1.2 Dike and Revetment

1.2.1 Slope Stability Analysis

The calculation sheets are shown in the following pages.

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.1　Normal and Seismic Conditions

(1)　L5+400

Circular Slip Surface

L+5400

Contents

Page

1. Input Data 1

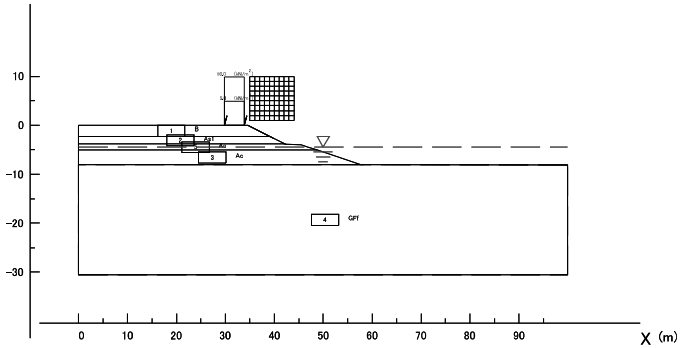
2. Check list 13

3. Action 01 Result list ... 14

4. Action 02 Result list ... 24

1. Input data list

// Design section //



// Design level of reliability design method //

Level of reliability design ..... Level 1(Design for value, part coefficient method)

// Combination of action //

// Setting of action //

Action	Action name	Seisimic inertia	Newmark No.	Same hydraul-ic line
1	normal			
2	seismic	○		

// Partial coefficient concerning analytical technique γ_α //

Action No.	Partial coefficient concerning analytical technique γ_α
1	1.00
2	1.00

// Partial coefficient concerning W,C,ϕ $\gamma w, \gamma c, \gamma \tan\phi$ //

No.	Action 1			Action 2											
	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$
1	1.00	1.00	1.00	1.00	1.00	1.00						
2	1.00	1.00	1.00	1.00	1.00	1.00						
3	1.00	1.00	1.00	1.00	1.00	1.00						
4	1.00	1.00	1.00	1.00	1.00	1.00						
5	1.00	1.00	1.00	1.00	1.00	1.00						

$$M = \Sigma [C_d l + \{ (W_d' + q_d) \cos\theta - K_k W_d \sin\theta \} \tan\phi_d]$$

$$W_d' = \gamma_w W_k'$$

$$C_d = \gamma_c C_k$$

$$\tan\phi_d = \gamma_{\tan\phi} \tan\phi_k$$

- M : Resistance moment
- γ_w : Partial coefficient concerning weight
- W_d' : Effective weight of slice of amount for each unit length splinter (value for design) (kN/m)
- W_k' : Effective weight of slice of amount for each unit length splinter (characteristic value)(kN/m)
- q_d : Perpendicular action because of the upper part of amount of slice (kN/m)
- γ_c : Partial coefficient concerning Cohesion
- C_d : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (value for design) (kN/m²)
- C_k : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (characteristic value) (kN/m²)
- l : Length in base of amount of Slice (m)
- $\gamma_{\tan\phi}$: Partial coefficient concerning shearing resistance angle
- ϕ_d : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(value for design)(°)
- ϕ_k : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(characteristic value)(°)

// Partial coefficient of partial coefficient γ_{vl} to distribution load (Think as well as the ground) and inertia force γ_{vlEQ} //

Action No.	Load1		Load2							
	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force
1	1.00	1.00	−	−						
2	−	−	1.00	1.00						

$$M_{r,vl} = K \cdot r \Sigma (FR \cdot \gamma_{vl,i} - K_{hp} \cdot FO \cdot \gamma_{vlEQ,i}) \cdot \tan\phi$$

$$M_{d,vl} = r \Sigma (FO \cdot \gamma_{vl,i} + K_{hp} \cdot FR \cdot \gamma_{vlEQ,i})$$

$$FR = F \cdot \cos\theta$$

$$FO = F \cdot \sin\theta$$

- $M_{r,vl}$: Resistance moment of distribution load (Think as well as the ground)
- $M_{d,vl}$: Sliding moment of distribution load (Think as well as the ground)
- K : Resistance power coefficient
- r : Radius of slipping circular arc
- F : Distribution load i
- FR : Slipping line orthogonalization direction load value of load i
- FO : Slipping line direction load value of load i
- θ : Angle that slice bottom (slide surface) does to the horizontal
- $\gamma_{vl,i}$: Partial coefficient of distribution load i (Think as well as the ground).
- K_{hp} : The horizontal seismic intensity
- $\gamma_{vlEQ,i}$: Partial coefficient of inertia force of distribution load i (Think as well as the ground).
- ϕ : Internal friction angle of soil

// Partial coefficient to residual water level //

Action number	rRWL
1	1.00
2	1.00

$$RWL_d = \gamma_{RWL} RWL_k$$

- γ_{RWL} : Partial coefficient concerning residual water level
- RWL_d : Difference between residual water level and water level line (value for design) (m)
- RWL_k : Difference between residual water level and water level line (input value) (m)

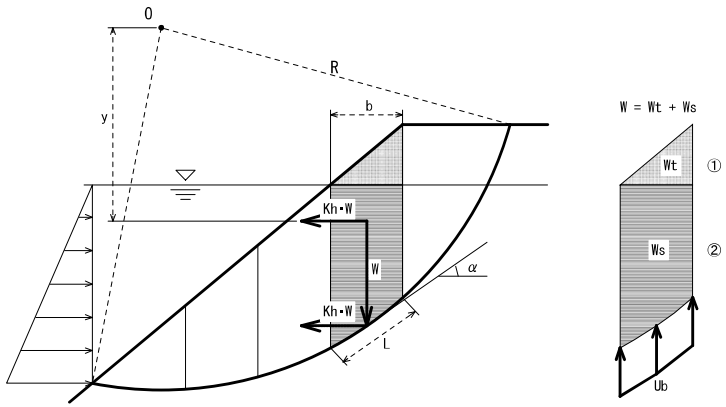
(DATA 01.)　// ANALYSIS //

Title　.....　Test of Embankment Stability
Analysis type　.....　Analysis of Bearing force Action ratio
Calculation method .....　Revised Feleniu s (Total stress)

Expression

$$\frac{R\Sigma[C_d l+\{((1+K_v)W_d-u\,b)\cos\theta-K_h W_d\sin\theta\}\tan\phi_d]}{\gamma_a R\Sigma\{(1+K_v)W_d\sin\theta+K_h W_d\cos\theta\}} \geqq 1.0$$

R	:	Radius of slipping circle of circular arc (m)
C_d	:	Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (kN/m²)
l	:	Length in base of amount of crack splinter (m)
q_d	:	Perpendicular action because of the upper part of amount of crack splinter (kN/m)
θ	:	Angle that amount of crack splinter bottom does to a horizontal plane (degree)
ϕ_d	:	0 in case of viscous land board. Shearing resistance in drain condition in case of the sandy soil ground etc.(°)
W_d	:	Full weight of crack of amount for each unit length splinter (full weight of soil and water) (kN/m)
γ_a	:	Partial coefficient concerning analytical technique
K_h	:	The horizontal seismic intensity
K_v	:	Vertical seismic coefficient
u	:	Pore pressure (kN/m²)
b	:	Width of slice (m)



Treatment of its own weight W of the resistance force
　Above the water level.....Calculate the weight Wt in Wet weight γt　①
　Below the water level.....Calculate weight Ws in Saturated weight γsat　②
Treatment of its own weight W of impetus
　Above the water level.....Calculate the weight Wt in Wet weight γt
　Below the water level.....Calculate weight in Saturated weight γsat
Water pressure acting on the slip plane.....Consider in the Ubcosα
　(Modify Fereniusu method)
Lateral hydrostatic pressure due to water storage.....Including

(DATA 02.)　// CONTROL //

Second pursuit　.....　0 (=0 No)
　(>0 Yes　)
Run　.....　0 (=0 Input data check + Analysis)
　(=1 Input data check　)

(DATA 04.) // SEISMIC LOAD //

```
Seismic load                    .....  0 ( =0 Same for the whole model )
                                       ( =1 Different on each layer  )
Condition                       .....  1 ( =0 Acts on only sliding force )
                                       ( =1 Sliding + Resisting force  )
Acting point                    .....  0 ( =0 On the slip surface              )
                                       ( =1 Center of gravity of sliding mass )
                                       ( =2 Resisting:on the slip surface
                                            Sliding  :Center of gravity of sliding mass )
Unit weight                     .....  0 ( =0 Saturated weight )
                                       ( =1 Submerged weight )
Horizontal seismic coefficient.....  0.200
Vertical seismic coefficient  .....  0.000
```


(DATA 06.) // NODAL POINT //

No.	Coordinate		Y-coordinate
	x (m)	y (m)	before settlement (m)
1	0.00	0.00	0.00
2	29.83	0.00	0.00
3	33.83	0.00	0.00
4	34.53	0.00	0.00
5	39.10	-2.28	0.00
6	0.00	-2.28	0.00
7	0.00	-5.07	0.00
8	48.74	-5.07	0.00
9	42.20	-3.83	0.00
10	45.53	-4.00	0.00
11	46.80	-4.42	0.00
12	0.00	-4.42	0.00
13	0.00	-8.06	0.00
14	57.72	-8.06	0.00
15	100.00	-8.07	0.00
16	100.00	-30.59	0.00
17	0.00	-30.59	0.00
18	0.00	-3.81	0.00
19	42.15	-3.81	0.00

(DATA 07.) // WATER LEVEL //

Unit weight of water (kN/m³) = 10.00

Action No.	Water level line number
1	1
2	1

Water level line number: 1

No.	Coordinate	
	X (m)	Y (m)
1	0.00	-4.42
2	100.00	-4.42

Water level line number: 2

No.	Coordinate	
	X (m)	Y (m)
1	0.00	-2.44
2	39.00	-2.44
3	44.00	-4.42
4	100.00	-4.42

(DATA 08.) // LAYER //

No.	material property No.	The name of the strata
1	5	B
2	6	As1
3	9	Ac
4	8	GFf
5	9	Ac

No.	Num of Node	Node numbers composing a layer	Slip existence
1	6	1 6 5 4 3 2	Slip
2	4	6 18 19 5	Slip
3	4	7 13 14 8	Slip
4	5	13 17 16 15 14	Not Slip
5	8	9 19 18 12 7 8 11 10	Slip

(DATA 09.1) // MATERIAL PROPERTIES //

No.	Nature of soil division	Saturated weight (kN/m³)	Wet weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
5	B	19.00	18.00	1.00	0.00	30.00	0.00	0.000	0.0
6	As1	18.50	17.50	0.00	0.00	27.80	0.00	0.000	0.0
8	GFf	18.00	17.00	******	0.00	30.00	0.00	0.000	0.0
9	Ac	16.50	15.50	50.00	0.00	0.00	0.00	0.000	0.0

(DATA 09.2) // Characteristic of soil //

No.	Action Number									
	Act 1	Act 2								
1	5	5								
2	6	6								
3	9	9								
4	8	8								
5	9	9								

(DATA 11.) // GRID POINT //

No.	Slip direction	Double cutting	GX (m)	GY (m)	X-point	Y-point	X-pitch (m)	Y-pitch (m)	Dx/Dy	NEXCO Radius
1	Downstream	Rigt lump	35.00	10.00	10	10	1.00	1.00	0.000	0.000

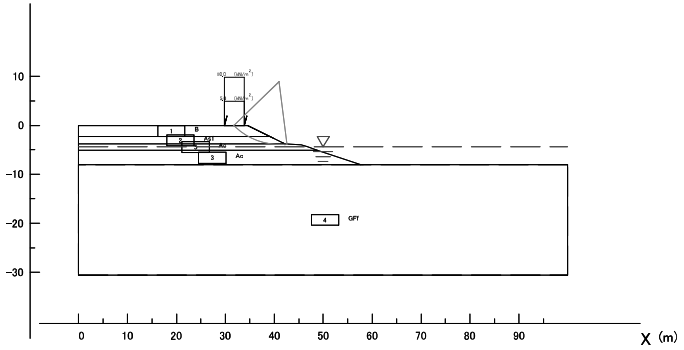
2. Check list

// Check of circular arc //

Action No.	Action name	Bearing force Action ratio	Judgment
1	normal	2.665	OK
2	seismic	1.832	OK

Action No.	Bearing force Action ratio	Partial coefficient	Center of slipping circular arc		Radius of	Resistance	Sliding
			X (m)	Y (m)	circular arc(m)	Moment (kNm)	Moment (kNm)
		r_a					
1	2.665	1.00	41.00	9.00	12.942	3685.0	1382.9
2	1.832	1.00	41.00	9.00	12.942	3556.3	1941.4

// Check Result chart //



3. Action01 (normal)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle ϕ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	5	19.00	18.00	9.00	1.00	0.00	30.00	0.00	0.00	0.0
2	6	18.50	17.50	8.50	0.00	0.00	27.80	0.00	0.00	0.0
3	9	16.50	15.50	6.50	50.00	0.00	0.00	0.00	0.00	0.0
4	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0	5	9 16.5	0 15.5	0 6.5	0 50.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.
0										

// Distribution load that considers partial coefficient //

load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
1	29.83	0.00	10.0	33.83	0.00	10.0	0.000	0.000	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	-4.42	
2	100.00	-4.42	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	10.00	0.00	0.001	0.0	0.0	***5
35.00	9.00	0.00	0.001	0.0	0.0	***5
35.00	8.00	0.00	0.001	0.0	0.0	***5
35.00	7.00	0.00	0.001	0.0	0.0	***5
35.00	6.00	0.00	0.001	0.0	0.0	***5
35.00	5.00	0.00	0.001	0.0	0.0	***5
35.00	4.00	0.00	0.001	0.0	0.0	***5
35.00	3.00	0.00	0.001	0.0	0.0	***5
35.00	2.00	0.00	0.001	0.0	0.0	***5
35.00	1.00	0.00	0.001	0.0	0.0	***5
36.00	10.00	0.00	0.001	0.0	0.0	***5
36.00	9.00	0.00	0.001	0.0	0.0	***5
36.00	8.00	0.00	0.001	0.0	0.0	***5
36.00	7.00	0.00	0.001	0.0	0.0	***5
36.00	6.00	0.00	0.001	0.0	0.0	***5
36.00	5.00	0.00	0.001	0.0	0.0	***5
36.00	4.00	0.00	0.001	0.0	0.0	***5
36.00	3.00	0.00	0.001	0.0	0.0	***5
36.00	2.00	0.00	0.001	0.0	0.0	***5
36.00	1.00	0.00	0.001	0.0	0.0	***5
37.00	10.00	0.00	0.001	0.0	0.0	***5
37.00	9.00	0.00	0.001	0.0	0.0	***5
37.00	8.00	0.00	0.001	0.0	0.0	***5
37.00	7.00	0.00	0.001	0.0	0.0	***5
37.00	6.00	0.00	0.001	0.0	0.0	***5
37.00	5.00	0.00	0.001	0.0	0.0	***5
37.00	4.00	0.00	0.001	0.0	0.0	***5
37.00	3.00	0.00	0.001	0.0	0.0	***5
37.00	2.00	0.00	0.001	0.0	0.0	***5
37.00	1.00	0.00	0.001	0.0	0.0	***5
38.00	10.00	0.00	0.001	0.0	0.0	***5
38.00	9.00	0.00	0.001	0.0	0.0	***5
38.00	8.00	0.00	0.001	0.0	0.0	***5
38.00	7.00	0.00	0.001	0.0	0.0	***5
38.00	6.00	0.00	0.001	0.0	0.0	***5
38.00	5.00	0.00	0.001	0.0	0.0	***5
38.00	4.00	9.00	2.966	4742.7	1599.1	
38.00	3.00	0.00	0.001	0.0	0.0	***5
38.00	2.00	-7.66	999.000	0.0	0.0	
38.00	1.00	-7.56	999.000	0.0	0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	1.00	-6.56	999.000	0.0	0.0	
39.00	10.00	0.00	0.001	0.0	0.0	***5
39.00	9.00	0.00	0.001	0.0	0.0	***5
39.00	8.00	0.00	0.001	0.0	0.0	***5
39.00	7.00	0.00	0.001	0.0	0.0	***5
39.00	6.00	-10.64	999.000	0.0	0.0	
		10.36	2.935	4499.2	1532.9	
39.00	5.00	-9.53	999.000	0.0	0.0	
		9.47	2.953	4131.4	1399.0	
		10.00	3.059	5523.5	1805.6	
39.00	4.00	-9.43	999.000	0.0	0.0	
		8.57	2.976	3718.3	1249.4	
		9.00	3.045	4699.3	1543.4	
39.00	3.00	-9.32	999.000	0.0	0.0	
		-8.32	999.000	0.0	0.0	
		7.68	3.020	3274.2	1084.3	
		8.00	3.059	3919.3	1281.4	
39.00	2.00	-9.21	999.000	0.0	0.0	
		-8.21	999.000	0.0	0.0	
		-7.21	999.000	0.0	0.0	
		6.79	3.111	2811.2	903.5	
		7.00	3.124	3186.0	1019.7	
39.00	1.00	-8.11	999.000	0.0	0.0	
		-7.11	999.000	0.0	0.0	
		-6.11	999.000	0.0	0.0	
		5.89	3.311	2341.1	707.2	
		6.00	3.303	2504.5	758.2	
40.00	10.00	0.00	0.001	0.0	0.0	***5
40.00	9.00	13.50	3.261	7085.5	2173.1	
40.00	8.00	12.60	3.259	6699.7	2055.6	
40.00	7.00	-11.29	999.000	0.0	0.0	
		11.71	3.254	6254.8	1922.2	
		12.00	3.284	7228.2	2201.2	
40.00	6.00	-11.19	999.000	0.0	0.0	
		-10.19	999.000	0.0	0.0	
		10.81	3.251	5763.9	1773.1	
		11.00	3.264	6325.5	1937.9	
40.00	5.00	-11.08	999.000	0.0	0.0	
		-10.08	999.000	0.0	0.0	
		9.92	3.258	5238.2	1608.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
40.00	5.00	10.00	3.261	5460.9	1674.8
40.00	4.00	-9.98	999.000	0.0	0.0
		-8.98	999.000	0.0	0.0
		9.00	3.285	4637.4	1411.8
40.00	3.00	-9.87	999.000	0.0	0.0
		-8.87	999.000	0.0	0.0
		-7.87	999.000	0.0	0.0
		8.00	3.358	3858.4	1149.1
40.00	2.00	-9.77	999.000	0.0	0.0
		-8.77	999.000	0.0	0.0
		-7.77	999.000	0.0	0.0
		-6.77	999.000	0.0	0.0
		7.00	3.529	3128.3	886.5
40.00	1.00	-8.66	999.000	0.0	0.0
		-7.66	999.000	0.0	0.0
		-6.66	999.000	0.0	0.0
41.00	10.00	14.84	3.555	9209.8	2590.7
41.00	9.00	12.94	2.665	3685.0	1382.9
		13.94	3.525	8666.9	2458.8
		14.00	3.508	8860.5	2525.8
41.00	8.00	12.05	3.003	3914.4	1303.6
		13.00	3.517	7948.9	2260.4
41.00	7.00	11.15	3.236	3912.3	1209.0
		12.00	3.540	7065.0	1995.5
41.00	6.00	-11.74	999.000	0.0	0.0
		-10.74	999.000	0.0	0.0
		10.26	3.427	3766.4	1098.9
		11.00	3.588	6210.8	1731.1
41.00	5.00	-11.64	999.000	0.0	0.0
		-10.64	999.000	0.0	0.0
		-9.64	999.000	0.0	0.0
		9.36	3.620	3522.2	973.1
		10.00	3.653	5359.2	1467.2
41.00	4.00	-11.53	999.000	0.0	0.0
		-10.53	999.000	0.0	0.0
		-9.53	999.000	0.0	0.0
		-8.53	999.000	0.0	0.0
		8.47	3.859	3208.9	831.5
		9.00	3.773	4540.8	1203.6
41.00	3.00	-10.43	999.000	0.0	0.0

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
41.00	3.00	-9.43	999.000	0.0	0.0
		-8.43	999.000	0.0	0.0
		8.00	4.009	3769.0	940.0
41.00	2.00	-9.32	999.000	0.0	0.0
		-8.32	999.000	0.0	0.0
41.00	1.00	-8.22	999.000	0.0	0.0
42.00	10.00	14.28	3.757	6212.3	1653.5
		15.00	3.701	9332.1	2521.3
42.00	9.00	13.39	3.896	6079.0	1560.4
		14.00	3.738	8422.8	2253.4
42.00	8.00	12.49	4.020	5835.5	1451.5
		13.00	3.797	7540.2	1985.8
42.00	7.00	11.60	4.127	5475.3	1326.6
		12.00	3.891	6686.4	1718.6
42.00	6.00	-11.30	999.000	0.0	0.0
		-10.30	999.000	0.0	0.0
		10.70	4.265	5058.2	1185.9
		11.00	4.039	5863.5	1451.7
42.00	5.00	-12.19	999.000	0.0	0.0
		-11.19	999.000	0.0	0.0
		-10.19	999.000	0.0	0.0
		9.81	4.478	4608.3	1029.1
		10.00	4.281	5073.8	1185.3
42.00	4.00	-11.09	999.000	0.0	0.0
		-10.09	999.000	0.0	0.0
42.00	3.00	-10.98	999.000	0.0	0.0
		-9.98	999.000	0.0	0.0
		-8.98	999.000	0.0	0.0
42.00	2.00	-9.87	999.000	0.0	0.0
		-8.87	999.000	0.0	0.0
42.00	1.00	-8.77	999.000	0.0	0.0
43.00	10.00	14.73	4.212	7695.6	1827.3
		15.00	4.036	8783.7	2176.2
43.00	9.00	13.83	4.277	7300.6	1706.9
		14.00	4.148	7909.8	1907.0
43.00	8.00	12.94	4.370	6860.8	1569.9
		13.00	4.313	7063.4	1637.9
43.00	7.00	12.00	4.563	6246.4	1368.9
43.00	6.00	11.00	4.964	5461.6	1100.2
43.00	5.00	-11.74	999.000	0.0	0.0

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
43.00	5.00	-10.74	999.000	0.0	0.0	
43.00	4.00	-11.64	999.000	0.0	0.0	
		-10.64	999.000	0.0	0.0	
43.00	3.00	-10.53	999.000	0.0	0.0	
43.00	2.00	-9.43	999.000	0.0	0.0	
43.00	1.00	0.00	0.001	0.0	0.0	***5
44.00	10.00	15.00	4.660	8148.5	1748.8	
44.00	9.00	14.00	4.946	7316.2	1479.1	
44.00	8.00	13.00	5.385	6513.1	1209.6	
44.00	7.00	0.00	0.001	0.0	0.0	***5
44.00	6.00	0.00	0.001	0.0	0.0	***5
44.00	5.00	0.00	0.001	0.0	0.0	***5
44.00	4.00	-11.19	999.000	0.0	0.0	
44.00	3.00	0.00	0.001	0.0	0.0	***5
44.00	2.00	0.00	0.001	0.0	0.0	***5
44.00	1.00	0.00	0.001	0.0	0.0	***5

Table of B.A

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	35.00	36.00	37.00	38.00	39.00	40.00
10.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
9.00	Fs	999.000	999.000	999.000	999.000	999.000	3.261
	R(m)	0.00	0.00	0.00	0.00	0.00	13.50
8.00	Fs	999.000	999.000	999.000	999.000	999.000	3.259
	R(m)	0.00	0.00	0.00	0.00	0.00	12.60
7.00	Fs	999.000	999.000	999.000	999.000	999.000	3.254
	R(m)	0.00	0.00	0.00	0.00	0.00	11.71
6.00	Fs	999.000	999.000	999.000	999.000	2.935	3.251
	R(m)	0.00	0.00	0.00	0.00	10.36	10.81
5.00	Fs	999.000	999.000	999.000	999.000	2.953	3.258
	R(m)	0.00	0.00	0.00	0.00	9.47	9.92
4.00	Fs	999.000	999.000	999.000	2.966	2.976	3.285
	R(m)	0.00	0.00	0.00	9.00	8.57	9.00
3.00	Fs	999.000	999.000	999.000	999.000	3.020	3.358
	R(m)	0.00	0.00	0.00	0.00	7.68	8.00
2.00	Fs	999.000	999.000	999.000	999.000	3.111	3.529
	R(m)	0.00	0.00	0.00	0.00	6.79	7.00
1.00	Fs	999.000	999.000	999.000	999.000	3.303	999.000
	R(m)	0.00	0.00	0.00	0.00	6.00	0.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

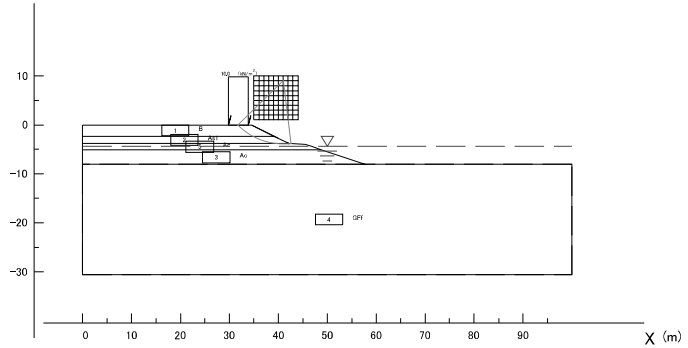
Y(m)	X(m)	41.00	42.00	43.00	44.00
10.00	Fs	3.555	3.701	4.036	4.660
	R(m)	14.84	15.00	15.00	15.00
9.00	Fs	2.665	3.738	4.148	4.946
	R(m)	12.94	14.00	14.00	14.00
8.00	Fs	3.003	3.797	4.313	5.385
	R(m)	12.05	13.00	13.00	13.00
7.00	Fs	3.236	3.891	4.563	999.000
	R(m)	11.15	12.00	12.00	0.00
6.00	Fs	3.427	4.039	4.964	999.000
	R(m)	10.26	11.00	11.00	0.00
5.00	Fs	3.620	4.281	999.000	999.000
	R(m)	9.36	10.00	0.00	0.00
4.00	Fs	3.773	999.000	999.000	999.000
	R(m)	9.00	0.00	0.00	0.00
3.00	Fs	4.009	999.000	999.000	999.000
	R(m)	8.00	0.00	0.00	0.00
2.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
1.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	2.665
Failure circle X(m)	=	41.00
Y(m)	=	9.00
R(m)	=	12.942
Resisting moment(kNm)	=	3685.0
Sliding moment(kNm)	=	1382.9
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



WARNING ***5 There are no arc contacting with base line.

count = 49

4. Action02 (seismic)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	5	19.00	18.00	9.00	1.00	0.00	30.00	0.00	0.00	0.0
2	6	18.50	17.50	8.50	0.00	0.00	27.80	0.00	0.00	0.0
3	9	16.50	15.50	6.50	50.00	0.00	0.00	0.00	0.00	0.0
4	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0	5	9 16.5	0 15.5	0 6.5	0 50.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.
0										

// Distribution load that considers partial coefficient //

load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
2	29.83	0.00	5.0	33.83	0.00	5.0	0.000	0.200	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	-4.42	
2	100.00	-4.42	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	10.00	0.00	0.001	0.0	0.0	***5
35.00	9.00	0.00	0.001	0.0	0.0	***5
35.00	8.00	0.00	0.001	0.0	0.0	***5
35.00	7.00	0.00	0.001	0.0	0.0	***5
35.00	6.00	0.00	0.001	0.0	0.0	***5
35.00	5.00	0.00	0.001	0.0	0.0	***5
35.00	4.00	0.00	0.001	0.0	0.0	***5
35.00	3.00	0.00	0.001	0.0	0.0	***5
35.00	2.00	0.00	0.001	0.0	0.0	***5
35.00	1.00	0.00	0.001	0.0	0.0	***5
36.00	10.00	0.00	0.001	0.0	0.0	***5
36.00	9.00	0.00	0.001	0.0	0.0	***5
36.00	8.00	0.00	0.001	0.0	0.0	***5
36.00	7.00	0.00	0.001	0.0	0.0	***5
36.00	6.00	0.00	0.001	0.0	0.0	***5
36.00	5.00	0.00	0.001	0.0	0.0	***5
36.00	4.00	0.00	0.001	0.0	0.0	***5
36.00	3.00	0.00	0.001	0.0	0.0	***5
36.00	2.00	0.00	0.001	0.0	0.0	***5
36.00	1.00	0.00	0.001	0.0	0.0	***5
37.00	10.00	0.00	0.001	0.0	0.0	***5
37.00	9.00	0.00	0.001	0.0	0.0	***5
37.00	8.00	0.00	0.001	0.0	0.0	***5
37.00	7.00	0.00	0.001	0.0	0.0	***5
37.00	6.00	0.00	0.001	0.0	0.0	***5
37.00	5.00	0.00	0.001	0.0	0.0	***5
37.00	4.00	0.00	0.001	0.0	0.0	***5
37.00	3.00	0.00	0.001	0.0	0.0	***5
37.00	2.00	0.00	0.001	0.0	0.0	***5
37.00	1.00	0.00	0.001	0.0	0.0	***5
38.00	10.00	0.00	0.001	0.0	0.0	***5
38.00	9.00	0.00	0.001	0.0	0.0	***5
38.00	8.00	0.00	0.001	0.0	0.0	***5
38.00	7.00	0.00	0.001	0.0	0.0	***5
38.00	6.00	0.00	0.001	0.0	0.0	***5
38.00	5.00	0.00	0.001	0.0	0.0	***5
38.00	4.00	9.00	1.907	4650.5	2438.9	
38.00	3.00	0.00	0.001	0.0	0.0	***5
38.00	2.00	-7.66	999.000	0.0	0.0	
38.00	1.00	-7.56	999.000	0.0	0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	1.00	-6.56	999.000	0.0	0.0	
39.00	10.00	0.00	0.001	0.0	0.0	***5
39.00	9.00	0.00	0.001	0.0	0.0	***5
39.00	8.00	0.00	0.001	0.0	0.0	***5
39.00	7.00	0.00	0.001	0.0	0.0	***5
39.00	6.00	-10.64	999.000	0.0	0.0	
		10.36	1.953	4380.8	2243.0	
39.00	5.00	-9.53	999.000	0.0	0.0	
		9.47	1.973	4026.8	2040.6	
		10.00	2.013	5417.1	2691.3	
39.00	4.00	-9.43	999.000	0.0	0.0	
		8.57	1.992	3627.7	1820.9	
		9.00	2.014	4607.0	2286.9	
39.00	3.00	-9.32	999.000	0.0	0.0	
		-8.32	999.000	0.0	0.0	
		7.68	2.018	3197.7	1584.5	
		8.00	2.028	3841.4	1893.8	
39.00	2.00	-9.21	999.000	0.0	0.0	
		-8.21	999.000	0.0	0.0	
		-7.21	999.000	0.0	0.0	
		6.79	2.063	2749.0	1332.6	
		7.00	2.064	3122.7	1512.6	
39.00	1.00	-8.11	999.000	0.0	0.0	
		-7.11	999.000	0.0	0.0	
		-6.11	999.000	0.0	0.0	
		5.89	2.150	2293.5	1066.8	
		6.00	2.146	2456.2	1144.8	
40.00	10.00	0.00	0.001	0.0	0.0	***5
40.00	9.00	13.50	2.172	6925.7	3189.3	
40.00	8.00	12.60	2.178	6553.4	3008.5	
40.00	7.00	-11.29	999.000	0.0	0.0	
		11.71	2.181	6122.2	2807.5	
		12.00	2.172	7093.6	3266.2	
40.00	6.00	-11.19	999.000	0.0	0.0	
		-10.19	999.000	0.0	0.0	
		10.81	2.182	5645.3	2586.7	
		11.00	2.173	6205.5	2855.4	
40.00	5.00	-11.08	999.000	0.0	0.0	
		-10.08	999.000	0.0	0.0	
		9.92	2.188	5133.7	2346.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
40.00	5.00	10.00	2.182	5355.8	2454.4
40.00	4.00	-9.98	999.000	0.0	0.0
		-8.98	999.000	0.0	0.0
		9.00	2.203	4547.4	2064.0
40.00	3.00	-9.87	999.000	0.0	0.0
		-8.87	999.000	0.0	0.0
		-7.87	999.000	0.0	0.0
		8.00	2.246	3783.9	1684.9
40.00	2.00	-9.77	999.000	0.0	0.0
		-8.77	999.000	0.0	0.0
		-7.77	999.000	0.0	0.0
		-6.77	999.000	0.0	0.0
		7.00	2.329	3069.6	1318.1
40.00	1.00	-8.66	999.000	0.0	0.0
		-7.66	999.000	0.0	0.0
		-6.66	999.000	0.0	0.0
41.00	10.00	14.84	2.354	9035.4	3838.2
41.00	9.00	12.94	1.832	3556.3	1941.4
		13.94	2.337	8506.4	3640.0
		14.00	2.319	8699.3	3752.0
41.00	8.00	12.05	2.074	3795.2	1830.2
		13.00	2.339	7802.9	3336.5
41.00	7.00	11.15	2.236	3803.8	1701.1
		12.00	2.367	6934.4	2930.2
41.00	6.00	-11.74	999.000	0.0	0.0
		-10.74	999.000	0.0	0.0
		10.26	2.361	3669.7	1554.0
		11.00	2.406	6096.0	2533.5
41.00	5.00	-11.64	999.000	0.0	0.0
		-10.64	999.000	0.0	0.0
		-9.64	999.000	0.0	0.0
		9.36	2.475	3438.0	1389.2
		10.00	2.450	5260.4	2146.9
41.00	4.00	-11.53	999.000	0.0	0.0
		-10.53	999.000	0.0	0.0
		-9.53	999.000	0.0	0.0
		-8.53	999.000	0.0	0.0
		8.47	2.599	3137.8	1207.3
		9.00	2.517	4458.3	1771.0
41.00	3.00	-10.43	999.000	0.0	0.0

