+99	0.0	0.0	0.0%
P15	4	0.8	1.E+99	1.E+99	1.E+101	1.E+99	0.0	0.0	0.0%
P16	4	0.8	1.E+99	1.E+99	1.E+101	1.E+99	0.0	0.0	0.0%
P17	4	0.8	1.E+99	1.E+99	1.E+101	1.E+99	0.0	0.0	0.0%
P18	4	0.8	1.E+99	1.E+99	1.E+101	1.E+99	0.0	0.0	0.0%
P19	4	0.8	1.E+99	1.E+99	1.E+101	1.E+99	0.0	0.0	0.0%

2） Checking of shear deformation

$$\gamma_{se} = \frac{u_B}{\Sigma t_e} \leqq \gamma_{sea}$$

Where, γ_{se}： Shear deformation in seismic condition (%)
u_B： Movement in seismic condition(mm)
Σt_e： Total thickness of rubber layers (mm)
γ_{sea}： Allowable value (%) （Seismic L1 ：150%）

Bridge longitudinal direction in seismic level I

	Calculating condition: Design movement u_B (mm)	Calculating condition: Total thickness Σt_e (mm)	Calculated results: Calculated result γ_{se} (%)	Calculated results: Allowable Value $\leqq\gamma_{sea}$ (%)	Calculated results: Conclusions
P14	0.0	80	0.0%	150.0%	OK
P15	0.0	84	0.0%	150.0%	OK
P16	0.0	84	0.0%	150.0%	OK
P17	0.0	84	0.0%	150.0%	OK
P18	0.0	84	0.0%	150.0%	OK
P19	0.0	80	0.0%	150.0%	OK

3） Effects due to vertical force

a ） Buckling stability

$$\sigma_{ce} = \frac{R_L}{A_{ce}} \leqq \sigma_{cra}$$

Where,

σ_{ce} : Maximum compressive stress in seismic condition （N/mm^2）

R_L : Vertical force in seismic condition （N/mm^2）

A_{ce} : Effective area in seismic condition (mm^2)

Bridge longitudinal direction （$= A_e - u_{B1} \cdot b$）

Bridge transversal direction （$= A_e - u_{B2} \cdot a$）

σ_{cra} : Allowable value of compressive stress when considering buckling （N/mm2）

（$= G_e \cdot S_1 \cdot S_2 / f_{cr}$）

Calculation of allowable value

	Elastic shear modulus G_e (N/mm^2)	1st shape factor S_1 -	2nd shape factor S_2 -	Factor Seismic f_{cr} -	Allowable Seismic σ_{cra} (N/mm^2)
P14	0.8	11.25	11.25	1.5	67.50
P15	0.8	10.71	10.71	1.5	61.22
P16	0.8	10.71	10.71	1.5	61.22
P17	0.8	10.71	10.71	1.5	61.22
P18	0.8	10.71	10.71	1.5	61.22
P19	0.8	11.25	11.25	1.5	67.50

・Bridge longitudinal direction in seismic level I

	Calculation condition					Calculation results		
	Vertical force in seismic cond. R_L (kN)	Plane area of bearing A_e (㎜^{2})	Design movement u_{B1} (㎜)	Bearing dimensions b (㎜)	Effective area A_{ce} (㎜^{2})	Calculated value σ_{ce} (N/mm^2)	Allowable value $\leqq\sigma_{cra}$ (N/mm^2)	Conclusions
P14	6890	810000	0.0	900	810000	8.51	67.50	OK
P15	5770	810000	0.0	900	810000	7.12	61.22	OK
P16	6110	810000	0.0	900	810000	7.54	61.22	OK
P17	6050	810000	0.0	900	810000	7.47	61.22	OK
P18	5830	810000	0.0	900	810000	7.20	61.22	OK
P19	6560	810000	0.0	900	810000	8.10	67.50	OK

・Bridge transversal direction in seismic level I

	Calculation condition		Calculation results		
	Vertical force in seismic cond. R_L (kN)	Plane area of bearing A_{ce} (㎜^{2})	Calculated value σ_{ce} (N/mm^2)	Allowable value $\leqq\sigma_{cra}$ (N/mm^2)	Conclusions
P14	7910	810000	9.77	67.50	OK
P15	6630	810000	8.19	61.22	OK
P16	7010	810000	8.65	61.22	OK
P17	6950	810000	8.58	61.22	OK
P18	6700	810000	8.27	61.22	OK
P19	7530	810000	9.30	67.50	OK

b） Checking of tensile stress

Uplift force in seismic condition

$$\sigma_{te} = \frac{R_U}{A_{ce}} \leqq \sigma_{ta}$$

Where, σ_{te} : Tensile stress in seismic condition （N/mm^2）

R_U : Vertical force in seismic condition

（= Uplift force in seismic condition） （kN）

A_{ce} : Effective area in seismic condition (mm^2)

In bridge transversal direction （$= A_e - u_{B2} \cdot a$）

σ_{ta} : Allowable value (N/mm^2)

For the case of uplift force （$0.1R_d$）

$$\sigma_{te} = \frac{0.1R_d}{A_e} \leqq \sigma_{ta}$$

Where, σ_{te} : Tensile stress due to uplift force （N/mm^2）

A_e : Effective area (mm^2)

σ_{ta} : Allowable value (N/mm^2)

・Bridge transversal direction in seismic level I

	Calculation condition		Calculation results		
	Vertical force in seismic cond. R_U (kN)	Plane area of bearing A_{ce} (mm^2)	Calculated value σ_{te} (N/mm^2)	Allowable value $\leqq\sigma_{ta}$ (N/mm^2)	Conclusions
P14	4240	810000	0.00	2.00	OK
P15	3530	810000	0.00	2.00	OK
P16	3740	810000	0.00	2.00	OK
P17	3710	810000	0.00	2.00	OK
P18	3650	810000	0.00	2.00	OK
P19	4020	810000	0.00	2.00	OK

・Uplift force acting in seismic level 1

	Calculation condition		Calculation results		
	Uplift force $0.1R_d$ (kN)	Plane area of bearing A_e (mm^2)	Calculated value σ_{te} (N/mm^2)	Allowable value $\leqq\sigma_{ta}$ (N/mm^2)	Conclusions
P14	-610	810000	0.75	1.60	OK
P15	-514	810000	0.63	1.60	OK
P16	-533	810000	0.66	1.60	OK
P17	-529	810000	0.65	1.60	OK
P18	-517	810000	0.64	1.60	OK
P19	-583	810000	0.72	1.60	OK

Design of steel components in rubber bearing

1． Design condition

Level I

	Dead load	Seismic force in bridge longitudinal direction			Seismic force in bridge transversal direction			Uplift force
	R_D	RL1	RU1	Rh1	RL2	RU2	Rh2	RU
	kN	(kN/ bearing)	(kN/ bearing)	(kN/ bearing)	(kN/ bearing)	(kN/ bearing)	(kN/ bearing)	(kN/ bearing)
P14	6101	6890	5270	2060	7910	4240	1892	610
P15	5137	5770	4390	1861	6630	3530	1589	514
P16	5332	6110	4650	1830	7010	3740	1678	533
P17	5293	6050	4610	1810	6950	3710	1661	529
P18	5171	5830	4520	1867	6700	3650	1618	517
P19	5826	6560	5010	1970	7530	4020	1806	583

Displacement

	Level 1	
	ΔLe1 mm	ΔLe2 mm
P14	0.0	0.0
P15	0.0	0.0
P16	0.0	0.0
P17	0.0	0.0
P18	0.0	0.0
P19	0.0	0.0

Where,

R_D	Dead load reaction	
RL1	Vertical force when considering bridge longitudinal seismic	
RU1	Uplift force when considering bridge longitudinal seismic	
Rh1	Longitudinal force due to longitudinal seismic	
RL2	Vertical force due to transversal seismic	
RU2	Uplift force when considering bridge transversal seismic	
Rh2	Longitudinal force due to transversal seismic	
RU	Uplift force in seismic level I	-0.1・Ｒd
ΔLe1	Movement in bridge longitudinal direction due to seismic	
ΔLe2	Movement in bridge transversal direction due to seismic	
V	min(RU1,RU2,RU)	

2． Allowable stress of steel materials

※Data related in section 3.5.3 of bridge bearing manual (April 2004) published by Japan Road Association

2．１ Allowable stress of steel materials

Stresses / Materials		Thickness of steel component mm	Flexural stress σa N/mm^2	Shear stress τa N/mm^2	Compressive stress σba N/mm^2
Rolled steel	SS400, SM400	Equal or less than 40	140	80	210
		Above 40	125	75	190
	SM490A	Equal or less than 40	185	105	280
		40＜ｔ≦100	175	100	260
		100＜ｔ≦160	170	95	255
		160＜ｔ≦200	165	90	250
Cast steel	SCW410N	Equal or less than 150	140	80	210
		Above 150	126	72	189
	SCW480N	Equal or less than 150	170	100	250
		Above 150	153	90	225
Carbon steel	S35CN		190	110	280
	S45CN		210	120	310

２．２　Allowable stress of anchor bolts

Shear stress of anchor bolt τa （N/mm^2)

	SS400	S35CN	S45CN	SD295A SD295B	SD345
Seismic	80	110	110	105	115

Tensile stress of anchor bolt σta （N/mm^2)

	SS400	S35CN	S45CN	SD295A SD295B	SD345
Seismic	140	190	210	180	200

Adhensive stress of anchor bolt τo （N/mm^2)

	Standard strength of concrete						
	21	24	27	30	40	50	60
Rounded shape	0.70	0.80	0.85	0.90	1.00	1.00	1.00
Deformed shape	1.40	1.60	1.70	1.80	2.00	2.00	2.00

２．３　Allowable stress of bolt

		4.8(4.6) N/mm^2	8.8 N/mm^2	10.9 N/mm^2	12.9 N/mm^2
Tensile stress	σta	140	360	470	470
Shear stress	τa	90	200	270	270
Compressive strength	σba	210	540	700	700
Tensile strength		-	830	1040	-

２．４　Surcharges coefficient of allowable stress

Main load combination except for live load and impact+ Effects in seismic condition (EQ)

	Level 1
Concrete component	1.5
Steel component	1.5

3．Material of bearing components

3．1　Inner steel plate of rubber bearing

$$\sigma s = fc \cdot \sigma c \cdot te / ts$$

fc : Coefficient of tensile stress
(In case of laminar rubber bearing, $fc = 2$)
σc : Compressive stress
te : Thickness of a rubber layer (mm)
ts : Thickness a inner steel plate (mm)

Calculated results（Ordinary condition）

	Coefficient fc	Compressive stress σc (N/mm^2)	Thickness rubber layer te (mm)	Thickness inner steel plate ts (mm)	Material inner steel plate	Tensile stress σs (N/mm^2)	Allowable stress σsa (N/mm^2)
P14	2	9.96	20	4.5	SS400	88.6	140.0
P15	2	8.65	21	4.5	SS400	80.8	140.0
P16	2	9.19	21	4.5	SS400	85.8	140.0
P17	2	9.09	21	4.5	SS400	84.8	140.0
P18	2	8.86	21	4.5	SS400	82.7	140.0
P19	2	9.55	20	4.5	SS400	84.9	140.0

Calculated results（Seismic level 1）

	Coefficient fc	Maximum compressive stress σc (N/mm^2)	Tensile stress σse (N/mm^2)	Allowable stress σsa (N/mm^2)
P14	2	9.77	86.8	210.0
P15	2	8.19	76.4	210.0
P16	2	8.65	80.7	210.0
P17	2	8.58	80.1	210.0
P18	2	8.27	77.2	210.0
P19	2	9.30	82.7	210.0

４． Shear key

Design horizontal force ②
Maximum design horizontal reaction
Hs'＝max(Rh1e,Rh2e)
※Incase of the bearing is fixed in horizontal direction, the value of hs2 shall be equal to Rh1e.
In this case, surcharge coefficient shall be 1.5.

（a） Compressive stress

$$\sigma bi = \frac{H,Hs'}{D\cdot(hsi-2)} \leqq \sigma ba$$

（b） Shear stress

$$\tau = \frac{4\cdot(H,Hs')}{\pi\cdot D^2} \leqq \tau a$$

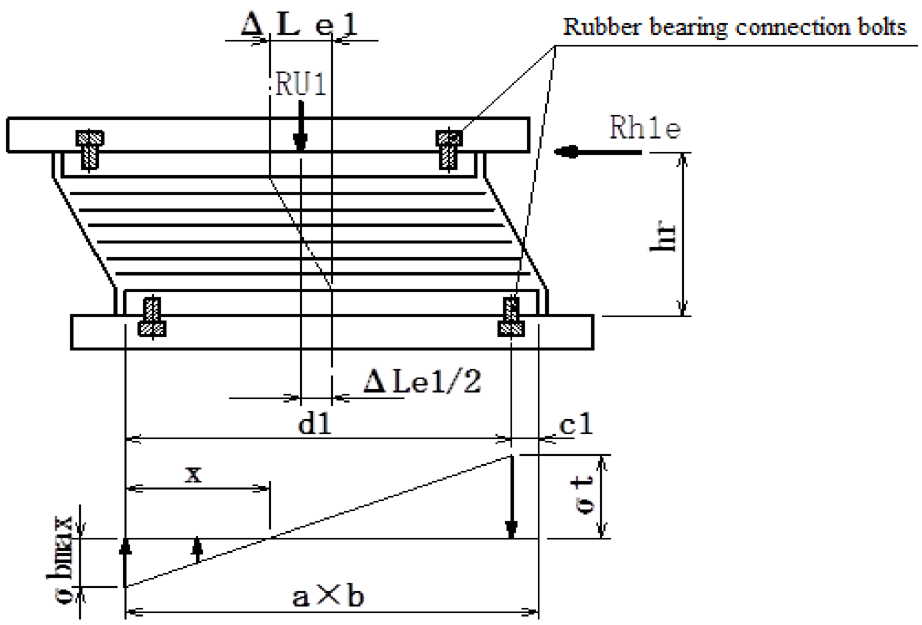
Calculated results

	D mm	hs0 mm	hs1 mm	hs2 mm	hs3 mm
P14	350	35	－	－	70
P15	300	30	－	－	60
P16	300	30	－	－	60
P17	300	30	－	－	60
P18	300	30	－	－	60
P19	350	35	－	－	70

	Design horizontal force ②								
	Rh1e kN	Rh2e kN	σb0 N/mm^2	σba N/mm^2	σb1 N/mm^2	σb2 N/mm^2	σba N/mm^2	τ N/mm^2	τa N/mm^2
P14	2180	1892	188.8	285.0	－	－	390.0	22.7	150.0
P15	1861	1589	221.6	285.0	－	－	390.0	26.4	150.0
P16	1830	1678	217.9	285.0	－	－	390.0	25.9	150.0
P17	1810	1661	215.5	285.0	－	－	390.0	25.7	150.0
P18	1867	1618	222.3	285.0	－	－	390.0	26.5	150.0
P19	2330	1806	201.8	285.0	－	－	390.0	24.3	150.0

5． Connection bolts of rubber bearing

5． 1 Stress checking in case of longitudinal seismic



(1) Tesile stress due to combination of RU1＋Rh1
With the same horizontal force, the smaller the value of vertical force,
the more critical the value of tensile force.
Therefore, load case of RU1＋Rh1 in combination shall be selected
for checking (Compressive area ： a×b).

Eccentric E

$$\Delta L e1/2 + \frac{Rh1 \cdot hr}{RU1}$$

Case of compression
case－1 : 0 ＜ E ≦ Eo ＝ a ／ 6
case－2 : Eo ＜ E ≦ Eo' ＝ a ／ 6 ＋ c 1 ／ 3
case－3 : Eo' ＜ E, E ＜ 0

Dimensions

	Longitudinal dimensions a mm	Transversal dimensions b mm	c 1 mm	h r mm
P14	900	900	50	184
P15	900	900	50	188
P16	900	900	50	188
P17	900	900	50	188
P18	900	900	50	188
P19	900	900	50	184

Level 1

	RU1 kN	Rh1 kN	ΔLe1 mm	Eo mm	Eo' mm	E mm	case
P14	5270	2060	0.0	—	—	—	—
P15	4390	1861	0.0	—	—	—	—
P16	4650	1830	0.0	—	—	—	—
P17	4610	1810	0.0	—	—	—	—
P18	4520	1867	0.0	—	—	—	—
P19	5010	1970	0.0	—	—	—	—

Case－1 : Trapezoidal shape of stress distribution
In this case, there is no tensile force in bolts, calculations concerning could be neglected

Case－2 : Triangle shape of stress distribution but no tension in bolts
In this case, there is no tensile force in bolts, calculations concerning could be neglected

Case－3 : Triangle shape of stress distribution, there in tension in bolts
Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Nominal diameter of bolt : d_B
Root diameter of bolt : d_0
Number of effective bolts : m_1
Area of root diameter : A_s (1 bolt)
Define $l = a/2 - E$.

By solving the following equation to obtain position x of neutral axis
Ratio of young's modulus : n

$$f(x) = x^3 - 3 \cdot l \cdot x^2 + \frac{6 \cdot n \cdot m_1 \cdot A_s}{b} \cdot (d_1 - l) \cdot (x - d_1) = 0$$

Maximum compressive stress of contacting surfaces

$$\sigma_{bmax} = \frac{2 \cdot R_{U1} \cdot x}{b \cdot x^2 - 2 \cdot n \cdot m_1 \cdot A_s \cdot (d_1 - x)}$$

Tensile stress of rubber bearing connection bolts

$$\sigma_t = \sigma_{bmax} \cdot n \cdot \frac{d_1 - x}{x} \leqq \sigma_{ta}$$

Dimensions

	Class of bolt	d_B	d_0 mm	m_1 pcs	A_s mm²/bolt	d mm	n
P14	10.9	24	20.752	3	338.2	850	1
P15	10.9	24	20.752	3	338.2	850	1
P16	10.9	24	20.752	3	338.2	850	1
P17	10.9	24	20.752	3	338.2	850	1
P18	10.9	24	20.752	3	338.2	850	1
P19	10.9	24	20.752	3	338.2	850	1

Level 1

	l mm	x mm	σbmax N/mm²	σt N/mm²	σta N/mm²
P14	－	－	－	－	705.0
P15	－	－	－	－	705.0
P16	－	－	－	－	705.0
P17	－	－	－	－	705.0
P18	－	－	－	－	705.0
P19	－	－	－	－	705.0

(2) Shear stress due to Rh1

Total number of bolts : Σm

$$\tau = \frac{4 \cdot Rh1}{\pi \cdot do^2 \cdot \Sigma m} \leqq \tau a$$

(3) Stress combination

$$U = (\sigma t / \sigma ta)^2 + (\tau / \tau a)^2 \leqq Ua = 1.2$$

(4) Tension due to V

$$\sigma t = \frac{4 \cdot V}{\pi \cdot do^2 \cdot \Sigma m} \leqq \sigma ta$$

Dimensions and design forces

	Class of bolt	d_B	do mm	Σm bolts
P14	10.9	24	20.752	8
P15	10.9	24	20.752	8
P16	10.9	24	20.752	8
P17	10.9	24	20.752	8
P18	10.9	24	20.752	8
P19	10.9	24	20.752	8

Level 1

	RU1 case						V	V case	
	Rh1 kN	σt N/mm²	σta N/mm²	τ N/mm²	τa N/mm²	U	kN	σt N/mm²	σta N/mm²
P14	2060	—	705.0	—	405.0	—	610	225.5	705.0
P15	1861	—	705.0	—	405.0	—	514	190.0	705.0
P16	1830	—	705.0	—	405.0	—	533	197.0	705.0
P17	1810	—	705.0	—	405.0	—	529	195.6	705.0
P18	1867	—	705.0	—	405.0	—	517	191.1	705.0
P19	1970	—	705.0	—	405.0	—	583	215.5	705.0
P20	0	—	705.0	0.0	405.0	—	183	67.7	705.0

５． ２ Checking embedded length of the bolt （LB)

（1） Necessity screw length of the bolt L_B1(mm)

$$L_B1 = \frac{f \cdot (d_B - k2 \cdot p)}{3} \cdot \frac{\sigma(B)t}{\tau(B)a} + 2 \cdot p$$

（2） Necessity screw length of connecting components L_B2(mm)

$$L_B2 = \frac{2 \cdot f \cdot (d_B - k2 \cdot p)^2}{7 \cdot d_B} \cdot \frac{\sigma(B)t}{\tau(N)a} + 2 \cdot p$$

Where,

ｆ	:	Safety factor （recommended ｆ ＝1.05）
d_B	:	Bolt diameter (Nominal diameter)(mm)
ｐ	:	Screw pitch
k2	:	Factor for determined inner diameter of screw in connecting components (k2=1.082532）
σ(B)t	:	Maximum shear stress of bolt (N/mm^2)
τ(B)a	:	Shear stress of bolts (N/mm^2)
τ(N)a	:	Allowable shear stress of crew component (N/mm^2)

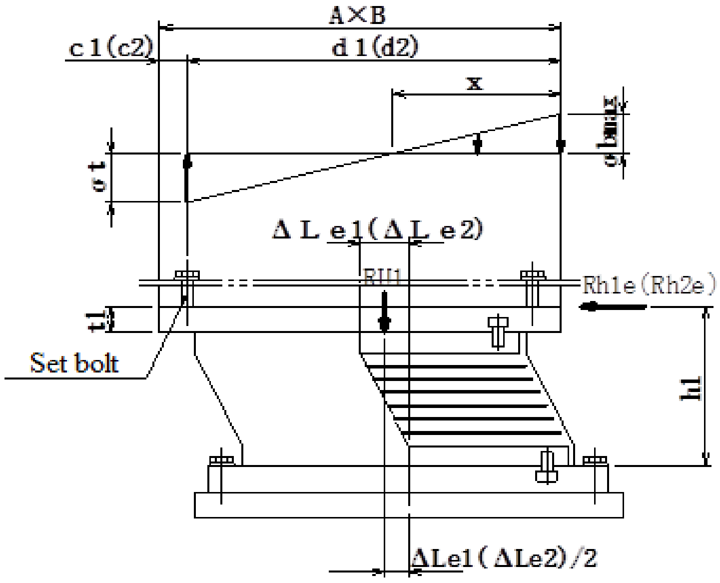
Dimensions

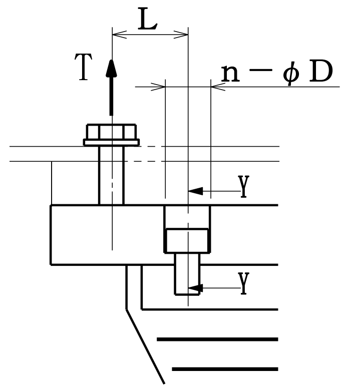
	ｆ	d_B mm	ｐ	k2
P14	1.05	24	3.0	1.082532
P15	1.05	24	3.0	1.082532
P16	1.05	24	3.0	1.082532
P17	1.05	24	3.0	1.082532
P18	1.05	24	3.0	1.082532
P19	1.05	24	3.0	1.082532

Level 1

	σ(B)t N/mm^2	τ(B)a N/mm^2	τ(N)a N/mm^2	L_B1 mm	L_B2 mm	L_B mm
P14	225.5	405.0	150.0	10.0	14.1	26.0
P15	190.0	405.0	150.0	9.4	12.8	26.0
P16	197.0	405.0	150.0	9.5	13.1	26.0
P17	195.6	405.0	150.0	9.5	13.0	26.0
P18	191.1	405.0	150.0	9.4	12.9	26.0
P19	215.5	405.0	150.0	9.9	13.7	26.0

６． Set bolts





６．１ Stress checking in case of longitudinal seismic

(1) Tensile stress in case of RU1＋Rh1 in combination

With the same horizontal force, the smaller the value of vertical force, the more critical the value of tensile force.
Therefore, load case of RU1＋Rh1 in combination shall be selected for checking (Compressive area : A×B).