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
41.00	3.00	-9.43	999.000	0.0	0.0
		-8.43	999.000	0.0	0.0
		8.00	2.633	3703.1	1406.7
41.00	2.00	-9.32	999.000	0.0	0.0
		-8.32	999.000	0.0	0.0
41.00	1.00	-8.22	999.000	0.0	0.0
42.00	10.00	14.28	2.592	6069.1	2341.7
		15.00	2.457	9162.7	3728.5
42.00	9.00	13.39	2.681	5946.7	2218.5
		14.00	2.491	8269.5	3319.1
42.00	8.00	12.49	2.753	5715.1	2075.6
		13.00	2.537	7403.3	2918.1
42.00	7.00	11.60	2.805	5367.3	1913.4
		12.00	2.599	6566.1	2526.1
42.00	6.00	-11.30	999.000	0.0	0.0
		-10.30	999.000	0.0	0.0
		10.70	2.866	4963.5	1732.1
		11.00	2.687	5760.0	2143.6
42.00	5.00	-12.19	999.000	0.0	0.0
		-11.19	999.000	0.0	0.0
		-10.19	999.000	0.0	0.0
		9.81	2.955	4527.5	1532.1
		10.00	2.816	4987.6	1771.3
42.00	4.00	-11.09	999.000	0.0	0.0
		-10.09	999.000	0.0	0.0
42.00	3.00	-10.98	999.000	0.0	0.0
		-9.98	999.000	0.0	0.0
		-8.98	999.000	0.0	0.0
42.00	2.00	-9.87	999.000	0.0	0.0
		-8.87	999.000	0.0	0.0
42.00	1.00	-8.77	999.000	0.0	0.0
43.00	10.00	14.73	2.842	7551.5	2657.2
		15.00	2.690	8628.2	3207.4
43.00	9.00	13.83	2.867	7169.0	2500.8
		14.00	2.762	7771.5	2813.9
43.00	8.00	12.94	2.902	6742.5	2323.3
		13.00	2.859	6942.7	2428.7
43.00	7.00	12.00	2.993	6143.6	2052.5
43.00	6.00	11.00	3.190	5377.1	1685.8
43.00	5.00	-11.74	999.000	0.0	0.0

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
43.00	5.00	-10.74	999.000	0.0	0.0	
43.00	4.00	-11.64	999.000	0.0	0.0	
		-10.64	999.000	0.0	0.0	
43.00	3.00	-10.53	999.000	0.0	0.0	
43.00	2.00	-9.43	999.000	0.0	0.0	
43.00	1.00	0.00	0.001	0.0	0.0	***5
44.00	10.00	15.00	3.075	8015.2	2606.3	
44.00	9.00	14.00	3.229	7201.5	2230.3	
44.00	8.00	13.00	3.445	6417.4	1862.8	
44.00	7.00	0.00	0.001	0.0	0.0	***5
44.00	6.00	0.00	0.001	0.0	0.0	***5
44.00	5.00	0.00	0.001	0.0	0.0	***5
44.00	4.00	-11.19	999.000	0.0	0.0	
44.00	3.00	0.00	0.001	0.0	0.0	***5
44.00	2.00	0.00	0.001	0.0	0.0	***5
44.00	1.00	0.00	0.001	0.0	0.0	***5

Table of B.A

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	35.00	36.00	37.00	38.00	39.00	40.00
10.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
9.00	Fs	999.000	999.000	999.000	999.000	999.000	2.172
	R(m)	0.00	0.00	0.00	0.00	0.00	13.50
8.00	Fs	999.000	999.000	999.000	999.000	999.000	2.178
	R(m)	0.00	0.00	0.00	0.00	0.00	12.60
7.00	Fs	999.000	999.000	999.000	999.000	999.000	2.172
	R(m)	0.00	0.00	0.00	0.00	0.00	12.00
6.00	Fs	999.000	999.000	999.000	999.000	1.953	2.173
	R(m)	0.00	0.00	0.00	0.00	10.36	11.00
5.00	Fs	999.000	999.000	999.000	999.000	1.973	2.182
	R(m)	0.00	0.00	0.00	0.00	9.47	10.00
4.00	Fs	999.000	999.000	999.000	1.907	1.992	2.203
	R(m)	0.00	0.00	0.00	9.00	8.57	9.00
3.00	Fs	999.000	999.000	999.000	999.000	2.018	2.246
	R(m)	0.00	0.00	0.00	0.00	7.68	8.00
2.00	Fs	999.000	999.000	999.000	999.000	2.063	2.329
	R(m)	0.00	0.00	0.00	0.00	6.79	7.00
1.00	Fs	999.000	999.000	999.000	999.000	2.146	999.000
	R(m)	0.00	0.00	0.00	0.00	6.00	0.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

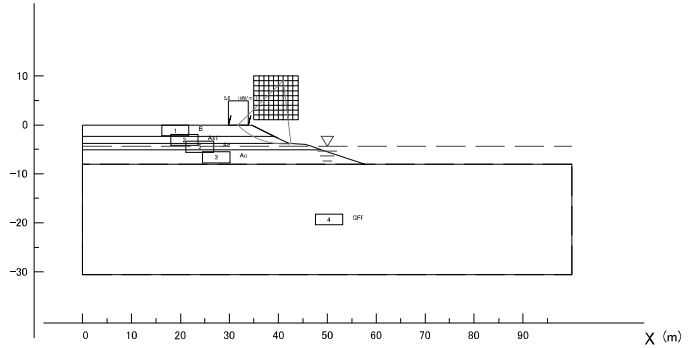
Y(m)	X(m)	41.00	42.00	43.00	44.00
10.00	Fs	2.354	2.457	2.690	3.075
	R(m)	14.84	15.00	15.00	15.00
9.00	Fs	1.832	2.491	2.762	3.229
	R(m)	12.94	14.00	14.00	14.00
8.00	Fs	2.074	2.537	2.859	3.445
	R(m)	12.05	13.00	13.00	13.00
7.00	Fs	2.236	2.599	2.993	999.000
	R(m)	11.15	12.00	12.00	0.00
6.00	Fs	2.361	2.687	3.190	999.000
	R(m)	10.26	11.00	11.00	0.00
5.00	Fs	2.450	2.816	999.000	999.000
	R(m)	10.00	10.00	0.00	0.00
4.00	Fs	2.517	999.000	999.000	999.000
	R(m)	9.00	0.00	0.00	0.00
3.00	Fs	2.633	999.000	999.000	999.000
	R(m)	8.00	0.00	0.00	0.00
2.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
1.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	1.832
Failure circle X(m)	=	41.00
Y(m)	=	9.00
R(m)	=	12.942
Resisting moment(kNm)	=	3556.3
Sliding moment(kNm)	=	1941.4
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



WARNING ***5 There are no arc contacting with base line.
count = 49

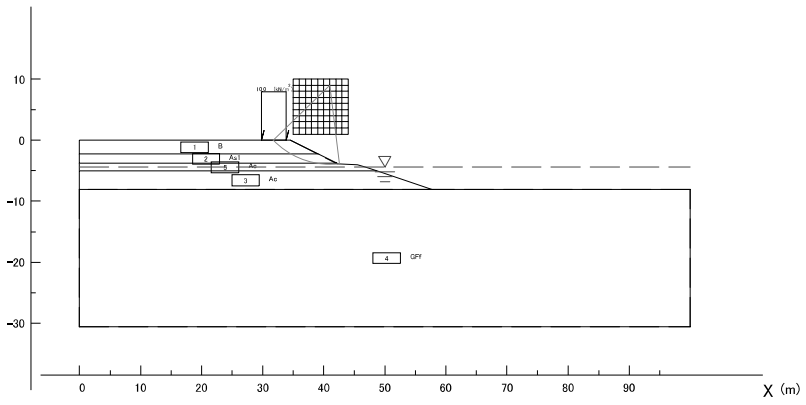
33

Test of Embankment Stability

Action number = 1
Action name : normal
Examination at earthquake : It doesn't do.

Scale : 1/ 792

Required Bearing force Action ratio	F S	=	1.000	
Bearing force Action ratio		=	2.665	≧ 1.0 (OK)
Center of arc	X	=	41.00	(m)
	Y	=	9.00	(m)
Radius	R	=	12.942	(m)
Resisting moment	M R	=	3685.0	(kNm)
Sliding moment	M D	=	1382.9	(kNm)
Partial coefficient concerning	γ α	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	19.00	18.00	30.00	1.00	0.00	0.000	0.000
2	18.50	17.50	27.80	0.00	0.00	0.000	0.000
3	16.50	15.50	0.00	50.00	0.00	0.000	0.000
4	18.00	17.00	30.00	1000.00	0.00	0.000	0.000
5	16.50	15.50	0.00	50.00	0.00	0.000	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Ordinary Condition)

Test of Embankment Stability

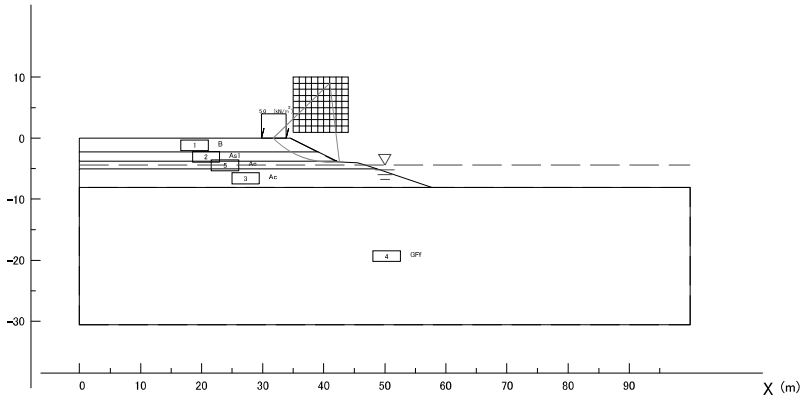
Action number = 2

Action name : seismic

Examination at earthquake : It does.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	1.832	≧ 1.0 (OK)
Center of arc	X	=	41.00	(m)
	Y	=	9.00	(m)
Radius	R	=	12.942	(m)
Resisting moment	M_R	=	3556.3	(kNm)
Sliding moment	M_D	=	1941.4	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	18.00	18.00	30.00	1.00	0.00	0.200	0.000
2	18.50	17.50	27.00	0.00	0.00	0.200	0.000
3	16.50	15.50	0.00	50.00	0.00	0.200	0.000
4	18.00	17.00	30.00	1000.00	0.00	0.200	0.000
5	16.50	15.50	0.00	50.00	0.00	0.200	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Seismic Condition)

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.1　Normal and Seismic Conditions

(2)　L5+780

Circular Slip Surface

L+5780

Contents

Page

1. Input Data 1

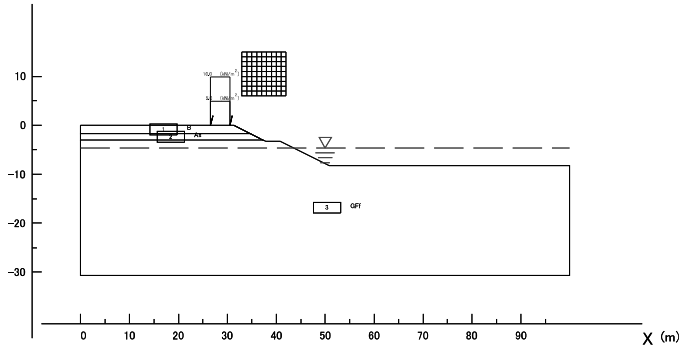
2. Check list 12

3. Action 01 Result list ... 13

4. Action 02 Result list ... 57

1. Input data list

// Design section //



// Design level of reliability design method //

Level of reliability design ..... Level 1(Design for value, part coefficient method)

// Combination of action //

// Setting of action //

Action	Action name	Seisimic inertia	Newmark No.	Same hydraul-ic line
1	normal			
2	seismic	○		

// Partial coefficient concerning analytical technique γ_α //

Action No.	Partial coefficient concerning analytical technique γ_α
1	1.00
2	1.00

// Partial coefficient concerning W,C,ϕ $\gamma w, \gamma c, \gamma \tan\phi$ //

No.	Action 1			Action 2											
	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$			
1	1.00	1.00	1.00	1.00	1.00	1.00									
2	1.00	1.00	1.00	1.00	1.00	1.00									
3	1.00	1.00	1.00	1.00	1.00	1.00									

$$M = \Sigma [C_d l + \{ (W_d' + q_d) \cos\theta - K_k W_d \sin\theta \} \tan\phi_d]$$

$$W_d' = \gamma_w W_k'$$

$$C_d = \gamma_c C_k$$

$$\tan\phi_d = \gamma_{\tan\phi} \tan\phi_k$$

M : Resistance moment

γ_w : Partial coefficient concerning weight

W_d' : Effective weight of slice of amount for each unit length splinter (value for design) (kN/m)

W_k' : Effective weight of slice of amount for each unit length splinter (characteristic value)(kN/m)

q_d : Perpendicular action because of the upper part of amount of slice (kN/m)

γ_c : Partial coefficient concerning Cohesion

C_d : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (value for design) (kN/m²)

C_k : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (characteristic value) (kN/m²)

l : Length in base of amount of Slice (m)

$\gamma_{\tan\phi}$: Partial coefficient concerning shearing resistance angle

ϕ_d : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(value for design)(°)

ϕ_k : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(characteristic value)(°)

// Partial coefficient of partial coefficient γ_{vl} to distribution load (Think as well as the ground) and inertia force γ_{vlEQ} //

Action No.	Load1		Load2							
	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force
1	1.00	1.00	—	—						
2	—	—	1.00	1.00						

$$M_{r,vl} = K \cdot r \Sigma (FR \cdot \gamma_{vl,i} - K_{hp} \cdot FO \cdot \gamma_{vlEQ,i}) \cdot \tan\phi$$

$$M_{d,vl} = r \Sigma (FO \cdot \gamma_{vl,i} + K_{hp} \cdot FR \cdot \gamma_{vlEQ,i})$$

$$FR = F \cdot \cos\theta$$

$$FO = F \cdot \sin\theta$$

$M_{r,vl}$: Resistance moment of distribution load (Think as well as the ground)

$M_{d,vl}$: Sliding moment of distribution load (Think as well as the ground)

K : Resistance power coefficient

r : Radius of slipping circular arc

F : Distribution load i

FR : Slipping line orthogonalization direction load value of load i

FO : Slipping line direction load value of load i

θ : Angle that slice bottom (slide surface) does to the horizontal

$\gamma_{vl,i}$: Partial coefficient of distribution load i(Think as well as the ground).

K_{hp} : The horizontal seismic intensity

$\gamma_{vlEQ,i}$: Partial coefficient of inertia force of distribution load i(Think as well as the ground).

ϕ : Internal friction angle of soil

// Partial coefficient to residual water level //

Action number	rRWL
1	1.00
2	1.00

$$RWL_d = \gamma_{RWL} RWL_k$$

γ_{RWL} : Partial coefficient concerning residual water level

RWL_d : Difference between residual water level and water level line (value for design) (m)

RWL_k : Difference between residual water level and water level line (input value) (m)

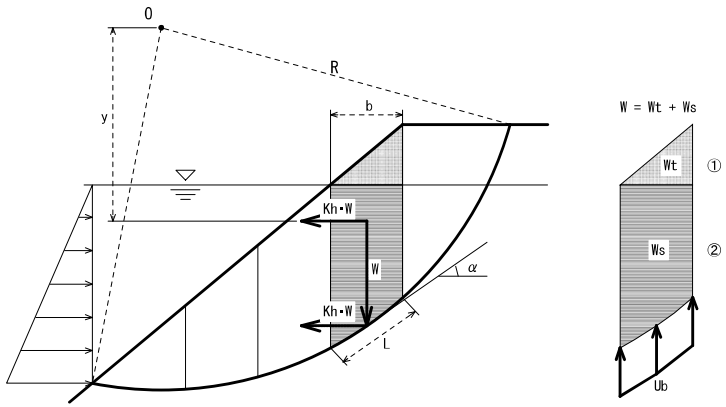
(DATA 01.)　// ANALYSIS //

Title　.....　Test of Embankment Stability
Analysis type　.....　Analysis of Bearing force Action ratio
Calculation method .....　Revised Feleniu s (Total stress)

Expression

$$\frac{R\Sigma[C_d l + \{((1+K_v)W_d - u b)\cos\theta - K_h W_d \sin\theta\}\tan\phi_d]}{\gamma_a R\Sigma\{(1+K_v)W_d \sin\theta + K_h W_d \cos\theta\}} \geqq 1.0$$

R　: Radius of slipping circle of circular arc (m)
C_d　: Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (kN/m²)
l　: Length in base of amount of crack splinter (m)
q_d　: Perpendicular action because of the upper part of amount of crack splinter (kN/m)
θ　: Angle that amount of crack splinter bottom does to a horizontal plane (degree)
ϕ_d　: 0 in case of viscous land board. Shearing resistance in drain condition in case of the sandy soil ground etc.(°)
W_d　: Full weight of crack of amount for each unit length splinter (full weight of soil and water) (kN/m)
γ_a　: Partial coefficient concerning analytical technique
K_h　: The horizontal seismic intensity
K_v　: Vertical seismic coefficient
u　: Pore pressure (kN/m²)
b　: Width of slice (m)



Treatment of its own weight W of the resistance force
　Above the water level.....Calculate the weight Wt in Wet weight γt　①
　Below the water level.....Calculate weight Ws in Saturated weight γsat　②
Treatment of its own weight W of impetus
　Above the water level.....Calculate the weight Wt in Wet weight γt
　Below the water level.....Calculate weight in Saturated weight γsat
Water pressure acting on the slip plane.....Consider in the Ubcosα
　(Modify Fereniusu method)
Lateral hydrostatic pressure due to water storage.....Including

(DATA 02.)　// CONTROL //

Second pursuit　.....　0 (=0 No)
　(>0 Yes　)
Run　.....　0 (=0 Input data check + Analysis)
　(=1 Input data check　)

(DATA 04.) // SEISMIC LOAD //

```
Seismic load                    .....  0 ( =0 Same for the whole model )
                                       ( =1 Different on each layer  )
Condition                       .....  1 ( =0 Acts on only sliding force )
                                       ( =1 Sliding + Resisting force  )
Acting point                    .....  0 ( =0 On the slip surface              )
                                       ( =1 Center of gravity of sliding mass )
                                       ( =2 Resisting:on the slip surface
                                            Sliding  :Center of gravity of sliding mass )
Unit weight                     .....  0 ( =0 Saturated weight )
                                       ( =1 Submerged weight )
Horizontal seismic coefficient.....  0.200
Vertical seismic coefficient  .....  0.000
```


(DATA 06.) // NODAL POINT //

No.	Coordinate		Y-coordinate
	x (m)	y (m)	before settlement (m)
1	0.00	0.00	0.00
2	26.55	0.00	0.00
3	30.55	0.00	0.00
4	31.25	0.00	0.00
5	34.68	-1.71	0.00
6	0.00	-1.71	0.00
7	0.00	-2.97	0.00
8	37.19	-2.97	0.00
9	37.81	-3.28	0.00
10	40.81	-3.28	0.00
11	50.72	-8.23	0.00
12	100.00	-8.23	0.00
13	100.00	-30.61	0.00
14	0.00	-30.61	0.00
15	0.00	-4.63	0.00

(DATA 07.) // WATER LEVEL //

Unit weight of water (kN/m^3) = 10.00

Action No.	Water level line number
1	1
2	1

Water level line number: 1

No.	Coordinate	
	X (m)	Y (m)
1	0.00	-4.63
2	100.00	-4.63

Water level line number: 2

No.	Coordinate	
	X (m)	Y (m)
1	0.00	0.00

No.	Coordinate	
	X (m)	Y (m)
2	150.00	0.00

(DATA 08.) // LAYER //

No.	material property No.	The name of the strata
1	5	B
2	6	As
3	8	GFf

No.	Num of Node	Node numbers composing a layer	Slip existence
1	6	1 6 5 4 3 2	Slip
2	4	6 7 8 5	Slip
3	9	7 15 14 13 12 11 10 9 8	Slip

(DATA 09.1) // MATERIAL PROPERTIES //

No.	Nature of soil division	Saturated weight (kN/m³)	Wet weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
5	B	19.00	18.00	1.00	0.00	30.00	0.00	0.000	0.0
6	As	18.50	17.50	0.00	0.00	27.00	0.00	0.000	0.0
8	GFf	18.00	17.00	******	0.00	30.00	0.00	0.000	0.0

(DATA 09.2) // Characteristic of soil //

No.	Action Number									
	Act 1	Act 2								
1	5	5								
2	6	6								
3	8	8								

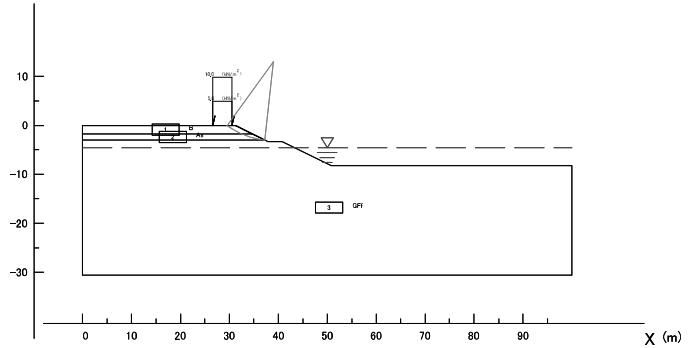
2. Check list

// Check of circular arc //

Action No.	Action name	Bearing force Action ratio	Judgment
1	normal	6.128	OK
2	seismic	4.435	OK

Action No.	Bearing force Action ratio	Partial coefficient r_a	Center of slipping circular arc X (m)	Center of slipping circular arc Y (m)	Radius of circular arc(m)	Resistance Moment (kNm)	Sliding Moment (kNm)
1	6.128	1.00	39.00	13.00	16.092	4249.2	693.4
2	4.435	1.00	39.00	13.00	16.092	4183.6	943.3

// Check Result chart //



3. Action01 (normal)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	5	19.00	18.00	9.00	1.00	0.00	30.00	0.00	0.00	0.0
2	6	18.50	17.50	8.50	0.00	0.00	27.00	0.00	0.00	0.0
3	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0										