Eccentric Ｅ

$$\Delta L e1/2 + \frac{Rh1 \cdot h1}{RU1}$$

Case of compression

case－1 : $0 < E \leqq Eo = A/6$
case－2 : $Eo < E \leqq Eo' = A/6 + c1/3$
case－3 : $Eo' < E,\ E < 0$

Dimensions

	Longitudinal dimensions A mm	Transversal dimensions B mm	c1 mm	h1 mm
P14	970	1100	140	30
P15	970	1100	140	25
P16	970	1100	140	25
P17	970	1100	140	25
P18	970	1100	140	25
P19	970	1100	140	30

Level 1

	RU1 kN	Rh1 kN	ΔLe1 mm	Eo mm	Eo' mm	E mm	case
P14	5270	2060	0.0	161.7	208.3	11.7	case-1
P15	4390	1861	0.0	161.7	208.3	10.6	case-1
P16	4650	1830	0.0	161.7	208.3	9.8	case-1
P17	4610	1810	0.0	161.7	208.3	9.8	case-1
P18	4520	1867	0.0	161.7	208.3	10.3	case-1
P19	5010	1970	0.0	161.7	208.3	11.8	case-1

Case－1 : Trapezoidal shape of stress distribution
In this case, there is no tensile force in bolts, calculations concerning could be neglected

Case－2 : Triangle shape of stress distribution but no tension in bolts
In this case, there is no tensile force in bolts, calculations concerning could be neglected

Case－3 : Triangle shape of stress distribution, there in tension in bolts
Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Nominal diameter of bolt : d_B
Root diameter of bolt : do
Number of effective bolts : $m1$
Area of root diameter : As (1 bolt)
Define $l = A/2 - E$.

By solving the following equation to obtain position x of neutral axis
Ratio of young's modulus : n

$$f(x) = x^3 - 3 \cdot l \cdot x^2 + \frac{6 \cdot n \cdot m1 \cdot As}{B} \cdot (d1 - l) \cdot (x - d1) = 0$$

Maximum compressive stress of contacting surfaces

$$\sigma bmax = \frac{2 \cdot RU1 \cdot x}{B \cdot x^2 - 2 \cdot n \cdot m1 \cdot As \cdot (d1 - x)}$$

Tensile stress of rubber bearing set bolts

$$\sigma t = \sigma bmax \cdot n \cdot \frac{d1 - x}{x} \leqq \sigma ta$$

Dimensions

	Class of bolt	d_B	do mm	m1 bolts	As mm^2/bolt	d mm	n
P14	8.8	24	20.752	2	338.2	830	1
P15	8.8	24	20.752	2	338.2	830	1
P16	8.8	24	20.752	2	338.2	830	1
P17	8.8	24	20.752	2	338.2	830	1
P18	8.8	24	20.752	2	338.2	830	1
P19	8.8	24	20.752	2	338.2	830	1

Level 1

	l mm	x mm	σbmax N/mm^2	σt N/mm^2	σta N/mm^2
P14	473.3	－	－	－	540.0
P15	474.4	－	－	－	540.0
P16	475.2	－	－	－	540.0
P17	475.2	－	－	－	540.0
P18	474.7	－	－	－	540.0
P19	473.2	－	－	－	540.0

(2) Tension due to V

$$\sigma t = \frac{4 \cdot V}{\pi \cdot do^2 \cdot \Sigma m} \leqq \sigma ta$$

Dimensions and design forces

	Class of bolt	d_B	do mm	Σm bolts
P14	8.8	24	20.752	8
P15	8.8	24	20.752	8
P16	8.8	24	20.752	8
P17	8.8	24	20.752	8
P18	8.8	24	20.752	8
P19	8.8	24	20.752	8

Level 1

	RU1 Case						V	V case	
	Rh1 kN	σt N/mm^2	σta N/mm^2				kN	σt N/mm^2	σta N/mm^2
P14	2060	－	540.0				610	225.5	540.0
P15	1861	－	540.0				514	190.0	540.0
P16	1830	－	540.0				533	197.0	540.0
P17	1810	－	540.0				529	195.6	540.0
P18	1867	－	540.0				517	191.1	540.0
P19	1970	－	540.0				583	215.5	540.0

6．2 Stress checking in case of transversal seismic

(1) Tensile stress in case of RU2＋Rh2 in combination

With the same horizontal force, the smaller the value of vertical force, the more critical the value of tensile force.
Therefore, load case of RU2＋Rh2 in combination shall be selected for checking (Compressive area : A×B).

Eccentric E

$$\Delta Le2/2 + \frac{Rh2 \cdot h1}{RU2}$$

Case of compression

case－1 : 0 < E ≦ Eo ＝ B ／ 6
case－2 : Eo < E ≦ Eo' ＝ B ／ 6 ＋ c2 ／ 3
case－3 : Eo' < E, E < 0

Dimensions

	Longitudinal dimensions A mm	Transversal dimensions B mm	c2 mm	h1 mm
P14	970	1100	205	30.0
P15	970	1100	205	25.0
P16	970	1100	205	25.0
P17	970	1100	205	25.0
P18	970	1100	205	25.0
P19	970	1100	205	30.0

Level 1

	RU2 kN	Rh2 kN	ΔLe2 mm	Eo mm	Eo' mm	E mm	case
P14	4240	1892	0.0	183.3	251.7	13.4	case-1
P15	3530	1589	0.0	183.3	251.7	11.3	case-1
P16	3740	1678	0.0	183.3	251.7	11.2	case-1
P17	3710	1661	0.0	183.3	251.7	11.2	case-1
P18	3650	1618	0.0	183.3	251.7	11.1	case-1
P19	4020	1806	0.0	183.3	251.7	13.5	case-1

Case－1 : Trapezoidal shape of stress distribution
In this case, there is no tensile force in bolts, calculations concerning could be neglected

Case－2 : Triangle shape of stress distribution but no tension in bolts
In this case, there is no tensile force in bolts, calculations concerning could be neglected

Case－3 : Triangle shape of stress distribution, there in tension in bolts
Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Nominal diameter of bolt : d_B
Root diameter of bolt : do
Number of effective bolts : $m2$
Area of root diameter : As (1 bolt)
Define $l = B/2 - E$.

By solving the following equation to obtain position x of neutral axis
Ratio of young's modulus : n

$$f(x) = x^3 - 3 \cdot l \cdot x^2 + \frac{6 \cdot n \cdot m2 \cdot As}{A} \cdot (d2 - l) \cdot (x - d2) = 0$$

Maximum compressive stress of contacting surfaces

$$\sigma bmax = \frac{2 \cdot RU2 \cdot x}{A \cdot x^2 - 2 \cdot n \cdot m2 \cdot As \cdot (d2 - x)}$$

Tensile stress of rubber bearing set bolts

$$\sigma t = \sigma bmax \cdot n \cdot \frac{d2 - x}{x} \leqq \sigma ta$$

Calculated results

	Class of bolt	d_B	do mm	m2 bolts	As mm²/bolts	d2 mm	n
P14	8.8	24	20.752	4	338.2	895	1
P15	8.8	24	20.752	4	338.2	895	1
P16	8.8	24	20.752	4	338.2	895	1
P17	8.8	24	20.752	4	338.2	895	1
P18	8.8	24	20.752	4	338.2	895	1
P19	8.8	24	20.752	4	338.2	895	1

Level 1

	l mm	x mm	σbmax N/mm²	σt N/mm²	σta N/mm²
P14	536.6	－	－	－	－
P15	538.7	－	－	－	－
P16	538.8	－	－	－	－
P17	538.8	－	－	－	－
P18	538.9	－	－	－	－
P19	536.5	－	－	－	－

Dimensions

	Class of bolt	d_B	d o mm	Σm bolts
P14	8.8	24	20.752	8
P15	8.8	24	20.752	8
P16	8.8	24	20.752	8
P17	8.8	24	20.752	8
P18	8.8	24	20.752	8
P19	8.8	24	20.752	8

Level 1

	ＲU2 Case					
	Rh2 kN	σt N/mm²	σta N/mm²			
P14	1892	－	－			
P15	1589	－	－			
P16	1678	－	－			
P17	1661	－	－			
P18	1618	－	－			
P19	1806	－	－			

６．3　Checking embedded length of the bolt（L_B)

（1） Necessity screw length of the bolt　L_B1(mm)

$$L_B1=\frac{f\cdot(d_B-k2\cdot p)}{3}\cdot\frac{\sigma(B)t}{\tau(B)a}+2\cdot p$$

（2） Necessity screw length of connecting components　L_B2(mm)

$$L_B2=\frac{2\cdot f\cdot(d_B-k2\cdot p)^2}{7\cdot d_B}\cdot\frac{\sigma(B)t}{\tau(N)a}+2\cdot p$$

Where,
ｆ：Safety factor（recommended ｆ＝1.05）
d_B：Bolt diameter (Nominal diameter)(mm)
ｐ：Screw pitch
k2：Factor for determined inner diameter of screw

σ(B)t：Maximum shear stress of bolt (N/mm²)
τ(B)a：Shear stress of bolts (N/mm²)
τ(N)a：Allowable shear stress of crew component (N/mm²)

Dimensions

	ｆ	d_B mm	ｐ	k2
P14	1.05	24	3.0	1.082532
P15	1.05	24	3.0	1.082532
P16	1.05	24	3.0	1.082532
P17	1.05	24	3.0	1.082532
P18	1.05	24	3.0	1.082532
P19	1.05	24	3.0	1.082532

Level 1

	σ(B)t N/mm²	τ(B)a N/mm²	τ(N)a N/mm²	L_B1 mm	L_B2 mm	L_B mm
P14	225.5	300.0	150.0	11.5	14.1	20.5
P15	190.0	300.0	157.5	10.6	12.5	20.5
P16	197.0	300.0	157.5	10.8	12.7	20.5
P17	195.6	300.0	157.5	10.7	12.7	20.5
P18	191.1	300.0	157.5	10.6	12.5	20.5
P19	215.5	300.0	150.0	11.2	13.7	20.5

7. Top plate

7. 1 Stress checking in case of longitudinal seismic

(1) Checking flexural moment of rubber bearing connection bolt counter bore section

Tensile force

$T = To \cdot m1$

To : Maximum tensile force on surrounding surface of the set bolt (Maximum tensile force in case of seismic horizontal force and uplift force acting)

$To = Max(T1, TV)$

$T1 = \sigma t \cdot As$

$TV = V / \Sigma m$

$m1$: Number of bolts used in calculation

Flexural moment

$M = T \cdot L$

L : Distance from a connection bolt to a set bolt

Flexural stress

$$\sigma = \frac{6 \cdot M}{B' \cdot t1^2} \leqq \sigma a$$

B' : Dimensions of bearing deducting diameter of connection bolts

$B' = B - n \cdot \varphi D$

B : Dimensions of bearing

n : Number of connection bolts used in calculation

φD : Countersunk diameter of connection bolts

$t1$: Thickness of upper bearing plate

(2) Shear stress at section of connection bolt counter bore

$$\tau = \frac{T}{B' \cdot t1} \leqq \tau a$$

(3) Stress combination checking of the connection bolt counter bore section

$$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2 \leqq Ua = 1.2$$

Calculated result

Level 1

	T1 N	TV N	To N	m1 bolts	T N	L mm	M kN・mm	B mm	n bolts
P14	—	76250	76250	2	152500	55	8388	1100	3
P15	—	64250	64250	2	128500	55	7068	1100	3
P16	—	66625	66625	2	133250	55	7329	1100	3
P17	—	66125	66125	2	132250	55	7274	1100	3
P18	—	64625	64625	2	129250	55	7109	1100	3
P19	—	72875	72875	2	145750	55	8016	1100	3

	φD mm	B' mm	t1 mm	Top plate material	σ N/mm^2	σa N/mm^2	τ N/mm^2	τa N/mm^2	U
P14	39	983	50	SM490A	20.5	262.5	3.2	150.0	0.01
P15	39	983	40	SM490A	27.0	277.5	3.3	157.5	0.01
P16	39	983	40	SM490A	28.0	277.5	3.4	157.5	0.02
P17	39	983	40	SM490A	27.8	277.5	3.4	157.5	0.02
P18	39	983	40	SM490A	27.2	277.5	3.3	157.5	0.02
P19	39	983	50	SM490A	19.6	262.5	3.0	150.0	0.01

7．2 Stress checking in case of transversal seismic

（1） Checking flexural moment of rubber bearing connection bolt counter bore section

Tensile force

$T = To \cdot m2$

To : Maximum tensile force on surrounding surface of the set bolt （Maximum tensile force in case of seismic horizontal force and uplift force acting）

$To = Max(T2, TV)$

$T2 = \sigma t \cdot As$

$TV = V / \Sigma m$

$m2$: Number of bolts used in calculation

Flexural moment

$M = T \cdot L$

L : Distance from a connection bolt to a set bolt

Flexural stress

$$\sigma = \frac{6 \cdot M}{A' \cdot t^2} \leqq \sigma a$$

A' : Dimensions of bearing deducting diameter of connection bolts

$A' = A - n \cdot \varphi D$

A : Dimensions of bearing

n : Number of connection bolts used in calculation

φD : Countersunk diameter of connection bolts

t : Thickness of upper bearing plate

（2） Shear stress at section of connection bolt counter bore

$$\tau = \frac{T}{A' \cdot t} \leqq \tau a$$

（3） Stress combination checking of the connection bolt counter bore section

$$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2 \leqq Ua = 1.2$$

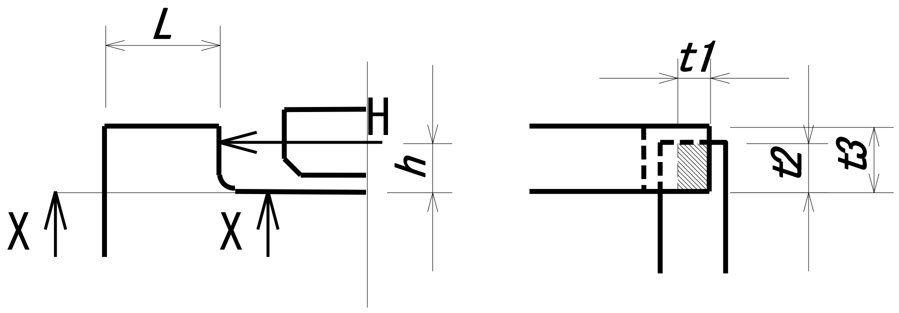
Calculated result

Level 1

	T2 N	TV N	To N	m2 bolts	T N	L mm	M kN・mm	A mm	n bolts
P14	－	76250	76250	4	305000	55	16775	970	3
P15	－	64250	64250	4	257000	55	14135	970	3
P16	－	66625	66625	4	266500	55	14658	970	3
P17	－	66125	66125	4	264500	55	14548	970	3
P18	－	64625	64625	4	258500	55	14218	970	3
P19	－	72875	72875	4	291500	55	16033	970	3

	φD mm	A' mm	t mm	Top plate material	σ N/mm^2	σa N/mm^2	τ N/mm^2	τa N/mm^2	U
P14	39	853	50	SM490A	47.2	262.5	7.2	150.0	0.04
P15	39	853	40	SM490A	62.2	277.5	7.6	157.5	0.06
P16	39	853	40	SM490A	64.5	277.5	7.9	157.5	0.06
P17	39	853	40	SM490A	64.0	277.5	7.8	157.5	0.06
P18	39	853	40	SM490A	62.6	277.5	7.6	157.5	0.06
P19	39	853	50	SM490A	45.2	262.5	6.9	150.0	0.04

７．３　Stress of fixing components (Fix bearing only)



Design horizontal force

Ｈ＝Ｒ H1/2

(1) Compressive stress

$$\sigma b = \frac{H}{t1 \cdot t2} \leqq \sigma ba$$

(2) Flexural stress in Ｘ－Ｘ cross section

$$\sigma = \frac{6 \cdot H \cdot h}{L^2 \cdot t3} \leqq \sigma a$$

(3) Shear stress in Ｘ－Ｘ cross section

$$\tau = \frac{H}{L \cdot t3} \leqq \tau a$$

(4) Checking of stress combination in Ｘ－Ｘ cross section

$$U = (\sigma／\sigma a)^2 \cdot (\tau／\tau a)^2 \qquad \leqq Ua = 1.2$$

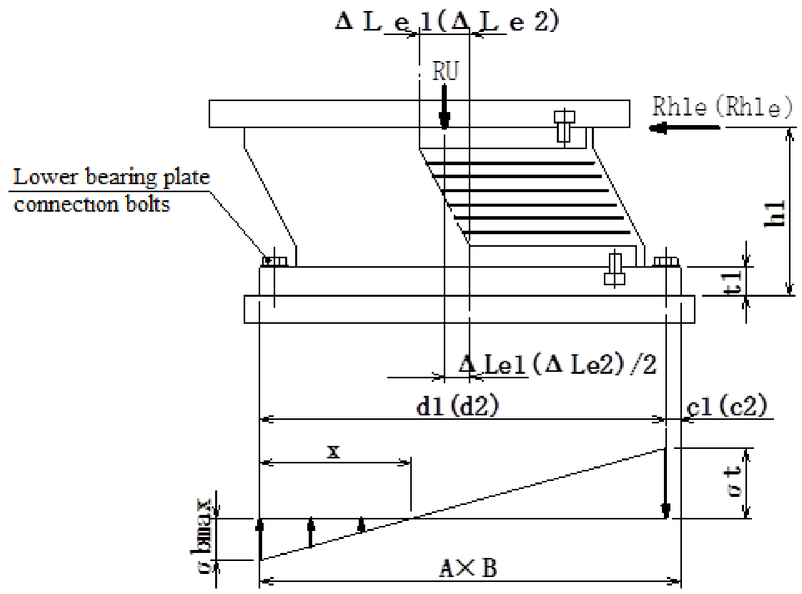
Dimensions

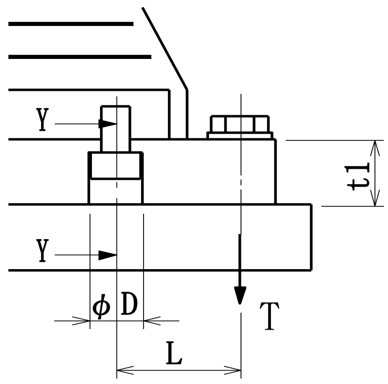
	Material of side blocks	Material of Upper PL	L mm	t1 mm	t2 mm	t3 mm	h
P14	SM490 or SCW480N	SM490A	378	103	40	50.0	69
P15	SM490 or SCW480N	SM490A	378	103	30	40.0	69
P16	SM490 or SCW480N	SM490A	378	103	30	40.0	69
P17	SM490 or SCW480N	SM490A	378	103	30	40.0	69
P18	SM490 or SCW480N	SM490A	378	103	30	40.0	69
P19	SM490 or SCW480N	SM490A	378	103	40	50.0	69

Level1

	H kN	σb N/mm^2	σba N/mm^2	σ N/mm^2	σa N/mm^2	τ N/mm^2	τa N/mm^2	U
P14	1030	250.0	337.5	59.3	262.5	54.5	150.0	0.19
P15	931	301.2	337.5	67.0	277.5	61.6	157.5	0.22
P16	915	296.2	337.5	65.8	277.5	60.6	157.5	0.21
P17	905	292.9	337.5	65.1	277.5	59.9	157.5	0.20
P18	934	302.2	337.5	67.2	277.5	61.8	157.5	0.22
P19	985	239.1	337.5	56.7	262.5	52.2	150.0	0.17

8． Connection bolts of lower bearing plate





8．1 Stress checking in case of longitudinal seismic

(1) Tensile stress in case of RU1＋Rh1 in combination
With the same horizontal force, the smaller the value of vertical force, the more critical the value of tensile force.
Therefore, load case of RU1＋Rh1 in combination shall be selected for checking (Compressive area：A×B).

Eccentric E

$$\Delta Le1/2 + \frac{Rh1}{RU1}$$

Case of compression
case－1：0＜E≦Eo＝A／6
case－2：Eo＜E≦ Eo'＝A／6＋c1／3
case－3：Eo'＜E, E＜0

Dimensions

	Longitudinal dimensions A mm	Transversal dimensions B mm	c1 mm	h1 mm
P14	1100	1100	40	224
P15	1100	1100	40	228
P16	1100	1100	40	228
P17	1100	1100	40	228
P18	1100	1100	40	228
P19	1100	1100	40	224

Level 1

	RU1 kN	Rh1 kN	ΔLe1 mm	Eo mm	Eo' mm	E mm	case
P14	5270	2060	0	－	－	－	－
P15	4390	1861	0	－	－	－	－
P16	4650	1830	0	－	－	－	－
P17	4610	1810	0	－	－	－	－
P18	4520	1867	0	－	－	－	－
P19	5010	1970	0	－	－	－	－

Case－1 : Trapezoidal shape of stress distribution
In this case, there is no tensile force in bolts, calculations concerning could be neglected
Case－2 : Triangle shape of stress distribution but no tension in bolts
In this case, there is no tensile force in bolts, calculations concerning could be neglected
Case－3 : Triangle shape of stress distribution, there in tension in bolts
Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Nominal diameter of bolt : d_B
Root diameter of bolt : d_0
Number of effective bolts : $m1$
Area of root diameter : A_s (1 bolt)
Define $l = A/2 - E$.

By solving the following equation to obtain position x of neutral axis
Ratio of young's modulus : n

$$f(x) = x^3 - 3 \cdot l \cdot x^2 + \frac{6 \cdot n \cdot m1 \cdot A_s}{B} \cdot (d1 - l) \cdot (x - d1) = 0$$

Maximum compressive stress of contacting surfaces

$$\sigma_{bmax} = \frac{2 \cdot RU1 \cdot x}{B \cdot x^2 - 2 \cdot n \cdot m1 \cdot A_s \cdot (d1 - x)}$$

Tensile stress of rubber bearing base plate connection bolts

$$\sigma_t = \sigma_{bmax} \cdot n \cdot \frac{d1 - x}{x} \leqq \sigma_{ta}$$

Dimensions

	Class of bolt	d_B	d0 mm	m1 pcs	As mm²/bolt	d1 mm	n
P14	8.8	24	20.752	4	338.2	1060	1
P15	8.8	24	20.752	4	338.2	1060	1
P16	8.8	24	20.752	4	338.2	1060	1
P17	8.8	24	20.752	4	338.2	1060	1
P18	8.8	24	20.752	4	338.2	1060	1
P19	8.8	24	20.752	4	338.2	1060	1

Level 1

	l mm	x mm	σbmax N/mm²	σt N/mm²	σta N/mm²
P14	－	－	－	－	540.0
P15	－	－	－	－	540.0
P16	－	－	－	－	540.0
P17	－	－	－	－	540.0
P18	－	－	－	－	540.0
P19	－	－	－	－	540.0

(2) Shear stress due to Rh1

Total number of bolts ：Σm

$$\tau = \frac{4 \cdot Rh1}{\pi \cdot do^2 \cdot \Sigma m} \leqq \tau a$$

(3) Stress combination

$$U = (\sigma t / \sigma ta)^2 + (\tau / \tau a)^2 \qquad \leqq Ua = 1.2$$

(4) Tension due to V

$$\sigma t = \frac{4 \cdot V}{\pi \cdot do^2 \cdot \Sigma m} \leqq \sigma ta$$

Dimensions and design forces

	Class of bolt	d_B	d o mm	Σm bolts
P14	8.8	24	20.752	12
P15	8.8	24	20.752	12
P16	8.8	24	20.752	12
P17	8.8	24	20.752	12
P18	8.8	24	20.752	12
P19	8.8	24	20.752	12

レベル1

	ＲU1 case						V	V case	
	Rh1 kN	σt N/mm²	σta N/mm²	τ N/mm²	τa N/mm²	U	kN	σt N/mm²	σta N/mm²
P14	2060	―	540.0	―	300.0	―	610	150.3	540.0
P15	1861	―	540.0	―	300.0	―	514	126.7	540.0
P16	1830	―	540.0	―	300.0	―	533	131.4	540.0
P17	1810	―	540.0	―	300.0	―	529	130.4	540.0
P18	1867	―	540.0	―	300.0	―	517	127.4	540.0
P19	1970	―	540.0	―	300.0	―	583	143.7	540.0

８．２　Checking embedded length of the bolt （LB)

（1）Necessity screw length of the bolt　L_B1(mm)

$$L_B1=\frac{f\cdot(d_B-k2\cdot p)}{3}\cdot\frac{\sigma(B)t}{\tau(B)a}+2\cdot p$$

（2）Necessity screw length of connecting components　L_B2(mm)

$$L_B2=\frac{2\cdot f\cdot(d_B-k2\cdot p)^2}{7\cdot d_B}\cdot\frac{\sigma(B)t}{\tau(N)a}+2\cdot p$$

Where,

f ： Safety factor （recommended ｆ＝1.05）
d_B ： Bolt diameter (Nominal diameter)(mm)
p ： Screw pitch
k2 ： Factor for determined inner diameter of screw in connecting components (k2=1.082532）
σ(B)t ： Maximum shear stress of bolt (N/mm^2)
τ(B)a ： Shear stress of bolts (N/mm^2)
τ(N)a ： Allowable shear stress of crew component (N/mm^2)

Dimensions

	f	d_B mm	p	k2
P14	1.05	24	3.0	1.082532
P15	1.05	24	3.0	1.082532
P16	1.05	24	3.0	1.082532
P17	1.05	24	3.0	1.082532
P18	1.05	24	3.0	1.082532
P19	1.05	24	3.0	1.082532

Calculated result
Level 1

	σ(B)t N/mm^2	τ(B)a N/mm^2	τ(N)a N/mm^2	L_B1 mm	L_B2 mm	L_B mm
P14	150.3	300.0	157.5	9.6	11.4	20.5
P15	126.7	300.0	157.5	9.1	10.5	20.5
P16	131.4	300.0	157.5	9.2	10.7	20.5
P17	130.4	300.0	157.5	9.2	10.7	20.5
P18	127.4	300.0	157.5	9.1	10.6	20.5
P19	143.7	300.0	157.5	9.5	11.2	20.5

９． Bottom plate

９．１ Stress checking in case of longitudinal seismic

(1) Checking flexural moment of rubber bearing connection bolt counter bore section

Tensile force

$T = To \cdot m1$

To : Maximum tensile force on surrounding surface of the set bolt (Maximum tensile force in case of seismic horizontal force and uplift force acting)

$To = \mathrm{Max}(T1, TV)$

$T1 = \sigma t \cdot As$ — Total tensile force of 1 bolt due to load combination.

$TV = V/\Sigma m$ — Tensile force of 1 bolt due to uplift force

$m1$: Number of bolts used in calculation

Flexural moment

$M = T \cdot L$

L : Distance from a connection bolt to a set bolt

Flexural stress

$$\sigma = \frac{6 \cdot M}{B' \cdot t1^2} \leqq \sigma a$$

B' : Dimensions of bearing deducting diameter of connection bolts

$B' = B - n \cdot \varphi D$

B : Dimensions of bearing

n : Number of connection bolts used in calculation

φD : Countersunk diameter of connection bolts

$t1$: Thickness of upper bearing plate

(2) Shear stress at section of connection bolt counter bore

$$\tau = \frac{T}{B' \cdot t1} \leqq \tau a$$

(3) Stress combination checking of the connection bolt counter bore section

$$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2 \leqq Ua = 1.2$$

Calculated result

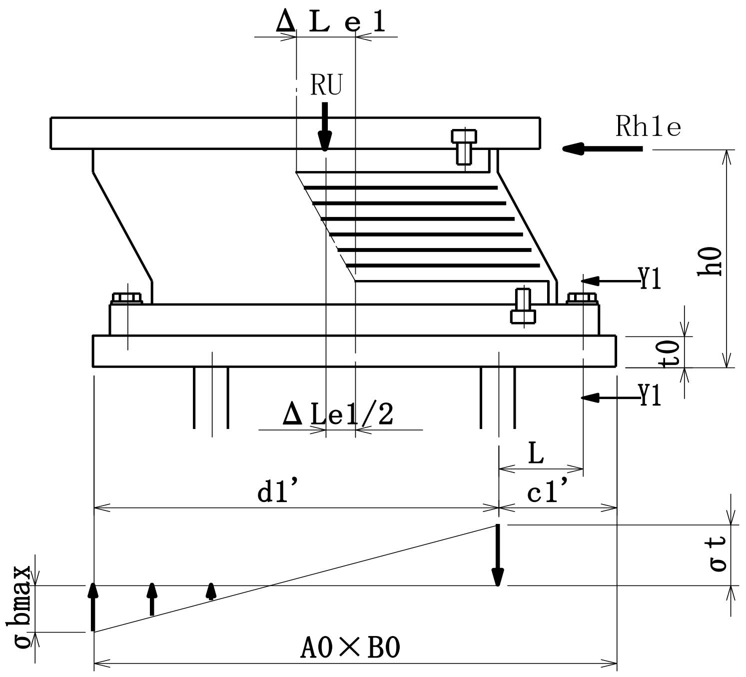
Level 1

	T1 N	TV N	To N	m1 pcs	T N	L mm	M kN・mm	B mm	n pcs
									3
P14	―	50833	50833	4	203332	110	22367	1100	3
P15	―	42833	42833	4	171332	110	18847	1100	3
P16	―	44417	44417	4	177668	110	19543	1100	3
P17	―	44083	44083	4	176332	110	19397	1100	3
P18	―	43083	43083	4	172332	110	18957	1100	3
P19	―	48583	48583	4	194332	110	21377	1100	3

	φD mm	B' mm	t1 mm	Bottom plate material	σ N/mm^2	σa N/mm^2	τ N/mm^2	τa N/mm^2	U
P14	39	983	40	SM490A	85.4	277.5	5.2	157.5	0.10
P15	39	983	40	SM490A	71.9	277.5	4.4	157.5	0.07
P16	39	983	40	SM490A	74.6	277.5	4.6	157.5	0.08
P17	39	983	40	SM490A	74.0	277.5	4.5	157.5	0.08
P18	39	983	40	SM490A	72.4	277.5	4.4	157.5	0.07
P19	39	983	40	SM490A	81.6	277.5	5.0	157.5	0.09

１０．　Anchor bolt

１０．１　Stress checking in case of longitudinal seismic



(1)　Tensile stress in case of RU1＋Rh1 in combination
With the same horizontal force, the smaller the value of vertical force, the more critical the value of tensile force.
Therefore, load case of RU1＋Rh1 in combination shall be selected for checking (Compressive area : A0×B0).

Eccentric Ｅ

$$\Delta Le1/2 + \frac{Rh1 \cdot h0}{RU1}$$

Case of compression
case－1 : 0 ＜ E ≦ Eo ＝ A0／6
case－2 : Eo ＜ E ≦ Eo' ＝ A0／6 ＋ c1'／3
case－3 : Eo' ＜ E,　E ＜ 0

Dimensions

	Longitudinal dimensions A0 mm	Transversal dimensions B0 mm	ｃ1' mm	ｈ0 mm
P14	1420	1620	160	329
P15	1370	1590	145	328
P16	1370	1590	145	328
P17	1370	1590	145	328
P18	1370	1590	145	328
P19	1420	1620	160	329

Level 1

	ＲU1 kN	Rh1 kN	ΔＬe1 mm	Ｅo mm	Ｅo' mm	Ｅ mm	case
P14	5270	2060	0	237	290	129	case-1
P15	4390	1861	0	228	277	139	case-1
P16	4650	1830	0	228	277	129	case-1
P17	4610	1810	0	228	277	129	case-1
P18	4520	1867	0	228	277	136	case-1
P19	5010	1970	0	237	290	129	case-1

Case－1：Trapezoidal shape of stress distribution

$$\begin{matrix}\sigma bmax\\ \sigma bmin\end{matrix} = RU1／(A0 \cdot B0) \pm (Rh1 \cdot h0 + RU1 \cdot \Delta L\, e1/2)／(1/6 \cdot A0^2 \cdot B0) \quad \leqq \sigma ba$$

Case－2：Triangle shape of stress distribution but no tension in bolts

$$\sigma bmax = 2 \cdot RU1／(3 \cdot A0 \cdot (B0/2 - E)) \quad \leqq \sigma ba$$

$$x = 3 \cdot (B0/2 - E)$$

Case－3：Triangle shape of stress distribution, there in tension in bolts

Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Root diameter of bolt　：$d o$
Number of effective bolts　：$m1$
Area of root diameter：As（1 bolt）
Define $l = A0／2 - E$

By solving the following equation to obtain position x of neutral axis

Ratio of young's modulus：n

$$f(x) = x^3 - 3 \cdot l \cdot x^2 + \frac{6 \cdot n \cdot m1 \cdot As}{B0} \cdot (d1' - l) \cdot (x - d1') = 0$$

Maximum compressive stress of contacting surfaces

$$\sigma bmax = \frac{2 \cdot RU1 \cdot x}{B0 \cdot x^2 - 2 \cdot n \cdot m1 \cdot As \cdot (d1' - x)}$$

Table of dimensions

	d o mm	m1 pcs	As mm²/bolt	d 1' mm	n
P14	93.505	2	6867	1260	15
P15	83.505	2	5477	1225	15
P16	83.505	2	5477	1225	15
P17	83.505	2	5477	1225	15
P18	83.505	2	5477	1225	15
P19	93.505	2	6867	1260	15

Level 1

	l mm	x mm	σbmax N/mm²	σba N/mm²
P14	581.4	－	3.6	10.8
P15	546.0	－	3.3	10.8
P16	555.9	－	3.4	10.8
P17	556.2	－	3.4	10.8
P18	549.5	－	3.4	10.8
P19	580.6	－	3.4	10.8

Stress in anchor bolt

Bolt diameter : da
Total number of bolts : Σm
Embedded length : La
Root diameter : do

Tensile stress (Calculation of case-1,2 could be neglected due to no tensile force)

$$\sigma t = \sigma bmax \cdot n \cdot \frac{d1' - x}{x} \leqq \sigma ta$$

(2) Shear stress due to Rh1

$$\tau = \frac{4 \cdot Rh1}{\pi \cdot do^2 \cdot \Sigma m} \leqq \tau a$$

(3) Stresses combination

$$U = (\sigma t / \sigma ta)^2 + (\tau / \tau a)^2 \leqq Ua = 1.2$$

(4) Concrete adhesive checking
Checking tensile force as the result of RHeq1 and RU acting in combination

$$\tau o1 = \frac{\sigma t \cdot As}{\pi \cdot da \cdot La} \leqq \tau oa$$

Checking case of uplift force

$$\tau o2 = \frac{V}{\pi \cdot da \cdot La \cdot \Sigma m} \leqq \tau oa$$

Dimensions

	Class of bolt	da	do mm	Σm bolts	La mm
P14	SS400	100	94	4	1000
P15	SS400	90	84	4	900
P16	SS400	90	84	4	900
P17	SS400	90	84	4	900
P18	SS400	90	84	4	900
P19	SS400	100	94	4	1000

Level 1

	Rh1 kN	σt N/mm²	σta N/mm²	τ N/mm²	τa N/mm²	U	τo1 N/mm²	τo2 N/mm²	τoa N/mm²
P14	2060	—	210.0	65.6	120.0	—	—	0.49	1.20
P15	1861	—	210.0	73.2	120.0	—	—	0.51	1.20
P16	1830	—	210.0	72.0	120.0	—	—	0.53	1.20
P17	1810	—	210.0	71.2	120.0	—	—	0.52	1.20
P18	1867	—	210.0	73.4	120.0	—	—	0.51	1.20
P19	1970	—	210.0	62.8	120.0	—	—	0.47	1.20

１０．４　Checking embedded length of the bolt（LB)

（1）Necessity screw length of the bolt　L_B1(mm)

$$L_B1 = \frac{f \cdot (d_B - k2 \cdot p)}{3} \cdot \frac{\sigma(B)t}{\tau(B)a} + 2 \cdot p$$

（2）Necessity screw length of connecting components　L_B2(mm)

$$L_B2 = \frac{2 \cdot f \cdot (d_B - k2 \cdot p)^2}{7 \cdot d_B} \cdot \frac{\sigma(B)t}{\tau(N)a} + 2 \cdot p$$

Where,

ｆ：Safety factor（recommended ｆ＝1.05）
d_B：Bolt diameter (Nominal diameter)(mm)
ｐ：Screw pitch
k2：Factor for determined inner diameter of screw in connecting components (k2=1.082532）
σ(B)t：Maximum shear stress of bolt (N/mm^2)
τ(B)a：Shear stress of bolts (N/mm^2)
τ(N)a：Allowable shear stress of crew component (N/mm^2)

Dimensions

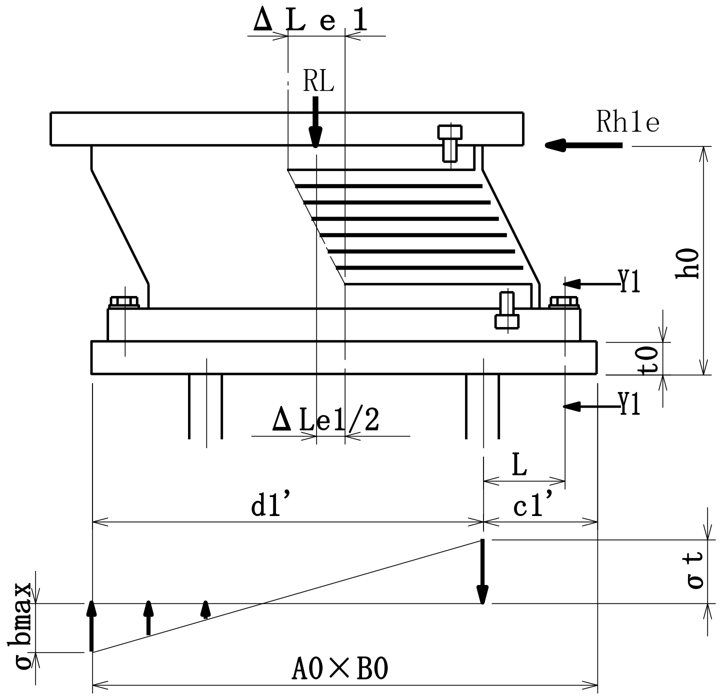
	ｆ	d_B mm	ｐ	k2
P14	1.05	100	6	1.082532
P15	1.05	90	6	1.082532
P16	1.05	90	6	1.082532
P17	1.05	90	6	1.082532
P18	1.05	90	6	1.082532
P19	1.05	100	6	1.082532

Level 1

	σ(B)t N/mm^2	τ(B)a N/mm^2	τ(N)a N/mm^2	L_B1 mm	L_B2 mm	L_B mm
P14	22.3	120	150	-	-	-
P15	23.5	120	150	-	-	-
P16	24.4	120	150	-	-	-
P17	24.2	120	150	-	-	-
P18	23.7	120	150	-	-	-
P19	21.3	120	150	-	-	-

１１． Checking of mortar concrete

１１．１ Stress checking in case of longitudinal seismic



（1） Tensile stress in case of RU1＋Rh1 in combination

With the same horizontal force, the smaller the value of vertical force, the more critical the value of tensile force.
Therefore, load case of RU1＋Rh1 in combination shall be selected for checking (Compressive area ： A0×B0).

Eccentric Ｅ

$$\Delta Le1/2 + \frac{Rh1 \cdot h0}{RL1}$$

Cases of compression

case－1：0 ＜ E ≦ Eo ＝ A0／6
case－2：Eo ＜ E ≦ Eo' ＝ A0／6 ＋ ｃ1'／3
case－3：Eo' ＜ E, E ＜ 0

Dimensions

	Longitudinal dimensions A0 mm	Transversal dimensions B0 mm	ｃ1' mm	ｈ0 mm
P14	1420	1620	160	329
P15	1370	1590	145	328
P16	1370	1590	145	328
P17	1370	1590	145	328
P18	1370	1590	145	328
P19	1420	1620	160	329

Level 1

	RL1 kN	Rh1 kN	ΔＬe1 mm	Ｅo mm	Ｅo' mm	Ｅ mm	case
P14	6890	2060	0	236.7	290.0	98.4	case-1
P15	5770	1861	0	228.3	276.7	105.8	case-1
P16	6110	1830	0	228.3	276.7	98.2	case-1
P17	6050	1810	0	228.3	276.7	98.1	case-1
P18	5830	1867	0	228.3	276.7	105.0	case-1
P19	6560	1970	0	236.7	290.0	98.8	case-1

Case－1：Trapezoidal shape of stress distribution

$$\begin{matrix}\sigma bmax \\ \sigma bmin\end{matrix} = RL1/(A0\cdot B0) \pm (Rh1\cdot h0 + RL1\cdot \Delta Le1/2)/(1/6\cdot A0^2\cdot B0) \quad \leqq \sigma ba$$

Case－2：Triangle shape of stress distribution but no tension in bolts

$$\sigma bmax = 2\cdot RL1/(3\cdot A0\cdot (B0/2 - E)) \quad \leqq \sigma ba$$

$$x = 3\cdot (B0/2 - E)$$

Case－3：Triangle shape of stress distribution, there in tension in bolts

Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Root diameter of bolt　：do
Number of effective bolts　：$m1$
Area of root diameter：As（1 bolt）
Define $l = A0/2 - E$

By solving the following equation to obtain position x of neutral axis
Ratio of young's modulus：n

$$f(x) = x^3 - 3\cdot l\cdot x^2 + \frac{6\cdot n\cdot m1\cdot As}{B0}\cdot (d1' - l)\cdot (x - d1') = 0$$

Maximum compressive stress of contacting surfaces

$$\sigma bmax = \frac{2\cdot RL1\cdot x}{B0\cdot x^2 - 2\cdot n\cdot m1\cdot As\cdot (d1' - x)}$$

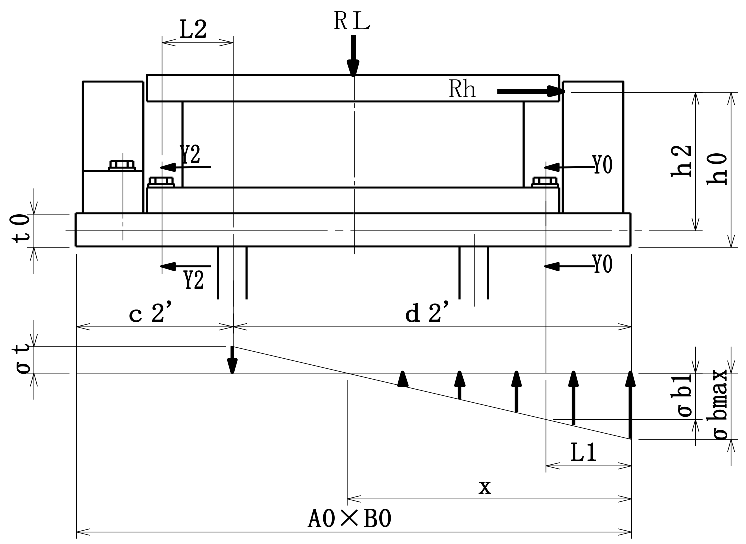
Table of dimensions

	do mm	m1 bolts	As mm^2/bolt	d1' mm	n
P13	42.587	2	1424.4	900	15
P14	93.505	2	6866.9	1260	15
P15	83.505	2	5476.6	1225	15
P16	83.505	2	5476.6	1225	15
P17	83.505	2	5476.6	1225	15
P18	83.505	2	5476.6	1225	15
P19	93.505	2	6866.9	1260	15

Level 1

	l mm	x mm	σbmax N/mm^2	σba N/mm^2
P14	611.6	―	4.3	10.8
P15	579.2	―	3.9	10.8
P16	586.8	―	4.1	10.8
P17	586.9	―	4.0	10.8
P18	580.0	―	4.0	10.8
P19	611.2	―	4.1	10.8

１１．２　Stress checking in case of transversal seismic



(1)　Tensile stress in case of RU2＋Rh2 in combination

With the same horizontal force, the smaller the value of vertical force, the more critical the value of tensile force.