// Distribution load that considers partial coefficient //

load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
1	26.55	0.00	10.0	30.55	0.00	10.0	0.000	0.000	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	-4.63	
2	100.00	-4.63	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	15.00	5.10	999.000	0.0	0.0	***6
		6.10	999.000	0.0	0.0	***6
		7.10	999.000	0.0	0.0	***6
		8.10	999.000	0.0	0.0	***6
		9.10	999.000	0.0	0.0	***6
		10.10	999.000	0.0	0.0	***6
		11.10	999.000	0.0	0.0	***6
		12.10	999.000	0.0	0.0	***6
		13.10	999.000	0.0	0.0	***6
		14.10	999.000	0.0	0.0	***6
		15.10	999.000	0.0	0.0	***6
		19.10	94.465	241137.6	2552.7	
		20.10	99.116	366372.2	3696.4	
		21.10	91.797	462682.5	5040.3	
		22.00	85.040	550986.7	6479.2	
33.00	14.00	4.11	999.000	0.0	0.0	***6
		5.11	999.000	0.0	0.0	***6
		6.11	999.000	0.0	0.0	***6
		7.11	999.000	0.0	0.0	***6
		8.11	999.000	0.0	0.0	***6
		9.11	999.000	0.0	0.0	***6
		10.11	999.000	0.0	0.0	***6
		11.11	999.000	0.0	0.0	***6
		12.11	999.000	0.0	0.0	***6
		13.11	999.000	0.0	0.0	***6
		14.11	999.000	0.0	0.0	***6
		18.11	92.481	223470.0	2416.4	
		19.11	97.869	342489.8	3499.5	
		20.11	91.074	433674.2	4761.8	
		21.00	84.692	517007.6	6104.6	
33.00	13.00	3.12	999.000	0.0	0.0	***6
		4.12	999.000	0.0	0.0	***6
		5.12	999.000	0.0	0.0	***6
		6.12	999.000	0.0	0.0	***6
		7.12	999.000	0.0	0.0	***6
		8.12	999.000	0.0	0.0	***6
		9.12	999.000	0.0	0.0	***6
		10.12	999.000	0.0	0.0	***6
		11.12	999.000	0.0	0.0	***6
		12.12	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	13.00	13.12	999.000	0.0	0.0	***6
		17.12	90.468	206299.3	2280.4	
		18.12	96.568	319076.2	3304.2	
		19.12	90.337	405225.0	4485.7	
		20.00	84.359	483621.7	5732.9	
33.00	12.00	2.13	999.000	0.0	0.0	***6
		3.13	999.000	0.0	0.0	***6
		4.13	999.000	0.0	0.0	***6
		5.13	999.000	0.0	0.0	***6
		6.13	999.000	0.0	0.0	***6
		7.13	999.000	0.0	0.0	***6
		8.13	999.000	0.0	0.0	***6
		9.13	999.000	0.0	0.0	***6
		10.13	999.000	0.0	0.0	***6
		11.13	999.000	0.0	0.0	***6
		12.13	999.000	0.0	0.0	***6
		16.13	88.427	189644.8	2144.6	
		17.13	94.976	295434.1	3110.6	
		18.13	89.587	377362.0	4212.3	
		19.00	84.044	450849.0	5364.4	
33.00	11.00	1.14	999.000	0.0	0.0	***6
		2.14	999.000	0.0	0.0	***6
		3.14	999.000	0.0	0.0	***6
		4.14	999.000	0.0	0.0	***6
		5.14	999.000	0.0	0.0	***6
		6.14	999.000	0.0	0.0	***6
		7.14	999.000	0.0	0.0	***6
		8.14	999.000	0.0	0.0	***6
		9.14	999.000	0.0	0.0	***6
		10.14	999.000	0.0	0.0	***6
		11.14	999.000	0.0	0.0	***6
		15.14	86.361	173528.1	2009.3	
		16.14	92.930	271157.7	2917.9	
		17.14	88.821	350116.7	3941.8	
		18.00	83.751	418711.4	4999.5	
33.00	10.00	0.15	999.000	0.0	0.0	***6
		1.15	999.000	0.0	0.0	***6
		2.15	999.000	0.0	0.0	***6
		3.15	999.000	0.0	0.0	***6
		4.15	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	10.00	5.15	999.000	0.0	0.0	***6
		6.15	999.000	0.0	0.0	***6
		7.15	999.000	0.0	0.0	***6
		8.15	999.000	0.0	0.0	***6
		9.15	999.000	0.0	0.0	***6
		10.15	999.000	0.0	0.0	***6
		14.15	84.275	157976.3	1874.5	
		15.15	90.868	247685.7	2725.8	
		16.15	88.041	323528.2	3674.8	
		17.00	83.484	387232.5	4638.4	
33.00	9.00	-0.83	999.000	0.0	0.0	***6
		0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6
		6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		13.17	82.437	143478.8	1740.5	
		14.17	88.799	225061.9	2534.5	
		15.17	87.244	297643.7	3411.6	
		16.00	83.248	356438.6	4281.7	
33.00	8.00	-1.81	999.000	0.0	0.0	***6
		-0.81	999.000	0.0	0.0	***6
		0.19	999.000	0.0	0.0	***6
		1.19	999.000	0.0	0.0	***6
		2.19	999.000	0.0	0.0	***6
		3.19	999.000	0.0	0.0	***6
		4.19	999.000	0.0	0.0	***6
		5.19	999.000	0.0	0.0	***6
		6.19	999.000	0.0	0.0	***6
		7.19	999.000	0.0	0.0	***6
		8.19	999.000	0.0	0.0	***6
		12.19	80.928	130100.3	1607.6	
		13.19	86.733	203341.6	2344.4	
		14.19	86.433	272525.1	3153.0	
		15.00	83.051	326359.3	3929.6	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	7.00	-2.78	999.000	0.0	0.0	***6
		-1.78	999.000	0.0	0.0	***6
		-0.78	999.000	0.0	0.0	***6
		0.22	999.000	0.0	0.0	***6
		1.22	999.000	0.0	0.0	***6
		2.22	999.000	0.0	0.0	***6
		3.22	999.000	0.0	0.0	***6
		4.22	999.000	0.0	0.0	***6
		5.22	999.000	0.0	0.0	***6
		6.22	999.000	0.0	0.0	***6
		7.22	999.000	0.0	0.0	***6
		11.22	79.392	117214.5	1476.4	
		12.22	84.692	182598.5	2156.0	
		13.22	85.610	248255.6	2899.9	
		14.00	82.900	297027.4	3583.0	
33.00	6.00	-3.75	999.000	0.0	0.0	***6
		-2.75	999.000	0.0	0.0	***6
		-1.75	999.000	0.0	0.0	***6
		-0.75	999.000	0.0	0.0	***6
		0.25	999.000	0.0	0.0	***6
		1.25	999.000	0.0	0.0	***6
		2.25	999.000	0.0	0.0	***6
		3.25	999.000	0.0	0.0	***6
		4.25	999.000	0.0	0.0	***6
		5.25	999.000	0.0	0.0	***6
		6.25	999.000	0.0	0.0	***6
		10.25	77.845	104895.3	1347.5	
		11.25	82.709	162937.4	1970.0	
		12.25	84.782	224954.9	2653.3	
		13.00	82.805	268480.0	3242.3	
34.00	15.00	5.25	999.000	0.0	0.0	***6
		6.25	999.000	0.0	0.0	***6
		7.25	999.000	0.0	0.0	***6
		8.25	999.000	0.0	0.0	***6
		9.25	999.000	0.0	0.0	***6
		10.25	999.000	0.0	0.0	***6
		11.25	999.000	0.0	0.0	***6
		12.25	999.000	0.0	0.0	***6
		13.25	999.000	0.0	0.0	***6
		14.25	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	15.00	15.25	999.000	0.0	0.0	***6
		19.25	92.844	261462.7	2816.1	
		20.25	91.545	368023.3	4020.1	
		21.25	84.588	464158.6	5487.3	
		22.00	79.427	537760.2	6770.5	
34.00	14.00	4.27	999.000	0.0	0.0	***6
		5.27	999.000	0.0	0.0	***6
		6.27	999.000	0.0	0.0	***6
		7.27	999.000	0.0	0.0	***6
		8.27	999.000	0.0	0.0	***6
		9.27	999.000	0.0	0.0	***6
		10.27	999.000	0.0	0.0	***6
		11.27	999.000	0.0	0.0	***6
		12.27	999.000	0.0	0.0	***6
		13.27	999.000	0.0	0.0	***6
		14.27	999.000	0.0	0.0	***6
		18.27	90.842	243663.2	2682.3	
		19.27	90.359	345065.8	3818.8	
		20.27	83.825	436147.8	5203.1	
		21.00	78.995	504543.2	6387.0	
34.00	13.00	3.29	999.000	0.0	0.0	***6
		4.29	999.000	0.0	0.0	***6
		5.29	999.000	0.0	0.0	***6
		6.29	999.000	0.0	0.0	***6
		7.29	999.000	0.0	0.0	***6
		8.29	999.000	0.0	0.0	***6
		9.29	999.000	0.0	0.0	***6
		10.29	999.000	0.0	0.0	***6
		11.29	999.000	0.0	0.0	***6
		12.29	999.000	0.0	0.0	***6
		13.29	999.000	0.0	0.0	***6
		16.29	68.044	108342.5	1592.3	
		17.29	88.813	226382.0	2549.0	
		18.29	89.137	322602.4	3619.2	
		19.29	83.053	408731.3	4921.3	
		20.00	78.590	471910.6	6004.7	
34.00	12.00	2.31	999.000	0.0	0.0	***6
		3.31	999.000	0.0	0.0	***6
		4.31	999.000	0.0	0.0	***6
		5.31	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	12.00	6.31	999.000	0.0	0.0	***6
		7.31	999.000	0.0	0.0	***6
		8.31	999.000	0.0	0.0	***6
		9.31	999.000	0.0	0.0	***6
		10.31	999.000	0.0	0.0	***6
		11.31	999.000	0.0	0.0	***6
		12.31	999.000	0.0	0.0	***6
		15.31	67.390	102125.4	1515.4	
		16.31	86.757	209644.8	2416.5	
		17.31	87.879	300665.5	3421.3	
		18.31	82.274	381946.7	4642.3	
		19.00	78.206	439880.6	5624.7	
34.00	11.00	1.34	999.000	0.0	0.0	***6
		2.34	999.000	0.0	0.0	***6
		3.34	999.000	0.0	0.0	***6
		4.34	999.000	0.0	0.0	***6
		5.34	999.000	0.0	0.0	***6
		6.34	999.000	0.0	0.0	***6
		7.34	999.000	0.0	0.0	***6
		8.34	999.000	0.0	0.0	***6
		9.34	999.000	0.0	0.0	***6
		10.34	999.000	0.0	0.0	***6
		11.34	999.000	0.0	0.0	***6
		14.34	66.699	95997.8	1439.3	
		15.34	84.679	193481.8	2284.9	
		16.34	86.584	279293.4	3225.7	
		17.34	81.491	355839.5	4366.6	
		18.00	77.841	408473.8	5247.6	
34.00	10.00	0.37	999.000	0.0	0.0	***6
		1.37	999.000	0.0	0.0	***6
		2.37	999.000	0.0	0.0	***6
		3.37	999.000	0.0	0.0	***6
		4.37	999.000	0.0	0.0	***6
		5.37	999.000	0.0	0.0	***6
		6.37	999.000	0.0	0.0	***6
		7.37	999.000	0.0	0.0	***6
		8.37	999.000	0.0	0.0	***6
		9.37	999.000	0.0	0.0	***6
		10.37	999.000	0.0	0.0	***6
		13.37	65.968	89976.7	1363.9	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	10.00	14.37	82.586	177932.6	2154.5	
		15.37	85.250	258535.9	3032.7	
		16.37	80.708	330468.0	4094.6	
		17.00	77.501	377713.2	4873.7	
34.00	9.00	-0.59	999.000	0.0	0.0	***6
		0.41	999.000	0.0	0.0	***6
		1.41	999.000	0.0	0.0	***6
		2.41	999.000	0.0	0.0	***6
		3.41	999.000	0.0	0.0	***6
		4.41	999.000	0.0	0.0	***6
		5.41	999.000	0.0	0.0	***6
		6.41	999.000	0.0	0.0	***6
		7.41	999.000	0.0	0.0	***6
		8.41	999.000	0.0	0.0	***6
		9.41	999.000	0.0	0.0	***6
		12.41	65.198	84085.9	1289.7	
		13.41	80.487	163046.7	2025.7	
		14.41	83.882	238456.6	2842.8	
		15.41	79.929	305906.9	3827.2	
		16.00	77.193	347624.5	4503.3	
34.00	8.00	-1.54	999.000	0.0	0.0	***6
		-0.54	999.000	0.0	0.0	***6
		0.46	999.000	0.0	0.0	***6
		1.46	999.000	0.0	0.0	***6
		2.46	999.000	0.0	0.0	***6
		3.46	999.000	0.0	0.0	***6
		4.46	999.000	0.0	0.0	***6
		5.46	999.000	0.0	0.0	***6
		6.46	999.000	0.0	0.0	***6
		7.46	999.000	0.0	0.0	***6
		8.46	999.000	0.0	0.0	***6
		11.46	64.392	78359.7	1216.9	
		12.46	78.401	148891.2	1899.1	
		13.46	82.484	219140.8	2656.8	
		14.46	79.165	282257.8	3565.4	
		15.00	76.925	318235.9	4137.0	
34.00	7.00	-2.48	999.000	0.0	0.0	***6
		-1.48	999.000	0.0	0.0	***6
		-0.48	999.000	0.0	0.0	***6
		0.52	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	7.00	1.52	999.000	0.0	0.0	***6
		2.52	999.000	0.0	0.0	***6
		3.52	999.000	0.0	0.0	***6
		4.52	999.000	0.0	0.0	***6
		5.52	999.000	0.0	0.0	***6
		6.52	999.000	0.0	0.0	***6
		7.52	999.000	0.0	0.0	***6
		10.52	63.557	72849.5	1146.2	
		11.52	76.355	135559.3	1775.4	
		12.52	81.072	200708.3	2475.7	
		13.52	78.432	259662.0	3310.7	
		14.00	76.710	289579.2	3775.0	
34.00	6.00	-3.40	999.000	0.0	0.0	***6
		-2.40	999.000	0.0	0.0	***6
		-1.40	999.000	0.0	0.0	***6
		-0.40	999.000	0.0	0.0	***6
		0.60	999.000	0.0	0.0	***6
		1.60	999.000	0.0	0.0	***6
		2.60	999.000	0.0	0.0	***6
		3.60	999.000	0.0	0.0	***6
		4.60	999.000	0.0	0.0	***6
		5.60	999.000	0.0	0.0	***6
		6.60	999.000	0.0	0.0	***6
		9.60	62.717	67635.3	1078.4	
		10.60	74.395	123188.8	1655.9	
		11.60	79.672	183334.6	2301.1	
		12.60	77.754	238328.1	3065.1	
		13.00	76.561	261690.1	3418.1	
35.00	15.00	5.46	999.000	0.0	0.0	***6
		6.46	999.000	0.0	0.0	***6
		7.46	999.000	0.0	0.0	***6
		8.46	999.000	0.0	0.0	***6
		9.46	999.000	0.0	0.0	***6
		10.46	999.000	0.0	0.0	***6
		11.46	999.000	0.0	0.0	***6
		12.46	999.000	0.0	0.0	***6
		13.46	999.000	0.0	0.0	***6
		14.46	999.000	0.0	0.0	***6
		15.46	999.000	0.0	0.0	***6
		18.46	67.287	134094.0	1992.9	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	15.00	19.46	89.944	279057.0	3102.6	
		20.46	84.732	375277.1	4429.0	
		21.46	78.091	471429.7	6036.9	
		22.00	74.860	524261.1	7003.2	
35.00	14.00	4.49	999.000	0.0	0.0	***6
		5.49	999.000	0.0	0.0	***6
		6.49	999.000	0.0	0.0	***6
		7.49	999.000	0.0	0.0	***6
		8.49	999.000	0.0	0.0	***6
		9.49	999.000	0.0	0.0	***6
		10.49	999.000	0.0	0.0	***6
		11.49	999.000	0.0	0.0	***6
		12.49	999.000	0.0	0.0	***6
		13.49	999.000	0.0	0.0	***6
		14.49	999.000	0.0	0.0	***6
		17.49	66.684	127931.4	1918.5	
		18.49	88.438	262708.0	2970.5	
		19.49	83.589	353301.2	4226.7	
		20.49	77.291	444510.1	5751.1	
		21.00	74.344	491816.9	6615.4	
35.00	13.00	3.53	999.000	0.0	0.0	***6
		4.53	999.000	0.0	0.0	***6
		5.53	999.000	0.0	0.0	***6
		6.53	999.000	0.0	0.0	***6
		7.53	999.000	0.0	0.0	***6
		8.53	999.000	0.0	0.0	***6
		9.53	999.000	0.0	0.0	***6
		10.53	999.000	0.0	0.0	***6
		11.53	999.000	0.0	0.0	***6
		12.53	999.000	0.0	0.0	***6
		13.53	999.000	0.0	0.0	***6
		16.53	66.374	122455.5	1844.9	
		17.53	86.890	246744.8	2839.7	
		18.53	82.423	331857.1	4026.3	
		19.53	76.487	418235.4	5468.0	
		20.00	73.845	459947.4	6228.5	
35.00	12.00	2.57	999.000	0.0	0.0	***6
		3.57	999.000	0.0	0.0	***6
		4.57	999.000	0.0	0.0	***6
		5.57	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	12.00	6.57	999.000	0.0	0.0	***6
		7.57	999.000	0.0	0.0	***6
		8.57	999.000	0.0	0.0	***6
		9.57	999.000	0.0	0.0	***6
		10.57	999.000	0.0	0.0	***6
		11.57	999.000	0.0	0.0	***6
		12.57	999.000	0.0	0.0	***6
		15.57	66.587	118021.9	1772.4	
		16.57	85.300	231200.5	2710.4	
		17.57	81.235	310987.5	3828.2	
		18.57	75.680	392656.9	5188.4	
		19.00	73.369	428671.1	5842.7	
35.00	11.00	1.62	999.000	0.0	0.0	***6
		2.62	999.000	0.0	0.0	***6
		3.62	999.000	0.0	0.0	***6
		4.62	999.000	0.0	0.0	***6
		5.62	999.000	0.0	0.0	***6
		6.62	999.000	0.0	0.0	***6
		7.62	999.000	0.0	0.0	***6
		8.62	999.000	0.0	0.0	***6
		9.62	999.000	0.0	0.0	***6
		10.62	999.000	0.0	0.0	***6
		11.62	999.000	0.0	0.0	***6
		14.62	66.688	113447.4	1701.2	
		15.62	83.671	216116.6	2582.9	
		16.62	80.029	290745.4	3633.0	
		17.62	74.874	367837.8	4912.8	
		18.00	72.923	398008.4	5457.9	
35.00	10.00	0.68	999.000	0.0	0.0	***6
		1.68	999.000	0.0	0.0	***6
		2.68	999.000	0.0	0.0	***6
		3.68	999.000	0.0	0.0	***6
		4.68	999.000	0.0	0.0	***6
		5.68	999.000	0.0	0.0	***6
		6.68	999.000	0.0	0.0	***6
		7.68	999.000	0.0	0.0	***6
		8.68	999.000	0.0	0.0	***6
		9.68	999.000	0.0	0.0	***6
		10.68	999.000	0.0	0.0	***6
		13.68	66.677	108782.5	1631.5	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	10.00	14.68	82.003	201541.2	2457.7	
		15.68	78.808	271200.1	3441.3	
		16.68	74.073	343860.5	4642.2	
		17.00	72.517	367981.5	5074.4	
35.00	9.00	-0.25	999.000	0.0	0.0	***6
		0.75	999.000	0.0	0.0	***6
		1.75	999.000	0.0	0.0	***6
		2.75	999.000	0.0	0.0	***6
		3.75	999.000	0.0	0.0	***6
		4.75	999.000	0.0	0.0	***6
		5.75	999.000	0.0	0.0	***6
		6.75	999.000	0.0	0.0	***6
		7.75	999.000	0.0	0.0	***6
		8.75	999.000	0.0	0.0	***6
		9.75	999.000	0.0	0.0	***6
		12.75	66.560	104087.5	1563.8	
		13.75	80.306	187542.9	2335.4	
		14.75	77.581	252441.4	3253.9	
		15.75	73.287	320832.4	4377.8	
		16.00	72.161	338614.7	4692.5	
35.00	8.00	-1.16	999.000	0.0	0.0	***6
		-0.16	999.000	0.0	0.0	***6
		0.84	999.000	0.0	0.0	***6
		1.84	999.000	0.0	0.0	***6
		2.84	999.000	0.0	0.0	***6
		3.84	999.000	0.0	0.0	***6
		4.84	999.000	0.0	0.0	***6
		5.84	999.000	0.0	0.0	***6
		6.84	999.000	0.0	0.0	***6
		7.84	999.000	0.0	0.0	***6
		8.84	999.000	0.0	0.0	***6
		11.84	66.345	99440.1	1498.8	
		12.84	78.594	174221.2	2216.7	
		13.84	76.362	234591.8	3072.1	
		14.84	72.527	298899.3	4121.2	
		15.00	71.851	309934.1	4313.6	
35.00	7.00	-2.06	999.000	0.0	0.0	***6
		-1.06	999.000	0.0	0.0	***6
		-0.06	999.000	0.0	0.0	***6
		0.94	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	7.00	1.94	999.000	0.0	0.0	***6
		2.94	999.000	0.0	0.0	***6
		3.94	999.000	0.0	0.0	***6
		4.94	999.000	0.0	0.0	***6
		5.94	999.000	0.0	0.0	***6
		6.94	999.000	0.0	0.0	***6
		7.94	999.000	0.0	0.0	***6
		10.94	66.162	94697.8	1431.3	
		11.94	76.895	161527.1	2100.6	
		12.94	75.183	217624.0	2894.6	
		13.94	71.827	278050.2	3871.1	
		14.00	71.598	281970.2	3938.2	
35.00	6.00	-2.96	999.000	0.0	0.0	***6
		-1.96	999.000	0.0	0.0	***6
		-0.96	999.000	0.0	0.0	***6
		0.04	999.000	0.0	0.0	***6
		1.04	999.000	0.0	0.0	***6
		2.04	999.000	0.0	0.0	***6
		3.04	999.000	0.0	0.0	***6
		4.04	999.000	0.0	0.0	***6
		5.04	999.000	0.0	0.0	***6
		6.04	999.000	0.0	0.0	***6
		7.04	999.000	0.0	0.0	***6
		10.04	66.747	88710.7	1329.1	
		11.04	75.240	148581.4	1974.8	
		12.04	74.125	200607.3	2706.3	
		13.00	71.420	254757.4	3567.0	
36.00	15.00	5.73	999.000	0.0	0.0	***6
		6.73	999.000	0.0	0.0	***6
		7.73	999.000	0.0	0.0	***6
		8.73	999.000	0.0	0.0	***6
		9.73	999.000	0.0	0.0	***6
		10.73	999.000	0.0	0.0	***6
		11.73	999.000	0.0	0.0	***6
		12.73	999.000	0.0	0.0	***6
		13.73	999.000	0.0	0.0	***6
		14.73	999.000	0.0	0.0	***6
		15.73	999.000	0.0	0.0	***6
		18.73	80.340	182311.6	2269.2	
		19.73	84.437	292375.2	3462.6	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	15.00	20.73	78.572	387865.6	4936.5	
		21.73	72.559	484333.5	6675.0	
		22.00	71.198	510472.2	7169.7	
36.00	14.00	4.78	999.000	0.0	0.0	***6
		5.78	999.000	0.0	0.0	***6
		6.78	999.000	0.0	0.0	***6
		7.78	999.000	0.0	0.0	***6
		8.78	999.000	0.0	0.0	***6
		9.78	999.000	0.0	0.0	***6
		10.78	999.000	0.0	0.0	***6
		11.78	999.000	0.0	0.0	***6
		12.78	999.000	0.0	0.0	***6
		13.78	999.000	0.0	0.0	***6
		14.78	999.000	0.0	0.0	***6
		17.78	79.879	175578.6	2198.0	
		18.78	83.036	276837.2	3333.9	
		19.78	77.454	366918.3	4737.2	
		20.78	71.706	458579.4	6395.2	
		21.00	70.640	478816.7	6778.3	
36.00	13.00	3.84	999.000	0.0	0.0	***6
		4.84	999.000	0.0	0.0	***6
		5.84	999.000	0.0	0.0	***6
		6.84	999.000	0.0	0.0	***6
		7.84	999.000	0.0	0.0	***6
		8.84	999.000	0.0	0.0	***6
		9.84	999.000	0.0	0.0	***6
		10.84	999.000	0.0	0.0	***6
		11.84	999.000	0.0	0.0	***6
		12.84	999.000	0.0	0.0	***6
		13.84	999.000	0.0	0.0	***6
		16.84	79.330	168819.8	2128.1	
		17.84	81.603	261712.9	3207.1	
		18.84	76.320	346550.3	4540.8	
		19.84	70.849	433533.9	6119.1	
		20.00	70.094	447726.0	6387.5	
36.00	12.00	2.91	999.000	0.0	0.0	***6
		3.91	999.000	0.0	0.0	***6
		4.91	999.000	0.0	0.0	***6
		5.91	999.000	0.0	0.0	***6
		6.91	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	12.00	7.91	999.000	0.0	0.0	***6
		8.91	999.000	0.0	0.0	***6
		9.91	999.000	0.0	0.0	***6
		10.91	999.000	0.0	0.0	***6
		11.91	999.000	0.0	0.0	***6
		12.91	999.000	0.0	0.0	***6
		15.91	78.691	162070.7	2059.6	
		16.91	80.141	247045.2	3082.6	
		17.91	75.171	326816.8	4347.7	
		18.91	69.991	409263.4	5847.4	
		19.00	69.564	417218.5	5997.6	
36.00	11.00	1.98	999.000	0.0	0.0	***6
		2.98	999.000	0.0	0.0	***6
		3.98	999.000	0.0	0.0	***6
		4.98	999.000	0.0	0.0	***6
		5.98	999.000	0.0	0.0	***6
		6.98	999.000	0.0	0.0	***6
		7.98	999.000	0.0	0.0	***6
		8.98	999.000	0.0	0.0	***6
		9.98	999.000	0.0	0.0	***6
		10.98	999.000	0.0	0.0	***6
		11.98	999.000	0.0	0.0	***6
		14.98	77.963	155376.2	1993.0	
		15.98	78.652	232888.1	2961.0	
		16.98	74.011	307787.3	4158.7	
		17.98	69.136	385851.4	5581.0	
		18.00	69.057	387313.7	5608.6	
36.00	10.00	1.07	999.000	0.0	0.0	***6
		2.07	999.000	0.0	0.0	***6
		3.07	999.000	0.0	0.0	***6
		4.07	999.000	0.0	0.0	***6
		5.07	999.000	0.0	0.0	***6
		6.07	999.000	0.0	0.0	***6
		7.07	999.000	0.0	0.0	***6
		8.07	999.000	0.0	0.0	***6
		9.07	999.000	0.0	0.0	***6
		10.07	999.000	0.0	0.0	***6
		11.07	999.000	0.0	0.0	***6
		13.07	37.060	39202.5	1057.8	
		14.07	77.151	148794.0	1928.6	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	10.00	15.07	77.142	219312.7	2843.0	
		16.07	72.846	289551.8	3974.8	
		17.00	68.581	358032.9	5220.6	
36.00	9.00	0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6
		6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		10.17	999.000	0.0	0.0	***6
		12.17	44.911	45940.4	1022.9	
		13.17	76.225	142167.2	1865.1	
		14.17	75.632	206237.6	2726.9	
		15.17	71.698	272044.1	3794.3	
		16.00	68.148	329400.0	4833.6	
36.00	8.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		11.28	50.132	49048.7	978.4	
		12.28	75.395	134118.7	1778.9	
		13.28	74.181	192820.8	2599.3	
		14.28	70.646	254384.5	3600.8	
		15.00	67.772	301441.4	4447.9	
36.00	7.00	-1.62	999.000	0.0	0.0	***6
		-0.62	999.000	0.0	0.0	***6
		0.38	999.000	0.0	0.0	***6
		1.38	999.000	0.0	0.0	***6
		2.38	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	7.00	3.38	999.000	0.0	0.0	***6
		4.38	999.000	0.0	0.0	***6
		5.38	999.000	0.0	0.0	***6
		6.38	999.000	0.0	0.0	***6
		7.38	999.000	0.0	0.0	***6
		8.38	999.000	0.0	0.0	***6
		10.38	53.984	49776.1	922.1	
		11.38	75.176	125020.7	1663.0	
		12.38	72.816	179000.8	2458.2	
		13.38	69.718	236491.7	3392.1	
		14.00	67.475	274186.3	4063.6	
36.00	6.00	-2.51	999.000	0.0	0.0	***6
		-1.51	999.000	0.0	0.0	***6
		-0.51	999.000	0.0	0.0	***6
		0.49	999.000	0.0	0.0	***6
		1.49	999.000	0.0	0.0	***6
		2.49	999.000	0.0	0.0	***6
		3.49	999.000	0.0	0.0	***6
		4.49	999.000	0.0	0.0	***6
		5.49	999.000	0.0	0.0	***6
		6.49	999.000	0.0	0.0	***6
		7.49	999.000	0.0	0.0	***6
		9.49	58.495	49917.7	853.4	
		10.49	75.198	115324.8	1533.6	
		11.49	71.561	164855.5	2303.7	
		12.49	68.943	218430.9	3168.3	
		13.00	67.287	247668.0	3680.8	
37.00	15.00	6.06	999.000	0.0	0.0	***6
		7.06	999.000	0.0	0.0	***6
		8.06	999.000	0.0	0.0	***6
		9.06	999.000	0.0	0.0	***6
		10.06	999.000	0.0	0.0	***6
		11.06	999.000	0.0	0.0	***6
		12.06	999.000	0.0	0.0	***6
		13.06	999.000	0.0	0.0	***6
		14.06	999.000	0.0	0.0	***6
		15.06	999.000	0.0	0.0	***6
		16.06	999.000	0.0	0.0	***6
		18.06	29.039	41979.1	1445.6	
		19.06	82.592	212534.8	2573.3	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	15.00	20.06	79.232	310308.2	3916.5	
		21.06	73.092	405557.2	5548.6	
		22.00	68.309	496369.2	7266.6	
37.00	14.00	5.13	999.000	0.0	0.0	***6
		6.13	999.000	0.0	0.0	***6
		7.13	999.000	0.0	0.0	***6
		8.13	999.000	0.0	0.0	***6
		9.13	999.000	0.0	0.0	***6
		10.13	999.000	0.0	0.0	***6
		11.13	999.000	0.0	0.0	***6
		12.13	999.000	0.0	0.0	***6
		13.13	999.000	0.0	0.0	***6
		14.13	999.000	0.0	0.0	***6
		15.13	999.000	0.0	0.0	***6
		17.13	36.395	51287.9	1409.2	
		18.13	81.380	204172.3	2508.9	
		19.13	77.878	295592.8	3795.6	
		20.13	71.991	385680.2	5357.3	
		21.00	67.741	465518.9	6872.0	
37.00	13.00	4.21	999.000	0.0	0.0	***6
		5.21	999.000	0.0	0.0	***6
		6.21	999.000	0.0	0.0	***6
		7.21	999.000	0.0	0.0	***6
		8.21	999.000	0.0	0.0	***6
		9.21	999.000	0.0	0.0	***6
		10.21	999.000	0.0	0.0	***6
		11.21	999.000	0.0	0.0	***6
		12.21	999.000	0.0	0.0	***6
		13.21	999.000	0.0	0.0	***6
		14.21	999.000	0.0	0.0	***6
		16.21	42.297	58184.5	1375.6	
		17.21	80.104	195991.5	2446.7	
		18.21	76.496	281331.6	3677.7	
		19.21	70.877	366438.2	5170.0	
		20.00	67.185	435224.2	6478.0	
37.00	12.00	3.31	999.000	0.0	0.0	***6
		4.31	999.000	0.0	0.0	***6
		5.31	999.000	0.0	0.0	***6
		6.31	999.000	0.0	0.0	***6
		7.31	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	12.00	8.31	999.000	0.0	0.0	***6
		9.31	999.000	0.0	0.0	***6
		10.31	999.000	0.0	0.0	***6
		11.31	999.000	0.0	0.0	***6
		12.31	999.000	0.0	0.0	***6
		13.31	999.000	0.0	0.0	***6
		15.31	47.980	64551.6	1345.4	
		16.31	78.764	188031.4	2387.3	
		17.31	75.087	267578.6	3563.6	
		18.31	69.753	347900.5	4987.6	
		19.00	66.644	405502.6	6084.7	
37.00	11.00	2.41	999.000	0.0	0.0	***6
		3.41	999.000	0.0	0.0	***6
		4.41	999.000	0.0	0.0	***6
		5.41	999.000	0.0	0.0	***6
		6.41	999.000	0.0	0.0	***6
		7.41	999.000	0.0	0.0	***6
		8.41	999.000	0.0	0.0	***6
		9.41	999.000	0.0	0.0	***6
		10.41	999.000	0.0	0.0	***6
		11.41	999.000	0.0	0.0	***6
		12.41	999.000	0.0	0.0	***6
		14.41	61.563	81005.0	1315.8	
		15.41	77.364	180172.1	2328.9	
		16.41	73.667	254232.4	3451.1	
		17.41	68.634	329976.7	4807.7	
		18.00	66.123	376372.9	5692.0	
37.00	10.00	1.51	999.000	0.0	0.0	***6
		2.51	999.000	0.0	0.0	***6
		3.51	999.000	0.0	0.0	***6
		4.51	999.000	0.0	0.0	***6
		5.51	999.000	0.0	0.0	***6
		6.51	999.000	0.0	0.0	***6
		7.51	999.000	0.0	0.0	***6
		8.51	999.000	0.0	0.0	***6
		9.51	999.000	0.0	0.0	***6
		10.51	999.000	0.0	0.0	***6
		11.51	999.000	0.0	0.0	***6
		13.51	68.897	87798.2	1274.3	
		14.51	75.933	171595.0	2259.8	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	10.00	15.51	72.303	240475.4	3325.9	
		16.51	67.584	311820.3	4613.8	
		17.00	65.632	347855.9	5300.1	
37.00	9.00	0.62	999.000	0.0	0.0	***6
		1.62	999.000	0.0	0.0	***6
		2.62	999.000	0.0	0.0	***6
		3.62	999.000	0.0	0.0	***6
		4.62	999.000	0.0	0.0	***6
		5.62	999.000	0.0	0.0	***6
		6.62	999.000	0.0	0.0	***6
		7.62	999.000	0.0	0.0	***6
		8.62	999.000	0.0	0.0	***6
		9.62	999.000	0.0	0.0	***6
		10.62	999.000	0.0	0.0	***6
		12.62	73.798	89984.1	1219.3	
		13.62	75.317	162265.9	2154.4	
		14.62	71.018	226245.4	3185.8	
		15.62	66.621	293352.9	4403.3	
		16.00	65.180	319974.5	4909.1	
37.00	8.00	-0.27	999.000	0.0	0.0	***6
		0.73	999.000	0.0	0.0	***6
		1.73	999.000	0.0	0.0	***6
		2.73	999.000	0.0	0.0	***6
		3.73	999.000	0.0	0.0	***6
		4.73	999.000	0.0	0.0	***6
		5.73	999.000	0.0	0.0	***6
		6.73	999.000	0.0	0.0	***6
		7.73	999.000	0.0	0.0	***6
		8.73	999.000	0.0	0.0	***6
		9.73	999.000	0.0	0.0	***6
		11.73	77.448	89122.6	1150.7	
		12.73	75.123	152264.4	2026.9	
		13.73	69.828	211609.2	3030.4	
		14.73	65.761	274630.8	4176.2	
		15.00	64.783	292754.3	4519.0	
37.00	7.00	-1.17	999.000	0.0	0.0	***6
		-0.17	999.000	0.0	0.0	***6
		0.83	999.000	0.0	0.0	***6
		1.83	999.000	0.0	0.0	***6
		2.83	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	7.00	3.83	999.000	0.0	0.0	***6
		4.83	999.000	0.0	0.0	***6
		5.83	999.000	0.0	0.0	***6
		6.83	999.000	0.0	0.0	***6
		7.83	999.000	0.0	0.0	***6
		8.83	999.000	0.0	0.0	***6
		10.83	80.503	86026.6	1068.6	
		11.83	75.196	141683.8	1884.2	
		12.83	68.755	196634.9	2859.9	
		13.83	65.025	255712.7	3932.6	
		14.00	64.460	266223.6	4130.1	
37.00	6.00	-2.06	999.000	0.0	0.0	***6
		-1.06	999.000	0.0	0.0	***6
		-0.06	999.000	0.0	0.0	***6
		0.94	999.000	0.0	0.0	***6
		1.94	999.000	0.0	0.0	***6
		2.94	999.000	0.0	0.0	***6
		3.94	999.000	0.0	0.0	***6
		4.94	999.000	0.0	0.0	***6
		5.94	999.000	0.0	0.0	***6
		6.94	999.000	0.0	0.0	***6
		7.94	999.000	0.0	0.0	***6
		9.94	83.484	81224.3	972.9	
		10.94	75.667	130621.3	1726.3	
		11.94	68.184	181392.5	2660.3	
		12.94	64.443	236659.5	3672.4	
		13.00	64.242	240414.3	3742.3	
38.00	15.00	6.45	999.000	0.0	0.0	***6
		7.45	999.000	0.0	0.0	***6
		8.45	999.000	0.0	0.0	***6
		9.45	999.000	0.0	0.0	***6
		10.45	999.000	0.0	0.0	***6
		11.45	999.000	0.0	0.0	***6
		12.45	999.000	0.0	0.0	***6
		13.45	999.000	0.0	0.0	***6
		14.45	999.000	0.0	0.0	***6
		15.45	999.000	0.0	0.0	***6
		16.45	999.000	0.0	0.0	***6
		18.45	75.345	125979.9	1672.0	
		19.45	79.880	236648.3	2962.6	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	15.00	20.45	74.275	332638.2	4478.5	
		21.45	68.650	428219.2	6237.8	
		22.00	66.105	481923.9	7290.3	
38.00	14.00	5.54	999.000	0.0	0.0	***6
		6.54	999.000	0.0	0.0	***6
		7.54	999.000	0.0	0.0	***6
		8.54	999.000	0.0	0.0	***6
		9.54	999.000	0.0	0.0	***6
		10.54	999.000	0.0	0.0	***6
		11.54	999.000	0.0	0.0	***6
		12.54	999.000	0.0	0.0	***6
		13.54	999.000	0.0	0.0	***6
		14.54	999.000	0.0	0.0	***6
		15.54	999.000	0.0	0.0	***6
		17.54	80.073	131572.9	1643.2	
		18.54	78.563	228654.2	2910.4	
		19.54	72.941	318773.9	4370.3	
		20.54	67.588	409451.7	6058.1	
		21.00	65.557	451896.7	6893.2	
38.00	13.00	4.65	999.000	0.0	0.0	***6
		5.65	999.000	0.0	0.0	***6
		6.65	999.000	0.0	0.0	***6
		7.65	999.000	0.0	0.0	***6
		8.65	999.000	0.0	0.0	***6
		9.65	999.000	0.0	0.0	***6
		10.65	999.000	0.0	0.0	***6
		11.65	999.000	0.0	0.0	***6
		12.65	999.000	0.0	0.0	***6
		13.65	999.000	0.0	0.0	***6
		14.65	999.000	0.0	0.0	***6
		16.65	81.537	131687.0	1615.1	
		17.65	77.188	220721.6	2859.5	
		18.65	71.597	305245.2	4263.4	
		19.65	66.527	391209.8	5880.5	
		20.00	65.022	422416.0	6496.5	
38.00	12.00	3.75	999.000	0.0	0.0	***6
		4.75	999.000	0.0	0.0	***6
		5.75	999.000	0.0	0.0	***6
		6.75	999.000	0.0	0.0	***6
		7.75	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	12.00	8.75	999.000	0.0	0.0	***6
		9.75	999.000	0.0	0.0	***6
		10.75	999.000	0.0	0.0	***6
		11.75	999.000	0.0	0.0	***6
		12.75	999.000	0.0	0.0	***6
		13.75	999.000	0.0	0.0	***6
		15.75	82.634	130262.2	1576.4	
		16.75	75.796	212019.3	2797.2	
		17.75	70.306	291251.2	4142.6	
		18.75	65.516	372669.5	5688.2	
		19.00	64.506	393498.3	6100.2	
38.00	11.00	2.86	999.000	0.0	0.0	***6
		3.86	999.000	0.0	0.0	***6
		4.86	999.000	0.0	0.0	***6
		5.86	999.000	0.0	0.0	***6
		6.86	999.000	0.0	0.0	***6
		7.86	999.000	0.0	0.0	***6
		8.86	999.000	0.0	0.0	***6
		9.86	999.000	0.0	0.0	***6
		10.86	999.000	0.0	0.0	***6
		11.86	999.000	0.0	0.0	***6
		12.86	999.000	0.0	0.0	***6
		14.86	83.540	127399.8	1525.0	
		15.86	74.516	202519.4	2717.8	
		16.86	69.084	276728.2	4005.7	
		17.86	64.570	353754.3	5478.6	
		18.00	64.013	365162.3	5704.5	
38.00	10.00	1.96	999.000	0.0	0.0	***6
		2.96	999.000	0.0	0.0	***6
		3.96	999.000	0.0	0.0	***6
		4.96	999.000	0.0	0.0	***6
		5.96	999.000	0.0	0.0	***6
		6.96	999.000	0.0	0.0	***6
		7.96	999.000	0.0	0.0	***6
		8.96	999.000	0.0	0.0	***6
		9.96	999.000	0.0	0.0	***6
		10.96	999.000	0.0	0.0	***6
		11.96	999.000	0.0	0.0	***6
		13.96	84.418	123296.0	1460.5	
		14.96	74.105	192309.8	2595.1	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	10.00	15.96	67.938	261734.8	3852.5	
		16.96	63.696	334513.9	5251.8	
		17.00	63.552	337428.0	5309.4	
38.00	9.00	1.07	999.000	0.0	0.0	***6
		2.07	999.000	0.0	0.0	***6
		3.07	999.000	0.0	0.0	***6
		4.07	999.000	0.0	0.0	***6
		5.07	999.000	0.0	0.0	***6
		6.07	999.000	0.0	0.0	***6
		7.07	999.000	0.0	0.0	***6
		8.07	999.000	0.0	0.0	***6
		9.07	999.000	0.0	0.0	***6
		10.07	999.000	0.0	0.0	***6
		11.07	999.000	0.0	0.0	***6
		12.07	21.359	11007.1	515.3	
		13.07	85.433	118113.0	1382.5	
		14.07	73.882	181471.6	2456.2	
		15.07	66.883	246330.7	3683.0	
		16.00	63.137	310317.2	4915.0	
38.00	8.00	0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6
		6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		10.17	999.000	0.0	0.0	***6
		11.17	40.866	19479.2	476.7	
		12.17	86.775	111991.4	1290.6	
		13.17	73.922	170083.3	2300.9	
		14.17	65.934	230576.0	3497.1	
		15.00	62.781	283854.8	4521.3	
38.00	7.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	7.00	4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	56.752	24235.3	427.0	
		11.28	88.701	105057.0	1184.4	
		12.28	74.326	158222.8	2128.8	
		13.28	65.500	214533.0	3275.3	
		14.00	62.510	258068.1	4128.5	
38.00	6.00	-1.62	999.000	0.0	0.0	***6
		-0.62	999.000	0.0	0.0	***6
		0.38	999.000	0.0	0.0	***6
		1.38	999.000	0.0	0.0	***6
		2.38	999.000	0.0	0.0	***6
		3.38	999.000	0.0	0.0	***6
		4.38	999.000	0.0	0.0	***6
		5.38	999.000	0.0	0.0	***6
		6.38	999.000	0.0	0.0	***6
		7.38	999.000	0.0	0.0	***6
		8.38	999.000	0.0	0.0	***6
		9.38	103.173	39480.7	382.7	
		10.38	91.600	97426.1	1063.6	
		11.38	75.249	145968.1	1939.8	
		12.38	65.945	198266.2	3006.6	
		13.00	62.354	232987.8	3736.5	
39.00	15.00	6.88	999.000	0.0	0.0	***6
		7.88	999.000	0.0	0.0	***6
		8.88	999.000	0.0	0.0	***6
		9.88	999.000	0.0	0.0	***6
		10.88	999.000	0.0	0.0	***6
		11.88	999.000	0.0	0.0	***6
		12.88	999.000	0.0	0.0	***6
		13.88	999.000	0.0	0.0	***6
		14.88	999.000	0.0	0.0	***6
		15.88	999.000	0.0	0.0	***6
		16.88	999.000	0.0	0.0	***6
		18.88	84.423	164218.4	1945.2	
		19.88	76.435	263860.8	3452.1	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	15.00	20.88	70.046	359118.5	5126.9	
		21.88	65.049	455545.9	7003.1	
		22.00	64.538	467103.2	7237.6	
39.00	14.00	5.99	999.000	0.0	0.0	***6
		6.99	999.000	0.0	0.0	***6
		7.99	999.000	0.0	0.0	***6
		8.99	999.000	0.0	0.0	***6
		9.99	999.000	0.0	0.0	***6
		10.99	999.000	0.0	0.0	***6
		11.99	999.000	0.0	0.0	***6
		12.99	999.000	0.0	0.0	***6
		13.99	999.000	0.0	0.0	***6
		14.99	999.000	0.0	0.0	***6
		15.99	999.000	0.0	0.0	***6
		17.99	84.882	162562.5	1915.2	
		18.99	75.063	255095.7	3398.4	
		19.99	68.859	344971.4	5009.8	
		20.99	64.093	436713.0	6813.8	
		21.00	64.039	437918.0	6838.4	
39.00	13.00	5.09	999.000	0.0	0.0	***6
		6.09	999.000	0.0	0.0	***6
		7.09	999.000	0.0	0.0	***6
		8.09	999.000	0.0	0.0	***6
		9.09	999.000	0.0	0.0	***6
		10.09	999.000	0.0	0.0	***6
		11.09	999.000	0.0	0.0	***6
		12.09	999.000	0.0	0.0	***6
		13.09	999.000	0.0	0.0	***6
		14.09	999.000	0.0	0.0	***6
		15.09	999.000	0.0	0.0	***6
		16.09	6.128	4249.2	693.4	
		17.09	85.247	159578.7	1872.0	
		18.09	73.718	245516.3	3330.5	
		19.09	67.727	330248.6	4876.1	
		20.00	63.557	409270.3	6439.4	
39.00	12.00	4.20	999.000	0.0	0.0	***6
		5.20	999.000	0.0	0.0	***6
		6.20	999.000	0.0	0.0	***6
		7.20	999.000	0.0	0.0	***6
		8.20	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	12.00	9.20	999.000	0.0	0.0	***6
		10.20	999.000	0.0	0.0	***6
		11.20	999.000	0.0	0.0	***6
		12.20	999.000	0.0	0.0	***6
		13.20	999.000	0.0	0.0	***6
		14.20	999.000	0.0	0.0	***6
		15.20	26.160	17769.2	679.3	
		16.20	85.622	155410.5	1815.1	
		17.20	72.784	235195.1	3231.4	
		18.20	66.657	315002.2	4725.7	
		19.00	63.100	381176.4	6040.9	
39.00	11.00	3.30	999.000	0.0	0.0	***6
		4.30	999.000	0.0	0.0	***6
		5.30	999.000	0.0	0.0	***6
		6.30	999.000	0.0	0.0	***6
		7.30	999.000	0.0	0.0	***6
		8.30	999.000	0.0	0.0	***6
		9.30	999.000	0.0	0.0	***6
		10.30	999.000	0.0	0.0	***6
		11.30	999.000	0.0	0.0	***6
		12.30	999.000	0.0	0.0	***6
		13.30	999.000	0.0	0.0	***6
		14.30	999.000	22303.1	0.0	***1
		15.30	86.111	150183.9	1744.1	
		16.30	72.352	224202.0	3098.8	
		17.30	65.655	299285.4	4558.5	
		18.00	62.675	353654.0	5642.7	
39.00	10.00	2.41	999.000	0.0	0.0	***6
		3.41	999.000	0.0	0.0	***6
		4.41	999.000	0.0	0.0	***6
		5.41	999.000	0.0	0.0	***6
		6.41	999.000	0.0	0.0	***6
		7.41	999.000	0.0	0.0	***6
		8.41	999.000	0.0	0.0	***6
		9.41	999.000	0.0	0.0	***6
		10.41	999.000	0.0	0.0	***6
		11.41	999.000	0.0	0.0	***6
		12.41	999.000	0.0	0.0	***6
		13.41	114.734	71176.9	620.4	
		14.41	86.833	144011.4	1658.5	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	10.00	15.41	72.108	212606.0	2948.4	
		16.41	64.732	283151.6	4374.2	
		17.00	62.292	326722.4	5245.0	
39.00	9.00	1.51	999.000	0.0	0.0	***6
		2.51	999.000	0.0	0.0	***6
		3.51	999.000	0.0	0.0	***6
		4.51	999.000	0.0	0.0	***6
		5.51	999.000	0.0	0.0	***6
		6.51	999.000	0.0	0.0	***6
		7.51	999.000	0.0	0.0	***6
		8.51	999.000	0.0	0.0	***6
		9.51	999.000	0.0	0.0	***6
		10.51	999.000	0.0	0.0	***6
		11.51	999.000	0.0	0.0	***6
		12.51	125.095	71643.1	572.7	
		13.51	87.937	136995.5	1557.9	
		14.51	72.110	200473.7	2780.1	
		15.51	63.903	266655.0	4172.8	
		16.00	61.968	300402.9	4847.7	
39.00	8.00	0.62	999.000	0.0	0.0	***6
		1.62	999.000	0.0	0.0	***6
		2.62	999.000	0.0	0.0	***6
		3.62	999.000	0.0	0.0	***6
		4.62	999.000	0.0	0.0	***6
		5.62	999.000	0.0	0.0	***6
		6.62	999.000	0.0	0.0	***6
		7.62	999.000	0.0	0.0	***6
		8.62	999.000	0.0	0.0	***6
		9.62	999.000	0.0	0.0	***6
		10.62	999.000	0.0	0.0	***6
		11.62	136.898	70495.9	515.0	
		12.62	89.630	129233.2	1441.9	
		13.62	72.433	187872.3	2593.7	
		14.62	63.617	249851.8	3927.4	
		15.00	61.720	274719.4	4451.1	
39.00	7.00	-0.28	999.000	0.0	0.0	***6
		0.72	999.000	0.0	0.0	***6
		1.72	999.000	0.0	0.0	***6
		2.72	999.000	0.0	0.0	***6
		3.72	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	7.00	4.72	999.000	0.0	0.0	***6
		5.72	999.000	0.0	0.0	***6
		6.72	999.000	0.0	0.0	***6
		7.72	999.000	0.0	0.0	***6
		8.72	999.000	0.0	0.0	***6
		9.72	999.000	0.0	0.0	***6
		10.72	145.684	68026.9	466.9	
		11.72	92.216	120806.0	1310.0	
		12.72	73.193	174869.5	2389.1	
		13.72	63.959	232799.5	3639.8	
		14.00	62.194	249697.9	4014.8	
39.00	6.00	-1.17	999.000	0.0	0.0	***6
		-0.17	999.000	0.0	0.0	***6
		0.83	999.000	0.0	0.0	***6
		1.83	999.000	0.0	0.0	***6
		2.83	999.000	0.0	0.0	***6
		3.83	999.000	0.0	0.0	***6
		4.83	999.000	0.0	0.0	***6
		5.83	999.000	0.0	0.0	***6
		6.83	999.000	0.0	0.0	***6
		7.83	999.000	0.0	0.0	***6
		8.83	999.000	0.0	0.0	***6
		9.83	158.006	64512.2	408.3	
		10.83	96.173	111861.5	1163.1	
		11.83	74.553	161594.0	2167.5	
		12.83	64.667	215623.4	3334.3	
		13.00	63.493	225368.4	3549.5	
40.00	15.00	7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6
		13.33	999.000	0.0	0.0	***6
		14.33	999.000	0.0	0.0	***6
		15.33	999.000	0.0	0.0	***6
		16.33	999.000	0.0	0.0	***6
		17.33	999.000	0.0	0.0	***6
		18.33	999.000	39963.9	0.1	***1
		19.33	85.861	194108.3	2260.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	15.00	20.33	72.944	291088.2	3990.6	
		21.33	66.831	386629.2	5785.1	
		22.00	63.597	451868.0	7105.2	
40.00	14.00	6.43	999.000	0.0	0.0	***6
		7.43	999.000	0.0	0.0	***6
		8.43	999.000	0.0	0.0	***6
		9.43	999.000	0.0	0.0	***6
		10.43	999.000	0.0	0.0	***6
		11.43	999.000	0.0	0.0	***6
		12.43	999.000	0.0	0.0	***6
		13.43	999.000	0.0	0.0	***6
		14.43	999.000	0.0	0.0	***6
		15.43	999.000	0.0	0.0	***6
		16.43	999.000	0.0	0.0	***6
		17.43	108.645	89533.6	824.1	
		18.43	85.852	189967.5	2212.7	
		19.43	71.750	280736.1	3912.7	
		20.43	65.834	371212.5	5638.6	
		21.00	63.175	423544.8	6704.3	
40.00	13.00	5.54	999.000	0.0	0.0	***6
		6.54	999.000	0.0	0.0	***6
		7.54	999.000	0.0	0.0	***6
		8.54	999.000	0.0	0.0	***6
		9.54	999.000	0.0	0.0	***6
		10.54	999.000	0.0	0.0	***6
		11.54	999.000	0.0	0.0	***6
		12.54	999.000	0.0	0.0	***6
		13.54	999.000	0.0	0.0	***6
		14.54	999.000	0.0	0.0	***6
		15.54	999.000	0.0	0.0	***6
		16.54	115.598	93328.4	807.4	
		17.54	85.939	184778.5	2150.1	
		18.54	71.201	269676.1	3787.5	
		19.54	64.893	355275.9	5474.8	
		20.00	62.782	395750.8	6303.6	
40.00	12.00	4.64	999.000	0.0	0.0	***6
		5.64	999.000	0.0	0.0	***6
		6.64	999.000	0.0	0.0	***6
		7.64	999.000	0.0	0.0	***6
		8.64	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	12.00	9.64	999.000	0.0	0.0	***6
		10.64	999.000	0.0	0.0	***6
		11.64	999.000	0.0	0.0	***6
		12.64	999.000	0.0	0.0	***6
		13.64	999.000	0.0	0.0	***6
		14.64	999.000	0.0	0.0	***6
		15.64	122.150	95142.1	778.9	
		16.64	86.197	178633.7	2072.4	
		17.64	70.857	257967.8	3640.7	
		18.64	64.016	338867.0	5293.5	
		19.00	62.424	368501.6	5903.2	
40.00	11.00	3.75	999.000	0.0	0.0	***6
		4.75	999.000	0.0	0.0	***6
		5.75	999.000	0.0	0.0	***6
		6.75	999.000	0.0	0.0	***6
		7.75	999.000	0.0	0.0	***6
		8.75	999.000	0.0	0.0	***6
		9.75	999.000	0.0	0.0	***6
		10.75	999.000	0.0	0.0	***6
		11.75	999.000	0.0	0.0	***6
		12.75	999.000	0.0	0.0	***6
		13.75	999.000	0.0	0.0	***6
		14.75	129.098	95298.5	738.2	
		15.75	86.706	171599.0	1979.1	
		16.75	70.687	245670.9	3475.5	
		17.75	63.211	322034.9	5094.6	
		18.00	62.114	341814.2	5503.0	
40.00	10.00	2.85	999.000	0.0	0.0	***6
		3.85	999.000	0.0	0.0	***6
		4.85	999.000	0.0	0.0	***6
		5.85	999.000	0.0	0.0	***6
		6.85	999.000	0.0	0.0	***6
		7.85	999.000	0.0	0.0	***6
		8.85	999.000	0.0	0.0	***6
		9.85	999.000	0.0	0.0	***6
		10.85	999.000	0.0	0.0	***6
		11.85	999.000	0.0	0.0	***6
		12.85	999.000	0.0	0.0	***6
		13.85	137.346	94036.6	684.7	
		14.85	87.589	163768.4	1869.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	10.00	15.85	70.735	232844.0	3291.8	
		16.85	62.490	304828.9	4878.0	
		17.00	61.865	315707.3	5103.2	
40.00	9.00	1.96	999.000	0.0	0.0	***6
		2.96	999.000	0.0	0.0	***6
		3.96	999.000	0.0	0.0	***6
		4.96	999.000	0.0	0.0	***6
		5.96	999.000	0.0	0.0	***6
		6.96	999.000	0.0	0.0	***6
		7.96	999.000	0.0	0.0	***6
		8.96	999.000	0.0	0.0	***6
		9.96	999.000	0.0	0.0	***6
		10.96	999.000	0.0	0.0	***6
		11.96	999.000	0.0	0.0	***6
		12.96	145.348	91546.3	629.8	
		13.96	89.013	155229.5	1743.9	
		14.96	71.064	219547.1	3089.4	
		15.96	62.358	287299.7	4607.3	
		16.00	62.088	290201.5	4674.0	
40.00	8.00	1.06	999.000	0.0	0.0	***6
		2.06	999.000	0.0	0.0	***6
		3.06	999.000	0.0	0.0	***6
		4.06	999.000	0.0	0.0	***6
		5.06	999.000	0.0	0.0	***6
		6.06	999.000	0.0	0.0	***6
		7.06	999.000	0.0	0.0	***6
		8.06	999.000	0.0	0.0	***6
		9.06	999.000	0.0	0.0	***6
		10.06	999.000	0.0	0.0	***6
		11.06	999.000	0.0	0.0	***6
		12.06	152.591	88052.0	577.0	
		13.06	91.190	146129.7	1602.5	
		14.06	71.751	205910.2	2869.8	
		15.00	63.097	265319.5	4205.0	
40.00	7.00	0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	7.00	6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		10.17	999.000	0.0	0.0	***6
		12.17	94.532	136475.8	1443.7	
		13.17	72.942	191920.9	2631.1	
		14.00	64.525	241086.7	3736.4	
40.00	6.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		11.28	99.725	126341.6	1266.9	
		12.28	74.851	177638.0	2373.2	
		13.00	66.559	217531.8	3268.2	
41.00	15.00	7.77	999.000	0.0	0.0	***6
		8.77	999.000	0.0	0.0	***6
		9.77	999.000	0.0	0.0	***6
		10.77	999.000	0.0	0.0	***6
		11.77	999.000	0.0	0.0	***6
		12.77	999.000	0.0	0.0	***6
		13.77	999.000	0.0	0.0	***6
		14.77	999.000	0.0	0.0	***6
		15.77	999.000	0.0	0.0	***6
		16.77	999.000	0.0	0.0	***6
		17.77	999.000	0.0	0.0	***6
		18.77	121.317	119270.5	983.1	
		19.77	85.349	221683.2	2597.4	
		20.77	70.539	317746.0	4504.6	
		21.77	64.412	414113.6	6429.1	
		22.00	63.306	436171.4	6889.9	
41.00	14.00	6.88	999.000	0.0	0.0	***6
		7.88	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	14.00	8.88	999.000	0.0	0.0	***6
		9.88	999.000	0.0	0.0	***6
		10.88	999.000	0.0	0.0	***6
		11.88	999.000	0.0	0.0	***6
		12.88	999.000	0.0	0.0	***6
		13.88	999.000	0.0	0.0	***6
		14.88	999.000	0.0	0.0	***6
		15.88	999.000	0.0	0.0	***6
		16.88	999.000	0.0	0.0	***6
		17.88	125.538	120858.4	962.7	
		18.88	85.267	215582.0	2528.3	
		19.88	70.151	305998.2	4362.0	
		20.88	63.583	397514.9	6251.9	
		21.00	63.001	408731.8	6487.7	
41.00	13.00	5.98	999.000	0.0	0.0	***6
		6.98	999.000	0.0	0.0	***6
		7.98	999.000	0.0	0.0	***6
		8.98	999.000	0.0	0.0	***6
		9.98	999.000	0.0	0.0	***6
		10.98	999.000	0.0	0.0	***6
		11.98	999.000	0.0	0.0	***6
		12.98	999.000	0.0	0.0	***6
		13.98	999.000	0.0	0.0	***6
		14.98	999.000	0.0	0.0	***6
		15.98	999.000	0.0	0.0	***6
		16.98	130.096	120959.5	929.8	
		17.98	85.414	208591.7	2442.1	
		18.98	69.896	293618.0	4200.8	
		19.98	62.814	380441.7	6056.7	
		20.00	62.740	381813.5	6085.7	
41.00	12.00	5.09	999.000	0.0	0.0	***6
		6.09	999.000	0.0	0.0	***6
		7.09	999.000	0.0	0.0	***6
		8.09	999.000	0.0	0.0	***6
		9.09	999.000	0.0	0.0	***6
		10.09	999.000	0.0	0.0	***6
		11.09	999.000	0.0	0.0	***6
		12.09	999.000	0.0	0.0	***6
		13.09	999.000	0.0	0.0	***6
		14.09	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	12.00	15.09	999.000	0.0	0.0	***6
		16.09	135.497	119739.8	883.7	
		17.09	85.859	200786.9	2338.6	
		18.09	69.802	280658.9	4020.8	
		19.00	62.534	355431.5	5683.8	
41.00	11.00	4.19	999.000	0.0	0.0	***6
		5.19	999.000	0.0	0.0	***6
		6.19	999.000	0.0	0.0	***6
		7.19	999.000	0.0	0.0	***6
		8.19	999.000	0.0	0.0	***6
		9.19	999.000	0.0	0.0	***6
		10.19	999.000	0.0	0.0	***6
		11.19	999.000	0.0	0.0	***6
		12.19	999.000	0.0	0.0	***6
		13.19	999.000	0.0	0.0	***6
		14.19	999.000	0.0	0.0	***6
		15.19	142.407	117339.4	824.0	
		16.19	86.696	192238.4	2217.4	
		17.19	69.909	267173.5	3821.7	
		18.00	62.746	329602.3	5253.0	
41.00	10.00	3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		11.28	999.000	0.0	0.0	***6
		12.28	999.000	0.0	0.0	***6
		13.28	999.000	0.0	0.0	***6
		14.28	149.228	112597.1	754.5	
		15.28	88.566	181753.1	2052.2	
		16.28	70.484	251905.3	3573.9	
		17.00	63.650	304343.9	4781.5	
41.00	9.00	2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	9.00	7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		11.28	999.000	0.0	0.0	***6
		12.28	999.000	0.0	0.0	***6
		13.28	171.587	101563.0	591.9	
		14.28	94.158	165291.5	1755.5	
		15.28	72.544	230563.7	3178.2	
		16.00	64.885	279675.8	4310.3	
41.00	8.00	1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		11.28	999.000	0.0	0.0	***6
		13.28	102.343	149298.7	1458.8	
		14.28	75.387	209781.5	2782.7	
		15.00	66.578	255620.3	3839.4	
41.00	7.00	0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		12.28	111.577	133795.2	1199.1	
		13.28	79.410	189581.4	2387.4	
		14.00	68.928	232201.8	3368.8	
41.00	6.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	6.00	1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		12.28	85.326	169989.5	1992.2	
		13.00	72.261	209448.1	2898.5	
42.00	15.00	8.22	999.000	0.0	0.0	***6
		9.22	999.000	0.0	0.0	***6
		10.22	999.000	0.0	0.0	***6
		11.22	999.000	0.0	0.0	***6
		12.22	999.000	0.0	0.0	***6
		13.22	999.000	0.0	0.0	***6
		14.22	999.000	0.0	0.0	***6
		15.22	999.000	0.0	0.0	***6
		16.22	999.000	0.0	0.0	***6
		17.22	999.000	0.0	0.0	***6
		18.22	999.000	0.0	0.0	***6
		19.22	129.672	148546.5	1145.6	
		20.22	84.655	247872.5	2928.0	
		21.22	69.467	344144.3	4954.0	
		22.00	63.739	419956.5	6588.7	
42.00	14.00	7.32	999.000	0.0	0.0	***6
		8.32	999.000	0.0	0.0	***6
		9.32	999.000	0.0	0.0	***6
		10.32	999.000	0.0	0.0	***6
		11.32	999.000	0.0	0.0	***6
		12.32	999.000	0.0	0.0	***6
		13.32	999.000	0.0	0.0	***6
		14.32	999.000	0.0	0.0	***6
		15.32	999.000	0.0	0.0	***6
		16.32	999.000	0.0	0.0	***6
		17.32	999.000	0.0	0.0	***6
		18.32	133.614	147018.6	1100.3	
		19.32	85.007	239737.8	2820.2	
		20.32	69.346	330699.5	4768.8	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	14.00	21.00	63.603	393423.6	6185.6	
42.00	13.00	6.32	999.000	0.0	0.0	***6
		7.32	999.000	0.0	0.0	***6
		8.32	999.000	0.0	0.0	***6
		9.32	999.000	0.0	0.0	***6
		10.32	999.000	0.0	0.0	***6
		11.32	999.000	0.0	0.0	***6
		12.32	999.000	0.0	0.0	***6
		13.32	999.000	0.0	0.0	***6
		14.32	999.000	0.0	0.0	***6
		15.32	999.000	0.0	0.0	***6
		16.32	999.000	0.0	0.0	***6
		17.32	151.547	135668.3	895.2	
		18.32	88.178	222521.7	2523.6	
		19.32	70.493	308247.6	4372.7	
		20.00	63.965	367404.6	5743.9	
42.00	12.00	5.33	999.000	0.0	0.0	***6
		6.33	999.000	0.0	0.0	***6
		7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6
		13.33	999.000	0.0	0.0	***6
		14.33	999.000	0.0	0.0	***6
		15.33	999.000	0.0	0.0	***6
		16.33	170.086	124626.2	732.7	
		17.33	92.372	205711.6	2227.0	
		18.33	71.989	286280.7	3976.8	
		19.00	64.867	341914.1	5271.0	
42.00	11.00	4.33	999.000	0.0	0.0	***6
		5.33	999.000	0.0	0.0	***6
		6.33	999.000	0.0	0.0	***6
		7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	11.00	13.33	999.000	0.0	0.0	***6
		14.33	999.000	0.0	0.0	***6
		16.33	98.069	189320.3	1930.5	
		17.33	73.951	264815.5	3581.0	
		18.00	66.060	316968.2	4798.2	
42.00	10.00	3.33	999.000	0.0	0.0	***6
		4.33	999.000	0.0	0.0	***6
		5.33	999.000	0.0	0.0	***6
		6.33	999.000	0.0	0.0	***6
		7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6
		13.33	999.000	0.0	0.0	***6
		15.33	106.091	173361.6	1634.1	
		16.33	76.559	243868.8	3185.4	
		17.00	67.641	292583.9	4325.5	
42.00	9.00	2.34	999.000	0.0	0.0	***6
		3.34	999.000	0.0	0.0	***6
		4.34	999.000	0.0	0.0	***6
		5.34	999.000	0.0	0.0	***6
		6.34	999.000	0.0	0.0	***6
		7.34	999.000	0.0	0.0	***6
		8.34	999.000	0.0	0.0	***6
		9.34	999.000	0.0	0.0	***6
		10.34	999.000	0.0	0.0	***6
		11.34	999.000	0.0	0.0	***6
		12.34	999.000	0.0	0.0	***6
		14.34	115.165	157852.3	1370.7	
		15.34	80.092	223460.1	2790.0	
		16.00	69.758	268780.3	3853.1	
42.00	8.00	1.34	999.000	0.0	0.0	***6
		2.34	999.000	0.0	0.0	***6
		3.34	999.000	0.0	0.0	***6
		4.34	999.000	0.0	0.0	***6
		5.34	999.000	0.0	0.0	***6
		6.34	999.000	0.0	0.0	***6
		7.34	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	8.00	8.34	999.000	0.0	0.0	***6
		9.34	999.000	0.0	0.0	***6
		10.34	999.000	0.0	0.0	***6
		11.34	999.000	0.0	0.0	***6
		14.34	85.016	203611.6	2395.0	
		15.00	72.641	245579.6	3380.7	
42.00	7.00	0.35	999.000	0.0	0.0	***6
		1.35	999.000	0.0	0.0	***6
		2.35	999.000	0.0	0.0	***6
		3.35	999.000	0.0	0.0	***6
		4.35	999.000	0.0	0.0	***6
		5.35	999.000	0.0	0.0	***6
		6.35	999.000	0.0	0.0	***6
		7.35	999.000	0.0	0.0	***6
		8.35	999.000	0.0	0.0	***6
		9.35	999.000	0.0	0.0	***6
		10.35	999.000	0.0	0.0	***6
		13.35	91.715	184347.9	2010.0	
		14.00	76.670	223005.1	2908.6	
42.00	6.00	-0.64	999.000	0.0	0.0	***6
		0.36	999.000	0.0	0.0	***6
		1.36	999.000	0.0	0.0	***6
		2.36	999.000	0.0	0.0	***6
		3.36	999.000	0.0	0.0	***6
		4.36	999.000	0.0	0.0	***6
		5.36	999.000	0.0	0.0	***6
		6.36	999.000	0.0	0.0	***6
		7.36	999.000	0.0	0.0	***6
		8.36	999.000	0.0	0.0	***6
		9.36	999.000	0.0	0.0	***6
		12.36	98.726	165699.1	1678.4	
		13.00	82.522	201083.3	2436.7	