Therefore, load case of RU2＋Rh2 in combination shall be selected for checking (Compressive area：A0×B0).

Eccentric Ｅ

$$E = Rh \cdot h0 / RL$$

Case of compression

case－1：0 ＜ E ≦ Eo ＝ B0／6

case－2：Eo ＜ E ≦　Eo' ＝ B0／6＋ｃ2'／3

case－3：Eo' ＜ E,　E ＜ 0

Dimensions

	A0 mm	B0 mm	ｃ2' mm	ｈ0 mm
P14	1620	1420	160	329.0
P15	1590	1370	145	328.0
P16	1590	1370	145	328.0
P17	1590	1370	145	328.0
P18	1590	1370	145	328.0
P19	1620	1420	160	329.0

Level 1

	RL2 kN	Rh2 kN	Ｅo mm	Ｅo' mm	Ｅ mm	case
P14	7910	1819	270.0	323.3	75.7	case-1
P15	6630	1527	265.0	313.3	75.5	case-1
P16	7010	1613	265.0	313.3	75.5	case-1
P17	6950	1597	265.0	313.3	75.4	case-1
P18	6700	1555	265.0	313.3	76.1	case-1
P19	7530	1736	270.0	323.3	75.8	case-1

Case－1：Trapezoidal shape of stress distribution

$\sigma bmax$ / $\sigma bmin$ ＝RL／(A0・B0)±Rh2・h0／(1/6・$A0^2$・B0)　≦ σba

Case－2：Triangle shape of stress distribution but no tension in bolts

σbmax ＝2・RL／(3・A0a・(B0/2－E))　≦ σba

x ＝3・(B0/2－E)

Case－3：Triangle shape of stress distribution, there in tension in bolts

Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Root diameter of bolt　　：do
Number of effective bolts　：m2
Area of root diameter：As（1 bolt）
Define l ＝B0／2－E

By solving the following equation to obtain position x of neutral axis

Ratio of young's modulus：n

$$f(x) = x^3 - 3 \cdot l \cdot x^2 + \frac{6 \cdot n \cdot m2 \cdot As}{B0} \cdot (d2' - l) \cdot (x - d2') = 0$$

Maximum compressive stress of contacting surfaces

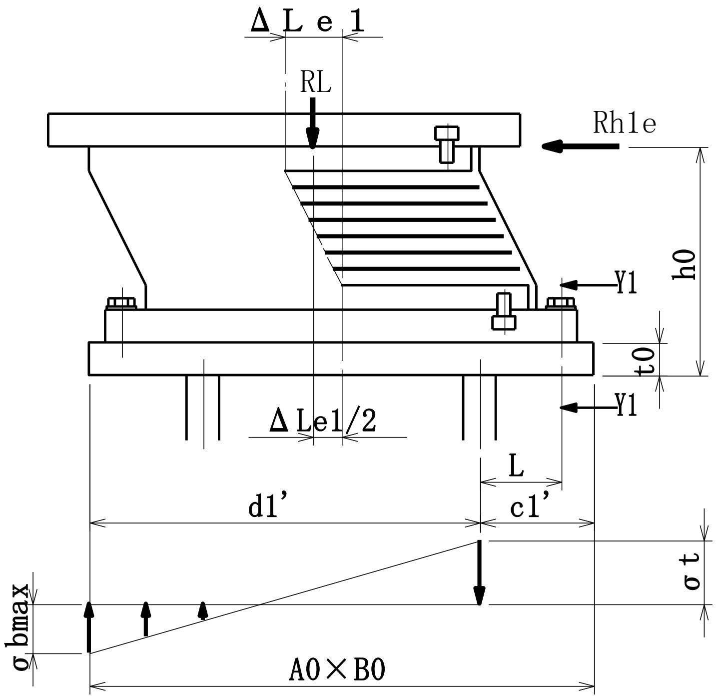
$$\sigma bmax = \frac{2 \cdot RL \cdot x}{B0 \cdot x^2 - 2 \cdot n \cdot m2 \cdot As \cdot (d2' - x)}$$

Level 1

	l mm	do mm	m2 bolts	As mm^2/bolt	d2' mm	n	x mm	σbmax N/mm^2	σba N/mm^2
P14	734.3	93.505	2	6866.9	1460	15	－	4.4	10.8
P15	719.5	83.505	2	5476.6	1445	15	－	3.9	10.8
P16	719.5	83.505	2	5476.6	1445	15	－	4.1	10.8
P17	719.6	83.505	2	5476.6	1445	15	－	4.1	10.8
P18	718.9	83.505	2	5476.6	1445	15	－	4.0	10.8
P19	734.2	93.505	2	6866.9	1460	15	－	4.2	10.8

１２． Base plate

１２．１ Stress checking in case of longitudinal seismic



（1） Checking flexural moment of rubber bearing connection bolt counter bore section

Tensile force

$T = To \cdot m1$

To : Maximum tensile force on surrounding surface of the set bolt (Maximum tensile force in case of seismic horizontal force and uplift force acting)

$To = Max(T1, TV)$

$T1 = \sigma t \cdot As$

$TV = V / \Sigma m$

$m1$: Number of anchor bolts used in calculation

Flexural moment

$M = T \cdot L$

L : Distance from a connection bolt to an anchor bolt

Flexural stress

$$\sigma t = \frac{6 \cdot M}{B0' \cdot t0^2} \leqq \sigma ta$$

B0' : Dimensions of bearing deducting diameter of connection bolts

$B0' = B0 - m1' \cdot \varphi$

$m1'$: Number of bolt in outer column in transversal direction

φ : Root diameter of a connection bolt

$t0$: Thickness of base plate

（2） Shear stress at section of bolt hole

$$\tau t = \frac{T}{B0' \cdot t0} \leqq \tau ta$$

（3） Stress combination checking of the bolt hole

$$U = (\sigma t / \sigma ta)^2 + (\tau t / \tau ta)^2 \leqq Ua = 1.2$$

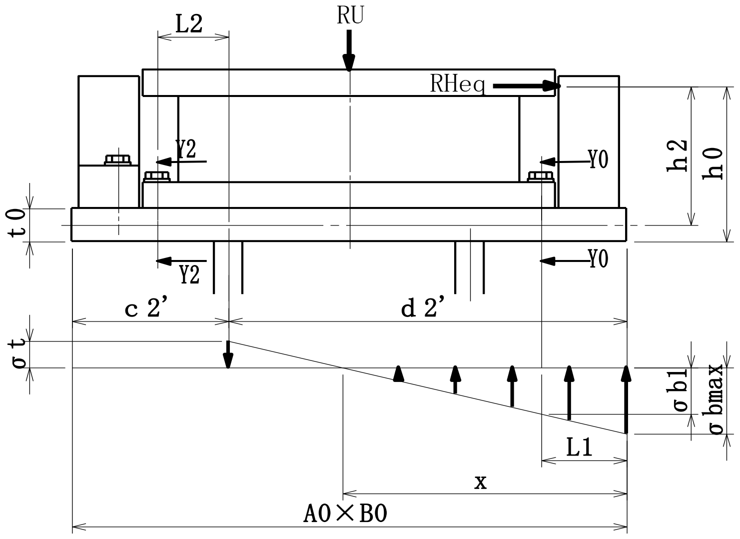
Level 1

	T1 N	TV N	To N	m1' bolts	T N	L mm	M kN・mm	t0 mm	B0 mm
P14	－	152500	152500	2	305000	40	12200	85	1620
P15	－	128500	128500	2	257000	30	7710	85	1590
P16	－	133250	133250	2	266500	30	7995	85	1590
P17	－	132250	132250	2	264500	30	7935	85	1590
P18	－	129250	129250	2	258500	30	7755	85	1590
P19	－	145750	145750	2	291500	40	11660	85	1620

	m1' bolts	φ mm	B0' mm	Base plate material	σt N/mm^2	σta N/mm^2	σt N/mm^2	σta N/mm^2	U
P14	4	24	1524	SM490A	6.7	262.5	2.4	150.0	0.01
P15	4	24	1494	SM490A	4.3	262.5	2.1	150.0	0.01
P16	4	24	1494	SM490A	4.5	262.5	2.1	150.0	0.01
P17	4	24	1494	SM490A	4.5	262.5	2.1	150.0	0.01
P18	4	24	1494	SM490A	4.4	262.5	2.1	150.0	0.01
P19	4	24	1524	SM490A	6.4	262.5	2.3	150.0	0.01

12.2 Stress in transversal direction in case of using side blocks

ＲＵ case



（1） Compressive stress

Eccentric Ｅ

$$E = Rh \cdot h0 / RU$$

Case of compression

case－1 : 0 ＜ E ≦ Eo ＝ B0／ 6

case－2 : Eo ＜ E ≦ Eo' ＝ B0 ／ 6 ＋ ｃ2' ／ 3

case－3 : Eo' ＜ E, E ＜ 0

Calculated results

	A0 mm	B0 mm	ｃ2' mm	ｈ0 mm
P14	1620	1420	160	329.0
P15	1590	1370	145	328.0
P16	1590	1370	145	328.0
P17	1590	1370	145	328.0
P18	1590	1370	145	328.0
P19	1620	1420	160	329.0

Level 1

	RU2 kN	Rh2 kN	Ｅo mm	Ｅo' mm	Ｅ mm	case
P14	4240	1892	270.0	323.3	146.8	case-1
P15	3530	1589	265.0	313.3	147.6	case-1
P16	3740	1678	265.0	313.3	147.2	case-1
P17	3710	1661	265.0	313.3	146.8	case-1
P18	3650	1618	265.0	313.3	145.4	case-1
P19	4020	1806	270.0	323.3	147.8	case-1

Case－1：Trapezoidal shape of stress distribution

$$\begin{matrix}\sigma bmax \\ \sigma bmin\end{matrix} = RU／(A0 \cdot B0) \pm Rh2 \cdot h0／(1/6 \cdot A0^2 \cdot B0) \quad \leqq \sigma ba$$

Case－2：Triangle shape of stress distribution but no tension in bolts

$$\sigma bmax = 2 \cdot RU／(3 \cdot A0\,a \cdot (B0/2 - E)) \quad \leqq \sigma ba$$

$$x = 3 \cdot (B0/2 - E)$$

Case－3：Triangle shape of stress distribution, there in tension in bolts

Calculations based on explanation of single rebar concrete section under compression to calculate tensile force in bolts. And, it could be calculated in only 1 column of the outer row.

Root diameter of bolt　　　：do
Number of effective bolts　：$m2$
Area of root diameter：As（1 bolt）
Define $l = a／2 - E$

By solving the following equation to obtain position x of neutral axis
Ratio of young's modulus：n

$$f(x) = x^3 - 3 \cdot l \cdot x^2 + \frac{6 \cdot n \cdot m2 \cdot As}{B0} \cdot (d2' - l) \cdot (x - d2') = 0$$

Maximum compressive stress of contacting surfaces

$$\sigma bmax = \frac{2 \cdot RU \cdot x}{B0 \cdot x^2 - 2 \cdot n \cdot m2 \cdot As \cdot (d2' - x)}$$

Level 1

	l mm	do mm	m2 bolts	As mm²/bolt	d2' mm	n	x mm	σbmax N/mm²	σba N/mm²
P14	663.2	93.505	2	6866.9	1460	15	－	2.8	10.8
P15	647.4	83.505	2	5476.6	1445	15	－	2.5	10.8
P16	647.8	83.505	2	5476.6	1445	15	－	2.7	10.8
P17	648.2	83.505	2	5476.6	1445	15	－	2.6	10.8
P18	649.6	83.505	2	5476.6	1445	15	－	2.6	10.8
P19	662.2	93.505	2	6866.9	1460	15	－	2.7	10.8

（2） Stresses of anchor bolt

Bolt diameter　　：da
Total bolt number　：Σm
Embedded length：La

Tensile force

$$\sigma t = \sigma bmax \cdot n \cdot \frac{d2' - x}{x} \quad \leqq \sigma ta$$

Shear stress due to Rh2

$$\tau = \frac{4 \cdot Rh2}{\pi \cdot do^2 \cdot \Sigma m} \quad \leqq \tau a$$

Stress combination

$$U = (\sigma t／\sigma ta)^2 + (\tau／\tau a)^2 \quad \leqq Ua = 1.2$$

Concrete cohesive stress

$$\tau o = \frac{\sigma t \cdot As}{\pi \cdot da \cdot La} \quad \leqq \tau oa$$

Dimensions and horizontal forces

	Class of bolt	da	do mm	Σm bolts	La mm
P14	SS400	100	93.505	4	1000
P15	SS400	90	83.505	4	900
P16	SS400	90	83.505	4	900
P17	SS400	90	83.505	4	900
P18	SS400	90	83.505	4	900
P19	SS400	100	93.505	4	1000

Calculated results

	Rh2 kN	σt N/mm2	σta N/mm2	τ N/mm2	τa N/mm2	U	τo N/mm2	τoa N/mm^2
P14	1892	―	―	60.3	120.0	―	―	―
P15	1589	―	―	62.5	120.0	―	―	―
P16	1678	―	―	66.0	120.0	―	―	―
P17	1661	―	―	65.3	120.0	―	―	―
P18	1618	―	―	63.6	120.0	―	―	―
P19	1806	―	―	57.5	120.0	―	―	―

(3) Stresses in section Y0－Y0

Flexural moment

In case of $x \geqq L1$

$M = Rh2 \cdot h2 - (2 \cdot \sigma bmax + \sigma b1) \cdot L1^2 \cdot A0/6$

case-1 : $\sigma b1 = (\sigma bmax - \sigma bmin) / B0 \times (B0 - L1) + \sigma bmin$

case-2,3 : $\sigma b1 = \sigma bmax / x \times (x - L1)$

In case of $x < L$

$M = Rh \cdot h2 - (\sigma bmax \cdot (3 \cdot L1 - x) \cdot x) \cdot A0/6$

In case of $\sigma bmax < 0$

$M = Rh \cdot h2$

Tensile bending stress

When position of the outer column of the anchor bolt is set inside the position of connection bolts

$\sigma t = 6 \cdot M / (A0' \cdot t0^2) + Rh2 / (A0' \cdot t0) \qquad \leqq \sigma ta$

A0' : Dimensions of base plate neglected holes of connection bolts

$A0' = A0 - m2' \cdot \varphi$

m2' : Number of connection bolts of the outer column in transversal direction

φ : Root diameter of bottom plate connection bolts

Level 1

	Base plate material	Rh2 kN	h2 mm	σbmax N/mm^2	σbmin N/mm^2	σb1 N/mm^2	L1 mm	M kN・mm
P14	SM490A	1892	286.5	2.8	0.8	2.5	300	367596
P15	SM490A	1589	285.5	2.5	0.7	2.2	285	319257
P16	SM490A	1678	285.5	2.7	0.7	2.3	285	337360
P17	SM490A	1661	285.5	2.6	0.7	2.3	285	333376
P18	SM490A	1618	285.5	2.6	0.7	2.3	285	323027
P19	SM490A	1806	286.5	2.7	0.7	2.3	300	353232

	t0 mm	B0 mm	m2' bolts	φ mm	A0' mm	A0 mm	σt N/mm^2	σta N/mm^2
P14	85	1620	4	24	1324	1420	247.4	262.5
P15	85	1590	4	24	1274	1370	222.8	262.5
P16	85	1590	4	24	1274	1370	235.5	262.5
P17	85	1590	4	24	1274	1370	232.7	262.5
P18	85	1590	4	24	1274	1370	225.6	262.5
P19	85	1620	4	24	1324	1420	237.7	262.5

(4) Stresses in cross section Ｙ２－Ｙ２

Tensile force

$T = To \cdot m2$

To : Maximum tensile force on surrounding surface of the set bolt
(Maximum tensile force in case of seismic horizontal force and uplift force acting)

$To = Max(T2, TV)$

$T2 = \sigma t \cdot As$

$TV = V\ (V')/\Sigma m$

m2 : Number of anchor bolts used in calculation

Flexural moment

$M = T \cdot L2$

Flexural stress

$$\sigma = \frac{6 \cdot M}{A0' \cdot t0^2} \leqq \sigma a$$

Shear stress

$$\tau = \frac{T}{A0' \cdot t0} \leqq \tau a$$

Stresses combination

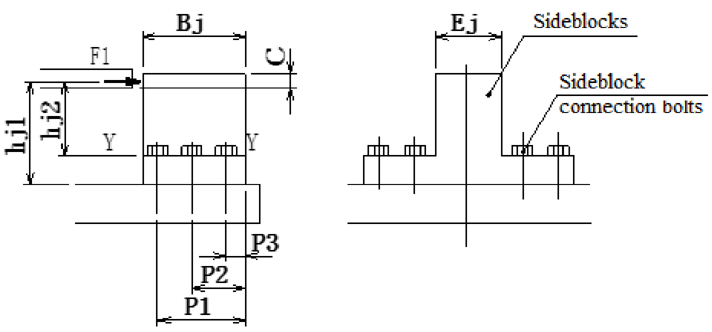
$$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2 \qquad \leqq Ua = 1.2$$

Level 1

	T2 N	TV N	T0 N	m2 bolts	T N	L2 mm	M kN・mm
P14	－	152500	152500	2	305000	140	42700
P15	－	128500	128500	2	257000	140	35980
P16	－	133250	133250	2	266500	140	37310
P17	－	132250	132250	2	264500	140	37030
P18	－	129250	129250	2	258500	140	36190
P19	－	145750	145750	2	291500	140	40810

	A0' mm	t0 mm	σ N/mm2	σa N/mm2	τ N/mm2	τa N/mm2	U
P14	1324	85	26.8	262.5	2.8	150.0	0.02
P15	1274	85	23.5	262.5	2.4	150.0	0.01
P16	1274	85	24.4	262.5	2.5	150.0	0.01
P17	1274	85	24.2	262.5	2.5	150.0	0.01
P18	1274	85	23.6	262.5	2.4	150.0	0.01
P19	1324	85	25.6	262.5	2.6	150.0	0.01

１３． Side blocks



１３．１ Checking stresses of side block connection bolts

Nominal diameter of bolt : d_B
Root diameter of bolt : ｄo
Total number of bolts : Σｍ
Number of bolts in 1 column : ｍｊ
Number of columns : ｎ
Root diameter area : Ａs （For 1 bolt）

$$As = \pi/4 \cdot do^2$$

（１） Stress due to of longitudinal horizontal force （Fix bearing only）

(a) Tensile stress

Tensile force : T

$$T = \frac{Rh1/2 \cdot h1 \cdot Li}{(L1^2 + L2^2 + \cdot \cdot \cdot + Li^2) \cdot n}$$

$$\sigma t = \frac{T}{As} \leqq \sigma ta$$

(b) Shear stress

$$\tau = \frac{RH1}{\Sigma m \cdot As} \leqq \tau a$$

(c) Stress combination

$$U = (\sigma t / \sigma ta)^2 \cdot (\tau / \tau a)^2 \qquad \leqq Ua = 1.2$$

Dimensions and properties of bolts

	Design condition	Class of bolt	d_B	ｄo mm	Σｍ pcs	ｍj pcs	ｎ columns	Ａs mm^2	h1 mm
P14	Fix	8.8	36	31.670	12	6	2	787.7	244.0
P15	Fix	8.8	36	31.670	12	6	2	787.7	243.0
P16	Fix	8.8	36	31.670	12	6	2	787.7	243.0
P17	Fix	8.8	36	31.670	12	6	2	787.7	243.0
P18	Fix	8.8	36	31.670	12	6	2	787.7	243.0
P19	Fix	8.8	36	31.670	12	6	2	787.7	244.0

	L1 mm	L2 mm	L3 mm	L4 mm	L5 mm	L6 mm	L7 mm	L8 mm	Li mm
P14	55	165	275	595	705	815	—	—	815
P15	55	165	275	595	705	815	—	—	815
P16	55	165	275	595	705	815	—	—	815
P17	55	165	275	595	705	815	—	—	815
P18	55	165	275	595	705	815	—	—	815
P19	55	165	275	595	705	815	—	—	815

Calculated results

	RH1 kN	T N	σt N/mm2	σta N/mm^2	τ N/mm^2	τa N/mm^2	U
P14	2060	63768	81.0	540.0	109.0	300.0	0.15
P15	1861	57372	72.9	540.0	98.5	300.0	0.13
P16	1830	56416	71.7	540.0	96.9	300.0	0.12
P17	1810	55799	70.9	540.0	95.8	300.0	0.12
P18	1867	57557	73.1	540.0	98.8	300.0	0.13
P19	1970	60982	77.5	540.0	104.3	300.0	0.14

（2） Stress due to of transverse horizontal force （Fix bearing only）

(a) Tensile stress

Tensile force ： T

$$T = \frac{RH2 \cdot h1 \cdot P1}{(P1^2 + P2^2 + P3^2) \cdot m}$$

$$\sigma t = \frac{T}{As} \leqq \sigma ta$$

（b） Shear stress

$$\tau = \frac{RH2}{\Sigma m \cdot As} \leqq \tau a$$

（c） Stress combination

$$U = (\sigma t / \sigma ta)^2 \cdot (\tau / \tau a)^2 \leqq Ua = 1.2$$

Dimensions and properties of bolts

	Design Condition	Class of bolt	d_B	d o mm	Σm bolts	m bolts	n bolts	As mm^2
P14	Fix	8.8	36	31.670	12	6	2	787.7
P15	Fix	8.8	36	31.670	12	6	2	787.7
P16	Fix	8.8	36	31.670	12	6	2	787.7
P17	Fix	8.8	36	31.670	12	6	2	787.7
P18	Fix	8.8	36	31.670	12	6	2	787.7
P19	Fix	8.8	36	31.670	12	6	2	787.7

	h 1 mm	P1 mm	P2 mm	P3 mm
P14	244.0	185	75	0
P15	243.0	175	65	0
P16	243.0	175	65	0
P17	243.0	175	65	0
P18	243.0	175	65	0
P19	244.0	185	75	0

Calculated results

Level 1

	RH2 kN	T N	σt N/mm2	σta N/mm^2	τ N/mm^2	τa N/mm^2	U
P14	1892	357193	453.5	540.0	200.2	300.0	1.15
P15	1589	323157	410.3	540.0	168.2	300.0	0.89
P16	1678	341258	433.3	540.0	177.6	300.0	0.99
P17	1661	337800	428.9	540.0	175.8	300.0	0.97
P18	1618	329055	417.8	540.0	171.2	300.0	0.92
P19	1806	340957	432.9	540.0	191.1	300.0	1.05

１３．２　Checking stress of side blocks

（１）Stress due to of longitudinal horizontal force （Fix bearing only）

（ａ）Flexural stress in Y－Y cross section

$$\sigma = \frac{6 \cdot Rh1/2 \cdot h2}{E^2 \cdot B} \leqq \sigma a$$

（ｂ）Shear stress in Y－Y cross section

$$\tau = \frac{Rh1/2}{B \cdot E} \leqq \tau a$$

（ｃ）Stress combination in Y－Y cross section

$$U = (\sigma / \sigma a)^2 \cdot (\tau / \tau a)^2 \leqq Ua = 1.2$$

Dimensions

	Side blocks material	B mm	E mm	C mm	h2 mm
P14	SM490A or SCW480N	240	210	40	134.0
P15	SM490A or SCW480N	230	210	30	133.0
P16	SM490A or SCW480N	230	210	30	133.0
P17	SM490A or SCW480N	230	210	30	133.0
P18	SM490A or SCW480N	230	210	30	133.0
P19	SM490A or SCW480N	240	210	40	134.0

Calculated results

	Rh1 kN	σb N/mm^2	σba N/mm^2	σ N/mm^2	σa N/mm^2	τ N/mm^2	τa N/mm^2	U
P14	2060	245.3	337.5	156.5	229.5	40.9	135.0	0.56
P15	1861	295.4	337.5	146.5	229.5	38.6	135.0	0.49
P16	1830	290.5	337.5	144.0	229.5	37.9	135.0	0.48
P17	1810	287.4	337.5	142.5	229.5	37.5	135.0	0.47
P18	1867	296.4	337.5	146.9	229.5	38.7	135.0	0.50
P19	1970	234.6	337.5	149.7	229.5	39.1	135.0	0.51

(2) Stress due to of transverse horizontal force

(a) Compressive stress

$$\sigma b = \frac{Rh2}{C \cdot Ej} \leqq \sigma ba$$

(b) Flexural stress in X－X cross section

$$\sigma = \frac{6 \cdot Rh2 \cdot h2}{B^2 \cdot E} \leqq \sigma a$$

(c) Shear stress in X－X cross section

$$\tau = \frac{Rh2}{B \cdot E} \leqq \tau a$$

(d) Stress combination in X－X cross section

$$U = (\sigma / \sigma a)^2 \cdot (\tau / \tau a)^2 \leqq Ua = 1.2$$

Dimensions

	Side blocks material	B mm	E mm	C mm	h2 mm
P14	SM490A or SCW480N	240	210	40	134.0
P15	SM490A or SCW480N	230	210	30	133.0
P16	SM490A or SCW480N	230	210	30	133.0
P17	SM490A or SCW480N	230	210	30	133.0
P18	SM490A or SCW480N	230	210	30	133.0
P19	SM490A or SCW480N	240	210	40	134.0

Calculated results

	Rh2 kN	σb N/mm²	σba N/mm²	σ N/mm²	σa N/mm²	τ N/mm²	τa N/mm²	U
P14	1892	225.3	337.5	125.8	229.5	37.6	135.0	0.38
P15	1589	252.3	337.5	114.2	229.5	32.9	135.0	0.31
P16	1678	266.4	337.5	120.6	229.5	34.8	135.0	0.35
P17	1661	263.7	337.5	119.4	229.5	34.4	135.0	0.34
P18	1618	256.9	337.5	116.3	229.5	33.5	135.0	0.32
P19	1806	215.0	337.5	120.1	229.5	35.9	135.0	0.35

１３．３　Checking embedded length of the bolt（LB）

（1） Necessity screw length of the bolt　L_B1(mm)

$$L_B1 = \frac{f \cdot (d_B - k2 \cdot p)}{3} \cdot \frac{\sigma(B)t}{\tau(B)a} + 2 \cdot p$$

（2） Necessity screw length of connecting components　L_B2(mm)

$$L_B2 = \frac{2 \cdot f \cdot (d_B - k2 \cdot p)^2}{7 \cdot d_B} \cdot \frac{\sigma(B)t}{\tau(N)a} + 2 \cdot p$$

Where,
- ｆ : Safety factor（recommended ｆ＝1.05）
- d_B : Bolt diameter (Nominal diameter)(mm)
- ｐ : Screw pitch
- k2 : Factor for determined inner diameter of screw in connecting components (k2=1.082532）
- σ(B)t : Maximum shear stress of bolt (N/mm^2)
- τ(B)a : Shear stress of bolts (N/mm^2)
- τ(N)a : Allowable shear stress of crew component (N/mm^2)

Dimensions

	f	d_B mm	p	k2	σ(B)t N/mm^2	τ(B)a N/mm^2	τ(N)a N/mm^2
P14	1.05	36	4	1.082532	0	340	170
P15	1.05	36	4	1.082532	0	340	170
P16	1.05	36	4	1.082532	0	340	170
P17	1.05	36	4	1.082532	0	340	170
P18	1.05	36	4	1.082532	0	340	170
P19	1.05	36	4	1.082532	0	340	170

Calculated results

	L_B1 mm	L_B2 mm	L_B mm
P14	24.8	30.3	64.0
P15	23.2	28.2	64.0
P16	24.0	29.3	64.0
P17	23.8	29.1	64.0
P18	23.4	28.5	64.0
P19	24.0	29.3	64.0

2. Design of Steel Bearing of P13 and P20

BAGO (P13&P20) Approach Bridge- Bearing calculation sheet

1． Design reaction load

Total reaction load	R	
Dead load reaction force	Rd	
Longitudinal Horizontal load（in movement）	RH1f ＝ 0.1・R	
Uplift force （in seismic）	V ＝ｍａｘ（0.1・Rd, －RU）	
Downward direction reaction force in seismic	RL	Refer "(Reference 1) RURL"
Upward direction reaction force in seismic	RU	Refer "(Reference 1) RURL"

Table of design reaction force

		Total reaction load R (kN)	Dead load reaction force Rd (kN)	Maximum Horizontal load Hmax (kN)	Uplift force V (kN)	Total Displacement e (mm)
P13		3200	2200	700	220	260
P20		3000	1900	600	190	240

		Movement period	Seismic period			
		Longitudinal Horizontal load	Longitudinal Horizontal load	Tranversal Horizontal load	Seismic coeffiction	
		ＲH1f	ＲH1e	ＲH2e	Ｋh	
		(kN)	(kN)	(kN)	(Longitudinal)	(Horizontal)
P13		350	500	700	0.30	0.30
P20		300	400	600	0.30	0.30

		Vertical load in seismic（Longitudinal）		Vertical load in seismic（Tranversal）	
		Downward	Upward	Downward	Upward
		ＲL	ＲU	ＲL	ＲU
		(kN)	(kN)	(kN)	(kN)
P13		2500	1900	2750	1650
P20		2050	1600	2300	1350

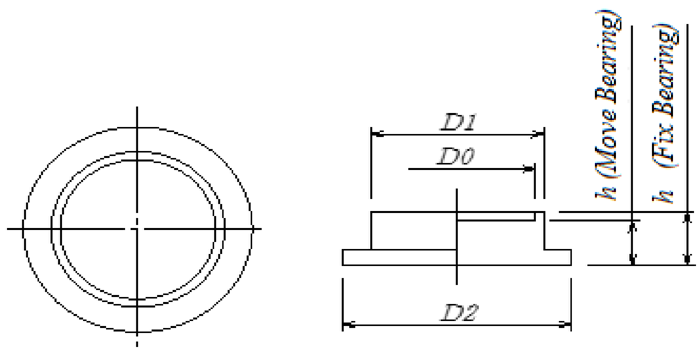
２．Sliding plate（ＰＴＦＥ）Check by contact pressure

$$\sigma b = \frac{R}{\pi/4 \cdot D^2} \leqq \sigma ba \quad (N/mm^2)$$

Calculation result

		Total reaction load R (kN)	Diameter φD (mm)	Contact pressure σb (N/mm2)	Allowable value
P13		3200	390	26.8	30.0
P20		3000	390	25.1	30.0

３． Bending stress checking at center section of Middle plate



Bending stress

Fix Bearing : $M = 1/2 \cdot R \cdot 2/3\pi \cdot (D2 - D1)$

Move Bearing : $M = 1/2 \cdot R \cdot 2/3\pi \cdot (D2 - D0)$

$JN = 1/12 \cdot D1 \cdot h^3$

$\sigma = M / JN \times h/2 \quad \leqq \quad \sigma a \quad (N/mm^2)$

Calculation result

		Total reaction load R (kN)	Hole diameter φD0 (mm)	Diameter (upper) φD1 (mm)	Diameter (lower) φD2 (mm)	Height h (mm)	Material
P13		3200	390	420	429	41	SS400
P20		3000	390	420	429	41	SS400

		M (N・mm)	J N (mm4)	Bending stress σa (N/mm2)	Allowable value
P13		13241691	2412235	112.5	125.0
P20		12414086	2412235	105.5	125.0

4． Compressive stress checking of Rubber plate（Chloroprene rubber）

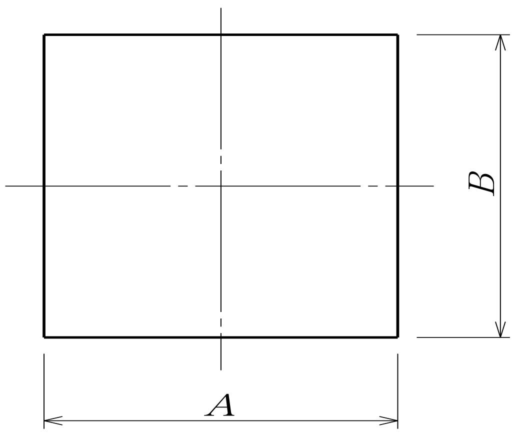
$$\sigma b = \frac{R}{\pi/4 \cdot D^2} \leqq \sigma ba \quad (N/mm^2)$$

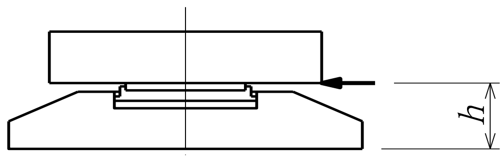
Calculation result

		Total reaction load R (kN)	Diameter φD (mm)	Compressive stress σb (N/mm2)	Allowable value
P13		3200	430	22.0	25.0
P20		3000	430	20.7	25.0

5． Lower plate

5． 1 Compressive stress





（1） Normal condition:

$$\sigma b = \frac{R}{A \times B} \leqq \sigma ba \quad (N/mm^2)$$

（2） In movement period

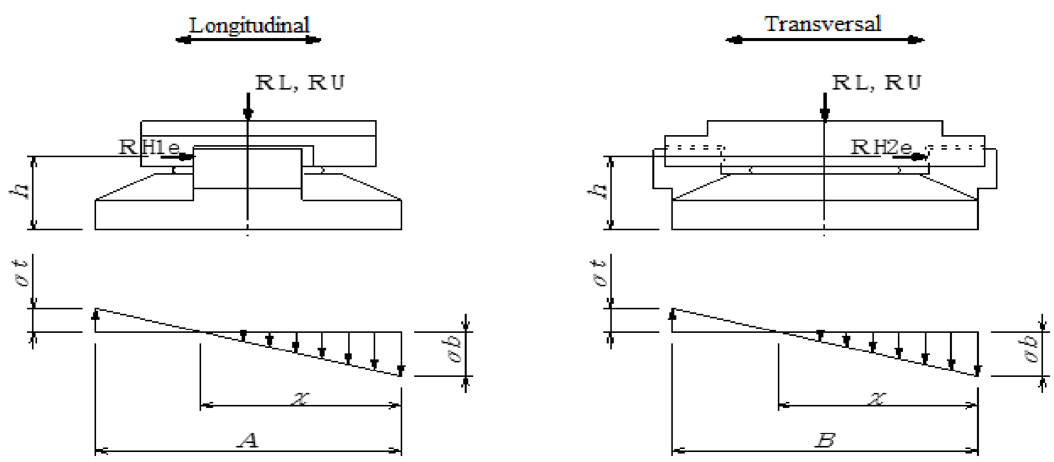
$$\begin{array}{l}\sigma bf(max) \\ \sigma bf(min)\end{array} = \frac{R}{A \times B} \pm \frac{RH1f \times h}{1/6 \times A^2 \times B} \leqq 1.15 \times \sigma ba \quad (N/mm^2)$$

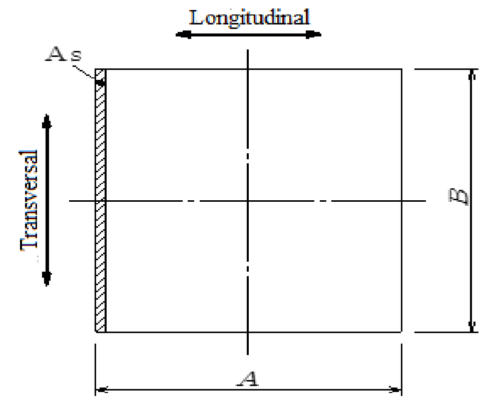
Calculation result

		Total reaction load R (kN)	Longitudinal Horizontal load RH1f (kN)	Longitudinal length A (mm)	Tranversal length B (mm)	Height h (mm)	Material	
							Lower plate	Base plate
P13		3200	350	580	580	160.0	SCW480N	SM490A
P20		3000	300	580	580	160.0	SCW480N	SM490A

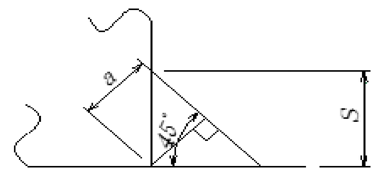
		Compressive stress of Substructure					
		σb		σbf(max)		σbf(min)	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		9.5	250.0	11.2	287.5	7.8	287.5
P20		8.9	250.0	10.4	287.5	7.4	287.5

（3） In seismic period

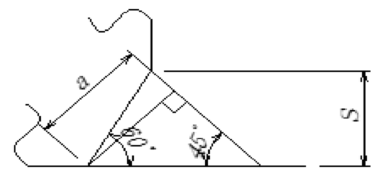




Detail of welding part



$a = S/\sqrt{2}$



$a = S \times 1/\sqrt{2} \times (1 + 1/\sqrt{3})$

（1） Check according to horizontal load

Eccentricity： E

$$E = \left| \frac{RH1e \times h}{RL, U} \right|$$

When Vertical load is positive ： $E0 = A/6$

When Vertical load is negative ： $E0 = A/2$

（a） When positive Vertical load $E \leqq E0$

The tensile force is not acted in welded part .

Compressive stress

$$\sigma bmax = \frac{RL, U}{A \times B} + \frac{6 \, (RH1e \cdot h)}{A^2 \cdot B} \leqq 1.5 \times \sigma ba \quad (N/mm^2)$$

Shear stress of welded part

$$\tau = RH1e / \{2 \times (A + B) \times a\} \leqq 1.5 \times \tau a \quad (N/mm^2)$$

（b） When $E > E0$

The tensile force is acted in welded part .

When Vertical load ís positive : $l = A/2 - E$

When Vertical load ís negative : $l = A/2 + E$

$As = B \times a$, Young coefficient rate : $n = 1$

Determind the neutral axis : χ

$$\chi^3 - 3 \cdot l \cdot \chi^2 + \frac{6 \cdot n \cdot As}{B} \cdot (A - l) \cdot (\chi - A) = 0$$

Compressive stress

$$\sigma bmax = \frac{2 \cdot RL,U}{B \cdot \chi - 2 \cdot n \cdot As \cdot (A - \chi) / \chi} \leqq 1.5 \times \sigma ba \quad (N/mm^2)$$

The tensile stress in welded part :

$$\sigma t = \sigma bmax \cdot n \cdot (A - \chi) / \chi \leqq 1.5 \times \sigma ta \quad (N/mm^2)$$

The shearing stress in welded part :

$$\tau = RH1e / \{2 \times (A + B) \times a\} \leqq 1.5 \times \tau a \quad (N/mm^2)$$

Composition of stress in welded part:

$$U = (\sigma t / \sigma ta)^2 + (\tau / \tau a)^2 \leqq 1.2$$

（c） When negative Vertical load $E \leqq E0$

The compressive force is not created in welded part , only the tensile stress acting on the welding part.

Tensile stress of welded part:

$$\sigma tmax = \frac{RL,U \cdot \{(A/2) + E\}}{2 \cdot As \cdot (A/2)} \leqq 1.5 \times \sigma ta \quad (N/mm^2)$$

Shear stress in welding part:

$$\tau = RH1e / \{2 \times (A + B) \times a\} \leqq 1.5 \times \tau a \quad (N/mm^2)$$

Composition of stress in welded part:

$$U = (\sigma t / \sigma ta)^2 + (\tau / \tau a)^2 \leqq 1.2$$

Reaction force and dimension value（Longitudinal direction）

		Vertical load in seismic		Horizontal load	Acting height	Longitudinal length	Transversal length
		RL (kN)	RU (kN)	RH1e (kN)	h (mm)	A (mm)	B (mm)
P13		2500	1900	500	170.5	580	580
P20		2050	1600	400	170.5	580	580

		Size	Effective thickness		Young coefficient rate	Material	
		S (mm)	a (mm)	As (mm2)	n	Lower plate	Base plate
P13		10	7.07	4101	1	SCW480N	SM490A
P20		10	7.07	4101	1	SCW480N	SM490A

Calculation result（Longitudinal direction ：ＲＬ）

		Decision checking				Neutral axis
		Eccentricity		Decision		
		E (mm)	E0 (mm)		l (mm)	χ (mm)
P13		34.1	96.7	(a)		
P20		33.3	96.7	(a)		

		Stress cheking							
		Compressive stress σbmax		Tensile stress σt		Shear stress τ		Composition U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		10.1	375.0		150.0	30.5	150.0	0.04	1.00
P20		8.2	375.0		150.0	24.4	150.0	0.03	1.00

Calculation result（Longitudinal direction：ＲU）

		Decision checking				
		Eccentricity		Decision		Neutral axis
		E (mm)	E 0 (mm)		l (mm)	χ (mm)
P13		44.9	96.7	(a)		
P20		42.6	96.7	(a)		

		Stress checking							
		Compressive stress σbmax		Tensile stress σt		Shear stress τ		Composition U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		8.3	375.0		150.0	30.5	150.0	0.04	1.00
P20		6.9	375.0		150.0	24.4	150.0	0.03	1.00

Reaction force and dimension （Transversal）

		Vertical load in seismic		Tranversal Horizontal load	Acting height	Longitudinal length	Transversal length
		RL (kN)	RU (kN)	RH2e (kN)	h (mm)	A (mm)	B (mm)
P13		2750	1650	700	170.5	580	580
P20		2300	1350	600	170.5	580	580

		Size S (mm)	Effective thickness a (mm)	As (mm2)	Young coefficient rate n
P13		10	7.07	4101	1
P20		10	7.07	4101	1

Calculation result（Transversal direction ：ＲL）

		Decision checking				
		Eccentricity		Decision		Neutral axis
		Ｅ (mm)	Ｅ0 (mm)		l (mm)	χ (mm)
P13		43.4	96.7	(a)		
P20		44.5	96.7	(a)		

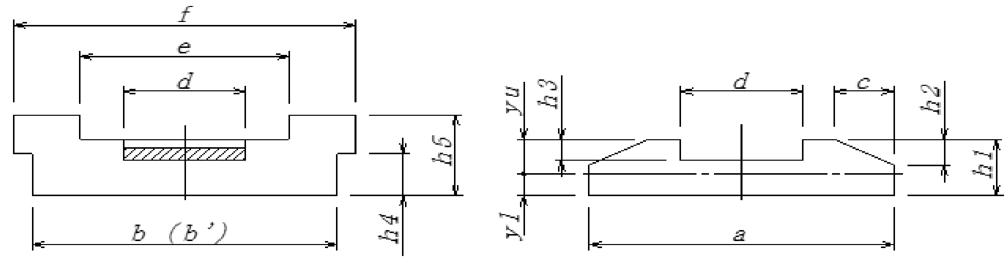
		Stress checking							
		Compressive stress σbmax		Tensile stress σt		Shear stress τ		Composition U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		11.8	375.0		150.0	42.7	150.0	0.08	1.00
P20		10.0	375.0		150.0	36.6	150.0	0.06	1.00

Calculation result（Transversal direction ：ＲＵ）

		Decision checking				
		Eccentricity E (mm)	Ｅ0 (mm)	Decision	l (mm)	Neutral axis χ (mm)
P13		72.3	96.7	(a)		
P20		75.8	96.7	(a)		

		Stress checking							
		Compressive stress σbmax		Tensile stress σt		Shear stress τ		Composition U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		8.6	375.0		150.0	42.7	150.0	0.08	1.00
P20		7.2	375.0		150.0	36.6	150.0	0.06	1.00