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	33.00	34.00	35.00	36.00	37.00	38.00
15.00	Fs	85.040	79.427	67.287	71.198	29.039	66.105
	R(m)	22.00	22.00	18.46	22.00	18.06	22.00
14.00	Fs	84.692	78.995	66.684	70.640	36.395	65.557
	R(m)	21.00	21.00	17.49	21.00	17.13	21.00
13.00	Fs	84.359	68.044	66.374	70.094	42.297	65.022
	R(m)	20.00	16.29	16.53	20.00	16.21	20.00
12.00	Fs	84.044	67.390	66.587	69.564	47.980	64.506
	R(m)	19.00	15.31	15.57	19.00	15.31	19.00
11.00	Fs	83.751	66.699	66.688	69.057	61.563	64.013
	R(m)	18.00	14.34	14.62	18.00	14.41	18.00
10.00	Fs	83.484	65.968	66.677	37.060	65.632	63.552
	R(m)	17.00	13.37	13.68	13.07	17.00	17.00
9.00	Fs	82.437	65.198	66.560	44.911	65.180	21.359
	R(m)	13.17	12.41	12.75	12.17	16.00	12.07
8.00	Fs	80.928	64.392	66.345	50.132	64.783	40.866
	R(m)	12.19	11.46	11.84	11.28	15.00	11.17
7.00	Fs	79.392	63.557	66.162	53.984	64.460	56.752
	R(m)	11.22	10.52	10.94	10.38	14.00	10.28
6.00	Fs	77.845	62.717	66.747	58.495	64.242	62.354
	R(m)	10.25	9.60	10.04	9.49	13.00	13.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

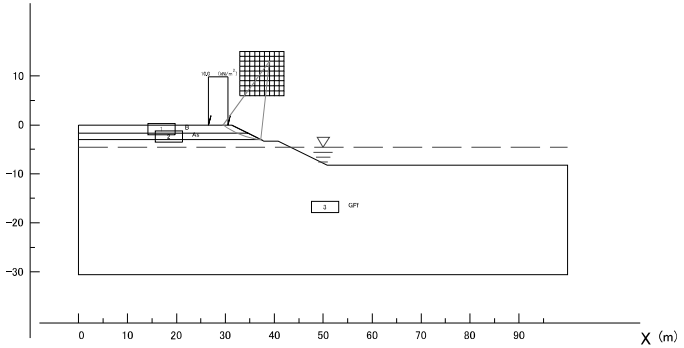
Y(m)	X(m)	39.00	40.00	41.00	42.00
15.00	Fs	64.538	63.597	63.306	63.739
	R(m)	22.00	22.00	22.00	22.00
14.00	Fs	64.039	63.175	63.001	63.603
	R(m)	21.00	21.00	21.00	21.00
13.00	Fs	6.128	62.782	62.740	63.965
	R(m)	16.09	20.00	20.00	20.00
12.00	Fs	26.160	62.424	62.534	64.867
	R(m)	15.20	19.00	19.00	19.00
11.00	Fs	62.675	62.114	62.746	66.060
	R(m)	18.00	18.00	18.00	18.00
10.00	Fs	62.292	61.865	63.650	67.641
	R(m)	17.00	17.00	17.00	17.00
9.00	Fs	61.968	62.088	64.885	69.758
	R(m)	16.00	16.00	16.00	16.00
8.00	Fs	61.720	63.097	66.578	72.641
	R(m)	15.00	15.00	15.00	15.00
7.00	Fs	62.194	64.525	68.928	76.670
	R(m)	14.00	14.00	14.00	14.00
6.00	Fs	63.493	66.559	72.261	82.522
	R(m)	13.00	13.00	13.00	13.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	6.128
Failure circle X(m)	=	39.00
Y(m)	=	13.00
R(m)	=	16.092
Resisting moment(kNm)	=	4249.2
Sliding moment(kNm)	=	693.4
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



WARNING ***1 Points of intersection of an arc and the ground are more than three points. count = 2

WARNING ***6 An arc does not cut the ground, or An arc cuts the side of a model. count =***

4. Action02 (seismic)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	5	19.00	18.00	9.00	1.00	0.00	30.00	0.00	0.00	0.0
2	6	18.50	17.50	8.50	0.00	0.00	27.00	0.00	0.00	0.0
3	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0										