５． ２　Bending stress of center section



Y－Y Cross section　　　　X－X Cross section

Dimension table

		a (mm)	b (mm)	b’ (mm)	c (mm)	φd (mm)	e (mm)	f (mm)
P13		580	580	690	45	430	520	770
P20		580	580	690	45	430	520	770

		h1 (mm)	h2 (mm)	h3 (mm)	h4 (mm)	h5 (mm)	Material
P13		140	90	54	89	179	SCW480N
P20		140	90	54	89	179	SCW480N

Geometric characteristics of cross section

		X－X Cross section				Y－Y Cross section			
		Y1 (mm)	Yu (mm)	JN (mm4)	ΣA (mm2)	Y1 (mm)	Yu (mm)	JN (mm4)	JN (mm4)
P13		48.5	91.5	50777272	53930	70.6	108.4	197467663	87210
P20		48.5	91.5	50777272	53930	70.6	108.4	197467663	87210

(1) Normal condition

Bending moment

$M = 1/2 \cdot R \cdot (b/4 - 2/3\pi \cdot d)$

$\sigma = M / JN \times Yu \leqq \sigma a$ (N/mm^2)

Calculation result

		Total reaction load R (kN)	Bending moment M (N・mm)	Bending stress σb (N/mm2)	Allowable value
P13		3200	86001866	155.0	170.0
P20		3000	80626749	145.3	170.0

(2) In movement [Y－Y Cross section]

Bending moment

$M1 = 1/6 \cdot \{2 \cdot \sigma bfmax + (\sigma bfmax + \sigma bfmin)/2\} \cdot (a/2)^2 \cdot b)$

$M2 = 1/2 \cdot R \cdot 2/3\pi \cdot d$

$M = M1 - M2$

$\sigma = M / JN \times Yu \leqq 1.15 \times \sigma a$ (N/mm^2)

Calculation result

		Total reaction load R (kN)	Maximum compressive stress σbfmax (N/mm2)	Minimum compressive stress σbfmin (N/mm2)	Bending moment M1 (N・mm)	Bending moment M2 (N・mm)	Bending moment M (N・mm)	Bending stress σb (N/mm2)	Allowable value
P13		3200	11.2	7.8	260000000	145998134	114001866	62.6	195.5
P20		3000	10.4	7.4	241500000	136873251	104626749	57.4	195.5

（３）In seismic

Bending moment

Longitudinal direction

$M1 = 1/6 \cdot \{2 \cdot \sigma bmax + (\sigma bmax + \sigma bmin)/2\} \cdot (a/2)^2 \cdot$ ＜Decision：（ａ）＞

$M1 = 1/2 \cdot \sigma bmax \cdot \chi \cdot b \cdot (a/2 - \chi/3)$ ＜Decision：（ｂ）＞

$M2 = 1/2 \cdot RL,U \cdot 2/3\pi \cdot d$

$M = M1 - M2$

Transversal direction

$M1 = 1/6 \cdot \{2 \cdot \sigma bmax + (\sigma bmax + \sigma bmin)/2\} \cdot (b/2)^2 \cdot$ ＜Decision：（ａ）＞

$M1 = 1/2 \cdot \sigma bmax \cdot \chi \cdot a \cdot (b/2 - \chi/3)$ ＜Decision：（ｂ）＞

$M2 = 1/2 \cdot RL,U \cdot 2/3\pi \cdot d$

$M3 = RH2e \cdot h$

$M = M1 - M2 - M3$

Bending stress

Longitudinal direction

$\sigma = M / JN \times Yu \leqq 1.5 \times \sigma a \quad (N/mm^2)$

Transversal direction

$\sigma = M / JN \times Yu + RH2e / \Sigma A \leqq 1.5 \times \sigma a \quad (N/mm^2)$

Calculation result［When Longitudinal direction ＲＬ：Ｙ－ＹCross section］

		Vertical reaction load ＲＬ (kN)	Maximum compressive stress σbmax (N/mm2)	Minimum compressive stress σbmin (N/mm2)	Neutral axis χ (mm)
P13		2500	10.1	4.8	
P20		2050	8.2	4.0	

		Bending moment M1 (N･mm)	Bending moment M2 (N･mm)	Bending moment M (N･mm)	Bending stress σb (N/mm2)	Allowable value
P13		223875000	114061043	109813957	60.3	255.0
P20		182725000	93530055	89194945	48.9	255.0

Calculation result［When Longitudinal direction ＲＵ：Ｙ－Ｙ Cross section］

		Vertical reaction force ＲＵ (kN)	Maximum compressive stress σbmax (N/mm2)	Minimum compressive stress σbmin (N/mm2)	Neutral axis χ (mm)
P13		1900	8.3	3.0	
P20		1600	6.9	2.7	

		Bending moment M1 (N･mm)	Bending moment M2 (N･mm)	Bending moment M (N･mm)	Bending stress σb (N/mm2)	
						Allowable value
P13		180375000	86686392	93688608	51.4	255.0
P20		150100000	72999067	77100933	42.3	255.0

Calculation result［When Transversal direction ＲL：Ｙ－ＹCross section］

		Vertical rection load ＲL (kN)	Horizontal load ＲH2e (kN)	Maximum compressive stress σbmax (N/mm2)	Minimum compressive stress σbmin (N/mm2)	Neutral axis χ (mm)
P13		2750	700	11.8	4.5	
P20		2300	600	10.0	3.7	

		Bending moment M1	Bending moment M2	Bending moment M3	Bending moment M	Bending stress σb	
		(N・mm)	(N・mm)	(N・mm)	(N・mm)	(N/mm2)	Allowable value
P13		259050000	125467147	119350000	14232853	38.6	255.0
P20		217900000	104936159	102300000	10663841	30.3	255.0

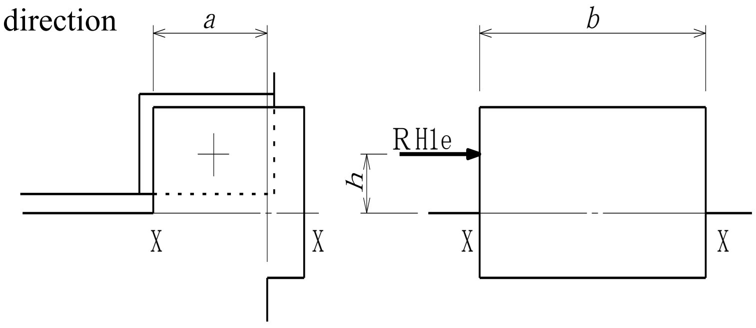
Calculation result［When Transversal direction ＲU：Ｙ－Ｙ Cross section］

		Vertical rection load ＲU (kN)	Horizontal load ＲH2e (kN)	Maximum compressive stress σbmax (N/mm2)	Minimum compressive stress σbmin (N/mm2)	Neutral axis χ (mm)
P13		1650	700	8.6	1.2	
P20		1350	600	7.2	0.9	

		Bending moment M1 (N･mm)	Bending moment M2 (N･mm)	Bending moment M3 (N･mm)	Bending moment M (N･mm)	Bending stress σb (N/mm2)	
							Allowable value
P13		179300000	75280288	119350000	15330288	40.6	255.0
P20		149025000	61592963	102300000	14867963	37.9	255.0

５． ３ Bending stress of lower bottom convex part

（１）Longitudinal direction



Bending stress

$$\sigma = \frac{1/2 \cdot RH1e \cdot h}{1/6 \times a \times b^{2}} \leqq 1.5 \times \sigma a \quad (N/mm^{2})$$

Shear stress

$$\tau = 1/2 \cdot RH1e / (a \times b) \leqq 1.5 \times \tau a \quad (N/mm^{2})$$

Composition stress

$$U = (\sigma / \sigma a)^{2} + (\tau / \tau a)^{2} \leqq 1.2$$

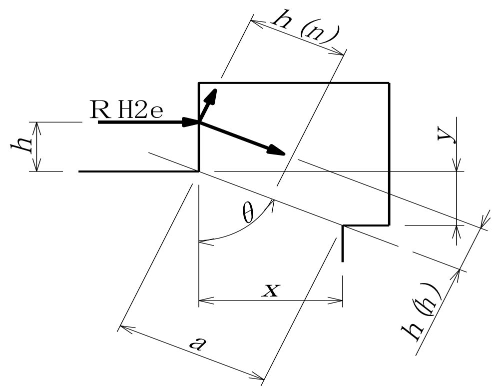
Design Horizontal load and dimension table

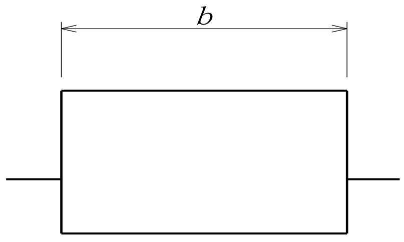
		Horizontal load RH1e (kN)	Convex part width a (mm)	Convex part length b (mm)	Height h (mm)
P13		500	85		
P20		400	85		

Calculation result

		Bending stress σ		Shear stress τ		Composition stress U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13			255.0		150.0		1.20
P20			255.0		150.0		1.20

（2）Transversal





Horizontal load Checking

$RH2e(h) = RH2e \times \sin\theta$

$RH2e(n) = RH2e \times \cos\theta$

Bending stress checking

$$\sigma = \frac{RH2e(h) \cdot h(h) + RH2e(n) \cdot h(n)}{1/6 \times a^2 \times b} + \frac{RH2e(n)}{a \times b} \leqq 1.5 \times \sigma a \quad (N/mm^2)$$

Shear stress

$$\tau = RH2e(h) / (a \times b) \leqq 1.5 \times \tau a \quad (N/mm^2)$$

Composition stress

$$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2 \leqq 1.2$$

Design horizontal load and dimension table

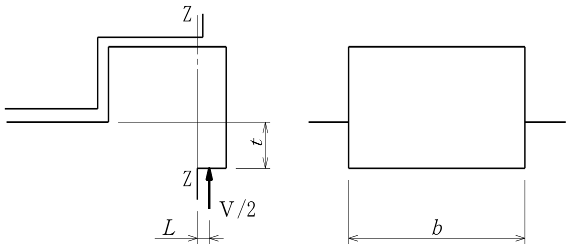
		Horizontal load RH2e (kN)	Convex part effective width a (mm)	Convex part length b (mm)	Effective length x (mm)	Effective length y (mm)	Angle θ (deg)
P13		700	99.1	290	85	51	59.0
P20		600	99.1	290	85	51	59.0

		Height h (mm)	Height h (h) (mm)	Height h(n) (mm)
P13		30.5	26.2	65.3
P20		30.5	26.2	65.3

Calculation result

		Horizontal load		Bending stress σ		Shear stress τ		Composition stress U	
		R H2e(h) (kN)	R H2e(n) (kN)	(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		600	360	95.1	255.0	20.9	150.0	0.16	1.20
P20		514	309	81.5	255.0	17.9	150.0	0.12	1.20

(3) Uplift force



Bending stress

$$\sigma = \frac{V/2 \cdot L}{1/6 \times t^2 \times b} \leqq 1.5\times\sigma a \quad (N/mm^2)$$

Shear stress

$$\tau = V/2 / (t \times b) \leqq 1.5\times\tau a \quad (N/mm^2)$$

Composition stress

$$U = (\sigma/\sigma a)^2 + (\tau/\tau a)^2 \leqq 1.2$$

Design Horizontal load and dimension table

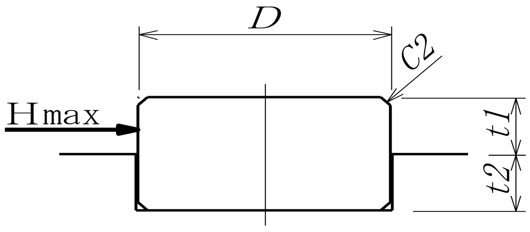
		Uplift force V (kN)	Effective thickness of convex part t (mm)	Convex part length b (mm)	Acting distance L (mm)
P13		220	51	290	30.0
P20		190	51	290	30.0

Calculation result

		Bending stress σ		Shear stress τ		Composition stress U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		26.2	255.0	14.9	150.0	0.03	1.20
P20		22.7	255.0	12.8	150.0	0.02	1.20

６． Upper plate

６． １　Shear key



Compressive stress

$\sigma b1$ = Hmax／（D×（t1−2））　Sole plate side　≦　1.5×σba　(N/mm^2)

$\sigma b2$ = Hmax／（D×（t2−2））　Upper plate side　≦　1.5×σba　(N/mm^2)

Shear stress

τ = Hmax／（π/4×D^2）　≦　1.5×τa　(N/mm^2)

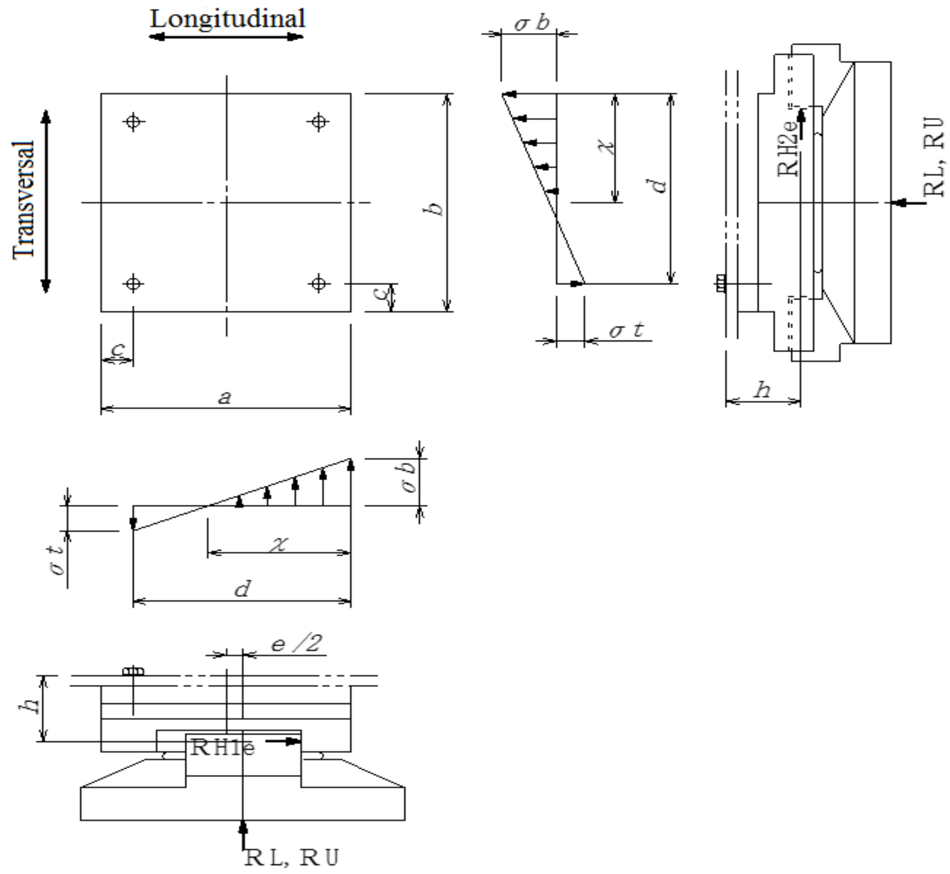
Calculation result

		Maximum Horizontal load Hmax (kN)	Diameter D (mm)	Height (Sole plate side) t1 (mm)	Height (Upper plate side) t2 (mm)	Material		
						Shear key	Upper plate	Sole plate
P13		700	140	25	25	SM490A	SM490A	SM400orEquivalent
P20		600	140	25	25	SM490A	SM490A	SM400orEquivalent

		Compressive stress (Sole plate side) σb1		Compressive stress (Upper plate side) σb2		Shear stress τ	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		217.4	285.0	217.4	382.5	45.5	150.0
P20		186.3	285.0	186.3	382.5	39.0	150.0

6．2　Compressive stress

Diameter of used bolt	D
Root diameter bolt in use	D1
Number of bolt in use	Nt
Diameter of effective bolt in use	N



（1）Checking according to Horizontal load

Eccentricity：E

$$E = \frac{RH1e \times h}{RU} + e/2$$

When Vertical load ís positive　：　E0 = a/6 + c/3

When Vertical load ís negative　：　E0 = a/2 − c

（a）When Vertical load ís positive and E ≦ E0

The tensile force is not acted on the bolt.

Compressive stress

$$\sigma bmax = \frac{RU}{a \cdot b} + \frac{6 (RH1e \cdot h + RU \cdot e/2)}{a \cdot b^2} \leqq 1.5 \times \sigma ba \quad (N/mm^2)$$

（b）When E > E0

The tensile force is acted on the bolt.

When Vertical load ís positive　：　l = a/2 − E

When Vertical load ís negative　：　l = a/2 + E

$As = \pi/4 \times D1^2 \times N$（Effective coefficient），Young coefficient rate：n = 1

Determined the neutral axis: χ

$$\chi^3 + 3 \cdot l \cdot \chi^2 + \frac{6 \cdot n \cdot As}{b} \cdot (d + l)(\chi - d) = 0$$

Compressive stress

$$\sigma bmax = \frac{2 \cdot RU}{b \cdot \chi - 2 \cdot n \cdot As \cdot (d - \chi) / \chi} \leqq 1.5 \times \sigma ba \quad (N/mm^2)$$

Tensile stress of bolt

$$\sigma t = \sigma bmax \cdot n \cdot (d - \chi) / \chi \leqq 1.5 \times \sigma ta \quad (N/mm^2)$$

（c）When Vertical load ís negative E ≦ E0

The compressive í not acted, the tensile force only acted on the bolt.

Tensile stress of the bolt :

$$\sigma tmax = \frac{RU \cdot \{(a/2 - c) + E\}}{2 \cdot As \cdot (a/2 - c)} \leqq 1.5 \times \sigma ta \quad (N/mm^2)$$

Shear stress of the bolt

$$\tau = RH1e / (\pi/4 \times D1^2 \times Nt) \leqq 1.5 \times \tau a \quad (N/mm^2)$$

Composition stress of the bolt

$$U = (\sigma t / \sigma ta)^2 + (\tau / \tau a)^2 \leqq 1.2$$

Reaction force and dimension（Longitudinal direction）

		Vertical load in seismic		Longitudinal Horizontal load	Acting height	Displacement	Longitudinal length	Transversal length
		RL	RU	RH1e	h	e	a	b
		(kN)	(kN)	(kN)	(mm)	(mm)	(mm)	(mm)
P13		2500	1900	500	109.5	260.0	790	690
P20		2050	1600	400	109.5	240.0	790	690

		Edge	Bolt diameter	Root diameter	Number of effective bolt	Total number of bolt		Young coefficient rate	Strength grade
		c	D	D1	N	Nt	As	n	
		(mm)	(mm)	(mm)			(mm2)		
P13		65	24	20.752	2	8	676	1	8.8
P20		65	24	20.752	2	8	676	1	8.8

Calculation result（Longitudinal direction：ＲＬ）

		Decision checking				
		Eccentricity Ｅ (mm)	Ｅ0 (mm)	Decision	l (mm)	Neutral axis χ (mm)
P13		151.9	153.3	(a)		
P20		141.4	153.3	(a)		

		Stress checking			
		Compressive stress σbmax		Tensile stress σt	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		9.9	285.0		540.0
P20		7.8	285.0		540.0

Calculation result（Longitudinal direction: ＲＵ）

		Decision checking				
		Eccentricity Ｅ (mm)	Ｅ0 (mm)	Decicsion	l (mm)	Neutral axis χ (mm)
P13		158.8	153.3	(b)	236.2	708.6
P20		147.4	153.3	(a)		

		Stress checking			
		Compressive stress σbmax		Tensile stress σt	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		7.8	285.0	0.2	540.0
P20		6.2	285.0		540.0

Reaction load and dimension（Transversal direction）

		Horizontal load in seismic		Transversal horizontal load	Acting height	Displacement	Longitudinal length	Transversal length
		RL (kN)	RU (kN)	RH2e (kN)	h (mm)	uB (mm)	a (mm)	b (mm)
P13		2750	1650	700	109.5		790	690
P20		2300	1350	600	109.5		790	690

		Edge c (mm)	Bolt diameter D (mm)	Root diameter D1 (mm)	Number of effective bolt N	Total number of bolts Nt	As (mm2)	Young coefficcient rate n
P13		140	24	20.752	4	8	1353	1
P20		140	24	20.752	4	8	1353	1

Caculation result（Transversal direction ：ＲＬ）

		Decision checking				
		Eccentricity		Decision		Neutral axis
		Ｅ (mm)	Ｅ0 (mm)		l (mm)	χ (mm)
P13		27.9	161.7	(a)		
P20		28.6	161.7	(a)		

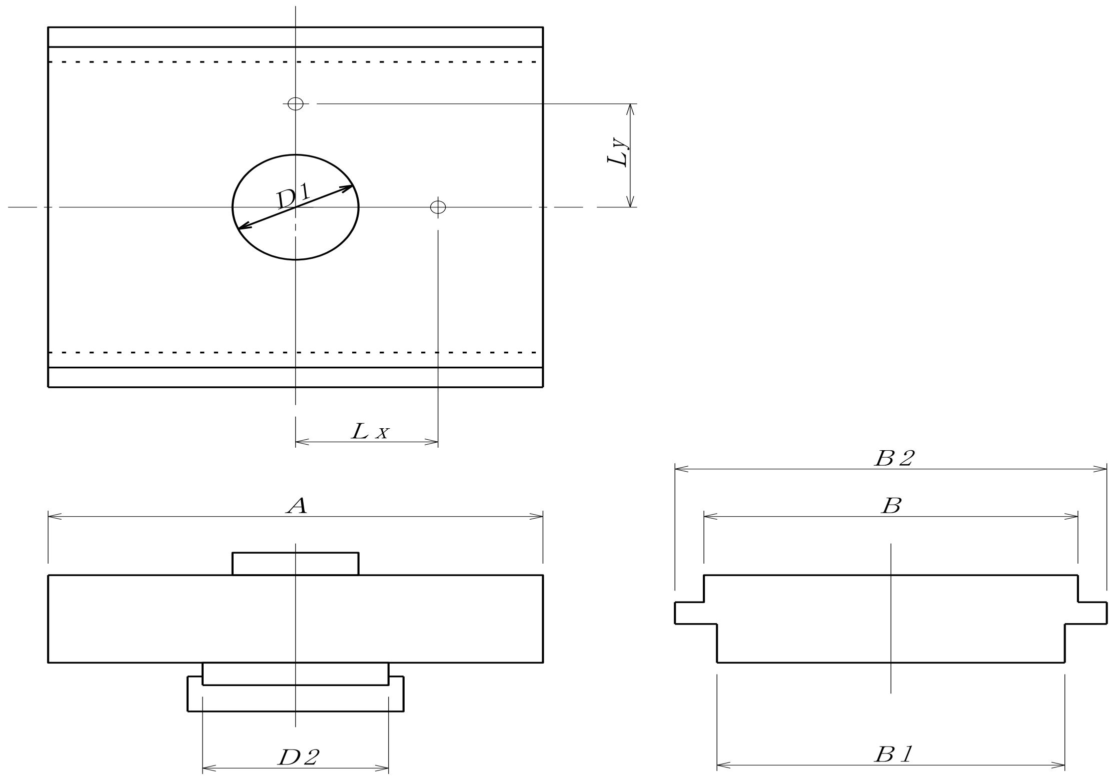
		Stress checking			
		Compressive stress σbmax		Tensile stress σt	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		6.3	285.0		540.0
P20		5.3	285.0		540.0

Calculation result（Transversal direction ：ＲU）

		Decision checking				
		Eccentricity E (mm)	E0 (mm)	Decision	l (mm)	Neutral axis χ (mm)
P13		46.5	161.7	(a)		
P20		48.7	161.7	(a)		

		Stress checking			
		Compressive stress σbmax		Tensile stress σt	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		4.2	285.0		540.0
P20		3.5	285.0		540.0

６．３　Bending stress of center cross section



Determined the Central of inertia axis

$$L_x = \frac{1/2\times (A/2)^2 \times B - 1/12\times D1^3}{A/2\times B - \pi/8\times D1^2}$$

$$L_y = \frac{1/2\times (B/2)^2 \times A - 1/12\times D1^3}{B/2\times A - \pi/8\times D1^2}$$

Table of dimension and calculation result

		Total reaction load R (kN)	Longitudinal length A (mm)	Transversal width B (mm)	B1 (mm)	B2 (mm)	Boss Diameter φD1 (mm)	Diameter of sliding plate φD2 (mm)	Upper thickness t (mm)
P13		3200	790	690	510	754	140	390	118
P20		3000	790	690	510	754	140	390	118

		Parts thickness h1 (mm)	h2 (mm)	h3 (mm)	Upper centroid Lx (mm)	Ly (mm)
P13		23	23	72	202.4	176.6
P20		23	23	72	202.4	176.6

		Longitudinal direction: Moment of inertial I n1 (mm4)	Distance to neutral axis y l1 (mm)	y u1 (mm)	Transversal direction: Moment of inertial (mm4)	Distance to neutral axis y l2 (mm)	y u2 (mm)
P13		78095049	59.0	59.0	100062510	57.2	60.8
P20		78095049	59.0	59.0	100062510	57.2	60.8

Longitudinal direction

Bending stress

$$Mx = 1/2 \cdot R \cdot \{Lx - 2/(3 \cdot \pi) \times D2\}$$

$$\sigma 1 = Mx \times y1 / In1 \leqq 1.0 \times \sigma a \quad (N/mm^2)$$

Transversal direction

Bending stress

$$My = 1/2 \cdot R \cdot \{Ly - 2/(3 \cdot \pi) \times D2\}$$

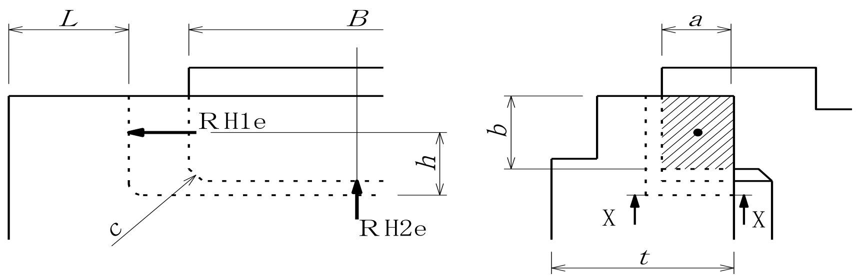
$$\sigma 2 = My \times y2 / In2 \leqq 1.0 \times \sigma a \quad (N/mm^2)$$

Calculation result

		Longitudinal direction			Transversal direction		
		Bending moment Mx	Bending stress σ1		Bending moment My	Bending stress σ2	
		(N・mm)	(N/mm2)	Allowable value	(N・mm)	(N/mm2)	Allowable value
P13		191384976	144.7	170.0	150222535	91.3	170.0
P20		179423415	135.7	170.0	140833627	85.6	170.0

6．4　Stress of stopper part

（1）Stress according to Horizontal load



Longitudinal direction

Compressive stress

$\sigma b = 1/2 \cdot RH1e / (a \cdot b)$　　$\leqq$ $1.5 \times \sigma ba$　(N/mm^2)

Bending stress

$\sigma = 1/2 \cdot RH1e \cdot h / (1/6 \cdot t \cdot L^2)$　　$\leqq$ $1.5 \times \sigma a$　(N/mm^2)

Shear stress

$\tau = 1/2 \cdot RH1e / (t \cdot L)$　　$\leqq$ $1.5 \times \tau a$　(N/mm^2)

Composition stress

$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2$　　$\leqq$ 1.2

Transversal direction

Compressive stress

$\sigma b = RH2e / \{a \cdot (B - 2 \cdot c)\}$　　$\leqq$ $1.5 \times \sigma ba$　(N/mm^2)

Table of design Horizontal load and dimensions

		Longitudinal Horizontal load RH1e (kN)	Tranversal Horizontal load RH2e (kN)
P13		500	700
P20		400	600

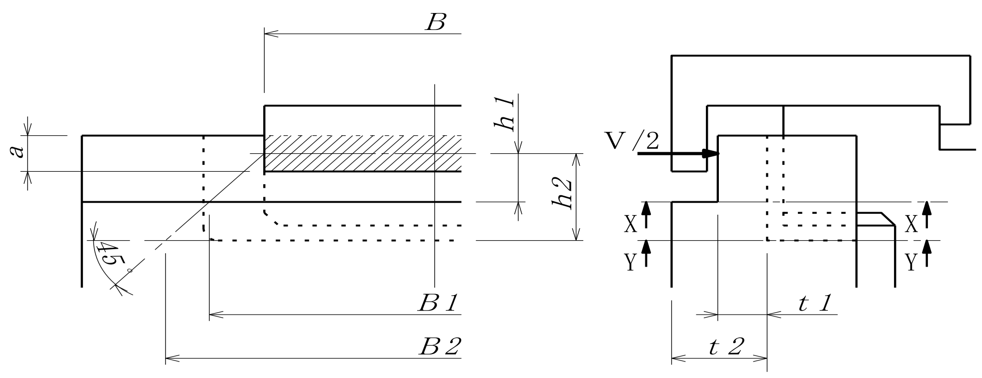
		Dimension						
		L (mm)	B (mm)	t (mm)	a (mm)	b (mm)	h (mm)	c (mm)
P13			290	118	17	105	69.5	12
P20			290	118	17	105	69.5	12

Calculation result

		Longitudinal direction							
		Compressive stress σb		Bending stress σ		Shear stress τ		Composition stress U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13			375.0	0.0	255.0		142.5	0.00	1.20
P20			375.0	0.0	255.0		142.5	0.00	1.20

		Longitudinal direction	
		Compressive stress σb	
		(N/mm2)	Allowable value
P13		154.8	375.0
P20		132.7	375.0

（２） Stress according to uplift force



X－X Cross section

Bending stress

$\sigma = 1/2 \cdot V \cdot h1 / (1/6 \cdot B1 \cdot t1^2) \leqq 1.5 \times \sigma a$ (N/mm^2)

Shear stress

$\tau = 1/2 \cdot V / (B1 \cdot t1) \leqq 1.5 \times \tau a$ (N/mm^2)

Composition stress

$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2 \leqq 1.2$

Y－Y Cross section

Bending stress

$\sigma = 1/2 \cdot V \cdot h2 / (1/6 \cdot B2 \cdot t2^2) \leqq 1.5 \times \sigma a$ (N/mm^2)

Shear stress

$\tau = 1/2 \cdot V / (B2 \cdot t2) \leqq 1.5 \times \tau a$ (N/mm^2)

Composition stress

$U = (\sigma / \sigma a)^2 + (\tau / \tau a)^2 \leqq 1.2$

Table of Hrizontal load and dimension

		Uplift force V (kN)	Dimension B (mm)	 B 1 (mm)	 B 2 (mm)	 a (mm)	 t 1 (mm)	 t 2 (mm)
P13		220	290	336	516	18	23	95
P20		190	290	336	516	18	23	95

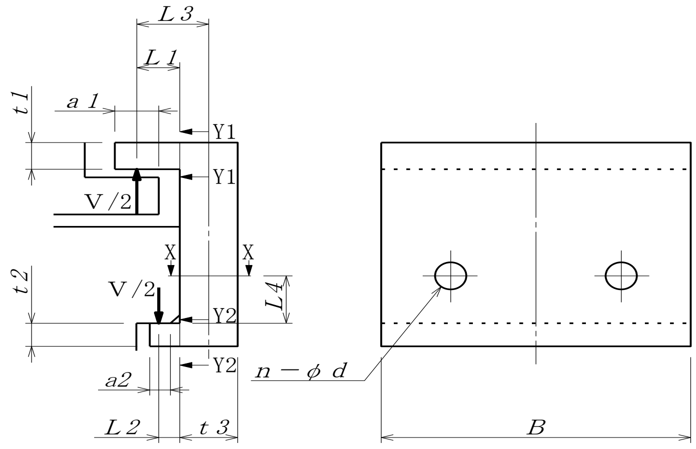
		Dimension h 1 (mm)	 h 2 (mm)
P13		23.0	113.0
P20		23.0	113.0

Calculation result

		X－X Cross section					
		Bending stress σ		Shear stress τ		Composition stress U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		85.4	255.0	14.2	142.5	0.12	1.20
P20		73.8	255.0	12.3	142.5	0.09	1.20

		Y－Y Cross section					
		Bending stress σ		Shear stress τ		Composition stress U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		16.0	255.0	2.2	142.5	0.00	1.20
P20		13.8	255.0	1.9	142.5	0.00	1.20

7． Slide block and bolt.



Diameter of Side block bolt　　D

Root diameter of Side block bolt　　D1

Table of design condition and dimension

		Uplift force V (kN)	Material	
			Body	Bolt
P13		220	SM490A	4.8
P20		190	SM490A	4.8

		Dimension							
		B (mm)	a 1 (mm)	a 2 (mm)	t 1 (mm)	t 2 (mm)	t 3 (mm)	L 1 (mm)	L 2 (mm)
P13		290	18	20	21	20	34	17.0	15.0
P20		290	18	20	21	20	34	17.0	15.0

		Dimension					
		L 3 (mm)	L 4 (mm)	d (mm)	n	D (mm)	D 1 (mm)
P13		34.0	30.0	22	2	20	17.294
P20		34.0	30.0	22	2	20	17.294

7．1　Checking the body of side block

Compressive stress

$\sigma b = 1/2 \cdot V / (a1 \cdot B) \quad \leqq \quad 1.5\times\sigma ba \quad (N/mm^2)$

$\sigma b = 1/2 \cdot V / (a2 \cdot B) \quad \leqq \quad 1.5\times\sigma ba \quad (N/mm^2)$

（1）Stress of Y1－Y1 cross section

Bending stress

$$\sigma = \frac{1/2 \times V \times L1}{1/6 \times B \times t1^2} \quad \leqq \quad 1.5\times\sigma a \quad (N/mm^2)$$

Shear stress

$$\tau = \frac{1/2 \times V}{t1 \times B} \quad \leqq \quad 1.5\times\tau a \quad (N/mm^2)$$

Composition stress

$$U = (\sigma/\sigma a)^2 + (\tau/\tau a)^2 \quad \leqq \quad 1.2$$

（2）Stress of Y2－Y2 cross section

Bending stress

$$\sigma = \frac{1/2 \times V \times L2}{1/6 \times B \times t2^2} \quad \leqq \quad 1.5\times\sigma a \quad (N/mm^2)$$

Shear stress

$$\tau = \frac{1/2 \times V}{t2 \times B} \quad \leqq \quad 1.5\times\tau a \quad (N/mm^2)$$

Compositon stress

$$U = (\sigma/\sigma a)^2 + (\tau/\tau a)^2 \quad \leqq \quad 1.2$$

（3）Blended tensile stress of X－X cross section

$$\sigma t = \frac{V/2 \times L3}{1/6 \times (B - n \cdot d) \times t3^2} + \frac{V/2}{(B - n \cdot d) \times t3} \leqq 1.5\times\sigma ta \quad (N/mm^2)$$

Calculation result

		Compressive stress (Upper side) σb		Compressive stress (Lower side) σb	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		21.1	382.5	19.0	375.0
P20		18.2	382.5	16.4	375.0

		Y１－Y１ Cross section					
		Bending stress σ		Shear stress τ		Composition stress U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		87.7	262.5	18.1	150.0	0.13	1.20
P20		75.8	262.5	15.6	150.0	0.09	1.20

		Y2－Y2 Cross section					
		Bending stress σ		Shear stress τ		Compositon stress U	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value		Allowable value
P13		85.3	262.5	19.0	150.0	0.12	1.20
P20		73.7	262.5	16.4	150.0	0.09	1.20

		X－X Cross section	
		Bended tensile stress σt	
		(N/mm2)	Allowable value
P13		92.1	262.5
P20		79.5	262.5

７．２　Sile block bolt

Diameter of bolt in use　D

Root diameter of bolt　D1

Number of bolts in use（a side）　n

Tensile stress

$$\sigma t = \frac{V/2 \times (L1 - L2) / L4}{\pi/4 \times D1^2 \times n} \leqq 1.5 \times \sigma ta \quad (N/mm^2)$$

Calculation result

		Tensile stress σt (N/mm2)	Allowable value
P13		15.6	210.0
P20		13.5	210.0

8． Set bolt.

Diameter of bolt D

Root diameter of bolt D1

Number of bolt in use Nt

Tensile stress

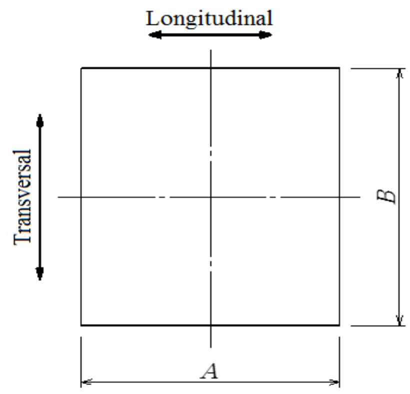
$\sigma t = V / (\pi/4 \times D1^2 \times Nt) \leqq 1.5 \times \sigma ta$ (N/mm^2)

Calculation result

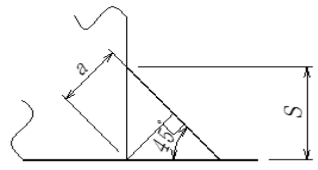
		Maximum Horizontal load Hmax (kN)	Uplift force V (kN)	Bolt diameter D (mm)	Root diameter D1 (mm)	Number of bolt in use Nt	Strength classify
P13		700	220	24	20.752	8	8.8
P20		600	190	24	20.752	8	8.8

		Tensile stress σt (N/mm2)	
			Allowable value
P13		81.3	540.0
P20		70.2	540.0

9． Checking welding part



Detail of welding part



$a = S/\sqrt{2}$

$a = S \times 1/\sqrt{2} \times (1 + 1/\sqrt{3})$

Shear stress

$\tau = Hmax / (2\times(A+B)\times a)$ $\leqq 1.5\times\tau a$ (N/mm^2)

Tensile stress

$\sigma t = V / (2\times(A+B)\times a)$ $\leqq 1.5\times\sigma ta$ (N/mm^2)

Calculation result

		Maximum Horizontal load Hmax (kN)	Uplift force V (kN)	Longitudinal length A (mm)	Transversal length B (mm)	Weld leg length S (mm)	Effective thickness a (mm)	Material	
								Lower plate	Base plate
P13		700	220	580	580	10	7.07	SCW480N	SM490A
P20		600	190	580	580	10	7.07	SCW480N	SM490A

		Shear stress τ		Tensile stress σt	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		42.7	150.0	13.4	150.0
P20		36.6	150.0	11.6	150.0

１０． Anchor bolt

Diameter of bolt in use	$\varphi D'$
Axis diameter of bolt in use	φD
Root diameter of bolt in use	$D1$
Number of bolt in use	Nt
Embed length of anchor bolt	L

Shear stress

$$\tau = H_{max} / (\pi/4 \times D^2 \times Nt) \leqq 1.5 \times \tau a \quad (N/mm^2)$$

Concrete contact stress

$$\tau 0 = V / (\pi \times D' \times L \times Nt) \leqq 1.5 \times \tau 0a \quad (N/mm^2)$$

Tensile stress of screw

$$\sigma t = V / (\pi/4 \times D1^2 \times Nt) \leqq 1.5 \times \sigma t a \quad (N/mm^2)$$

Table of dimension

		Maximum Horizontal load Hmax (kN)	Uplift force V (kN)	Material		Substructure σck (N/mm2)
				Material	Shape	
P13		700	220	SS400	Circular steel bar	24.0
P20		600	190	SS400	Circular steel bar	24.0

		Bolt diameter D' (mm)	Aixs diameter D (mm)	Root diameter D1 (mm)	Number of bolt in use Nt	Embed length L (mm)
P13		48	50	42.587	4	500
P20		48	50	42.587	4	500

Calculation result

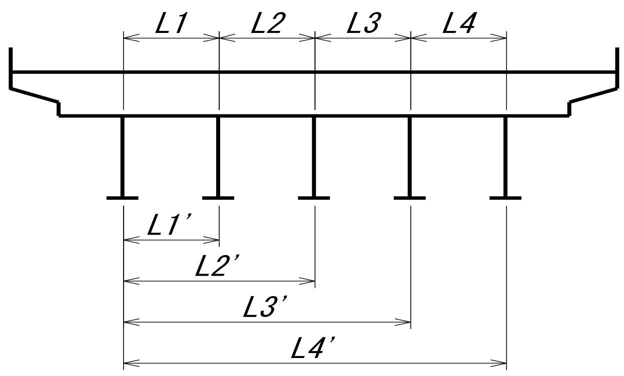
		Shear stress τ		Bond stress τ0		Tensile stress σt	
		(N/mm2)	Allowable value	(N/mm2)	Allowable value	(N/mm2)	Allowable value
P13		96.7	120.0	0.700	1.200	30.4	210.0
P20		82.9	120.0	0.605	1.200	26.2	210.0

(Reference 1) RLRU

BAGO (P13-P20) Approach Bridge- Seismic vertical reaction calculation sheet

○ The calculation of the Vertical reaction in seismic period

a) The calculation of gravity central position



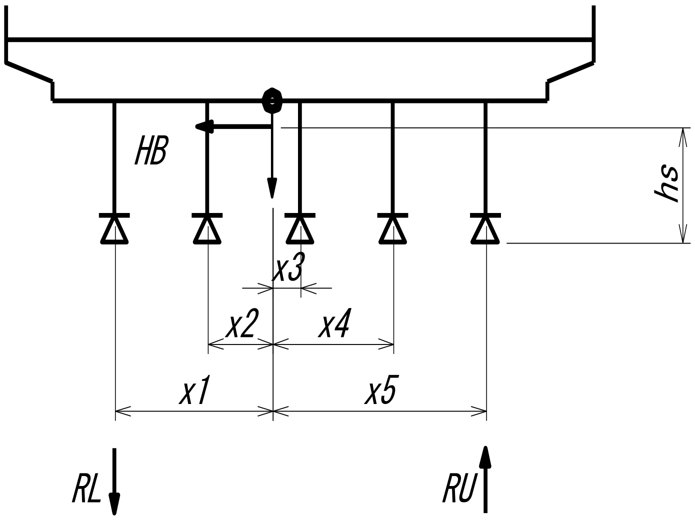
	The distance between bearing								
	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)	L6 (mm)	L7 (mm)	L8 (mm)	L9 (mm)
P13	**4200**	**8200**	**4200**						
P20	**4200**	**8200**	**4200**						

Calculation result

	Bearing number n	L1' (mm)	L2' (mm)	L3' (mm)	L4' (mm)	L5' (mm)	L6' (mm)	L7' (mm)	L8' (mm)	L9' (mm)
P13	4	4200	12400	16600	-	-	-	-	-	-
P20	4	4200	12400	16600	-	-	-	-	-	-

	Dead load reaction									
	Rd1 (kN)	Rd2 (kN)	Rd3 (kN)	Rd4 (kN)	Rd5 (kN)	Rd6 (kN)	Rd7 (kN)	Rd8 (kN)	Rd9 (kN)	Rd10 (kN)
P13	**2188**	**2188**	**2188**	**2188**						
P20	**1825**	**1825**	**1825**	**1825**						

b)The calculation of the vertical reaction（RL，RU）in seismic condition



Calculate according to 15.2(3) in JRA specification

RL＝Rd＋√（RVEQ2＋RHEQ2)
RU＝Rd－√（RVEQ2＋RHEQ2)
RVEQ＝Rd×Kv

(1) Vertical reaction in longitudinal direction

RL＝Rd＋RVEQ
RU＝Rd－RVEQ

(2) Vertical reaction in transversal direction

HB×hs＝Σ(RHEQi×xi)
ΣRHEQi＝0
RHEQi＝K×xi

・The distance between bearing xi
x1＝ΣLi／n，x2＝x1－L1'，…
・Ratio coefficient K
K＝HB×hs／Σxi2

	Acting height of inertial force hs (mm)	ΣLi'	Σxi2	Longitudinal direction Land classification	Transversal direction Land classification	Region classify Correction coefficient ○○Region	Region classify Correction coefficient cz	Region classify Correction coefficient cIz	Region classify Correction coefficient cIIz
P13	**3650**	33200	171400000	3 Type	3 Type	A1	1.00	1.20	1.00
P20	**3650**	33200	171400000	3 Type	3 Type	A1	1.00	1.20	1.00

	x1 (mm)	x2 (mm)	x3 (mm)	x4 (mm)	x5 (mm)	x6 (mm)	x7 (mm)	x8 (mm)	x9 (mm)	x10 (mm)
P13	8300	4100	-4100	-8300	0	0	0	0	0	0
P20	8300	4100	-4100	-8300	0	0	0	0	0	0