// Distribution load that considers partial coefficient //

load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
2	26.55	0.00	5.0	30.55	0.00	5.0	0.000	0.200	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	-4.63	
2	100.00	-4.63	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	15.00	5.10	999.000	0.0	0.0	***6
		6.10	999.000	0.0	0.0	***6
		7.10	999.000	0.0	0.0	***6
		8.10	999.000	0.0	0.0	***6
		9.10	999.000	0.0	0.0	***6
		10.10	999.000	0.0	0.0	***6
		11.10	999.000	0.0	0.0	***6
		12.10	999.000	0.0	0.0	***6
		13.10	999.000	0.0	0.0	***6
		14.10	999.000	0.0	0.0	***6
		15.10	999.000	0.0	0.0	***6
		19.10	46.900	240875.8	5136.0	
		20.10	46.921	365978.3	7799.9	
		21.10	41.729	462133.4	11074.7	
		22.00	37.743	550271.5	14579.3	
33.00	14.00	4.11	999.000	0.0	0.0	***6
		5.11	999.000	0.0	0.0	***6
		6.11	999.000	0.0	0.0	***6
		7.11	999.000	0.0	0.0	***6
		8.11	999.000	0.0	0.0	***6
		9.11	999.000	0.0	0.0	***6
		10.11	999.000	0.0	0.0	***6
		11.11	999.000	0.0	0.0	***6
		12.11	999.000	0.0	0.0	***6
		13.11	999.000	0.0	0.0	***6
		14.11	999.000	0.0	0.0	***6
		18.11	46.496	223223.3	4800.9	
		19.11	46.863	342118.0	7300.4	
		20.11	41.753	433156.7	10374.3	
		21.00	37.841	516334.9	13644.7	
33.00	13.00	3.12	999.000	0.0	0.0	***6
		4.12	999.000	0.0	0.0	***6
		5.12	999.000	0.0	0.0	***6
		6.12	999.000	0.0	0.0	***6
		7.12	999.000	0.0	0.0	***6
		8.12	999.000	0.0	0.0	***6
		9.12	999.000	0.0	0.0	***6
		10.12	999.000	0.0	0.0	***6
		11.12	999.000	0.0	0.0	***6
		12.12	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	13.00	13.12	999.000	0.0	0.0	***6
		17.12	46.086	206067.5	4471.4	
		18.12	46.802	318726.2	6810.0	
		19.12	41.786	404738.6	9686.0	
		20.00	37.957	482991.2	12724.7	
33.00	12.00	2.13	999.000	0.0	0.0	***6
		3.13	999.000	0.0	0.0	***6
		4.13	999.000	0.0	0.0	***6
		5.13	999.000	0.0	0.0	***6
		6.13	999.000	0.0	0.0	***6
		7.13	999.000	0.0	0.0	***6
		8.13	999.000	0.0	0.0	***6
		9.13	999.000	0.0	0.0	***6
		10.13	999.000	0.0	0.0	***6
		11.13	999.000	0.0	0.0	***6
		12.13	999.000	0.0	0.0	***6
		16.13	45.670	189428.0	4147.8	
		17.13	46.626	295105.8	6329.2	
		18.13	41.829	376906.5	9010.7	
		19.00	38.093	450260.4	11820.0	
33.00	11.00	1.14	999.000	0.0	0.0	***6
		2.14	999.000	0.0	0.0	***6
		3.14	999.000	0.0	0.0	***6
		4.14	999.000	0.0	0.0	***6
		5.14	999.000	0.0	0.0	***6
		6.14	999.000	0.0	0.0	***6
		7.14	999.000	0.0	0.0	***6
		8.14	999.000	0.0	0.0	***6
		9.14	999.000	0.0	0.0	***6
		10.14	999.000	0.0	0.0	***6
		11.14	999.000	0.0	0.0	***6
		15.14	45.250	173326.2	3830.4	
		16.14	46.237	270850.9	5857.9	
		17.14	41.884	349691.7	8349.1	
		18.00	38.254	418164.2	10931.2	
33.00	10.00	0.15	999.000	0.0	0.0	***6
		1.15	999.000	0.0	0.0	***6
		2.15	999.000	0.0	0.0	***6
		3.15	999.000	0.0	0.0	***6
		4.15	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	10.00	5.15	999.000	0.0	0.0	***6
		6.15	999.000	0.0	0.0	***6
		7.15	999.000	0.0	0.0	***6
		8.15	999.000	0.0	0.0	***6
		9.15	999.000	0.0	0.0	***6
		10.15	999.000	0.0	0.0	***6
		14.15	44.832	157789.2	3519.6	
		15.15	45.845	247400.4	5396.5	
		16.15	41.953	323133.3	7702.3	
		17.00	38.445	386726.3	10059.3	
33.00	9.00	-0.83	999.000	0.0	0.0	***6
		0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6
		6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		13.17	44.562	143306.5	3215.9	
		14.17	45.453	224797.9	4945.7	
		15.17	42.039	297278.5	7071.5	
		16.00	38.671	355972.9	9205.1	
33.00	8.00	-1.81	999.000	0.0	0.0	***6
		-0.81	999.000	0.0	0.0	***6
		0.19	999.000	0.0	0.0	***6
		1.19	999.000	0.0	0.0	***6
		2.19	999.000	0.0	0.0	***6
		3.19	999.000	0.0	0.0	***6
		4.19	999.000	0.0	0.0	***6
		5.19	999.000	0.0	0.0	***6
		6.19	999.000	0.0	0.0	***6
		7.19	999.000	0.0	0.0	***6
		8.19	999.000	0.0	0.0	***6
		12.19	44.499	129942.7	2920.1	
		13.19	45.068	203098.8	4506.5	
		14.19	42.145	272189.0	6458.4	
		15.00	38.942	325933.6	8369.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	7.00	-2.78	999.000	0.0	0.0	***6
		-1.78	999.000	0.0	0.0	***6
		-0.78	999.000	0.0	0.0	***6
		0.22	999.000	0.0	0.0	***6
		1.22	999.000	0.0	0.0	***6
		2.22	999.000	0.0	0.0	***6
		3.22	999.000	0.0	0.0	***6
		4.22	999.000	0.0	0.0	***6
		5.22	999.000	0.0	0.0	***6
		6.22	999.000	0.0	0.0	***6
		7.22	999.000	0.0	0.0	***6
		11.22	44.457	117071.3	2633.3	
		12.22	44.698	182376.8	4080.2	
		13.22	42.274	247948.1	5865.2	
		14.00	39.267	296640.9	7554.5	
33.00	6.00	-3.75	999.000	0.0	0.0	***6
		-2.75	999.000	0.0	0.0	***6
		-1.75	999.000	0.0	0.0	***6
		-0.75	999.000	0.0	0.0	***6
		0.25	999.000	0.0	0.0	***6
		1.25	999.000	0.0	0.0	***6
		2.25	999.000	0.0	0.0	***6
		3.25	999.000	0.0	0.0	***6
		4.25	999.000	0.0	0.0	***6
		5.25	999.000	0.0	0.0	***6
		6.25	999.000	0.0	0.0	***6
		10.25	44.449	104766.3	2357.0	
		11.25	44.356	162736.5	3668.9	
		12.25	42.431	224675.0	5295.1	
		13.00	39.660	268132.2	6760.7	
34.00	15.00	5.25	999.000	0.0	0.0	***6
		6.25	999.000	0.0	0.0	***6
		7.25	999.000	0.0	0.0	***6
		8.25	999.000	0.0	0.0	***6
		9.25	999.000	0.0	0.0	***6
		10.25	999.000	0.0	0.0	***6
		11.25	999.000	0.0	0.0	***6
		12.25	999.000	0.0	0.0	***6
		13.25	999.000	0.0	0.0	***6
		14.25	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	15.00	15.25	999.000	0.0	0.0	***6
		19.25	48.783	261175.1	5353.9	
		20.25	45.322	367596.7	8110.8	
		21.25	40.259	463562.6	11514.5	
		22.00	37.023	537015.8	14504.9	
34.00	14.00	4.27	999.000	0.0	0.0	***6
		5.27	999.000	0.0	0.0	***6
		6.27	999.000	0.0	0.0	***6
		7.27	999.000	0.0	0.0	***6
		8.27	999.000	0.0	0.0	***6
		9.27	999.000	0.0	0.0	***6
		10.27	999.000	0.0	0.0	***6
		11.27	999.000	0.0	0.0	***6
		12.27	999.000	0.0	0.0	***6
		13.27	999.000	0.0	0.0	***6
		14.27	999.000	0.0	0.0	***6
		18.27	48.370	243390.3	5031.8	
		19.27	45.215	344661.7	7622.8	
		20.27	40.227	435583.9	10828.2	
		21.00	37.097	503842.5	13581.9	
34.00	13.00	3.29	999.000	0.0	0.0	***6
		4.29	999.000	0.0	0.0	***6
		5.29	999.000	0.0	0.0	***6
		6.29	999.000	0.0	0.0	***6
		7.29	999.000	0.0	0.0	***6
		8.29	999.000	0.0	0.0	***6
		9.29	999.000	0.0	0.0	***6
		10.29	999.000	0.0	0.0	***6
		11.29	999.000	0.0	0.0	***6
		12.29	999.000	0.0	0.0	***6
		13.29	999.000	0.0	0.0	***6
		16.29	38.908	108194.8	2780.8	
		17.29	47.948	226123.8	4716.1	
		18.29	45.103	322220.7	7144.1	
		19.29	40.199	408199.2	10154.5	
		20.00	37.190	471253.4	12671.6	
34.00	12.00	2.31	999.000	0.0	0.0	***6
		3.31	999.000	0.0	0.0	***6
		4.31	999.000	0.0	0.0	***6
		5.31	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	12.00	6.31	999.000	0.0	0.0	***6
		7.31	999.000	0.0	0.0	***6
		8.31	999.000	0.0	0.0	***6
		9.31	999.000	0.0	0.0	***6
		10.31	999.000	0.0	0.0	***6
		11.31	999.000	0.0	0.0	***6
		12.31	999.000	0.0	0.0	***6
		15.31	39.229	101985.9	2599.8	
		16.31	47.517	209401.2	4406.9	
		17.31	44.987	300305.9	6675.5	
		18.31	40.175	381446.1	9494.5	
		19.00	37.304	439266.5	11775.5	
34.00	11.00	1.34	999.000	0.0	0.0	***6
		2.34	999.000	0.0	0.0	***6
		3.34	999.000	0.0	0.0	***6
		4.34	999.000	0.0	0.0	***6
		5.34	999.000	0.0	0.0	***6
		6.34	999.000	0.0	0.0	***6
		7.34	999.000	0.0	0.0	***6
		8.34	999.000	0.0	0.0	***6
		9.34	999.000	0.0	0.0	***6
		10.34	999.000	0.0	0.0	***6
		11.34	999.000	0.0	0.0	***6
		14.34	39.561	95866.4	2423.3	
		15.34	47.078	193252.7	4105.0	
		16.34	44.864	278955.7	6217.8	
		17.34	40.158	355370.0	8849.4	
		18.00	37.441	407902.6	10894.5	
34.00	10.00	0.37	999.000	0.0	0.0	***6
		1.37	999.000	0.0	0.0	***6
		2.37	999.000	0.0	0.0	***6
		3.37	999.000	0.0	0.0	***6
		4.37	999.000	0.0	0.0	***6
		5.37	999.000	0.0	0.0	***6
		6.37	999.000	0.0	0.0	***6
		7.37	999.000	0.0	0.0	***6
		8.37	999.000	0.0	0.0	***6
		9.37	999.000	0.0	0.0	***6
		10.37	999.000	0.0	0.0	***6
		13.37	39.904	89853.2	2251.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	10.00	14.37	46.634	177717.8	3810.9	
		15.37	44.735	258219.8	5772.2	
		16.37	40.147	330029.2	8220.6	
		17.00	37.608	377184.5	10029.4	
34.00	9.00	-0.59	999.000	0.0	0.0	***6
		0.41	999.000	0.0	0.0	***6
		1.41	999.000	0.0	0.0	***6
		2.41	999.000	0.0	0.0	***6
		3.41	999.000	0.0	0.0	***6
		4.41	999.000	0.0	0.0	***6
		5.41	999.000	0.0	0.0	***6
		6.41	999.000	0.0	0.0	***6
		7.41	999.000	0.0	0.0	***6
		8.41	999.000	0.0	0.0	***6
		9.41	999.000	0.0	0.0	***6
		12.41	40.258	83970.3	2085.8	
		13.41	46.189	162846.1	3525.6	
		14.41	44.599	238161.6	5340.0	
		15.41	40.144	305498.3	7610.0	
		16.00	37.810	347137.8	9181.1	
34.00	8.00	-1.54	999.000	0.0	0.0	***6
		-0.54	999.000	0.0	0.0	***6
		0.46	999.000	0.0	0.0	***6
		1.46	999.000	0.0	0.0	***6
		2.46	999.000	0.0	0.0	***6
		3.46	999.000	0.0	0.0	***6
		4.46	999.000	0.0	0.0	***6
		5.46	999.000	0.0	0.0	***6
		6.46	999.000	0.0	0.0	***6
		7.46	999.000	0.0	0.0	***6
		8.46	999.000	0.0	0.0	***6
		11.46	40.624	78251.8	1926.2	
		12.46	45.749	148704.5	3250.4	
		13.46	44.456	218866.6	4923.3	
		14.46	40.151	281878.7	7020.5	
		15.00	38.056	317790.8	8350.5	
34.00	7.00	-2.48	999.000	0.0	0.0	***6
		-1.48	999.000	0.0	0.0	***6
		-0.48	999.000	0.0	0.0	***6
		0.52	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	7.00	1.52	999.000	0.0	0.0	***6
		2.52	999.000	0.0	0.0	***6
		3.52	999.000	0.0	0.0	***6
		4.52	999.000	0.0	0.0	***6
		5.52	999.000	0.0	0.0	***6
		6.52	999.000	0.0	0.0	***6
		7.52	999.000	0.0	0.0	***6
		10.52	41.001	72749.0	1774.3	
		11.52	45.322	135386.2	2987.2	
		12.52	44.303	200454.3	4524.6	
		13.52	40.169	259311.6	6455.5	
		14.00	38.358	289175.2	7538.8	
34.00	6.00	-3.40	999.000	0.0	0.0	***6
		-2.40	999.000	0.0	0.0	***6
		-1.40	999.000	0.0	0.0	***6
		-0.40	999.000	0.0	0.0	***6
		0.60	999.000	0.0	0.0	***6
		1.60	999.000	0.0	0.0	***6
		2.60	999.000	0.0	0.0	***6
		3.60	999.000	0.0	0.0	***6
		4.60	999.000	0.0	0.0	***6
		5.60	999.000	0.0	0.0	***6
		6.60	999.000	0.0	0.0	***6
		9.60	41.388	67542.0	1631.9	
		10.60	44.923	123028.8	2738.7	
		11.60	44.141	183100.0	4148.0	
		12.60	40.198	238005.3	5920.8	
		13.00	38.731	261326.5	6747.1	
35.00	15.00	5.46	999.000	0.0	0.0	***6
		6.46	999.000	0.0	0.0	***6
		7.46	999.000	0.0	0.0	***6
		8.46	999.000	0.0	0.0	***6
		9.46	999.000	0.0	0.0	***6
		10.46	999.000	0.0	0.0	***6
		11.46	999.000	0.0	0.0	***6
		12.46	999.000	0.0	0.0	***6
		13.46	999.000	0.0	0.0	***6
		14.46	999.000	0.0	0.0	***6
		15.46	999.000	0.0	0.0	***6
		18.46	39.612	133906.1	3380.5	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	15.00	19.46	49.027	278740.9	5685.5	
		20.46	43.600	374807.9	8596.5	
		21.46	38.688	470774.8	12168.4	
		22.00	36.475	523492.0	14352.0	
35.00	14.00	4.49	999.000	0.0	0.0	***6
		5.49	999.000	0.0	0.0	***6
		6.49	999.000	0.0	0.0	***6
		7.49	999.000	0.0	0.0	***6
		8.49	999.000	0.0	0.0	***6
		9.49	999.000	0.0	0.0	***6
		10.49	999.000	0.0	0.0	***6
		11.49	999.000	0.0	0.0	***6
		12.49	999.000	0.0	0.0	***6
		13.49	999.000	0.0	0.0	***6
		14.49	999.000	0.0	0.0	***6
		17.49	39.867	127751.4	3204.4	
		18.49	48.801	262406.5	5377.1	
		19.49	43.432	352854.7	8124.3	
		20.49	38.593	443887.5	11501.8	
		21.00	36.523	491092.7	13446.1	
35.00	13.00	3.53	999.000	0.0	0.0	***6
		4.53	999.000	0.0	0.0	***6
		5.53	999.000	0.0	0.0	***6
		6.53	999.000	0.0	0.0	***6
		7.53	999.000	0.0	0.0	***6
		8.53	999.000	0.0	0.0	***6
		9.53	999.000	0.0	0.0	***6
		10.53	999.000	0.0	0.0	***6
		11.53	999.000	0.0	0.0	***6
		12.53	999.000	0.0	0.0	***6
		13.53	999.000	0.0	0.0	***6
		16.53	40.318	122283.3	3033.0	
		17.53	48.556	246457.6	5075.8	
		18.53	43.254	331433.0	7662.4	
		19.53	38.496	417644.8	10849.1	
		20.00	36.588	459267.9	12552.4	
35.00	12.00	2.57	999.000	0.0	0.0	***6
		3.57	999.000	0.0	0.0	***6
		4.57	999.000	0.0	0.0	***6
		5.57	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	12.00	6.57	999.000	0.0	0.0	***6
		7.57	999.000	0.0	0.0	***6
		8.57	999.000	0.0	0.0	***6
		9.57	999.000	0.0	0.0	***6
		10.57	999.000	0.0	0.0	***6
		11.57	999.000	0.0	0.0	***6
		12.57	999.000	0.0	0.0	***6
		15.57	41.113	117857.3	2866.6	
		16.57	48.288	230927.6	4782.3	
		17.57	43.066	310585.5	7211.8	
		18.57	38.397	392097.8	10211.7	
		19.00	36.674	428035.9	11671.4	
35.00	11.00	1.62	999.000	0.0	0.0	***6
		2.62	999.000	0.0	0.0	***6
		3.62	999.000	0.0	0.0	***6
		4.62	999.000	0.0	0.0	***6
		5.62	999.000	0.0	0.0	***6
		6.62	999.000	0.0	0.0	***6
		7.62	999.000	0.0	0.0	***6
		8.62	999.000	0.0	0.0	***6
		9.62	999.000	0.0	0.0	***6
		10.62	999.000	0.0	0.0	***6
		11.62	999.000	0.0	0.0	***6
		14.62	41.867	113290.3	2706.0	
		15.62	47.996	215857.7	4497.4	
		16.62	42.866	290365.3	6773.8	
		17.62	38.295	367309.9	9591.5	
		18.00	36.786	397417.3	10803.4	
35.00	10.00	0.68	999.000	0.0	0.0	***6
		1.68	999.000	0.0	0.0	***6
		2.68	999.000	0.0	0.0	***6
		3.68	999.000	0.0	0.0	***6
		4.68	999.000	0.0	0.0	***6
		5.68	999.000	0.0	0.0	***6
		6.68	999.000	0.0	0.0	***6
		7.68	999.000	0.0	0.0	***6
		8.68	999.000	0.0	0.0	***6
		9.68	999.000	0.0	0.0	***6
		10.68	999.000	0.0	0.0	***6
		13.68	42.573	108632.8	2551.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	10.00	14.68	47.672	201296.0	4222.5	
		15.68	42.652	270841.3	6350.0	
		16.68	38.191	343363.2	8990.6	
		17.00	36.931	367434.2	9949.2	
35.00	9.00	-0.25	999.000	0.0	0.0	***6
		0.75	999.000	0.0	0.0	***6
		1.75	999.000	0.0	0.0	***6
		2.75	999.000	0.0	0.0	***6
		3.75	999.000	0.0	0.0	***6
		4.75	999.000	0.0	0.0	***6
		5.75	999.000	0.0	0.0	***6
		6.75	999.000	0.0	0.0	***6
		7.75	999.000	0.0	0.0	***6
		8.75	999.000	0.0	0.0	***6
		9.75	999.000	0.0	0.0	***6
		12.75	43.223	103944.9	2404.8	
		13.75	47.311	187311.2	3959.2	
		14.75	42.423	252103.6	5942.6	
		15.75	38.084	320364.9	8412.0	
		16.00	37.117	338110.8	9109.4	
35.00	8.00	-1.16	999.000	0.0	0.0	***6
		-0.16	999.000	0.0	0.0	***6
		0.84	999.000	0.0	0.0	***6
		1.84	999.000	0.0	0.0	***6
		2.84	999.000	0.0	0.0	***6
		3.84	999.000	0.0	0.0	***6
		4.84	999.000	0.0	0.0	***6
		5.84	999.000	0.0	0.0	***6
		6.84	999.000	0.0	0.0	***6
		7.84	999.000	0.0	0.0	***6
		8.84	999.000	0.0	0.0	***6
		11.84	43.808	99304.3	2266.8	
		12.84	46.909	174002.4	3709.4	
		13.84	42.177	234274.3	5554.6	
		14.84	37.973	298460.7	7859.8	
		15.00	37.348	309473.2	8286.1	
35.00	7.00	-2.06	999.000	0.0	0.0	***6
		-1.06	999.000	0.0	0.0	***6
		-0.06	999.000	0.0	0.0	***6
		0.94	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	7.00	1.94	999.000	0.0	0.0	***6
		2.94	999.000	0.0	0.0	***6
		3.94	999.000	0.0	0.0	***6
		4.94	999.000	0.0	0.0	***6
		5.94	999.000	0.0	0.0	***6
		6.94	999.000	0.0	0.0	***6
		7.94	999.000	0.0	0.0	***6
		10.94	44.325	94568.5	2133.5	
		11.94	46.478	161321.0	3470.9	
		12.94	41.926	217326.2	5183.6	
		13.94	37.868	277639.8	7331.7	
		14.00	37.638	281551.9	7480.6	
35.00	6.00	-2.96	999.000	0.0	0.0	***6
		-1.96	999.000	0.0	0.0	***6
		-0.96	999.000	0.0	0.0	***6
		0.04	999.000	0.0	0.0	***6
		1.04	999.000	0.0	0.0	***6
		2.04	999.000	0.0	0.0	***6
		3.04	999.000	0.0	0.0	***6
		4.04	999.000	0.0	0.0	***6
		5.04	999.000	0.0	0.0	***6
		6.04	999.000	0.0	0.0	***6
		7.04	999.000	0.0	0.0	***6
		10.04	44.876	88589.2	1974.1	
		11.04	46.110	148389.1	3218.2	
		12.04	41.757	200330.6	4797.5	
		13.00	38.002	254381.3	6694.0	
36.00	15.00	5.73	999.000	0.0	0.0	***6
		6.73	999.000	0.0	0.0	***6
		7.73	999.000	0.0	0.0	***6
		8.73	999.000	0.0	0.0	***6
		9.73	999.000	0.0	0.0	***6
		10.73	999.000	0.0	0.0	***6
		11.73	999.000	0.0	0.0	***6
		12.73	999.000	0.0	0.0	***6
		13.73	999.000	0.0	0.0	***6
		14.73	999.000	0.0	0.0	***6
		15.73	999.000	0.0	0.0	***6
		18.73	49.222	182096.4	3699.5	
		19.73	47.392	292022.2	6161.9	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	15.00	20.73	41.784	387342.4	9270.1	
		21.73	37.144	483605.8	13019.6	
		22.00	36.112	509683.9	14113.8	
36.00	14.00	4.78	999.000	0.0	0.0	***6
		5.78	999.000	0.0	0.0	***6
		6.78	999.000	0.0	0.0	***6
		7.78	999.000	0.0	0.0	***6
		8.78	999.000	0.0	0.0	***6
		9.78	999.000	0.0	0.0	***6
		10.78	999.000	0.0	0.0	***6
		11.78	999.000	0.0	0.0	***6
		12.78	999.000	0.0	0.0	***6
		13.78	999.000	0.0	0.0	***6
		14.78	999.000	0.0	0.0	***6
		17.78	49.553	175370.9	3539.1	
		18.78	47.093	276498.4	5871.3	
		19.78	41.546	366417.4	8819.5	
		20.78	36.978	457883.7	12382.7	
		21.00	36.146	478074.2	13226.1	
36.00	13.00	3.84	999.000	0.0	0.0	***6
		4.84	999.000	0.0	0.0	***6
		5.84	999.000	0.0	0.0	***6
		6.84	999.000	0.0	0.0	***6
		7.84	999.000	0.0	0.0	***6
		8.84	999.000	0.0	0.0	***6
		9.84	999.000	0.0	0.0	***6
		10.84	999.000	0.0	0.0	***6
		11.84	999.000	0.0	0.0	***6
		12.84	999.000	0.0	0.0	***6
		13.84	999.000	0.0	0.0	***6
		16.84	49.826	168619.5	3384.2	
		17.84	46.766	261388.0	5589.3	
		18.84	41.292	346071.4	8381.0	
		19.84	36.803	432869.8	11761.8	
		20.00	36.196	447029.2	12350.3	
36.00	12.00	2.91	999.000	0.0	0.0	***6
		3.91	999.000	0.0	0.0	***6
		4.91	999.000	0.0	0.0	***6
		5.91	999.000	0.0	0.0	***6
		6.91	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	12.00	7.91	999.000	0.0	0.0	***6
		8.91	999.000	0.0	0.0	***6
		9.91	999.000	0.0	0.0	***6
		10.91	999.000	0.0	0.0	***6
		11.91	999.000	0.0	0.0	***6
		12.91	999.000	0.0	0.0	***6
		15.91	50.034	161877.6	3235.4	
		16.91	46.406	246734.0	5316.8	
		17.91	41.021	326359.4	7955.9	
		18.91	36.620	408630.2	11158.8	
		19.00	36.265	416567.2	11486.8	
36.00	11.00	1.98	999.000	0.0	0.0	***6
		2.98	999.000	0.0	0.0	***6
		3.98	999.000	0.0	0.0	***6
		4.98	999.000	0.0	0.0	***6
		5.98	999.000	0.0	0.0	***6
		6.98	999.000	0.0	0.0	***6
		7.98	999.000	0.0	0.0	***6
		8.98	999.000	0.0	0.0	***6
		9.98	999.000	0.0	0.0	***6
		10.98	999.000	0.0	0.0	***6
		11.98	999.000	0.0	0.0	***6
		14.98	50.166	155190.1	3093.5	
		15.98	46.011	232590.2	5055.1	
		16.98	40.729	307351.1	7546.2	
		17.98	36.426	385248.6	10576.1	
		18.00	36.358	386707.6	10636.0	
36.00	10.00	1.07	999.000	0.0	0.0	***6
		2.07	999.000	0.0	0.0	***6
		3.07	999.000	0.0	0.0	***6
		4.07	999.000	0.0	0.0	***6
		5.07	999.000	0.0	0.0	***6
		6.07	999.000	0.0	0.0	***6
		7.07	999.000	0.0	0.0	***6
		8.07	999.000	0.0	0.0	***6
		9.07	999.000	0.0	0.0	***6
		10.07	999.000	0.0	0.0	***6
		11.07	999.000	0.0	0.0	***6
		13.07	26.046	39111.3	1501.6	
		14.07	50.213	148614.5	2959.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	10.00	15.07	45.575	219027.7	4805.9	
		16.07	40.416	289136.0	7154.1	
		17.00	36.483	357471.8	9798.4	
36.00	9.00	0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6
		6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		10.17	999.000	0.0	0.0	***6
		12.17	31.680	45850.9	1447.3	
		13.17	50.153	141994.4	2831.2	
		14.17	45.108	205965.3	4566.1	
		15.17	40.089	271648.5	6776.2	
		16.00	36.646	328883.5	8974.7	
36.00	8.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		11.28	35.468	48961.5	1380.4	
		12.28	49.968	133953.7	2680.8	
		13.28	44.691	192562.5	4308.8	
		14.28	39.818	254010.6	6379.2	
		15.00	36.859	300969.2	8165.4	
36.00	7.00	-1.62	999.000	0.0	0.0	***6
		-0.62	999.000	0.0	0.0	***6
		0.38	999.000	0.0	0.0	***6
		1.38	999.000	0.0	0.0	***6
		2.38	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
36.00	7.00	3.38	999.000	0.0	0.0	***6
		4.38	999.000	0.0	0.0	***6
		5.38	999.000	0.0	0.0	***6
		6.38	999.000	0.0	0.0	***6
		7.38	999.000	0.0	0.0	***6
		8.38	999.000	0.0	0.0	***6
		10.38	38.273	49692.4	1298.4	
		11.38	49.887	124864.8	2503.0	
		12.38	44.352	178758.0	4030.4	
		13.38	39.628	236141.2	5958.9	
		14.00	37.139	273758.2	7371.3	
36.00	6.00	-2.51	999.000	0.0	0.0	***6
		-1.51	999.000	0.0	0.0	***6
		-0.51	999.000	0.0	0.0	***6
		0.49	999.000	0.0	0.0	***6
		1.49	999.000	0.0	0.0	***6
		2.49	999.000	0.0	0.0	***6
		3.49	999.000	0.0	0.0	***6
		4.49	999.000	0.0	0.0	***6
		5.49	999.000	0.0	0.0	***6
		6.49	999.000	0.0	0.0	***6
		7.49	999.000	0.0	0.0	***6
		9.49	41.499	49838.6	1201.0	
		10.49	49.941	115179.3	2306.3	
		11.49	44.115	164629.9	3731.8	
		12.49	39.538	218105.5	5516.4	
		13.00	37.506	247283.4	6593.2	
37.00	15.00	6.06	999.000	0.0	0.0	***6
		7.06	999.000	0.0	0.0	***6
		8.06	999.000	0.0	0.0	***6
		9.06	999.000	0.0	0.0	***6
		10.06	999.000	0.0	0.0	***6
		11.06	999.000	0.0	0.0	***6
		12.06	999.000	0.0	0.0	***6
		13.06	999.000	0.0	0.0	***6
		14.06	999.000	0.0	0.0	***6
		15.06	999.000	0.0	0.0	***6
		16.06	999.000	0.0	0.0	***6
		18.06	20.182	41856.2	2073.9	
		19.06	51.346	212289.1	4134.5	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	15.00	20.06	45.530	309907.4	6806.6	
		21.06	39.941	404966.9	10139.0	
		22.00	35.942	495568.2	13787.8	
37.00	14.00	5.13	999.000	0.0	0.0	***6
		6.13	999.000	0.0	0.0	***6
		7.13	999.000	0.0	0.0	***6
		8.13	999.000	0.0	0.0	***6
		9.13	999.000	0.0	0.0	***6
		10.13	999.000	0.0	0.0	***6
		11.13	999.000	0.0	0.0	***6
		12.13	999.000	0.0	0.0	***6
		13.13	999.000	0.0	0.0	***6
		14.13	999.000	0.0	0.0	***6
		15.13	999.000	0.0	0.0	***6
		17.13	25.429	51166.8	2012.1	
		18.13	51.078	203933.3	3992.6	
		19.13	45.137	295205.3	6540.2	
		20.13	39.632	385111.2	9717.1	
		21.00	35.974	464764.6	12919.4	
37.00	13.00	4.21	999.000	0.0	0.0	***6
		5.21	999.000	0.0	0.0	***6
		6.21	999.000	0.0	0.0	***6
		7.21	999.000	0.0	0.0	***6
		8.21	999.000	0.0	0.0	***6
		9.21	999.000	0.0	0.0	***6
		10.21	999.000	0.0	0.0	***6
		11.21	999.000	0.0	0.0	***6
		12.21	999.000	0.0	0.0	***6
		13.21	999.000	0.0	0.0	***6
		14.21	999.000	0.0	0.0	***6
		16.21	29.688	58064.9	1955.8	
		17.21	50.745	195759.0	3857.7	
		18.21	44.708	280957.0	6284.2	
		19.21	39.302	365890.1	9309.6	
		20.00	36.022	434516.4	12062.6	
37.00	12.00	3.31	999.000	0.0	0.0	***6
		4.31	999.000	0.0	0.0	***6
		5.31	999.000	0.0	0.0	***6
		6.31	999.000	0.0	0.0	***6
		7.31	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	12.00	8.31	999.000	0.0	0.0	***6
		9.31	999.000	0.0	0.0	***6
		10.31	999.000	0.0	0.0	***6
		11.31	999.000	0.0	0.0	***6
		12.31	999.000	0.0	0.0	***6
		13.31	999.000	0.0	0.0	***6
		15.31	33.807	64433.0	1905.9	
		16.31	50.337	187805.1	3730.9	
		17.31	44.239	267216.5	6040.3	
		18.31	38.949	347372.6	8918.6	
		19.00	36.089	404841.1	11217.8	
37.00	11.00	2.41	999.000	0.0	0.0	***6
		3.41	999.000	0.0	0.0	***6
		4.41	999.000	0.0	0.0	***6
		5.41	999.000	0.0	0.0	***6
		6.41	999.000	0.0	0.0	***6
		7.41	999.000	0.0	0.0	***6
		8.41	999.000	0.0	0.0	***6
		9.41	999.000	0.0	0.0	***6
		10.41	999.000	0.0	0.0	***6
		11.41	999.000	0.0	0.0	***6
		12.41	999.000	0.0	0.0	***6
		14.41	43.447	80887.4	1861.8	
		15.41	49.861	179951.8	3609.1	
		16.41	43.738	253882.5	5804.7	
		17.41	38.580	329468.8	8539.8	
		18.00	36.181	375757.5	10385.4	
37.00	10.00	1.51	999.000	0.0	0.0	***6
		2.51	999.000	0.0	0.0	***6
		3.51	999.000	0.0	0.0	***6
		4.51	999.000	0.0	0.0	***6
		5.51	999.000	0.0	0.0	***6
		6.51	999.000	0.0	0.0	***6
		7.51	999.000	0.0	0.0	***6
		8.51	999.000	0.0	0.0	***6
		9.51	999.000	0.0	0.0	***6
		10.51	999.000	0.0	0.0	***6
		11.51	999.000	0.0	0.0	***6
		13.51	48.586	87682.5	1804.7	
		14.51	49.389	171382.0	3470.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	10.00	15.51	43.275	240139.2	5549.2	
		16.51	38.250	311334.1	8139.4	
		17.00	36.305	347286.5	9565.8	
37.00	9.00	0.62	999.000	0.0	0.0	***6
		1.62	999.000	0.0	0.0	***6
		2.62	999.000	0.0	0.0	***6
		3.62	999.000	0.0	0.0	***6
		4.62	999.000	0.0	0.0	***6
		5.62	999.000	0.0	0.0	***6
		6.62	999.000	0.0	0.0	***6
		7.62	999.000	0.0	0.0	***6
		8.62	999.000	0.0	0.0	***6
		9.62	999.000	0.0	0.0	***6
		10.62	999.000	0.0	0.0	***6
		12.62	51.934	89871.7	1730.5	
		13.62	49.128	162061.5	3298.7	
		14.62	42.871	225924.7	5269.8	
		15.62	37.974	292890.3	7712.9	
		16.00	36.468	319450.8	8759.7	
37.00	8.00	-0.27	999.000	0.0	0.0	***6
		0.73	999.000	0.0	0.0	***6
		1.73	999.000	0.0	0.0	***6
		2.73	999.000	0.0	0.0	***6
		3.73	999.000	0.0	0.0	***6
		4.73	999.000	0.0	0.0	***6
		5.73	999.000	0.0	0.0	***6
		6.73	999.000	0.0	0.0	***6
		7.73	999.000	0.0	0.0	***6
		8.73	999.000	0.0	0.0	***6
		9.73	999.000	0.0	0.0	***6
		11.73	54.322	89014.8	1638.7	
		12.73	49.005	152070.3	3103.2	
		13.73	42.540	211305.7	4967.2	
		14.73	37.762	274193.8	7261.2	
		15.00	36.683	292276.1	7967.6	
37.00	7.00	-1.17	999.000	0.0	0.0	***6
		-0.17	999.000	0.0	0.0	***6
		0.83	999.000	0.0	0.0	***6
		1.83	999.000	0.0	0.0	***6
		2.83	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	7.00	3.83	999.000	0.0	0.0	***6
		4.83	999.000	0.0	0.0	***6
		5.83	999.000	0.0	0.0	***6
		6.83	999.000	0.0	0.0	***6
		7.83	999.000	0.0	0.0	***6
		8.83	999.000	0.0	0.0	***6
		10.83	56.194	85924.6	1529.1	
		11.83	49.010	141501.5	2887.2	
		12.83	42.299	196350.4	4642.0	
		13.83	37.628	255303.3	6785.0	
		14.00	36.966	265790.5	7190.2	
37.00	6.00	-2.06	999.000	0.0	0.0	***6
		-1.06	999.000	0.0	0.0	***6
		-0.06	999.000	0.0	0.0	***6
		0.94	999.000	0.0	0.0	***6
		1.94	999.000	0.0	0.0	***6
		2.94	999.000	0.0	0.0	***6
		3.94	999.000	0.0	0.0	***6
		4.94	999.000	0.0	0.0	***6
		5.94	999.000	0.0	0.0	***6
		6.94	999.000	0.0	0.0	***6
		7.94	999.000	0.0	0.0	***6
		9.94	57.870	81129.5	1401.9	
		10.94	49.206	130452.2	2651.2	
		11.94	42.241	181128.7	4288.0	
		12.94	37.591	236279.6	6285.5	
		13.00	37.339	240026.1	6428.3	
38.00	15.00	6.45	999.000	0.0	0.0	***6
		7.45	999.000	0.0	0.0	***6
		8.45	999.000	0.0	0.0	***6
		9.45	999.000	0.0	0.0	***6
		10.45	999.000	0.0	0.0	***6
		11.45	999.000	0.0	0.0	***6
		12.45	999.000	0.0	0.0	***6
		13.45	999.000	0.0	0.0	***6
		14.45	999.000	0.0	0.0	***6
		15.45	999.000	0.0	0.0	***6
		16.45	999.000	0.0	0.0	***6
		18.45	52.603	125831.7	2392.1	
		19.45	50.176	236362.2	4710.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	15.00	20.45	43.497	332177.1	7636.8	
		21.45	38.254	427546.1	11176.5	
		22.00	35.980	481117.5	13371.7	
38.00	14.00	5.54	999.000	0.0	0.0	***6
		6.54	999.000	0.0	0.0	***6
		7.54	999.000	0.0	0.0	***6
		8.54	999.000	0.0	0.0	***6
		9.54	999.000	0.0	0.0	***6
		10.54	999.000	0.0	0.0	***6
		11.54	999.000	0.0	0.0	***6
		12.54	999.000	0.0	0.0	***6
		13.54	999.000	0.0	0.0	***6
		14.54	999.000	0.0	0.0	***6
		15.54	999.000	0.0	0.0	***6
		17.54	55.726	131425.6	2358.4	
		18.54	49.711	228373.5	4594.0	
		19.54	43.009	318324.5	7401.3	
		20.54	37.889	408798.3	10789.5	
		21.00	36.023	451137.5	12523.6	
38.00	13.00	4.65	999.000	0.0	0.0	***6
		5.65	999.000	0.0	0.0	***6
		6.65	999.000	0.0	0.0	***6
		7.65	999.000	0.0	0.0	***6
		8.65	999.000	0.0	0.0	***6
		9.65	999.000	0.0	0.0	***6
		10.65	999.000	0.0	0.0	***6
		11.65	999.000	0.0	0.0	***6
		12.65	999.000	0.0	0.0	***6
		13.65	999.000	0.0	0.0	***6
		14.65	999.000	0.0	0.0	***6
		16.65	56.510	131540.5	2327.8	
		17.65	49.183	220446.0	4482.1	
		18.65	42.493	304807.3	7173.1	
		19.65	37.508	390575.8	10413.1	
		20.00	36.084	421704.0	11686.8	
38.00	12.00	3.75	999.000	0.0	0.0	***6
		4.75	999.000	0.0	0.0	***6
		5.75	999.000	0.0	0.0	***6
		6.75	999.000	0.0	0.0	***6
		7.75	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	12.00	8.75	999.000	0.0	0.0	***6
		9.75	999.000	0.0	0.0	***6
		10.75	999.000	0.0	0.0	***6
		11.75	999.000	0.0	0.0	***6
		12.75	999.000	0.0	0.0	***6
		13.75	999.000	0.0	0.0	***6
		15.75	57.040	130117.3	2281.1	
		16.75	48.648	211750.3	4352.7	
		17.75	42.009	290826.4	6922.9	
		18.75	37.156	372056.7	10013.4	
		19.00	36.166	392833.4	10861.8	
38.00	11.00	2.86	999.000	0.0	0.0	***6
		3.86	999.000	0.0	0.0	***6
		4.86	999.000	0.0	0.0	***6
		5.86	999.000	0.0	0.0	***6
		6.86	999.000	0.0	0.0	***6
		7.86	999.000	0.0	0.0	***6
		8.86	999.000	0.0	0.0	***6
		9.86	999.000	0.0	0.0	***6
		10.86	999.000	0.0	0.0	***6
		11.86	999.000	0.0	0.0	***6
		12.86	999.000	0.0	0.0	***6
		14.86	57.437	127257.8	2215.6	
		15.86	48.158	202258.4	4199.9	
		16.86	41.572	276318.4	6646.8	
		17.86	36.842	353164.8	9585.8	
		18.00	36.277	364544.4	10049.0	
38.00	10.00	1.96	999.000	0.0	0.0	***6
		2.96	999.000	0.0	0.0	***6
		3.96	999.000	0.0	0.0	***6
		4.96	999.000	0.0	0.0	***6
		5.96	999.000	0.0	0.0	***6
		6.96	999.000	0.0	0.0	***6
		7.96	999.000	0.0	0.0	***6
		8.96	999.000	0.0	0.0	***6
		9.96	999.000	0.0	0.0	***6
		10.96	999.000	0.0	0.0	***6
		11.96	999.000	0.0	0.0	***6
		13.96	57.794	123158.1	2131.0	
		14.96	47.886	192058.5	4010.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	10.00	15.96	41.187	261341.9	6345.2	
		16.96	36.573	333950.0	9131.0	
		17.00	36.422	336856.8	9248.7	
38.00	9.00	1.07	999.000	0.0	0.0	***6
		2.07	999.000	0.0	0.0	***6
		3.07	999.000	0.0	0.0	***6
		4.07	999.000	0.0	0.0	***6
		5.07	999.000	0.0	0.0	***6
		6.07	999.000	0.0	0.0	***6
		7.07	999.000	0.0	0.0	***6
		8.07	999.000	0.0	0.0	***6
		9.07	999.000	0.0	0.0	***6
		10.07	999.000	0.0	0.0	***6
		11.07	999.000	0.0	0.0	***6
		12.07	15.401	10956.1	711.4	
		13.07	58.198	117980.5	2027.2	
		14.07	47.708	181231.5	3798.7	
		15.07	40.866	245956.5	6018.7	
		16.00	36.612	309792.7	8461.6	
38.00	8.00	0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6
		6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		10.17	999.000	0.0	0.0	***6
		11.17	29.160	19430.4	666.3	
		12.17	58.743	111865.6	1904.3	
		13.17	47.657	169856.2	3564.1	
		14.17	40.620	230222.6	5667.7	
		15.00	36.859	283376.7	7688.1	
38.00	7.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	7.00	4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	39.738	24189.7	608.7	
		11.28	59.541	104939.2	1762.5	
		12.28	47.777	158010.4	3307.3	
		13.28	40.543	214202.3	5283.3	
		14.00	37.183	257636.2	6928.9	
38.00	6.00	-1.62	999.000	0.0	0.0	***6
		-0.62	999.000	0.0	0.0	***6
		0.38	999.000	0.0	0.0	***6
		1.38	999.000	0.0	0.0	***6
		2.38	999.000	0.0	0.0	***6
		3.38	999.000	0.0	0.0	***6
		4.38	999.000	0.0	0.0	***6
		5.38	999.000	0.0	0.0	***6
		6.38	999.000	0.0	0.0	***6
		7.38	999.000	0.0	0.0	***6
		8.38	999.000	0.0	0.0	***6
		9.38	71.766	39439.2	549.6	
		10.38	60.749	97317.9	1602.0	
		11.38	48.130	145772.0	3028.7	
		12.38	40.724	197960.0	4861.0	
		13.00	37.609	232601.8	6184.8	
39.00	15.00	6.88	999.000	0.0	0.0	***6
		7.88	999.000	0.0	0.0	***6
		8.88	999.000	0.0	0.0	***6
		9.88	999.000	0.0	0.0	***6
		10.88	999.000	0.0	0.0	***6
		11.88	999.000	0.0	0.0	***6
		12.88	999.000	0.0	0.0	***6
		13.88	999.000	0.0	0.0	***6
		14.88	999.000	0.0	0.0	***6
		15.88	999.000	0.0	0.0	***6
		16.88	999.000	0.0	0.0	***6
		18.88	57.491	164039.4	2853.3	
		19.88	48.382	263522.8	5446.8	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	15.00	20.88	41.552	358582.7	8629.7	
		21.88	36.728	454772.8	12382.2	
		22.00	36.251	466299.5	12863.2	
39.00	14.00	5.99	999.000	0.0	0.0	***6
		6.99	999.000	0.0	0.0	***6
		7.99	999.000	0.0	0.0	***6
		8.99	999.000	0.0	0.0	***6
		9.99	999.000	0.0	0.0	***6
		10.99	999.000	0.0	0.0	***6
		11.99	999.000	0.0	0.0	***6
		12.99	999.000	0.0	0.0	***6
		13.99	999.000	0.0	0.0	***6
		14.99	999.000	0.0	0.0	***6
		15.99	999.000	0.0	0.0	***6
		17.99	57.611	162384.2	2818.6	
		18.99	47.797	254763.3	5330.1	
		19.99	41.078	344447.8	8385.3	
		20.99	36.372	435960.3	11986.2	
		21.00	36.320	437162.1	12036.3	
39.00	13.00	5.09	999.000	0.0	0.0	***6
		6.09	999.000	0.0	0.0	***6
		7.09	999.000	0.0	0.0	***6
		8.09	999.000	0.0	0.0	***6
		9.09	999.000	0.0	0.0	***6
		10.09	999.000	0.0	0.0	***6
		11.09	999.000	0.0	0.0	***6
		12.09	999.000	0.0	0.0	***6
		13.09	999.000	0.0	0.0	***6
		14.09	999.000	0.0	0.0	***6
		15.09	999.000	0.0	0.0	***6
		16.09	4.435	4183.6	943.3	
		17.09	57.668	159402.2	2764.1	
		18.09	47.241	245191.0	5190.3	
		19.09	40.640	329739.0	8113.7	
		20.00	36.411	408562.2	11220.7	
39.00	12.00	4.20	999.000	0.0	0.0	***6
		5.20	999.000	0.0	0.0	***6
		6.20	999.000	0.0	0.0	***6
		7.20	999.000	0.0	0.0	***6
		8.20	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	12.00	9.20	999.000	0.0	0.0	***6
		10.20	999.000	0.0	0.0	***6
		11.20	999.000	0.0	0.0	***6
		12.20	999.000	0.0	0.0	***6
		13.20	999.000	0.0	0.0	***6
		14.20	999.000	0.0	0.0	***6
		15.20	19.069	17703.6	928.4	
		16.20	57.717	155237.3	2689.6	
		17.20	46.800	234878.6	5018.8	
		18.20	40.242	314508.8	7815.4	
		19.00	36.530	380515.9	10416.6	
39.00	11.00	3.30	999.000	0.0	0.0	***6
		4.30	999.000	0.0	0.0	***6
		5.30	999.000	0.0	0.0	***6
		6.30	999.000	0.0	0.0	***6
		7.30	999.000	0.0	0.0	***6
		8.30	999.000	0.0	0.0	***6
		9.30	999.000	0.0	0.0	***6
		10.30	999.000	0.0	0.0	***6
		11.30	999.000	0.0	0.0	***6
		12.30	999.000	0.0	0.0	***6
		13.30	999.000	0.0	0.0	***6
		14.30	999.000	22303.1	1.1	***1
		15.30	57.814	150015.3	2594.8	
		16.30	46.504	223896.1	4814.5	
		17.30	39.891	298810.2	7490.6	
		18.00	36.682	353041.1	9624.4	
39.00	10.00	2.41	999.000	0.0	0.0	***6
		3.41	999.000	0.0	0.0	***6
		4.41	999.000	0.0	0.0	***6
		5.41	999.000	0.0	0.0	***6
		6.41	999.000	0.0	0.0	***6
		7.41	999.000	0.0	0.0	***6
		8.41	999.000	0.0	0.0	***6
		9.41	999.000	0.0	0.0	***6
		10.41	999.000	0.0	0.0	***6
		11.41	999.000	0.0	0.0	***6
		12.41	999.000	0.0	0.0	***6
		13.41	81.402	71113.9	873.6	
		14.41	58.012	143848.7	2479.6	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	10.00	15.41	46.302	212312.4	4585.4	
		16.41	39.595	282696.6	7139.7	
		17.00	36.876	326157.0	8844.7	
39.00	9.00	1.51	999.000	0.0	0.0	***6
		2.51	999.000	0.0	0.0	***6
		3.51	999.000	0.0	0.0	***6
		4.51	999.000	0.0	0.0	***6
		5.51	999.000	0.0	0.0	***6
		6.51	999.000	0.0	0.0	***6
		7.51	999.000	0.0	0.0	***6
		8.51	999.000	0.0	0.0	***6
		9.51	999.000	0.0	0.0	***6
		10.51	999.000	0.0	0.0	***6
		11.51	999.000	0.0	0.0	***6
		12.51	86.254	71583.0	829.9	
		13.51	58.379	136840.3	2344.0	
		14.51	46.215	200194.3	4331.8	
		15.51	39.362	266222.4	6763.4	
		16.00	37.125	299884.8	8077.7	
39.00	8.00	0.62	999.000	0.0	0.0	***6
		1.62	999.000	0.0	0.0	***6
		2.62	999.000	0.0	0.0	***6
		3.62	999.000	0.0	0.0	***6
		4.62	999.000	0.0	0.0	***6
		5.62	999.000	0.0	0.0	***6
		6.62	999.000	0.0	0.0	***6
		7.62	999.000	0.0	0.0	***6
		8.62	999.000	0.0	0.0	***6
		9.62	999.000	0.0	0.0	***6
		10.62	999.000	0.0	0.0	***6
		11.62	91.356	70439.8	771.1	
		12.62	58.997	129086.9	2188.0	
		13.62	46.277	187608.9	4054.1	
		14.62	39.290	249443.7	6348.7	
		15.00	37.444	274248.5	7324.2	
39.00	7.00	-0.28	999.000	0.0	0.0	***6
		0.72	999.000	0.0	0.0	***6
		1.72	999.000	0.0	0.0	***6
		2.72	999.000	0.0	0.0	***6
		3.72	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
39.00	7.00	4.72	999.000	0.0	0.0	***6
		5.72	999.000	0.0	0.0	***6
		6.72	999.000	0.0	0.0	***6
		7.72	999.000	0.0	0.0	***6
		8.72	999.000	0.0	0.0	***6
		9.72	999.000	0.0	0.0	***6
		10.72	96.121	67976.0	707.2	
		11.72	59.966	120670.2	2012.3	
		12.72	46.532	174624.0	3752.8	
		13.72	39.410	232418.1	5897.5	
		14.00	37.972	249274.1	6564.7	
39.00	6.00	-1.17	999.000	0.0	0.0	***6
		-0.17	999.000	0.0	0.0	***6
		0.83	999.000	0.0	0.0	***6
		1.83	999.000	0.0	0.0	***6
		2.83	999.000	0.0	0.0	***6
		3.83	999.000	0.0	0.0	***6
		4.83	999.000	0.0	0.0	***6
		5.83	999.000	0.0	0.0	***6
		6.83	999.000	0.0	0.0	***6
		7.83	999.000	0.0	0.0	***6
		8.83	999.000	0.0	0.0	***6
		9.83	102.448	64467.7	629.3	
		10.83	61.436	111737.7	1818.8	
		11.83	47.036	161368.2	3430.7	
		12.83	39.685	215270.7	5424.5	
		13.00	38.759	224991.4	5805.0	
40.00	15.00	7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6
		13.33	999.000	0.0	0.0	***6
		14.33	999.000	0.0	0.0	***6
		15.33	999.000	0.0	0.0	***6
		16.33	999.000	0.0	0.0	***6
		17.33	999.000	0.0	0.0	***6
		18.33	999.000	39963.9	4.8	***1
		19.33	57.501	193892.6	3372.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	15.00	20.33	46.448	290691.4	6258.4	
		21.33	39.980	386009.9	9655.0	
		22.00	36.791	451075.9	12260.5	
40.00	14.00	6.43	999.000	0.0	0.0	***6
		7.43	999.000	0.0	0.0	***6
		8.43	999.000	0.0	0.0	***6
		9.43	999.000	0.0	0.0	***6
		10.43	999.000	0.0	0.0	***6
		11.43	999.000	0.0	0.0	***6
		12.43	999.000	0.0	0.0	***6
		13.43	999.000	0.0	0.0	***6
		14.43	999.000	0.0	0.0	***6
		15.43	999.000	0.0	0.0	***6
		16.43	999.000	0.0	0.0	***6
		17.43	78.024	89453.9	1146.5	
		18.43	57.337	189754.0	3309.4	
		19.43	45.938	280347.1	6102.7	
		20.43	39.585	370608.3	9362.3	
		21.00	36.907	422801.1	11455.9	
40.00	13.00	5.54	999.000	0.0	0.0	***6
		6.54	999.000	0.0	0.0	***6
		7.54	999.000	0.0	0.0	***6
		8.54	999.000	0.0	0.0	***6
		9.54	999.000	0.0	0.0	***6
		10.54	999.000	0.0	0.0	***6
		11.54	999.000	0.0	0.0	***6
		12.54	999.000	0.0	0.0	***6
		13.54	999.000	0.0	0.0	***6
		14.54	999.000	0.0	0.0	***6
		15.54	999.000	0.0	0.0	***6
		16.54	81.418	93248.6	1145.3	
		17.54	57.218	184568.6	3225.7	
		18.54	45.594	269296.6	5906.4	
		19.54	39.227	354689.0	9041.9	
		20.00	37.052	395055.2	10662.2	
40.00	12.00	4.64	999.000	0.0	0.0	***6
		5.64	999.000	0.0	0.0	***6
		6.64	999.000	0.0	0.0	***6
		7.64	999.000	0.0	0.0	***6
		8.64	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	12.00	9.64	999.000	0.0	0.0	***6
		10.64	999.000	0.0	0.0	***6
		11.64	999.000	0.0	0.0	***6
		12.64	999.000	0.0	0.0	***6
		13.64	999.000	0.0	0.0	***6
		14.64	999.000	0.0	0.0	***6
		15.64	84.305	95063.3	1127.6	
		16.64	57.177	178428.9	3120.7	
		17.64	45.334	257599.7	5682.3	
		18.64	38.911	338299.5	8694.2	
		19.00	37.232	367854.2	9880.1	
40.00	11.00	3.75	999.000	0.0	0.0	***6
		4.75	999.000	0.0	0.0	***6
		5.75	999.000	0.0	0.0	***6
		6.75	999.000	0.0	0.0	***6
		7.75	999.000	0.0	0.0	***6
		8.75	999.000	0.0	0.0	***6
		9.75	999.000	0.0	0.0	***6
		10.75	999.000	0.0	0.0	***6
		11.75	999.000	0.0	0.0	***6
		12.75	999.000	0.0	0.0	***6
		13.75	999.000	0.0	0.0	***6
		14.75	87.114	95221.8	1093.1	
		15.75	57.231	171400.7	2994.9	
		16.75	45.157	245316.2	5432.5	
		17.75	38.643	321489.1	8319.5	
		18.00	37.456	341214.9	9109.7	
40.00	10.00	2.85	999.000	0.0	0.0	***6
		3.85	999.000	0.0	0.0	***6
		4.85	999.000	0.0	0.0	***6
		5.85	999.000	0.0	0.0	***6
		6.85	999.000	0.0	0.0	***6
		7.85	999.000	0.0	0.0	***6
		8.85	999.000	0.0	0.0	***6
		9.85	999.000	0.0	0.0	***6
		10.85	999.000	0.0	0.0	***6
		11.85	999.000	0.0	0.0	***6
		12.85	999.000	0.0	0.0	***6
		13.85	90.230	93963.1	1041.4	
		14.85	57.438	163578.4	2847.9	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	10.00	15.85	45.083	232504.6	5157.3	
		16.85	38.431	304307.1	7918.2	
		17.00	37.736	315156.1	8351.5	
40.00	9.00	1.96	999.000	0.0	0.0	***6
		2.96	999.000	0.0	0.0	***6
		3.96	999.000	0.0	0.0	***6
		4.96	999.000	0.0	0.0	***6
		5.96	999.000	0.0	0.0	***6
		6.96	999.000	0.0	0.0	***6
		7.96	999.000	0.0	0.0	***6
		8.96	999.000	0.0	0.0	***6
		9.96	999.000	0.0	0.0	***6
		10.96	999.000	0.0	0.0	***6
		11.96	999.000	0.0	0.0	***6
		12.96	93.500	91477.3	978.4	
		13.96	57.868	155049.3	2679.4	
		14.96	45.135	219225.0	4857.1	
		15.96	38.380	286804.2	7472.8	
		16.00	38.162	289698.2	7591.2	
40.00	8.00	1.06	999.000	0.0	0.0	***6
		2.06	999.000	0.0	0.0	***6
		3.06	999.000	0.0	0.0	***6
		4.06	999.000	0.0	0.0	***6
		5.06	999.000	0.0	0.0	***6
		6.06	999.000	0.0	0.0	***6
		7.06	999.000	0.0	0.0	***6
		8.06	999.000	0.0	0.0	***6
		9.06	999.000	0.0	0.0	***6
		10.06	999.000	0.0	0.0	***6
		11.06	999.000	0.0	0.0	***6
		12.06	97.018	87988.7	906.9	
		13.06	58.587	145960.9	2491.4	
		14.06	45.339	205607.2	4534.9	
		15.00	38.814	264864.0	6824.0	
40.00	7.00	0.17	999.000	0.0	0.0	***6
		1.17	999.000	0.0	0.0	***6
		2.17	999.000	0.0	0.0	***6
		3.17	999.000	0.0	0.0	***6
		4.17	999.000	0.0	0.0	***6
		5.17	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
40.00	7.00	6.17	999.000	0.0	0.0	***6
		7.17	999.000	0.0	0.0	***6
		8.17	999.000	0.0	0.0	***6
		9.17	999.000	0.0	0.0	***6
		10.17	999.000	0.0	0.0	***6
		12.17	59.741	136320.0	2281.9	
		13.17	45.752	191639.2	4188.6	
		14.00	39.646	240678.8	6070.7	
40.00	6.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		11.28	61.535	126200.8	2050.9	
		12.28	46.448	177379.6	3818.9	
		13.00	40.730	217171.5	5331.9	
41.00	15.00	7.77	999.000	0.0	0.0	***6
		8.77	999.000	0.0	0.0	***6
		9.77	999.000	0.0	0.0	***6
		10.77	999.000	0.0	0.0	***6
		11.77	999.000	0.0	0.0	***6
		12.77	999.000	0.0	0.0	***6
		13.77	999.000	0.0	0.0	***6
		14.77	999.000	0.0	0.0	***6
		15.77	999.000	0.0	0.0	***6
		16.77	999.000	0.0	0.0	***6
		17.77	999.000	0.0	0.0	***6
		18.77	83.667	119172.9	1424.4	
		19.77	56.532	221427.3	3916.8	
		20.77	44.986	317285.7	7053.0	
		21.77	38.756	413405.1	10666.8	
		22.00	37.657	435400.9	11562.2	
41.00	14.00	6.88	999.000	0.0	0.0	***6
		7.88	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	14.00	8.88	999.000	0.0	0.0	***6
		9.88	999.000	0.0	0.0	***6
		10.88	999.000	0.0	0.0	***6
		11.88	999.000	0.0	0.0	***6
		12.88	999.000	0.0	0.0	***6
		13.88	999.000	0.0	0.0	***6
		14.88	999.000	0.0	0.0	***6
		15.88	999.000	0.0	0.0	***6
		16.88	999.000	0.0	0.0	***6
		17.88	85.182	120760.9	1417.7	
		18.88	56.293	215330.1	3825.2	
		19.88	44.699	305548.1	6835.7	
		20.88	38.435	396824.7	10324.5	
		21.00	37.847	408009.9	10780.5	
41.00	13.00	5.98	999.000	0.0	0.0	***6
		6.98	999.000	0.0	0.0	***6
		7.98	999.000	0.0	0.0	***6
		8.98	999.000	0.0	0.0	***6
		9.98	999.000	0.0	0.0	***6
		10.98	999.000	0.0	0.0	***6
		11.98	999.000	0.0	0.0	***6
		12.98	999.000	0.0	0.0	***6
		13.98	999.000	0.0	0.0	***6
		14.98	999.000	0.0	0.0	***6
		15.98	999.000	0.0	0.0	***6
		16.98	86.729	120863.1	1393.6	
		17.98	56.157	208345.4	3710.1	
		18.98	44.477	293180.2	6591.8	
		19.98	38.153	379772.3	9954.0	
		20.00	38.077	381140.2	10009.8	
41.00	12.00	5.09	999.000	0.0	0.0	***6
		6.09	999.000	0.0	0.0	***6
		7.09	999.000	0.0	0.0	***6
		8.09	999.000	0.0	0.0	***6
		9.09	999.000	0.0	0.0	***6
		10.09	999.000	0.0	0.0	***6
		11.09	999.000	0.0	0.0	***6
		12.09	999.000	0.0	0.0	***6
		13.09	999.000	0.0	0.0	***6
		14.09	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	12.00	15.09	999.000	0.0	0.0	***6
		16.09	88.518	119645.8	1351.7	
		17.09	56.155	200547.8	3571.4	
		18.09	44.332	280235.4	6321.3	
		19.00	38.355	354806.7	9250.5	
41.00	11.00	4.19	999.000	0.0	0.0	***6
		5.19	999.000	0.0	0.0	***6
		6.19	999.000	0.0	0.0	***6
		7.19	999.000	0.0	0.0	***6
		8.19	999.000	0.0	0.0	***6
		9.19	999.000	0.0	0.0	***6
		10.19	999.000	0.0	0.0	***6
		11.19	999.000	0.0	0.0	***6
		12.19	999.000	0.0	0.0	***6
		13.19	999.000	0.0	0.0	***6
		14.19	999.000	0.0	0.0	***6
		15.19	90.775	117249.0	1291.6	
		16.19	56.321	192008.2	3409.2	
		17.19	44.279	266766.5	6024.7	
		18.00	38.762	329026.0	8488.3	
41.00	10.00	3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		11.28	999.000	0.0	0.0	***6
		12.28	999.000	0.0	0.0	***6
		13.28	999.000	0.0	0.0	***6
		14.28	94.186	112513.8	1194.6	
		15.28	57.041	181536.3	3182.6	
		16.28	44.495	251520.2	5652.7	
		17.00	39.365	303816.0	7717.9	
41.00	9.00	2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	9.00	7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		11.28	999.000	0.0	0.0	***6
		12.28	999.000	0.0	0.0	***6
		13.28	106.739	101497.7	950.9	
		14.28	59.888	165101.8	2756.9	
		15.28	45.659	230217.6	5042.1	
		16.00	40.114	279196.3	6960.1	
41.00	8.00	1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		11.28	999.000	0.0	0.0	***6
		13.28	63.725	149136.3	2340.3	
		14.28	47.149	209474.2	4442.8	
		15.00	41.057	255189.2	6215.5	
41.00	7.00	0.28	999.000	0.0	0.0	***6
		1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		10.28	999.000	0.0	0.0	***6
		12.28	68.474	133660.2	1952.0	
		13.28	49.100	189312.8	3855.6	
		14.00	42.267	231818.8	5484.7	
41.00	6.00	-0.72	999.000	0.0	0.0	***6
		0.28	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
41.00	6.00	1.28	999.000	0.0	0.0	***6
		2.28	999.000	0.0	0.0	***6
		3.28	999.000	0.0	0.0	***6
		4.28	999.000	0.0	0.0	***6
		5.28	999.000	0.0	0.0	***6
		6.28	999.000	0.0	0.0	***6
		7.28	999.000	0.0	0.0	***6
		8.28	999.000	0.0	0.0	***6
		9.28	999.000	0.0	0.0	***6
		12.28	51.737	169759.3	3281.2	
		13.00	43.853	209113.2	4768.5	
42.00	15.00	8.22	999.000	0.0	0.0	***6
		9.22	999.000	0.0	0.0	***6
		10.22	999.000	0.0	0.0	***6
		11.22	999.000	0.0	0.0	***6
		12.22	999.000	0.0	0.0	***6
		13.22	999.000	0.0	0.0	***6
		14.22	999.000	0.0	0.0	***6
		15.22	999.000	0.0	0.0	***6
		16.22	999.000	0.0	0.0	***6
		17.22	999.000	0.0	0.0	***6
		18.22	999.000	0.0	0.0	***6
		19.22	85.873	148427.6	1728.5	
		20.22	55.426	247573.2	4466.7	
		21.22	44.024	343616.2	7805.2	
		22.00	38.936	419218.2	10766.8	
42.00	14.00	7.32	999.000	0.0	0.0	***6
		8.32	999.000	0.0	0.0	***6
		9.32	999.000	0.0	0.0	***6
		10.32	999.000	0.0	0.0	***6
		11.32	999.000	0.0	0.0	***6
		12.32	999.000	0.0	0.0	***6
		13.32	999.000	0.0	0.0	***6
		14.32	999.000	0.0	0.0	***6
		15.32	999.000	0.0	0.0	***6
		16.32	999.000	0.0	0.0	***6
		17.32	999.000	0.0	0.0	***6
		18.32	87.099	146901.9	1686.6	
		19.32	55.408	239445.5	4321.5	
		20.32	43.878	330185.6	7525.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	14.00	21.00	39.238	392734.1	10009.0	
42.00	13.00	6.32	999.000	0.0	0.0	***6
		7.32	999.000	0.0	0.0	***6
		8.32	999.000	0.0	0.0	***6
		9.32	999.000	0.0	0.0	***6
		10.32	999.000	0.0	0.0	***6
		11.32	999.000	0.0	0.0	***6
		12.32	999.000	0.0	0.0	***6
		13.32	999.000	0.0	0.0	***6
		14.32	999.000	0.0	0.0	***6
		15.32	999.000	0.0	0.0	***6
		16.32	999.000	0.0	0.0	***6
		17.32	96.016	135569.5	1412.0	
		18.32	57.253	222256.6	3882.0	
		19.32	44.636	307773.0	6895.1	
		20.00	39.681	366763.9	9242.7	
42.00	12.00	5.33	999.000	0.0	0.0	***6
		6.33	999.000	0.0	0.0	***6
		7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6
		13.33	999.000	0.0	0.0	***6
		14.33	999.000	0.0	0.0	***6
		15.33	999.000	0.0	0.0	***6
		16.33	106.946	124545.3	1164.6	
		17.33	59.554	205473.7	3450.2	
		18.33	45.553	285845.3	6275.0	
		19.00	40.287	341322.3	8472.2	
42.00	11.00	4.33	999.000	0.0	0.0	***6
		5.33	999.000	0.0	0.0	***6
		6.33	999.000	0.0	0.0	***6
		7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	11.00	13.33	999.000	0.0	0.0	***6
		14.33	999.000	0.0	0.0	***6
		16.33	62.482	189109.6	3026.6	
		17.33	46.674	264419.2	5665.2	
		18.00	41.023	316425.1	7713.4	
42.00	10.00	3.33	999.000	0.0	0.0	***6
		4.33	999.000	0.0	0.0	***6
		5.33	999.000	0.0	0.0	***6
		6.33	999.000	0.0	0.0	***6
		7.33	999.000	0.0	0.0	***6
		8.33	999.000	0.0	0.0	***6
		9.33	999.000	0.0	0.0	***6
		10.33	999.000	0.0	0.0	***6
		11.33	999.000	0.0	0.0	***6
		12.33	999.000	0.0	0.0	***6
		13.33	999.000	0.0	0.0	***6
		15.33	66.313	173178.1	2611.5	
		16.33	48.067	243511.4	5066.0	
		17.00	41.926	292089.6	6966.7	
42.00	9.00	2.34	999.000	0.0	0.0	***6
		3.34	999.000	0.0	0.0	***6
		4.34	999.000	0.0	0.0	***6
		5.34	999.000	0.0	0.0	***6
		6.34	999.000	0.0	0.0	***6
		7.34	999.000	0.0	0.0	***6
		8.34	999.000	0.0	0.0	***6
		9.34	999.000	0.0	0.0	***6
		10.34	999.000	0.0	0.0	***6
		11.34	999.000	0.0	0.0	***6
		12.34	999.000	0.0	0.0	***6
		14.34	70.975	157696.1	2221.9	
		15.34	49.830	223141.5	4478.1	
		16.00	43.052	268334.7	6232.8	
42.00	8.00	1.34	999.000	0.0	0.0	***6
		2.34	999.000	0.0	0.0	***6
		3.34	999.000	0.0	0.0	***6
		4.34	999.000	0.0	0.0	***6
		5.34	999.000	0.0	0.0	***6
		6.34	999.000	0.0	0.0	***6
		7.34	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	8.00	8.34	999.000	0.0	0.0	***6
		9.34	999.000	0.0	0.0	***6
		10.34	999.000	0.0	0.0	***6
		11.34	999.000	0.0	0.0	***6
		14.34	52.111	203331.5	3901.9	
		15.00	44.481	245182.4	5512.1	
42.00	7.00	0.35	999.000	0.0	0.0	***6
		1.35	999.000	0.0	0.0	***6
		2.35	999.000	0.0	0.0	***6
		3.35	999.000	0.0	0.0	***6
		4.35	999.000	0.0	0.0	***6
		5.35	999.000	0.0	0.0	***6
		6.35	999.000	0.0	0.0	***6
		7.35	999.000	0.0	0.0	***6
		8.35	999.000	0.0	0.0	***6
		9.35	999.000	0.0	0.0	***6
		10.35	999.000	0.0	0.0	***6
		13.35	55.070	184106.5	3343.1	
		14.00	46.335	222656.2	4805.4	
42.00	6.00	-0.64	999.000	0.0	0.0	***6
		0.36	999.000	0.0	0.0	***6
		1.36	999.000	0.0	0.0	***6
		2.36	999.000	0.0	0.0	***6
		3.36	999.000	0.0	0.0	***6
		4.36	999.000	0.0	0.0	***6
		5.36	999.000	0.0	0.0	***6
		6.36	999.000	0.0	0.0	***6
		7.36	999.000	0.0	0.0	***6
		8.36	999.000	0.0	0.0	***6
		9.36	999.000	0.0	0.0	***6
		12.36	58.596	165496.3	2824.4	
		13.00	48.811	200782.5	4113.5	