・Calculation result（L1 in seismic period）

	Longitudinal direction		Transvesal direction			
	Horizontal seismic strength Kh	Vertical seismic strength Kv	Horizontal load HB(kN)	Horizontal seismic strength Kh	Vertical seismic strength Kv	Ratio coefficient K
P13	0.30	0.12	**2600**	0.30	0.12	0.055
P20	0.30	0.12	**2300**	0.30	0.12	0.049

Bridge axis	RVEQ1 (kN)	RVEQ2 (kN)	RVEQ3 (kN)	RVEQ4 (kN)	RVEQ5 (kN)	RVEQ6 (kN)	RVEQ7 (kN)	RVEQ8 (kN)	RVEQ9 (kN)	RVEQ10 (kN)
P13	263	263	263	263	-	-	-	-	-	-
P20	219	219	219	219	-	-	-	-	-	-

Bridge axis	RVEQ1 (kN)	RVEQ2 (kN)	RVEQ3 (kN)	RVEQ4 (kN)	RVEQ5 (kN)	RVEQ6 (kN)	RVEQ7 (kN)	RVEQ8 (kN)	RVEQ9 (kN)	RVEQ10 (kN)
P13	263	263	263	263	-	-	-	-	-	-
P20	219	219	219	219	-	-	-	-	-	-

	RHEQ1 (kN)	RHEQ2 (kN)	RHEQ3 (kN)	RHEQ4 (kN)	RHEQ5 (kN)	RHEQ6 (kN)	RHEQ7 (kN)	RHEQ8 (kN)	RHEQ9 (kN)	RHEQ10 (kN)
P13	460	227	-227	-460	-	-	-	-	-	-
P20	407	201	-201	-407	-	-	-	-	-	-

Longitudinal direction

	RL1 (kN)	RL2 (kN)	RL3 (kN)	RL4 (kN)	RL5 (kN)	RL6 (kN)	RL7 (kN)	RL8 (kN)	RL9 (kN)	RL10 (kN)
P13	2451	2451	2451	2451	-	-	-	-	-	-
P20	2044	2044	2044	2044	-	-	-	-	-	-

	RU1 (kN)	RU2 (kN)	RU3 (kN)	RU4 (kN)	RU5 (kN)	RU6 (kN)	RU7 (kN)	RU8 (kN)	RU9 (kN)	RU10 (kN)
P13	1925	1925	1925	1925	-	-	-	-	-	-
P20	1606	1606	1606	1606	-	-	-	-	-	-

Transversal direction

	RL1 (kN)	RL2 (kN)	RL3 (kN)	RL4 (kN)	RL5 (kN)	RL6 (kN)	RL7 (kN)	RL8 (kN)	RL9 (kN)	RL10 (kN)
P13	2717	2717	2717	2717	-	-	-	-	-	-
P20	2287	2287	2287	2287	-	-	-	-	-	-

	RU1 (kN)	RU2 (kN)	RU3 (kN)	RU4 (kN)	RU5 (kN)	RU6 (kN)	RU7 (kN)	RU8 (kN)	RU9 (kN)	RU10 (kN)
P13	1659	1659	1659	1659	-	-	-	-	-	-
P20	1363	1363	1363	1363	-	-	-	-	-	-

The abstract of maximum and minimum value

	Longitudinal direction		The transversal direction	
	RL (kN)	RU (kN)	RL (kN)	RU (kN)
P13	2451	1925	2717	1659
P20	2044	1606	2287	1363

3. Design of Expansion Joint at P20

Design and Calculation of Expansion Joint

EJ-3 (P20)

Design Condition

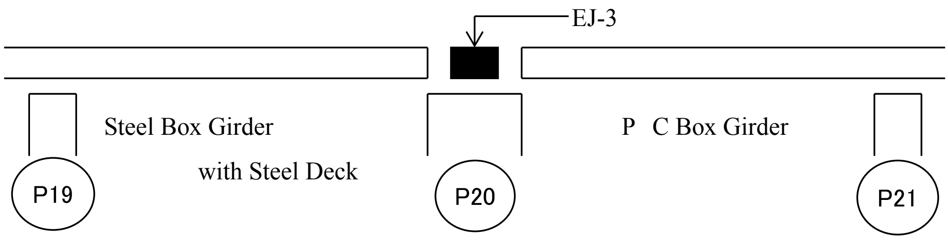
Design and Calculation of Expansion Joint EJ-3 (P20)

１. Desin Condition

	(Left Side)	(Right Side)
・ Type of Bridge	Steel Box Girder with Steel Deck	P C Box Girder
・ Temperature Zone	0 ℃ ～ 50 ℃	5 ℃ ～ 45 ℃
・ Traffic Load	(72.5KN per 1 -tire of Rear Wheel Axis)	
・ Calculation Formula	Section 4.2 Expansion Joint on JSHB	

２. Displacement of Expansion and Contraction

２－１. Normal Case



(Left Side)

Displacement due to Temperature	ΔLt =	=	98 mm
Extra Displacement	Δly = 0.2 × 98	=	20 mm

(Right Side)

Displacement due to Temperature	ΔLt =	=	224 mm
Extra Displacement	ΔLy = 0.2 × 224	=	45 mm
	Sum ΔLj	=	387 mm

２－２. Seismic Case

(Bridge Direction) $\Delta Lq = \sqrt{2} \times \pm 212 + \pm 15 = 630$ mm

３. Selection of Type as a sample

３－１. Displacement

ΔLj = 387 mm < ΔLq = 630 mm Earthquake case shall be considered

630 mm ≦ 640 mm

A kind of Modular Type (Maximum capacity of displacement 640mm) will be applied.

３－２. Space between the both bridges end

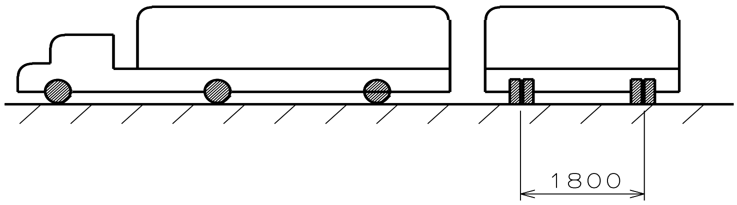
350 mm ≦ 950 mm

A kind of Modular Type (Maximum Space 950mm) will be applied.

Calculation of Middle Beam

Loading of wheel

325 KN in case that Loading condition is as the below.



17.5kN 72.5kN 72.5kN

17.5kN 72.5kN 72.5kN

The whole load	W =	325	〔KN〕
Front wheel (1-tire)	W' =	17.5	〔KN〕
Rear wheel (1-tire)	W" =	72.5	〔KN〕
Contact Length of a tire	a =	250	(mm) (mm)
Contact Width of a tire	b =	510	(mm)

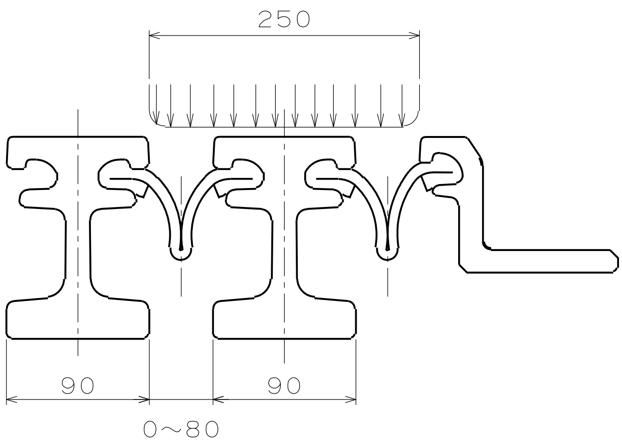
Middle Beam （ Standard: EN S355J2 + N ）

Mechanical Characteristics of Middle Beam

Material Class	Required characteristics		
	Yield N/mm2	Ultimate St N/mm2	Elongation %
EN S355J2+N	over 355	470 ～ 630	over 22

A tire load act on only a middle beam when the maximum expanded condition is occurred.

This case is the most critical one for a middle beam



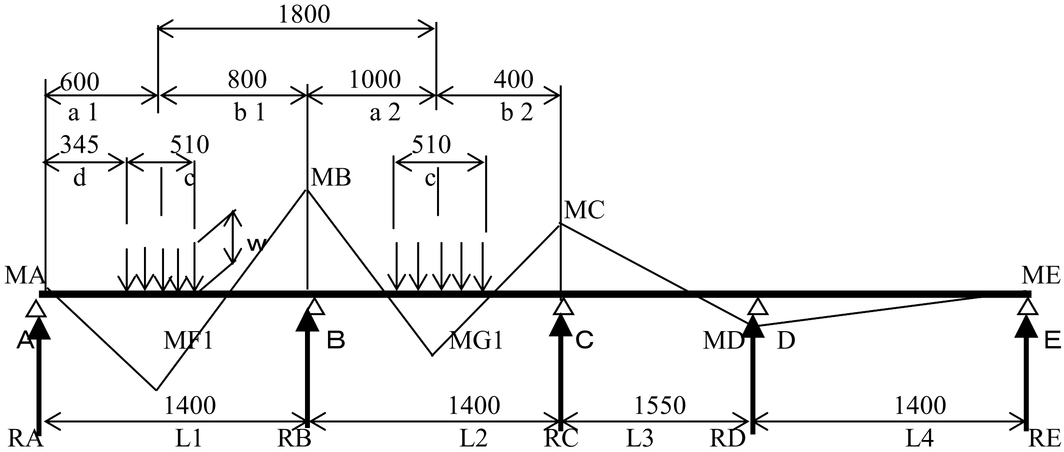
Maximum load transmitted to a middle beam

P= 72.5 〔KN〕

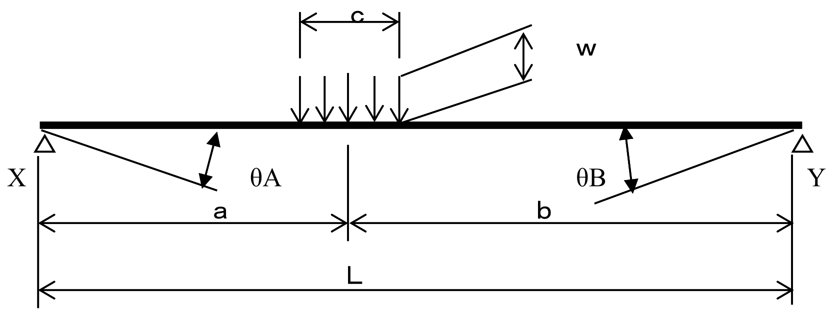
Bending Moment of Middle Beam

This B.M of a middle beam is calculated as continuous 4-span beam regarding the below loading condition.

(The distance a is 0.425xL1 that is the point where the maimum bending moment of continuous beam is considered to occur.)



Truck wheel is assumed so as to be between A－C



The load terms relating to cooperating beam are given by the following formula.

X ＝ E I θA = w･b･c･[4･a･(L＋b)－c2] ／ 24 ／ L

Y ＝ E I θB = w･a･c･[4･b･(L＋a)－c2] ／ 24 ／ L

Calculation of loading terms

P= 72.5 〔KN〕

w ＝ 72.5 / 510 ＝ 0.15 〔KN ／mm〕

Y (B-A) ＝w ・ a 1･c ･〔4 ・ b 1 ・ (L_1＋a 1)－c^2 〕／ 24 ／ L_1

= 0.15 x 600 x 510 x [4 x 800 x (1400 + 600) - 510^2] ／24／1400

= 8387600 〔KN ･mm2〕

X (B-C) ＝w ・ b 2 ・ c ･〔 4 ・ a 2 ･ (L_2＋b 2)－c^2 〕／ 24 ／ L_2

= 0.15 x 400 x 510 x [4 x 1000 x (1400 + 400) - 510^2] ／24／1400

= 6320300 〔KN ･mm2〕

$Y(C\text{-}B) = w \cdot a2 \cdot c \cdot [4 \cdot b2 \cdot (L_2 + a2) - c^2] / 24 / L_2$

$= 0.15 \times 1000 \times 510 \times [4 \times 400 \times (1400 + 1000) - 510^2] / 24 / 1400$

$= 8150700$ 〔KN・mm2〕

$X(C\text{-}D) = Y(D\text{-}C) = X(D\text{-}E) = 0$

Hereabout, the equation of tripple moment is applied.

Herein、 MA=ME= 0

$2 \cdot (L1 + L2) \cdot MB + (L2) \cdot MC = -6 \cdot (Y(B\text{-}A) + X(B\text{-}C))$

$2 \times (1400 + 1400) \times MB + 1400 \times MC = -6 \times (8387600 + 6320300)$

$5600 \times MB + 1400 \times MC = -88247400$ 〔KN・mm〕

$(L2) \cdot MB + 2 \cdot (L2 + L3) \cdot MC + L3 \cdot MD = -6 \cdot (Y(C\text{-}B) + X(C\text{-}D))$

$1400 \times MB + 2(1400 + 1550) \times MC + 1550 \times MD = -6(8150700 + 0)$

$1400 \times MB + 5900 \times MC + 1550 \times MD = -48904200$ 〔KN・mm〕

$(L3) \cdot MC + 2 \cdot (L3 + L4) \cdot MD = -6 \cdot (Y(D\text{-}C) + X(D\text{-}E))$

$1550 \times MC + 2 \times (1550 + 1400) \times MD = -6 \times (0 + 0)$

$1550 \times MC + 5900 \times MD = 0$ 〔KN・mm〕

In accordance with the above 3 equations, MB,MC,MD have been gotten.。

MB＝ -14453.61247 = -14454〔KN・mm〕

MC＝ -5219.407267 = -5220〔KN・mm〕

MD＝ 1371.200214 = 1372〔KN・mm〕

Then, every support reaction will be calculated.

$RA = RA' + MB / L1$ $RA' = w \cdot c \cdot b1 / L1$

$= 0.15 \times 510 \times 800 / 1400 + (-14454 / 1400)$

$= 33.39$ (KN)

$RB = RB' + (-MB)/L1 + (MC - MB)/L2$ $RB' = w \cdot c \cdot a1 / L1 + w \cdot c \cdot b2 / L2$

$= 0.15 \times 510 \times 600 / 1400 + 0.15 \times 510 \times 400 / 1400$

$- (-14454 / 1400) + (-5220 - (-14454)) / 1400$

$= 71.56$ (KN)

$RC = RC' + (MB - MC)/L2 + (MD - MC)/L3$ $RC' = w \cdot c \cdot a2 / L2$

$= 0.15 \times 510 \times 1000 / 1400 + (-14454 - (-5220)) / 1400$

$+ (1372 - (-5220)) / 1550$

$= 52.3$ (KN)

$RD = (MC - MD)/L3 + (ME - MD)/L4$

$= (-5220 - 1372) / 1550 + (-1372) / 1400$

$= \quad -5.23 \quad$ （KN）

RE ＝ MD ／ L4

$= 1372 / 1400$

$= \quad 0.98 \quad$ （KN）

RA＋RB＋ RC＋ RD＋ RE ＝ 2（P）＝ 2 x 100 ＝ 200 （KN）

$33.39 + 71.56 + 52.3 + -5.23 + 0.98 =$ 153 （KN）

The process for calculating the maximum bending moment of the span A-B

Vx1: Shearing Force due to a wheel load on the span A-B

$Vx1=RA-w\cdot(X-d)$

$= 33.39 - 0.15 \times (X - 345)$

X may be gotten from the Vx1=0

X1= 567.6 (mm）

MF1: Bending Moment due to a wheel load on span A-B

$MF1= RA\cdot X1-1/2\cdot w\cdot(X1-d)^2$

$= 33.39 \times 567.6 - 0.5 \times 0.15 \times (567.6 - 345)^2$

$= \quad 15240$ 〔KN・mm〕

The process for calculating the maximum bending moment of the span B-C

Vx2: Shearing Force due to a wheel load on the span B-C

$Vx2=RA+RB-P-w\cdot(X2-a1-1500)$

$= 33.39 + 71.56 - 72.5 - 0.15 \times (X - 600 - 1500)$

X may be gotten from the Vx2=0

X=X2= 2316.30 (mm） X=X2=

MG1: Bending Moment due to a wheel load on span B-C

$MG1 = RA\cdot X2 + RB\cdot(X2 - L1) - P\cdot(X2 - a1)$

$-1/2 \cdot w \cdot (X2 - a1 - 1500)^2$

$= 33.39 \times 2316.3 + 71.56 \times (2316.3 - 1400) - 72.5 \times (2316.3 - 600)$

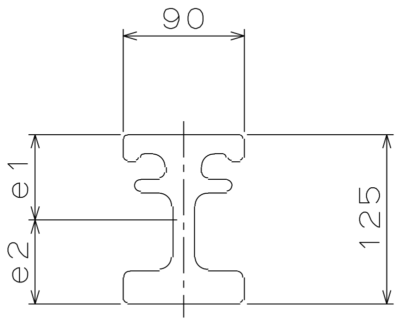
$- 0.5 \times 0.15 \times (2316.3 - 600 - 1500)^2$

$= \quad 14980$ 〔KN・mm〕

The maximum bending moment of the span A-E

M_{max} = 15240 〔KN・mm〕

σ_1: Stress due to Bending momnet



a =	90	mm
b =	125	mm
A =	5904	mm2
e1 =	63	mm
e2 =	62	mm
I =	11552000	mm4
A2=	1875	mm2 (Section Area of Web)

i: Impact coefficient

i= 0.4

The maximum bending moment of the span A-D

M_{max} = 15240 〔KN・mm〕

σ_1: Stress due to Bending momnet

$\sigma 1$ = Mmax x (1+i) x e1 x 1000 ／ I

= 15240 x (1 + 0.4) x 63 x 1000 ／ 11552000

= 116.4 N／mm2 $<\sigma ba$ = 210 N／mm2 (S355J2 + N)

$\sigma ba = \sigma y / 1.7$

$= 355 / 1.7$

$\fallingdotseq$ 210 N／mm2

τ_1: Stress due to Shearing Force

$\tau 1$ = Rmax x (1 + i) x 1000 / A2

= 72.5 x (1 + 0.4) x 1000 / 1875

= 54.1 N／mm2 $<\tau a$ = 120 N／mm2 (S355J2 + N)

$\tau a = \sigma y / \sqrt{3} / 1.7$

$= 355 / \sqrt{3} / 1.7$

$\fallingdotseq$ 120 N／mm2

U: The combination stress

U = (σ1 / σba)^2 + (τ1 / τa)^2

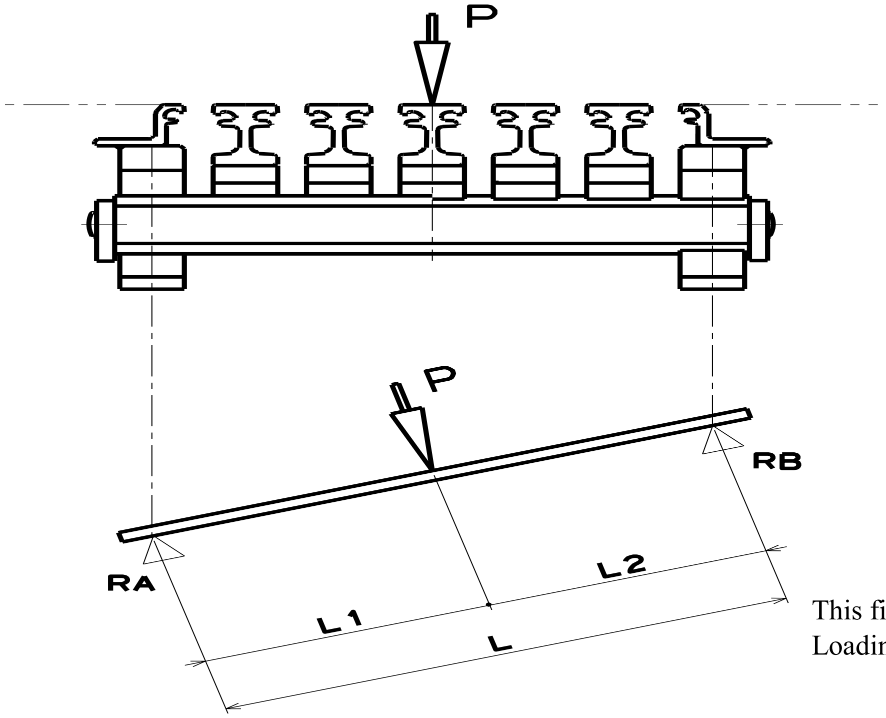
= (116.4 / 210) ^2 + (54.1 / 120) ^2

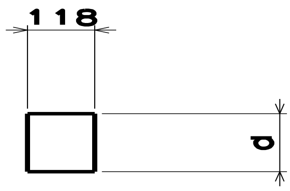
= 0.51 < 1.2

Calculation of Support Beam

Support Beam (SM490A)

The Support Beam is calculated as a simple beam supported at bearing position when the maximum expanded displacement occur.





This figure shows an image of Loading.

The maximum Load acting on Support Beam	72.5	KN
The Maximum Distance	1435	mm
The Loading Position	717.5	mm
The Loading Position	717.5	mm
The Height of Support Beam	145	mm

Impact Coefficient I

I = 0.4

Bending Moment M 1

M 1 = P x L1 x L2 / L

= 72.5 x 717.5 x 717.5 / 1435 = 26100 KN・mm

Section Modulus Z 1

Z 1 = 1/6 x d^2 x 118

= 1 / 6 x 145^2 x 118 = 413500 mm3

$\sigma 1$: Bending Moment Stress

$\sigma 1 = M 1 \times (1 + I) \times 1000 / Z 1$

$= 26100 \times (1 + 0.4) \times 1000 / 413500$

$= 88.4$ N /mm2 $<$ 167 N /mm2

$\tau 1$: Shearing Stress

$\tau 1 = P \times (1 + I) \times 1000 / (d \times H)$

$= 72.5 \times (1 + 0.4) \times 1000 / (145 \times 118)$

$= 5.9$ N /mm2 $<$ 98 N /mm2

U: Combination Stress factor

$U = (\sigma 1 / \sigma ba)^2 + (\tau 1 / \tau a)^2$

$= (88.4 / 167)^2 + (5.9 / 98)^2$

$= 0.284 < 1.2$