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	33.00	34.00	35.00	36.00	37.00	38.00
15.00	Fs	37.743	37.023	36.475	36.112	20.182	35.980
	R(m)	22.00	22.00	22.00	22.00	18.06	22.00
14.00	Fs	37.841	37.097	36.523	36.146	25.429	36.023
	R(m)	21.00	21.00	21.00	21.00	17.13	21.00
13.00	Fs	37.957	37.190	36.588	36.196	29.688	36.084
	R(m)	20.00	20.00	20.00	20.00	16.21	20.00
12.00	Fs	38.093	37.304	36.674	36.265	33.807	36.166
	R(m)	19.00	19.00	19.00	19.00	15.31	19.00
11.00	Fs	38.254	37.441	36.786	36.358	36.181	36.277
	R(m)	18.00	18.00	18.00	18.00	18.00	18.00
10.00	Fs	38.445	37.608	36.931	26.046	36.305	36.422
	R(m)	17.00	17.00	17.00	13.07	17.00	17.00
9.00	Fs	38.671	37.810	37.117	31.680	36.468	15.401
	R(m)	16.00	16.00	16.00	12.17	16.00	12.07
8.00	Fs	38.942	38.056	37.348	35.468	36.683	29.160
	R(m)	15.00	15.00	15.00	11.28	15.00	11.17
7.00	Fs	39.267	38.358	37.638	37.139	36.966	37.183
	R(m)	14.00	14.00	14.00	14.00	14.00	14.00
6.00	Fs	39.660	38.731	38.002	37.506	37.339	37.609
	R(m)	13.00	13.00	13.00	13.00	13.00	13.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

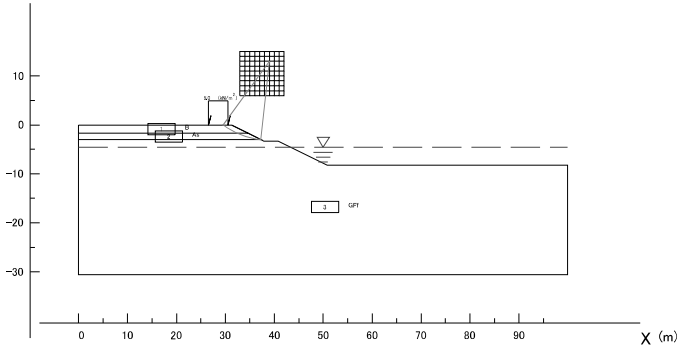
Y(m)	X(m)	39.00	40.00	41.00	42.00
15.00	Fs	36.251	36.791	37.657	38.936
	R(m)	22.00	22.00	22.00	22.00
14.00	Fs	36.320	36.907	37.847	39.238
	R(m)	21.00	21.00	21.00	21.00
13.00	Fs	4.435	37.052	38.077	39.681
	R(m)	16.09	20.00	20.00	20.00
12.00	Fs	19.069	37.232	38.355	40.287
	R(m)	15.20	19.00	19.00	19.00
11.00	Fs	36.682	37.456	38.762	41.023
	R(m)	18.00	18.00	18.00	18.00
10.00	Fs	36.876	37.736	39.365	41.926
	R(m)	17.00	17.00	17.00	17.00
9.00	Fs	37.125	38.162	40.114	43.052
	R(m)	16.00	16.00	16.00	16.00
8.00	Fs	37.444	38.814	41.057	44.481
	R(m)	15.00	15.00	15.00	15.00
7.00	Fs	37.972	39.646	42.267	46.335
	R(m)	14.00	14.00	14.00	14.00
6.00	Fs	38.759	40.730	43.853	48.811
	R(m)	13.00	13.00	13.00	13.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	4.435
Failure circle X(m)	=	39.00
Y(m)	=	13.00
R(m)	=	16.092
Resisting moment(kNm)	=	4183.6
Sliding moment(kNm)	=	943.3
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



WARNING ***1 Points of intersection of an arc and the ground are more than three points. count = 2

WARNING ***6 An arc does not cut the ground, or An arc cuts the side of a model. count =***

Test of Embankment Stability

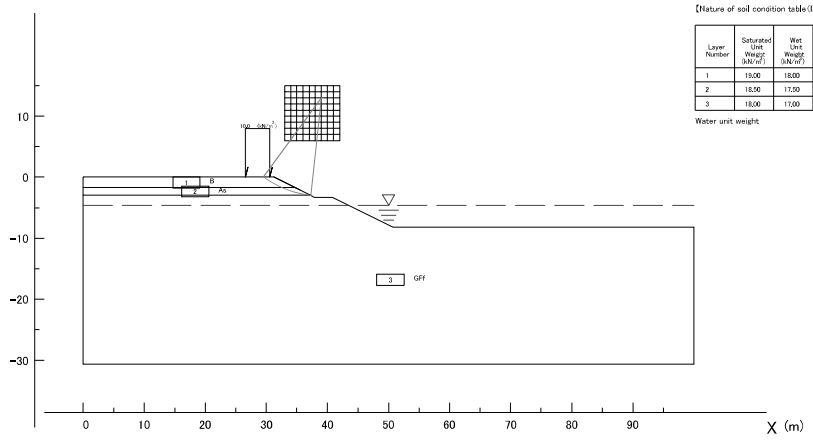
Action number = 1

Action name : normal

Examination at earthquake : It doesn't do.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	6.128	≧ 1.0 (OK)
Center of arc	X	=	39.00	(m)
	Y	=	13.00	(m)
Radius	R	=	16.092	(m)
Resisting moment	M_R	=	4249.2	(kNm)
Sliding moment	M_D	=	693.4	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	19.00	18.00	30.00	1.00	0.00	0.000	0.000
2	18.50	17.50	27.00	0.00	0.00	0.000	0.000
3	18.00	17.00	30.00	1000.00	0.00	0.000	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Ordinary Condition)

Test of Embankment Stability

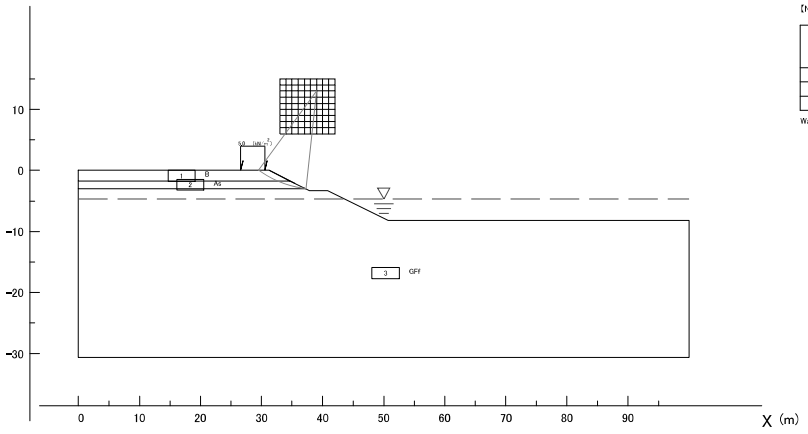
Action number = 2

Action name : seismic

Examination at earthquake : It does.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	4.435	≧ 1.0 (OK)
Center of arc	X	=	39.00	(m)
	Y	=	13.00	(m)
Radius	R	=	16.092	(m)
Resisting moment	M_R	=	4183.6	(kNm)
Sliding moment	M_D	=	943.3	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	19.00	18.00	30.00	1.00	0.00	0.200	0.000
2	18.50	17.50	27.00	0.00	0.00	0.200	0.000
3	18.00	17.00	30.00	1000.00	0.00	0.200	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Seismic Condition)

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.1　Normal and Seismic Conditions

(3)　L6+340

Circular Slip Surface

L+6340

Contents

Page

1. Input Data 1

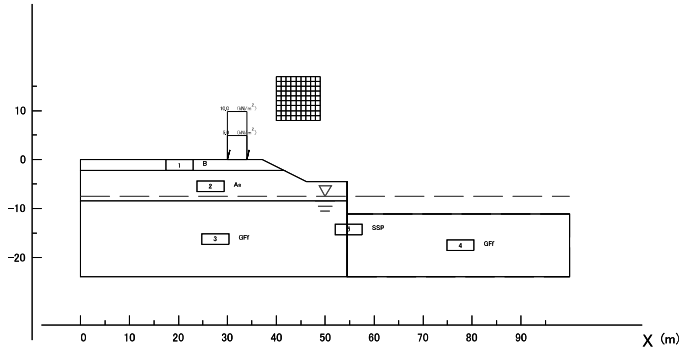
2. Check list 13

3. Action 01 Result list ... 14

4. Action 02 Result list ... 25

1. Input data list

// Design section //



// Design level of reliability design method //

Level of reliability design ..... Level 1(Design for value, part coefficient method)

// Combination of action //

// Setting of action //

Action	Action name	Seismic inertia	Newmark No.	Same hydraul-ic line
1	normal			
2	seismic	○		

// Partial coefficient concerning analytical technique γ_α //

Action No.	Partial coefficient concerning analytical technique γ_α
1	1.00
2	1.00

// Partial coefficient concerning W,C,ϕ $\gamma w, \gamma c, \gamma \tan\phi$ //

No.	Action 1			Action 2											
	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$
1	1.00	1.00	1.00	1.00	1.00	1.00						
2	1.00	1.00	1.00	1.00	1.00	1.00						
3	1.00	1.00	1.00	1.00	1.00	1.00						
4	1.00	1.00	1.00	1.00	1.00	1.00						
5	1.00	1.00	1.00	1.00	1.00	1.00						

$$M = \Sigma [C_d l + \{ (W_d' + q_d) \cos\theta - K_k W_d \sin\theta \} \tan\phi_d]$$

$$W_d' = \gamma_w W_k'$$

$$C_d = \gamma_c C_k$$

$$\tan\phi_d = \gamma_{\tan\phi} \tan\phi_k$$

- M : Resistance moment
- γ_w : Partial coefficient concerning weight
- W_d' : Effective weight of slice of amount for each unit length splinter (value for design) (kN/m)
- W_k' : Effective weight of slice of amount for each unit length splinter (characteristic value)(kN/m)
- q_d : Perpendicular action because of the upper part of amount of slice (kN/m)
- γ_c : Partial coefficient concerning Cohesion
- C_d : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (value for design) (kN/m²)
- C_k : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (characteristic value) (kN/m²)
- l : Length in base of amount of Slice (m)
- $\gamma_{\tan\phi}$: Partial coefficient concerning shearing resistance angle
- ϕ_d : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(value for design)(°)
- ϕ_k : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(characteristic value)(°)

// Partial coefficient of partial coefficient γ_{vl} to distribution load (Think as well as the ground) and inertia force γ_{vlEQ} //

Action No.	Load1		Load2							
	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force
1	1.00	1.00	−	−						
2	−	−	1.00	1.00						

$$M_{r,vl} = K \cdot r \Sigma (FR \cdot \gamma_{vl,i} - K_{hp} \cdot FO \cdot \gamma_{vlEQ,i}) \cdot \tan\phi$$

$$M_{d,vl} = r \Sigma (FO \cdot \gamma_{vl,i} + K_{hp} \cdot FR \cdot \gamma_{vlEQ,i})$$

$$FR = F \cdot \cos\theta$$

$$FO = F \cdot \sin\theta$$

- $M_{r,vl}$: Resistance moment of distribution load (Think as well as the ground)
- $M_{d,vl}$: Sliding moment of distribution load (Think as well as the ground)
- K : Resistance power coefficient
- r : Radius of slipping circular arc
- F : Distribution load i
- FR : Slipping line orthogonalization direction load value of load i
- FO : Slipping line direction load value of load i
- θ : Angle that slice bottom (slide surface) does to the horizontal
- $\gamma_{vl,i}$: Partial coefficient of distribution load i (Think as well as the ground).
- K_{hp} : The horizontal seismic intensity
- $\gamma_{vlEQ,i}$: Partial coefficient of inertia force of distribution load i (Think as well as the ground).
- ϕ : Internal friction angle of soil

// Partial coefficient to residual water level //

Action number	rRWL
1	1.00
2	1.00

$$RWL_d = \gamma_{RWL} RWL_k$$

- γ_{RWL} : Partial coefficient concerning residual water level
- RWL_d : Difference between residual water level and water level line (value for design) (m)
- RWL_k : Difference between residual water level and water level line (input value) (m)

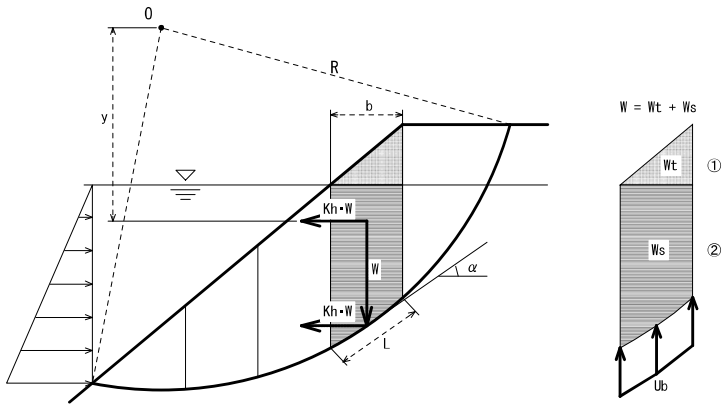
(DATA 01.)　// ANALYSIS //

Title　.....　Test of Embankment Stability
Analysis type　.....　Analysis of Bearing force Action ratio
Calculation method .....　Revised Feleniu s (Total stress)

Expression

$$\frac{R\Sigma[C_d l+\{((1+K_v)W_d-u\,b)\cos\theta-K_h W_d\sin\theta\}\tan\phi_d]}{\gamma_a R\Sigma\{(1+K_v)W_d\sin\theta+K_h W_d\cos\theta\}} \geqq 1.0$$

R　: Radius of slipping circle of circular arc (m)
C_d　: Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (kN/m²)
l　: Length in base of amount of crack splinter (m)
q_d　: Perpendicular action because of the upper part of amount of crack splinter (kN/m)
θ　: Angle that amount of crack splinter bottom does to a horizontal plane (degree)
ϕ_d　: 0 in case of viscous land board. Shearing resistance in drain condition in case of the sandy soil ground etc.(°)
W_d　: Full weight of crack of amount for each unit length splinter (full weight of soil and water) (kN/m)
γ_a　: Partial coefficient concerning analytical technique
K_h　: The horizontal seismic intensity
K_v　: Vertical seismic coefficient
u　: Pore pressure (kN/m²)
b　: Width of slice (m)



Treatment of its own weight W of the resistance force
　Above the water level.....Calculate the weight Wt in Wet weight γt　①
　Below the water level.....Calculate weight Ws in Saturated weight γsat　②
Treatment of its own weight W of impetus
　Above the water level.....Calculate the weight Wt in Wet weight γt
　Below the water level.....Calculate weight in Saturated weight γsat
Water pressure acting on the slip plane.....Consider in the Ubcosα
　(Modify Fereniusu method)
Lateral hydrostatic pressure due to water storage.....Including

(DATA 02.)　// CONTROL //

Second pursuit　.....　0 (=0 No)
　(>0 Yes　)
Run　.....　0 (=0 Input data check + Analysis)
　(=1 Input data check　)

(DATA 04.) // SEISMIC LOAD //

```
Seismic load                    .....  0 ( =0 Same for the whole model )
                                       ( =1 Different on each layer  )
Condition                       .....  1 ( =0 Acts on only sliding force )
                                       ( =1 Sliding + Resisting force  )
Acting point                    .....  0 ( =0 On the slip surface              )
                                       ( =1 Center of gravity of sliding mass )
                                       ( =2 Resisting:on the slip surface
                                            Sliding  :Center of gravity of sliding mass )
Unit weight                     .....  0 ( =0 Saturated weight )
                                       ( =1 Submerged weight )
Horizontal seismic coefficient.....  0.200
Vertical seismic coefficient  .....  0.000
```


(DATA 06.) // NODAL POINT //

No.	Coordinate		Y-coordinate
	x (m)	y (m)	before settlement (m)
1	0.00	0.00	0.00
2	30.01	0.00	0.00
3	34.01	0.00	0.00
4	37.13	0.00	0.00
5	41.58	-2.22	0.00
6	0.00	-2.22	0.00
7	0.00	-7.51	0.00
8	0.00	-8.47	0.00
9	54.38	-8.47	0.00
10	54.38	-4.50	0.00
11	46.13	-4.50	0.00
12	54.53	-4.50	0.00
13	54.53	-11.09	0.00
14	54.53	-23.98	0.00
15	54.38	-23.98	0.00
16	100.00	-11.09	0.00
17	100.00	-23.98	0.00
18	0.00	-23.98	0.00

(DATA 07.) // WATER LEVEL //

Unit weight of water (kN/m³) = 10.00

Action No.	Water level line number
1	1
2	1

Water level line number: 1

No.	Coordinate	
	X (m)	Y (m)
1	0.00	-7.51
2	100.00	-7.51

Water level line number: 2

No.	Coordinate	
	X (m)	Y (m)
1	0.00	0.00
2	150.00	0.00

(DATA 08.) // LAYER //

No.	material property No.	The name of the strata
1	5	B
2	6	As
3	8	GFf
4	8	GFf
5	2	SSP

No.	Num of Node	Node numbers composing a layer	Slip existence
1	6	1 6 5 4 3 2	Slip
2	7	5 6 7 8 9 10 11	Slip
3	4	8 18 15 9	Slip
4	4	13 14 17 16	Not Slip
5	6	9 15 14 13 12 10	Slip

(DATA 09.1) // MATERIAL PROPERTIES //

No.	Nature of soil division	Saturated weight (kN/m³)	Wet weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
2	SSP	77.00	77.00	******	0.00	0.00	0.00	0.000	0.0
5	B	19.00	18.00	1.00	0.00	30.00	0.00	0.000	0.0
6	As	18.50	17.50	0.00	0.00	32.00	0.00	0.000	0.0
8	GFf	18.00	17.00	******	0.00	30.00	0.00	0.000	0.0

(DATA 09.2) // Characteristic of soil //

No.	Action Number									
	Act 1	Act 2								
1	5	5								
2	6	6								
3	8	8								
4	8	8								
5	2	2								

(DATA 11.) // GRID POINT //

No.	Slip direction	Double cutting	GX (m)	GY (m)	X-point	Y-point	X-pitch (m)	Y-pitch (m)	Dx/Dy	NEXCO Radius
1	Downstream	Rigt lump	40.00	17.00	10	10	1.00	1.00	0.000	0.000

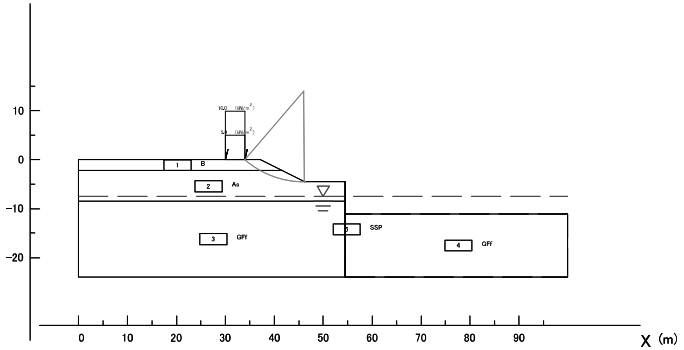
2. Check list

// Check of circular arc //

Action No.	Action name	Bearing force Action ratio	Judgment
1	normal	1.642	OK
2	seismic	1.001	OK

Action No.	Bearing force Action ratio	Partial coefficient r_a	Center of slipping circular arc X (m)	Center of slipping circular arc Y (m)	Radius of circular arc(m)	Resistance Moment (kNm)	Sliding Moment (kNm)
1	1.642	1.00	46.00	14.00	18.487	3322.1	2023.4
2	1.001	1.00	46.00	14.00	18.487	3077.0	3074.9

// Check Result chart //



3. Action01 (normal)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle ϕ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	5	19.00	18.00	9.00	1.00	0.00	30.00	0.00	0.00	0.0
2	6	18.50	17.50	8.50	0.00	0.00	32.00	0.00	0.00	0.0
3	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0	4	8 18.0	0 17.0	0 8.0	01000.	00 0.	0030.	00 0.	00 0.	00 0
0.0	5	2 77.	00 77.	00 67.	001000	0.00	0.00	0.00	0.00	0.00
0.0										

// Distribution load that considers partial coefficient //

load No.	Left X (m)	Left Y (m)	Left Load Value(kN)	Right X (m)	Right Y (m)	Right Load Value(kN)	Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
1	30.01	0.00	10.0	34.01	0.00	10.0	0.000	0.000	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate X (m)	Coordinate Y (m)	Residual water level
1	0.00	-7.51	
2	100.00	-7.51	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
40.00	17.00	18.24	3.050	763.2	250.2
		19.24	2.522	2573.0	1020.1
40.00	16.00	17.26	3.048	707.8	232.3
		18.26	2.476	2391.9	966.0
40.00	15.00	16.27	3.052	654.6	214.5
		17.27	2.431	2217.0	912.0
40.00	14.00	15.29	3.066	603.4	196.8
		16.29	2.387	2048.5	858.4
40.00	13.00	15.31	2.345	1887.6	805.0
		16.31	2.397	4095.2	1708.3
40.00	12.00	14.34	2.305	1733.9	752.1
		15.34	2.354	3771.9	1602.3
40.00	11.00	13.37	2.268	1586.8	699.8
		14.37	2.311	3460.8	1497.3
40.00	10.00	12.40	2.232	1446.7	648.1
		13.40	2.270	3162.8	1393.3
40.00	9.00	11.45	2.200	1314.4	597.3
		12.45	2.231	2879.2	1290.7
		13.45	2.321	5097.2	2195.9
40.00	8.00	-11.50	999.000	0.0	0.0
		-10.50	999.000	0.0	0.0
		10.50	2.173	1190.5	547.8
		11.50	2.194	2611.4	1190.1
		12.50	2.287	4640.8	2029.6
41.00	17.00	18.43	2.909	747.3	256.9
		19.43	2.300	2538.1	1103.6
41.00	16.00	17.46	2.911	699.9	240.4
		18.46	2.261	2378.8	1052.1
41.00	15.00	17.49	2.223	2225.2	1001.1
		18.49	2.275	4799.7	2110.0
41.00	14.00	16.53	2.185	2077.7	950.8
		17.53	2.234	4484.4	2006.9
41.00	13.00	15.56	2.149	1936.7	901.3
		16.56	2.195	4181.0	1905.1
41.00	12.00	14.61	2.113	1802.5	852.9
		15.61	2.156	3890.2	1804.6
41.00	11.00	13.66	2.080	1675.8	805.7
		14.66	2.118	3613.1	1706.0
41.00	10.00	12.72	2.049	1557.4	760.1
		13.72	2.082	3351.1	1609.6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
41.00	10.00	14.72	2.171	5864.6	2701.2
41.00	9.00	11.80	2.021	1448.3	716.7
		12.80	2.049	3105.8	1516.1
		13.80	2.139	5438.7	2542.6
41.00	8.00	-11.11	999.000	0.0	0.0
		10.89	1.997	1349.9	676.0
		11.89	2.019	2879.8	1426.5
		12.89	2.110	5042.6	2389.5
42.00	17.00	19.68	2.129	2588.0	1215.8
		20.68	2.180	5551.6	2546.4
42.00	16.00	18.72	2.093	2447.1	1168.9
		19.72	2.143	5245.1	2447.6
42.00	15.00	17.77	2.059	2312.6	1123.2
		18.77	2.106	4950.2	2350.2
42.00	14.00	16.82	2.025	2185.0	1078.8
		17.82	2.070	4667.6	2254.7
42.00	13.00	15.88	1.993	2064.8	1036.1
		16.88	2.035	4398.2	2161.3
42.00	12.00	14.95	1.962	1952.9	995.5
		15.95	2.001	4143.3	2070.5
		16.95	2.087	7168.8	3435.5
42.00	11.00	14.03	1.932	1850.1	957.4
		15.03	1.969	3904.4	1983.1
		16.03	2.055	6747.6	3282.7
42.00	10.00	13.12	1.905	1757.8	922.6
		14.12	1.939	3683.5	1899.8
		15.12	2.027	6354.2	3135.2
42.00	9.00	12.23	1.882	1669.3	887.2
		13.23	1.912	3471.2	1815.8
		14.23	2.001	5977.1	2986.7
42.00	8.00	11.33	1.863	1566.5	840.7
		12.33	1.887	3241.4	1717.6
		13.33	1.978	5580.5	2820.9
		14.33	2.164	8794.2	4063.9
43.00	17.00	19.98	1.989	2712.5	1363.9
		20.98	2.037	5763.8	2829.9
43.00	16.00	19.04	1.957	2592.0	1324.3
		20.04	2.003	5490.2	2740.4
43.00	15.00	18.11	1.926	2479.0	1286.8
		19.11	1.971	5229.7	2653.4

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
43.00	14.00	17.18	1.897	2374.4	1251.9
		18.18	1.939	4983.2	2569.5
43.00	13.00	16.26	1.868	2278.9	1220.0
		17.26	1.909	4752.3	2489.4
		18.26	2.024	8206.7	4054.7
43.00	12.00	15.36	1.841	2193.9	1191.7
		16.36	1.880	4538.6	2413.7
		17.36	2.004	7830.6	3907.9
43.00	11.00	14.46	1.816	2112.2	1163.1
		15.46	1.853	4332.1	2337.3
		16.46	1.986	7467.1	3759.3
43.00	10.00	13.57	1.794	2015.1	1123.1
		14.57	1.828	4106.1	2246.1
		15.57	1.970	7077.8	3593.5
43.00	9.00	13.67	1.805	3860.7	2139.1
		14.67	1.954	6662.5	3409.8
		15.67	2.201	10506.9	4773.2
43.00	8.00	12.78	1.784	3597.3	2015.9
		13.78	1.940	6222.8	3208.2
		14.78	2.186	9817.7	4491.2
44.00	17.00	20.34	1.874	2916.7	1556.4
		21.34	1.920	6104.1	3179.9
44.00	16.00	19.41	1.846	2820.0	1527.7
		20.41	1.890	5867.3	3103.8
44.00	15.00	18.50	1.819	2732.7	1502.6
		19.50	1.862	5645.6	3031.9
		20.50	2.056	9925.6	4826.9
44.00	14.00	17.59	1.793	2655.9	1481.6
		18.59	1.835	5440.8	2964.9
		19.59	2.044	9567.7	4680.6
44.00	13.00	16.70	1.768	2582.2	1460.5
		17.70	1.811	5244.9	2896.7
		18.70	2.034	9219.3	4532.0
44.00	12.00	15.80	1.745	2492.1	1427.7
		16.80	1.791	5035.6	2811.2
		17.80	2.025	8839.3	4366.1
44.00	11.00	14.91	1.726	2385.4	1382.3
		15.91	1.776	4808.3	2707.8
		16.91	2.015	8427.3	4182.3
44.00	10.00	15.02	1.764	4561.6	2586.5

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
44.00	10.00	16.02	2.006	7984.8	3980.6
		17.02	2.291	12520.4	5464.6
44.00	9.00	14.12	1.755	4294.9	2447.3
		15.12	1.998	7513.8	3761.0
		16.12	2.280	11774.2	5164.5
44.00	8.00	13.23	1.750	4008.6	2290.2
		14.23	1.991	7016.5	3523.5
		15.23	2.270	10999.7	4846.6
45.00	17.00	20.73	1.779	3209.7	1803.9
		21.73	1.841	6629.3	3601.4
45.00	16.00	19.83	1.755	3142.0	1790.7
		20.83	1.830	6471.0	3536.6
		21.83	2.129	11612.3	5453.3
45.00	15.00	18.94	1.731	3077.0	1777.6
		19.94	1.823	6323.1	3468.4
		20.94	2.126	11280.3	5304.7
45.00	14.00	18.04	1.709	2995.1	1752.7
		19.04	1.819	6151.9	3382.9
		20.04	2.123	10911.2	5138.7
45.00	13.00	17.15	1.689	2895.7	1714.8
		18.15	1.816	5954.9	3279.4
		19.15	2.120	10504.5	4954.8
45.00	12.00	17.25	1.815	5731.2	3158.0
		18.25	2.117	10061.6	4753.0
45.00	11.00	16.36	1.816	5481.0	3018.7
		17.36	2.114	9584.1	4533.3
		18.36	2.952	18073.1	6123.0
45.00	10.00	15.46	1.819	5204.8	2861.5
		16.46	2.112	9074.1	4295.7
		17.46	2.957	17170.4	5806.9
45.00	9.00	14.57	1.825	4903.7	2686.4
		15.57	2.112	8534.0	4040.2
		16.57	2.965	16233.4	5475.6
45.00	8.00	13.67	1.837	4579.3	2493.4
		14.67	2.115	7966.6	3766.8
		15.67	2.672	13702.9	5129.0
		16.67	15.940	105852.9	6640.8
46.00	17.00	21.17	1.701	3595.1	2113.2
		22.17	1.895	7655.5	4040.2
		23.17	2.870	17426.1	6072.2

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
46.00	16.00	20.28	1.680	3522.1	2096.6
		21.28	1.902	7520.8	3954.5
		22.28	2.870	16946.0	5904.2
46.00	15.00	19.38	1.660	3431.0	2066.8
		20.38	1.910	7353.8	3851.0
		21.38	2.872	16424.5	5718.8
46.00	14.00	18.49	1.642	3322.1	2023.4
		19.49	1.918	7154.0	3729.5
		20.49	2.876	15863.8	5516.0
46.00	13.00	18.59	1.928	6921.7	3590.1
		19.59	2.883	15265.8	5295.5
		20.59	2.955	21461.9	7262.1
46.00	12.00	17.70	1.939	6657.4	3432.8
		18.70	2.893	14632.9	5057.5
		19.70	2.953	20478.4	6934.1
46.00	11.00	16.80	1.953	6362.4	3257.7
		17.80	2.909	13968.0	4802.0
		18.80	2.954	19453.5	6584.7
46.00	10.00	15.91	1.970	6037.9	3064.6
		16.91	2.931	13274.0	4529.5
		17.91	2.961	18397.0	6213.9
46.00	9.00	15.01	1.993	5685.8	2853.6
		16.01	2.961	12554.9	4240.4
		17.01	2.974	17316.3	5822.1
		18.01	23.022	180976.8	7860.9
46.00	8.00	15.12	2.871	11300.8	3935.6
		16.12	2.998	16218.6	5409.8
		17.12	24.784	181638.0	7328.9
47.00	17.00	21.62	1.664	4051.4	2435.1
		22.62	2.046	9050.3	4422.5
		23.62	2.917	19227.3	6590.6
47.00	16.00	20.72	1.681	4023.1	2393.9
		21.72	2.064	8875.3	4301.0
		22.72	2.917	18656.0	6396.5
47.00	15.00	20.83	2.082	8662.2	4161.5
		21.83	2.919	18045.2	6182.5
47.00	14.00	19.93	2.317	9277.0	4004.0
		20.93	2.925	17396.8	5948.3
		21.93	2.826	23718.2	8392.2
47.00	13.00	19.04	2.749	10521.8	3827.6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
47.00	13.00	20.04	2.935	16712.9	5693.6
		21.04	2.814	22642.6	8047.0
47.00	12.00	18.14	2.969	10786.2	3633.1
		19.14	2.952	15995.8	5418.1
		20.14	2.805	21537.5	7677.3
47.00	11.00	17.25	3.015	10314.0	3421.1
		18.25	2.977	15248.0	5121.6
		19.25	2.802	20408.3	7283.0
47.00	10.00	17.35	3.013	14472.3	4804.1
		18.35	2.806	19259.9	6863.9
		19.35	26.612	250333.9	9407.0
47.00	9.00	16.46	3.062	13672.0	4465.5
		17.46	2.819	18097.2	6419.7
		18.46	27.783	245721.6	8844.3
47.00	8.00	15.57	3.128	12844.7	4106.7
		16.57	12.652	75298.1	5951.6
		17.57	28.981	239210.0	8253.9
		18.57	29.874	330440.3	11061.1
48.00	17.00	22.06	1.846	4993.4	2705.4
		23.06	2.975	14187.2	4769.6
		24.06	2.859	20868.8	7299.0
48.00	16.00	22.17	2.988	13806.8	4620.8
		23.17	2.855	20210.6	7078.3
48.00	15.00	21.27	3.007	13389.0	4453.4
		22.27	2.855	19514.9	6835.6
		23.27	2.640	25731.2	9747.2
48.00	14.00	20.38	3.032	12935.7	4267.0
		21.38	2.859	18783.9	6570.6
		22.38	2.618	24586.6	9389.8
48.00	13.00	19.49	3.065	12448.6	4061.1
		20.49	2.868	18019.5	6282.6
		21.49	6.322	56937.7	9006.0
48.00	12.00	18.59	3.111	11930.2	3835.4
		19.59	2.881	17203.6	5971.4
		20.59	13.184	113322.2	8595.7
		21.59	26.957	316885.2	11755.4
48.00	11.00	18.70	2.898	16332.7	5636.5
		19.70	16.909	137943.4	8158.2
		20.70	27.418	307137.6	11202.2
48.00	10.00	17.80	2.923	15429.7	5278.8

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
48.00	10.00	18.80	19.768	152106.1	7694.7
		19.80	27.925	296551.0	10619.5
48.00	9.00	16.91	2.961	14502.9	4897.3
		17.91	22.210	159995.3	7203.9
		18.91	28.505	285218.8	10006.0
		19.91	26.512	353632.8	13338.7
48.00	8.00	17.01	24.450	163443.3	6684.8
		18.01	29.189	273220.0	9360.4
		19.01	26.876	337358.9	12552.3
49.00	17.00	23.51	2.962	15588.8	5262.2
		24.51	2.740	22346.2	8154.6
49.00	16.00	22.62	2.972	15127.8	5090.7
		23.62	2.728	21563.3	7905.6
		24.62	14.079	158838.1	11281.6
49.00	15.00	21.72	2.987	14631.4	4898.7
		22.72	2.714	20717.8	7632.6
		23.72	17.363	189513.3	10914.8
49.00	14.00	20.83	3.009	14101.7	4685.8
		21.83	2.703	19828.0	7335.4
		22.83	19.842	208750.0	10520.6
49.00	13.00	19.93	3.042	13540.6	4451.4
		20.93	2.695	18903.3	7013.4
		21.93	21.869	220835.8	10098.1
		22.93	24.817	341321.2	13753.5
49.00	12.00	20.04	2.693	17952.8	6667.3
		21.04	23.619	227890.8	9648.5
		22.04	25.072	330584.2	13185.6
49.00	11.00	19.14	2.697	16981.0	6296.3
		20.14	25.192	231024.0	9170.6
		21.14	25.356	319138.8	12586.1
49.00	10.00	18.25	2.711	15992.0	5898.9
		19.25	26.573	230196.5	8662.8
		20.25	25.687	307044.5	11953.2
		21.25	23.874	377240.6	15801.1
49.00	9.00	18.36	27.507	223488.3	8124.7
		19.36	26.083	294379.7	11286.4
		20.36	24.051	360566.1	14991.4
49.00	8.00	17.46	28.546	215686.2	7555.7
		18.46	26.567	281217.5	10585.1
		19.46	24.294	343615.6	14144.0

Table of B.A

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	40.00	41.00	42.00	43.00	44.00	45.00
17.00	Fs	2.522	2.300	2.129	1.989	1.874	1.779
	R(m)	19.24	19.43	19.68	19.98	20.34	20.73
16.00	Fs	2.476	2.261	2.093	1.957	1.846	1.755
	R(m)	18.26	18.46	18.72	19.04	19.41	19.83
15.00	Fs	2.431	2.223	2.059	1.926	1.819	1.731
	R(m)	17.27	17.49	17.77	18.11	18.50	18.94
14.00	Fs	2.387	2.185	2.025	1.897	1.793	1.709
	R(m)	16.29	16.53	16.82	17.18	17.59	18.04
13.00	Fs	2.345	2.149	1.993	1.868	1.768	1.689
	R(m)	15.31	15.56	15.88	16.26	16.70	17.15
12.00	Fs	2.305	2.113	1.962	1.841	1.745	1.815
	R(m)	14.34	14.61	14.95	15.36	15.80	17.25
11.00	Fs	2.268	2.080	1.932	1.816	1.726	1.816
	R(m)	13.37	13.66	14.03	14.46	14.91	16.36
10.00	Fs	2.232	2.049	1.905	1.794	1.764	1.819
	R(m)	12.40	12.72	13.12	13.57	15.02	15.46
9.00	Fs	2.200	2.021	1.882	1.805	1.755	1.825
	R(m)	11.45	11.80	12.23	13.67	14.12	14.57
8.00	Fs	2.173	1.997	1.863	1.784	1.750	1.837
	R(m)	10.50	10.89	11.33	12.78	13.23	13.67

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

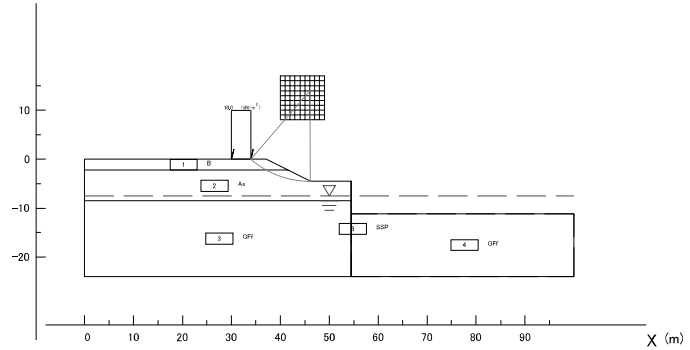
Y(m)	X(m)	46.00	47.00	48.00	49.00
17.00	Fs	1.701	1.664	1.846	2.740
	R(m)	21.17	21.62	22.06	24.51
16.00	Fs	1.680	1.681	2.855	2.728
	R(m)	20.28	20.72	23.17	23.62
15.00	Fs	1.660	2.082	2.640	2.714
	R(m)	19.38	20.83	23.27	22.72
14.00	Fs	1.642	2.317	2.618	2.703
	R(m)	18.49	19.93	22.38	21.83
13.00	Fs	1.928	2.749	2.868	2.695
	R(m)	18.59	19.04	20.49	20.93
12.00	Fs	1.939	2.805	2.881	2.693
	R(m)	17.70	20.14	19.59	20.04
11.00	Fs	1.953	2.802	2.898	2.697
	R(m)	16.80	19.25	18.70	19.14
10.00	Fs	1.970	2.806	2.923	2.711
	R(m)	15.91	18.35	17.80	18.25
9.00	Fs	1.993	2.819	2.961	24.051
	R(m)	15.01	17.46	16.91	20.36
8.00	Fs	2.871	3.128	24.450	24.294
	R(m)	15.12	15.57	17.01	19.46

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	1.642
Failure circle X(m)	=	46.00
Y(m)	=	14.00
R(m)	=	18.487
Resisting moment(kNm)	=	3322.1
Sliding moment(kNm)	=	2023.4
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



4. Action02 (seismic)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	5	19.00	18.00	9.00	1.00	0.00	30.00	0.00	0.00	0.0
2	6	18.50	17.50	8.50	0.00	0.00	32.00	0.00	0.00	0.0
3	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0	4	8 18.0	0 17.0	0 8.0	01000.	00 0.	0030.	00 0.	00 0.	00 0
0.0	5	2 77.	00 77.	00 67.	001000	0.00	0.00	0.00	0.00	0.00
0.0										

// Distribution load that considers partial coefficient //

Load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
2	30.01	0.00	5.0	34.01	0.00	5.0	0.000	0.200	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	-7.51	
2	100.00	-7.51	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
40.00	17.00	18.24	1.624	738.8	454.8
		19.24	1.435	2481.3	1729.4
40.00	16.00	17.26	1.608	684.4	425.5
		18.26	1.415	2304.1	1627.9
40.00	15.00	16.27	1.592	632.0	396.9
		17.27	1.396	2133.2	1528.4
40.00	14.00	15.29	1.576	581.8	369.1
		16.29	1.376	1968.5	1431.0
40.00	13.00	15.31	1.356	1811.4	1335.8
		16.31	1.372	3926.1	2861.7
40.00	12.00	14.34	1.337	1661.5	1243.0
		15.34	1.354	3611.9	2666.9
40.00	11.00	13.37	1.317	1518.1	1152.8
		14.37	1.336	3309.9	2476.8
40.00	10.00	12.40	1.297	1381.8	1065.6
		13.40	1.318	3020.9	2292.0
40.00	9.00	11.45	1.276	1252.9	981.6
		12.45	1.300	2746.0	2113.1
		13.45	1.329	4867.1	3661.9
40.00	8.00	-11.50	999.000	0.0	0.0
		-10.50	999.000	0.0	0.0
		10.50	1.256	1132.5	901.5
		11.50	1.281	2486.9	1941.0
		12.50	1.314	4426.3	3368.6
41.00	17.00	18.43	1.526	718.8	470.9
		19.43	1.339	2432.7	1816.3
41.00	16.00	17.46	1.509	672.1	445.4
		18.46	1.321	2277.0	1723.1
41.00	15.00	17.49	1.303	2127.0	1632.3
		18.49	1.321	4585.4	3471.1
41.00	14.00	16.53	1.284	1983.0	1544.1
		17.53	1.304	4279.0	3281.7
41.00	13.00	15.56	1.265	1845.3	1458.8
		16.56	1.286	3984.3	3097.2
41.00	12.00	14.61	1.245	1714.4	1376.7
		15.61	1.269	3702.1	2918.0
41.00	11.00	13.66	1.225	1590.8	1298.1
		14.66	1.251	3433.3	2744.9
41.00	10.00	12.72	1.206	1475.3	1223.8
		13.72	1.233	3179.4	2578.8

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
41.00	10.00	14.72	1.266	5574.3	4402.3
41.00	9.00	11.80	1.186	1368.9	1154.4
		12.80	1.215	2941.9	2420.7
		13.80	1.251	5163.1	4126.0
41.00	8.00	-11.11	999.000	0.0	0.0
		10.89	1.167	1272.9	1091.1
		11.89	1.198	2723.3	2272.5
		12.89	1.237	4781.2	3864.5
42.00	17.00	19.68	1.261	2465.4	1955.7
		20.68	1.280	5287.9	4130.2
42.00	16.00	18.72	1.243	2327.5	1873.0
		19.72	1.264	4989.8	3947.7
42.00	15.00	17.77	1.224	2196.0	1793.5
		18.77	1.247	4703.1	3770.3
42.00	14.00	16.82	1.206	2071.1	1717.5
		17.82	1.231	4428.4	3598.5
42.00	13.00	15.88	1.187	1953.5	1645.6
		16.88	1.214	4166.8	3433.1
42.00	12.00	14.95	1.168	1843.9	1578.2
		15.95	1.197	3919.3	3274.8
		16.95	1.230	6794.8	5524.3
42.00	11.00	14.03	1.150	1743.2	1516.3
		15.03	1.180	3687.5	3124.7
		16.03	1.215	6387.7	5255.3
42.00	10.00	13.12	1.131	1652.5	1460.8
		14.12	1.164	3473.2	2984.3
		15.12	1.202	6007.8	5000.1
42.00	9.00	12.23	1.113	1565.7	1406.1
		13.23	1.148	3267.5	2846.2
		14.23	1.188	5644.2	4749.2
42.00	8.00	11.33	1.096	1465.8	1336.9
		12.33	1.133	3045.8	2689.2
		13.33	1.176	5263.1	4475.8
		14.33	1.249	8338.8	6677.1
43.00	17.00	19.98	1.192	2568.3	2154.7
		20.98	1.216	5462.0	4492.1
43.00	16.00	19.04	1.175	2449.9	2085.8
		20.04	1.200	5195.7	4329.1
43.00	15.00	18.11	1.157	2338.9	2021.3
		19.11	1.184	4942.0	4172.8

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
43.00	14.00	17.18	1.140	2235.9	1962.0
		18.18	1.169	4702.2	4024.0
43.00	13.00	16.26	1.122	2141.7	1908.5
		17.26	1.153	4477.4	3883.7
		18.26	1.200	7758.4	6464.4
43.00	12.00	15.36	1.105	2057.6	1862.0
		16.36	1.138	4269.4	3753.2
		17.36	1.190	7395.7	6215.4
43.00	11.00	14.46	1.088	1976.7	1816.4
		15.46	1.123	4068.5	3624.5
		16.46	1.180	7045.7	5968.8
43.00	10.00	13.57	1.072	1881.6	1755.4
		14.57	1.108	3849.9	3475.7
		15.57	1.171	6672.0	5697.7
43.00	9.00	13.67	1.093	3613.5	3306.0
		14.67	1.162	6274.2	5401.4
		15.67	1.259	9967.2	7918.4
43.00	8.00	12.78	1.079	3360.9	3115.3
		13.78	1.152	5854.0	5080.4
		14.78	1.251	9306.4	7441.6
44.00	17.00	20.34	1.133	2745.4	2423.4
		21.34	1.160	5756.0	4960.5
44.00	16.00	19.41	1.117	2649.6	2372.9
		20.41	1.146	5524.7	4822.6
44.00	15.00	18.50	1.100	2562.7	2328.8
		19.50	1.131	5308.2	4693.5
		20.50	1.210	9388.9	7756.8
44.00	14.00	17.59	1.085	2485.9	2292.2
		18.59	1.117	5108.0	4574.5
		19.59	1.204	9044.4	7514.2
44.00	13.00	16.70	1.069	2412.0	2256.6
		17.70	1.103	4916.8	4457.4
		18.70	1.198	8709.5	7272.4
44.00	12.00	15.80	1.053	2323.1	2205.2
		16.80	1.091	4714.0	4319.6
		17.80	1.191	8345.0	7004.2
44.00	11.00	14.91	1.038	2218.9	2136.8
		15.91	1.081	4495.4	4159.3
		16.91	1.185	7950.5	6708.8
44.00	10.00	15.02	1.071	4259.2	3975.8

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
44.00	10.00	16.02	1.179	7527.6	6386.8
		17.02	1.288	11898.3	9238.8
44.00	9.00	14.12	1.063	4005.0	3769.0
		15.12	1.172	7078.0	6038.8
		16.12	1.281	11182.5	8726.8
44.00	8.00	13.23	1.055	3733.3	3539.1
		14.23	1.166	6604.2	5665.4
		15.23	1.275	10440.4	8188.9
45.00	17.00	20.73	1.083	3004.6	2775.3
		21.73	1.120	6226.1	5559.1
45.00	16.00	19.83	1.068	2935.8	2749.3
		20.83	1.113	6072.1	5457.2
		21.83	1.234	11000.5	8911.4
45.00	15.00	18.94	1.053	2869.8	2724.6
		19.94	1.107	5928.8	5355.5
		20.94	1.231	10682.1	8674.8
45.00	14.00	18.04	1.039	2788.0	2683.6
		19.04	1.102	5764.3	5229.9
		20.04	1.228	10328.5	8410.0
45.00	13.00	17.15	1.025	2690.1	2625.1
		18.15	1.098	5575.8	5079.1
		19.15	1.225	9939.4	8116.2
45.00	12.00	17.25	1.094	5362.7	4902.9
		18.25	1.221	9515.9	7794.0
45.00	11.00	16.36	1.090	5125.1	4701.3
		17.36	1.217	9059.9	7443.8
		18.36	1.632	17369.4	10640.5
45.00	10.00	15.46	1.087	4863.4	4474.5
		16.46	1.213	8573.4	7066.3
		17.46	1.635	16499.6	10091.9
45.00	9.00	14.57	1.084	4578.9	4222.9
		15.57	1.210	8058.8	6662.3
		16.57	1.639	15597.5	9518.6
45.00	8.00	13.67	1.083	4273.0	3946.9
		14.67	1.206	7518.9	6232.6
		15.67	1.469	13103.7	8922.3
		16.67	8.677	105069.2	12109.5
46.00	17.00	21.17	1.040	3348.5	3218.5
		22.17	1.136	7195.1	6334.9
		23.17	1.643	16739.2	10188.4

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
46.00	16.00	20.28	1.027	3274.6	3188.7
		21.28	1.136	7067.1	6220.9
		22.28	1.640	16274.4	9926.3
46.00	15.00	19.38	1.014	3183.9	3141.0
		20.38	1.136	6908.6	6079.7
		21.38	1.637	15770.3	9633.8
46.00	14.00	18.49	1.001	3077.0	3074.9
		19.49	1.137	6719.4	5911.1
		20.49	1.636	15228.9	9311.2
46.00	13.00	18.59	1.137	6499.6	5715.1
		19.59	1.636	14652.4	8958.9
		20.59	1.608	20614.3	12822.1
46.00	12.00	17.70	1.138	6250.0	5492.1
		18.70	1.637	14043.0	8577.7
		19.70	1.604	19664.4	12260.4
46.00	11.00	16.80	1.139	5971.5	5242.3
		17.80	1.641	13403.7	8168.2
		18.80	1.601	18675.6	11667.0
46.00	10.00	15.91	1.141	5665.5	4966.2
		16.91	1.647	12737.4	7731.5
		17.91	1.599	17657.6	11042.7
46.00	9.00	15.01	1.144	5334.0	4664.3
		16.01	1.657	12047.9	7269.0
		17.01	1.600	16618.1	10388.4
		18.01	12.640	180034.2	14243.7
46.00	8.00	15.12	1.596	10825.5	6782.5
		16.12	1.604	15564.1	9705.4
		17.12	13.549	180753.2	13341.1
47.00	17.00	21.62	1.016	3760.9	3700.3
		22.62	1.190	8539.0	7175.6
		23.62	1.629	18464.2	11336.2
47.00	16.00	20.72	1.020	3734.2	3662.3
		21.72	1.194	8374.6	7014.8
		22.72	1.625	17910.9	11021.4
47.00	15.00	20.83	1.198	8174.1	6824.9
		21.83	1.623	17320.2	10674.4
47.00	14.00	19.93	1.333	8803.5	6606.1
		20.93	1.622	16694.4	10295.3
		21.93	1.539	22725.7	14769.2
47.00	13.00	19.04	1.583	10064.8	6358.2

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
47.00	13.00	20.04	1.622	16035.5	9884.4
		21.04	1.529	21685.1	14178.1
47.00	12.00	18.14	1.701	10347.7	6081.9
		19.14	1.625	15345.7	9442.2
		20.14	1.521	20618.1	13552.1
47.00	11.00	17.25	1.713	9896.0	5778.2
		18.25	1.631	14627.8	8969.0
		19.25	1.515	19529.7	12891.8
47.00	10.00	17.35	1.640	13884.4	8465.7
		18.35	1.511	18425.1	12197.6
		19.35	14.932	249197.2	16688.5
47.00	9.00	16.46	1.654	13118.9	7933.0
		17.46	1.509	17309.1	11470.3
		18.46	15.542	244645.7	15741.0
47.00	8.00	15.57	1.672	12328.9	7373.8
		16.57	6.960	74559.7	10712.2
		17.57	16.138	238198.1	14760.2
		18.57	16.815	329105.1	19572.2
48.00	17.00	22.06	1.087	4664.4	4290.0
		23.06	1.690	13622.5	8062.1
		24.06	1.585	20007.7	12622.3
48.00	16.00	22.17	1.688	13254.9	7853.1
		23.17	1.581	19370.2	12255.3
48.00	15.00	21.27	1.688	12852.2	7613.8
		22.27	1.577	18697.8	11854.7
		23.27	1.451	24569.0	16933.0
48.00	14.00	20.38	1.691	12416.0	7344.4
		21.38	1.575	17992.5	11420.7
		22.38	1.438	23460.5	16316.7
48.00	13.00	19.49	1.696	11948.3	7045.1
		20.49	1.575	17256.7	10953.4
		21.49	3.566	55850.9	15663.7
48.00	12.00	18.59	1.705	11451.5	6716.1
		19.59	1.576	16471.9	10453.9
		20.59	7.498	112277.9	14973.7
		21.59	15.537	315470.2	20304.4
48.00	11.00	18.70	1.576	15634.9	9922.9
		19.70	9.612	136944.8	14247.2
		20.70	15.795	305782.6	19359.5
48.00	10.00	17.80	1.578	14768.6	9361.9

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment
X (m)	Y (m)	R (m)		(kNm)	(kNm)
48.00	10.00	18.80	11.207	151156.3	13487.4
		19.80	16.065	295259.3	18378.7
48.00	9.00	16.91	1.583	13881.2	8770.4
		17.91	12.534	159097.6	12693.5
		18.91	16.358	283993.9	17361.2
		19.91	15.422	352032.4	22826.4
48.00	8.00	17.01	13.704	162601.0	11865.1
		18.01	16.685	272065.5	16306.2
		19.01	15.604	335844.2	21523.5
49.00	17.00	23.51	1.651	14952.6	9055.6
		24.51	1.526	21370.4	14002.9
49.00	16.00	22.62	1.648	14506.8	8800.1
		23.62	1.517	20611.3	13584.3
		24.62	8.176	157486.2	19262.3
49.00	15.00	21.72	1.648	14027.9	8513.2
		22.72	1.507	19792.3	13132.0
		23.72	10.107	188198.5	18621.2
49.00	14.00	20.83	1.650	13518.2	8195.1
		21.83	1.497	18931.9	12645.7
		22.83	11.564	207475.7	17942.2
49.00	13.00	19.93	1.654	12979.5	7845.8
		20.93	1.488	18039.3	12125.3
		21.93	12.749	219605.4	17225.1
		22.93	14.660	339673.8	23169.8
49.00	12.00	20.04	1.480	17123.8	11573.0
		21.04	13.762	226707.4	16473.4
		22.04	14.822	328998.4	22196.8
49.00	11.00	19.14	1.473	16190.0	10988.2
		20.14	14.656	229891.0	15685.8
		21.14	14.992	317618.1	21185.3
49.00	10.00	18.25	1.470	15241.9	10369.5
		19.25	15.417	229117.5	14861.4
		20.25	15.178	305592.5	20134.1
		21.25	14.305	375356.5	26239.0
49.00	9.00	18.36	15.890	222467.5	14000.5
		19.36	15.386	293000.3	19043.6
		20.36	14.410	358770.1	24897.3
49.00	8.00	17.46	16.386	214727.2	13104.0
		18.46	15.625	279914.5	17914.5
		19.46	14.541	341911.9	23514.3

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	40.00	41.00	42.00	43.00	44.00	45.00
17.00	Fs	1.435	1.339	1.261	1.192	1.133	1.083
	R(m)	19.24	19.43	19.68	19.98	20.34	20.73
16.00	Fs	1.415	1.321	1.243	1.175	1.117	1.068
	R(m)	18.26	18.46	18.72	19.04	19.41	19.83
15.00	Fs	1.396	1.303	1.224	1.157	1.100	1.053
	R(m)	17.27	17.49	17.77	18.11	18.50	18.94
14.00	Fs	1.376	1.284	1.206	1.140	1.085	1.039
	R(m)	16.29	16.53	16.82	17.18	17.59	18.04
13.00	Fs	1.356	1.265	1.187	1.122	1.069	1.025
	R(m)	15.31	15.56	15.88	16.26	16.70	17.15
12.00	Fs	1.337	1.245	1.168	1.105	1.053	1.094
	R(m)	14.34	14.61	14.95	15.36	15.80	17.25
11.00	Fs	1.317	1.225	1.150	1.088	1.038	1.090
	R(m)	13.37	13.66	14.03	14.46	14.91	16.36
10.00	Fs	1.297	1.206	1.131	1.072	1.071	1.087
	R(m)	12.40	12.72	13.12	13.57	15.02	15.46
9.00	Fs	1.276	1.186	1.113	1.093	1.063	1.084
	R(m)	11.45	11.80	12.23	13.67	14.12	14.57
8.00	Fs	1.256	1.167	1.096	1.079	1.055	1.083
	R(m)	10.50	10.89	11.33	12.78	13.23	13.67

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

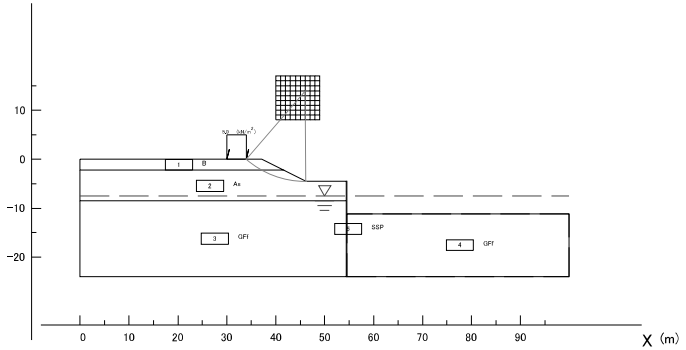
Y(m)	X(m)	46.00	47.00	48.00	49.00
17.00	Fs	1.040	1.016	1.087	1.526
	R(m)	21.17	21.62	22.06	24.51
16.00	Fs	1.027	1.020	1.581	1.517
	R(m)	20.28	20.72	23.17	23.62
15.00	Fs	1.014	1.198	1.451	1.507
	R(m)	19.38	20.83	23.27	22.72
14.00	Fs	1.001	1.333	1.438	1.497
	R(m)	18.49	19.93	22.38	21.83
13.00	Fs	1.137	1.529	1.575	1.488
	R(m)	18.59	21.04	20.49	20.93
12.00	Fs	1.138	1.521	1.576	1.480
	R(m)	17.70	20.14	19.59	20.04
11.00	Fs	1.139	1.515	1.576	1.473
	R(m)	16.80	19.25	18.70	19.14
10.00	Fs	1.141	1.511	1.578	1.470
	R(m)	15.91	18.35	17.80	18.25
9.00	Fs	1.144	1.509	1.583	14.410
	R(m)	15.01	17.46	16.91	20.36
8.00	Fs	1.596	1.672	13.704	14.541
	R(m)	15.12	15.57	17.01	19.46

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio		
	=	1.001
Failure circle X(m)	=	46.00
Y(m)	=	14.00
R(m)	=	18.487
Resisting moment(kNm)	=	3077.0
Sliding moment(kNm)	=	3074.9
Partial coefficient concerning analytical technique		
	=	1.0

// Check Result chart //



Test of Embankment Stability
Action number = 1
Action name : normal
Examination at earthquake : It doesn't do.

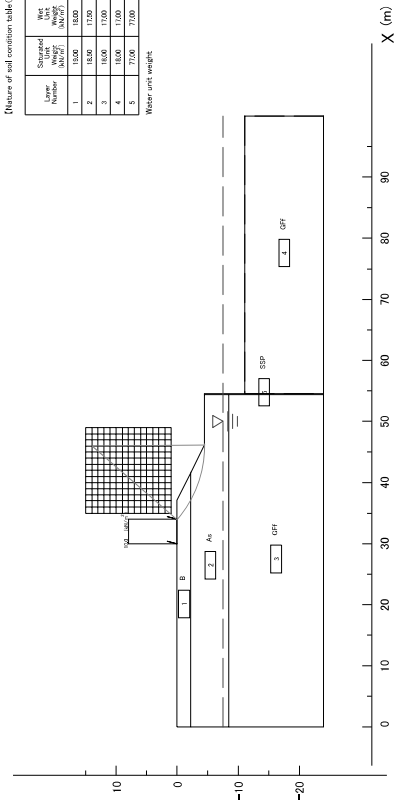
Scale : 1/ 792

Required Bearing force Action ratio	F s =	1.000	≧ 1.0 (OK)
Bearing force Action ratio	=	1.642	
Center of arc	X =	46.00	(m)
	Y =	14.00	(m)
Radius	R =	18.487	(m)
Resisting moment	M R =	3322.1	(kNm)
Sliding moment	M D =	2023.4	(kNm)
Partial coefficient concerning	γ α =	1.00	

[Nature of soil condition table(Input value)]

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Fiction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	19.00	18.00	30.00	1.00	0.00	0.000	0.000
2	18.90	17.50	32.00	0.00	0.00	0.000	0.000
3	18.00	17.00	30.00	1000.00	0.00	0.000	0.000
4	18.00	17.00	30.00	1000.00	0.00	0.000	0.000
5	77.00	77.00	0.00	1000.00	0.00	0.000	0.000

Water unit weight = 10.00 (kN/m³)



Safety Factor (Ordinary Condition)

Test of Embankment Stability

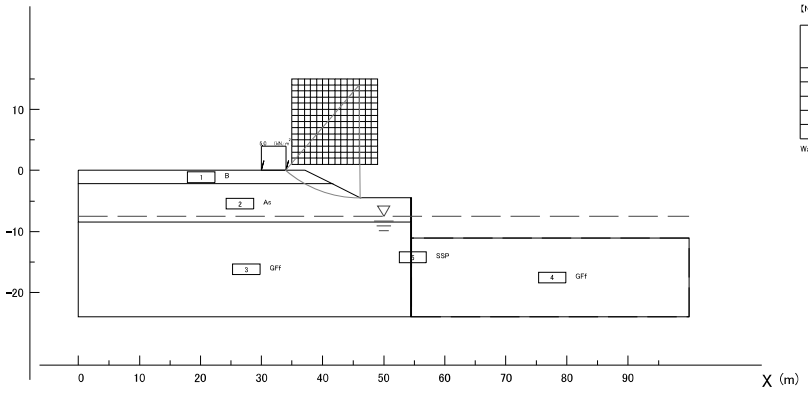
Action number = 2

Action name : seismic

Examination at earthquake : It does.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	1.001	≧ 1.0 (OK)
Center of arc	X	=	46.00	(m)
	Y	=	14.00	(m)
Radius	R	=	18.487	(m)
Resisting moment	M_R	=	3077.0	(kNm)
Sliding moment	M_D	=	3074.9	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	18.00	18.00	30.00	1.00	0.00	0.200	0.000
2	18.50	17.50	32.00	0.00	0.00	0.200	0.000
3	18.00	17.00	30.00	1000.00	0.00	0.200	0.000
4	18.00	17.00	30.00	1000.00	0.00	0.200	0.000
5	77.00	77.00	0.00	1000.00	0.00	0.200	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Seismic Condition)

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.1　Normal and Seismic Conditions

(4)　L7+820

Circular Slip Surface

L7+820

Contents

Page

1. Input Data 1

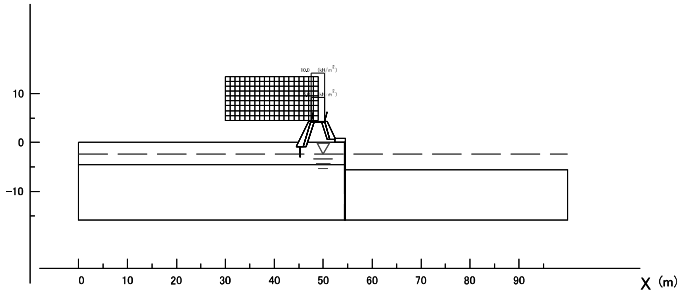
2. Check list 15

3. Action 01 Result list ... 16

4. Action 02 Result list ... 36

1. Input data list

// Design section //



// Design level of reliability design method //

Level of reliability design ..... Level 1(Design for value, part coefficient method)

// Combination of action //

// Setting of action //

Action	Action name	Seismic inertia	Newmark No.	Same hydraul-ic line
1	normal			
2	seismic	○		

// Partial coefficient concerning analytical technique γ_α //

Action No.	Partial coefficient concerning analytical technique γ_α
1	1.00
2	1.00

// Partial coefficient concerning W,C,ϕ $\gamma w, \gamma c, \gamma \tan\phi$ //

No.	Action 1			Action 2										
	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$
1	1.00	1.00	1.00	1.00	1.00	1.00						
2	1.00	1.00	1.00	1.00	1.00	1.00						
3	1.00	1.00	1.00	1.00	1.00	1.00						
4	1.00	1.00	1.00	1.00	1.00	1.00						
5	1.00	1.00	1.00	1.00	1.00	1.00						
6	1.00	1.00	1.00	1.00	1.00	1.00						
7	1.00	1.00	1.00	1.00	1.00	1.00						
8	1.00	1.00	1.00	1.00	1.00	1.00						
9	1.00	1.00	1.00	1.00	1.00	1.00						
10	1.00	1.00	1.00	1.00	1.00	1.00						
11	1.00	1.00	1.00	1.00	1.00	1.00						
12	1.00	1.00	1.00	1.00	1.00	1.00						

$$M = \Sigma [C_d l + \{ (W_d' + q_d) \cos\theta - K_k W_d \sin\theta \} \tan\phi_d]$$

$$W_d' = \gamma_w W_k'$$

$$C_d = \gamma_c C_k$$

$$\tan\phi_d = \gamma_{\tan\phi} \tan\phi_k$$

M : Resistance moment

γ_w : Partial coefficient concerning weight

W_d' : Effective weight of slice of amount for each unit length splinter (value for design) (kN/m)

W_k' : Effective weight of slice of amount for each unit length splinter (characteristic value)(kN/m)

q_d : Perpendicular action because of the upper part of amount of slice (kN/m)

γ_c : Partial coefficient concerning Cohesion

C_d : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (value for design) (kN/m²)

C_k : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (characteristic value) (kN/m²)

l : Length in base of amount of Slice (m)

$\gamma_{\tan\phi}$: Partial coefficient concerning shearing resistance angle

ϕ_d : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(value for design)(°)

ϕ_k : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(characteristic value)(°)

// Partial coefficient of partial coefficient γ_{vl} to distribution load (Think as well as the ground) and inertia force γ_{vlEQ} //

Action No.	Load1		Load2							
	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force
1	1.00	1.00	−	−						
2	−	−	1.00	1.00						

$$M_{r,vl} = K \cdot r \Sigma (FR \cdot \gamma_{vl,i} - K_{hp} \cdot FO \cdot \gamma_{vlEQ,i}) \cdot \tan\phi$$

$$M_{d,vl} = r \Sigma (FO \cdot \gamma_{vl,i} + K_{hp} \cdot FR \cdot \gamma_{vlEQ,i})$$

$$FR = F \cdot \cos\theta$$

$$FO = F \cdot \sin\theta$$

$M_{r,vl}$: Resistance moment of distribution load (Think as well as the ground)

$M_{d,vl}$: Sliding moment of distribution load (Think as well as the ground)

K : Resistance power coefficient

r : Radius of slipping circular arc

F : Distribution load i

FR : Slipping line orthogonalization direction load value of load i

FO : Slipping line direction load value of load i

θ : Angle that slice bottom (slide surface) does to the horizontal

$\gamma_{vl,i}$: Partial coefficient of distribution load i (Think as well as the ground).

K_{hp} : The horizontal seismic intensity

$\gamma_{vlEQ,i}$: Partial coefficient of inertia force of distribution load i (Think as well as the ground).

ϕ : Internal friction angle of soil

// Partial coefficient to residual water level //

Action number	rRWL
1	1.00
2	1.00

$$RWL_d = \gamma_{RWL} RWL_k$$

γ_{RWL} : Partial coefficient concerning residual water level

RWL_d : Difference between residual water level and water level line (value for design) (m)

RWL_k : Difference between residual water level and water level line (input value) (m)

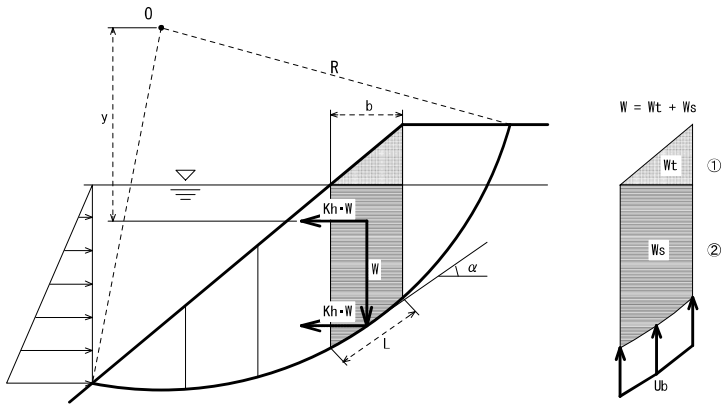
(DATA 01.)　// ANALYSIS //

Title　.....　Test of Embankment Stability
Analysis type　.....　Analysis of Bearing force Action ratio
Calculation method .....　Revised Feleniu s (Total stress)

Expression

$$\frac{R\Sigma[C_d l+\{((1+K_v)W_d-u\,b)\cos\theta-K_h W_d\sin\theta\}\tan\phi_d]}{\gamma_a R\Sigma\{(1+K_v)W_d\sin\theta+K_h W_d\cos\theta\}} \geqq 1.0$$

R	:	Radius of slipping circle of circular arc (m)
C_d	:	Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (kN/m²)
l	:	Length in base of amount of crack splinter (m)
q_d	:	Perpendicular action because of the upper part of amount of crack splinter (kN/m)
θ	:	Angle that amount of crack splinter bottom does to a horizontal plane (degree)
ϕ_d	:	0 in case of viscous land board. Shearing resistance in drain condition in case of the sandy soil ground etc.(°)
W_d	:	Full weight of crack of amount for each unit length splinter (full weight of soil and water) (kN/m)
γ_a	:	Partial coefficient concerning analytical technique
K_h	:	The horizontal seismic intensity
K_v	:	Vertical seismic coefficient
u	:	Pore pressure (kN/m²)
b	:	Width of slice (m)



Treatment of its own weight W of the resistance force
　Above the water level.....Calculate the weight Wt in Wet weight γt　①
　Below the water level.....Calculate weight Ws in Saturated weight γsat　②
Treatment of its own weight W of impetus
　Above the water level.....Calculate the weight Wt in Wet weight γt
　Below the water level.....Calculate weight in Saturated weight γsat
Water pressure acting on the slip plane.....Consider in the Ubcosα
　(Modify Fereniusu method)
Lateral hydrostatic pressure due to water storage.....Including

(DATA 02.)　// CONTROL //

Second pursuit　.....　0 (=0 No)
　(>0 Yes　)
Run　.....　0 (=0 Input data check + Analysis)
　(=1 Input data check　)

(DATA 04.) // SEISMIC LOAD //

```
Seismic load                  .....  0 ( =0 Same for the whole model )
                                     ( =1 Different on each layer  )
Condition                     .....  1 ( =0 Acts on only sliding force )
                                     ( =1 Sliding + Resisting force  )
Acting point                  .....  0 ( =0 On the slip surface              )
                                     ( =1 Center of gravity of sliding mass )
                                     ( =2 Resisting:on the slip surface
                                          Sliding  :Center of gravity of sliding mass )
Unit weight                   .....  0 ( =0 Saturated weight )
                                     ( =1 Submerged weight )
Horizontal seismic coefficient.....  0.200
Vertical seismic coefficient  .....  0.000
```


(DATA 06.) // NODAL POINT //

No.	Coordinate		Y-coordinate
	x (m)	y (m)	before settlement (m)
1	0.00	0.00	0.00
2	44.89	0.00	0.00
3	44.51	-0.75	0.00
4	44.51	-0.90	0.00
5	45.93	-0.90	0.00
6	46.56	-0.90	0.00
7	48.06	4.12	0.00
8	47.44	4.12	0.00
9	47.05	4.32	0.00
10	47.50	4.32	0.00
11	50.28	4.32	0.00
12	50.73	4.32	0.00
13	49.72	4.12	0.00
14	50.34	4.12	0.00
15	50.77	0.60	0.00
16	51.40	0.60	0.00
17	52.34	0.60	0.00
18	52.34	0.80	0.00
19	52.49	0.80	0.00
20	54.49	0.80	0.00
21	54.49	0.00	0.00
22	54.34	0.00	0.00
23	52.34	0.00	0.00
24	54.33	-4.50	0.00
25	54.49	-5.62	0.00
26	100.00	-5.62	0.00
27	100.00	-15.86	0.00
28	54.49	-15.86	0.00
29	54.34	-15.86	0.00
30	0.00	-15.86	0.00
31	0.00	-4.50	0.00
32	46.83	0.00	0.00
33	45.22	-0.90	0.00
34	45.22	-2.90	0.00
35	45.37	-2.90	0.00
36	45.37	-0.90	0.00

(DATA 07.) // WATER LEVEL //

Unit weight of water (kN/m³) = 10.00

Action No.	Water level line number
1	1
2	1

Water level line number: 1

No.	Coordinate	
	X (m)	Y (m)
1	0.00	-2.30
2	100.00	-2.30

Water level line number: 2

No.	Coordinate	
	X (m)	Y (m)
1	0.00	0.00
2	150.00	0.00

(DATA 08.) // LAYER //

No.	material property No.	The name of the strata
1	1	Co
2	1	Co
3	1	Co
4	2	SSP
5	3	Gr
6	3	Gr
7	4	PCCP

No.	material property No.	The name of the strata
8	5	B
9	6	As
10	7	Dc
11	7	Dc
12	2	SSP

No.	Num of Node	Node numbers composing a layer	Slip existence
1	7	2 3 4 5 8 10 9	Not Slip
2	7	11 14 16 17 18 19 12	Not Slip
3	7	17 23 22 21 20 19 18	Not Slip
4	6	21 22 24 29 28 25	Not Slip
5	4	5 6 7 8	Not Slip
6	4	13 15 16 14	Not Slip
7	6	10 8 7 13 14 11	Slip
8	7	32 23 17 16 15 13 7	Slip
9	15	1 31 24 22 23 32 6 5 36 35 34	Slip
		33 4 3 2	
10	4	24 31 30 29	Slip
11	4	25 28 27 26	Slip
12	4	33 34 35 36	Not Slip

(DATA 09.1) // MATERIAL PROPERTIES //

No.	Nature of soil division	Saturated weight (kN/m³)	Wet weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	1	24.00	24.00	******	0.00	0.00	0.00	0.000	0.0
2	2	77.00	77.00	******	0.00	0.00	0.00	0.000	0.0
3	3	20.00	19.00	0.00	0.00	35.00	0.00	0.000	0.0
4	4	24.00	24.00	1.00	0.00	30.00	0.00	0.000	0.0
5	5	19.00	18.00	1.00	0.00	30.00	0.00	0.000	0.0
6	6	18.50	17.50	0.00	0.00	27.00	0.00	0.000	0.0
7	7	19.00	18.00	100.00	0.00	0.00	0.00	0.000	0.0

(DATA 09.2)　// Characteristic of soil //

No.	Action Number									
	Act 1	Act 2								
1	1	1								
2	1	1								
3	1	1								
4	2	2								
5	3	3								
6	3	3								
7	4	4								
8	5	5								
9	6	6								
10	7	7								
11	7	7								
12	2	2								

(DATA 11.)　// GRID POINT //

No.	Slip direction	Double cutting	GX (m)	GY (m)	X-point	Y-point	X-pitch (m)	Y-pitch (m)	Dx/Dy	NEXCO Radius
1	Upstream	Left lump	30.00	13.50	20	10	1.00	1.00	0.000	0.000

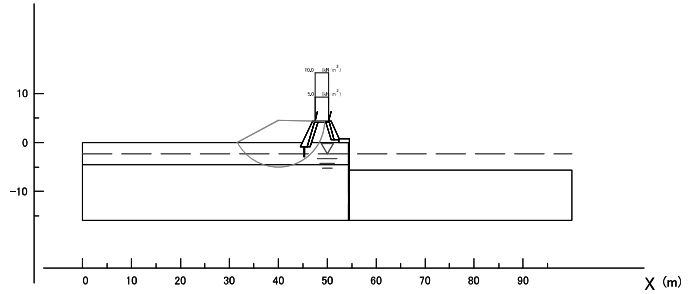
2. Check list

// Check of circular arc //

Action No.	Action name	Bearing force Action ratio	Judgment
1	normal	3.690	OK
2	seismic	1.886	OK

Action No.	Bearing force Action ratio	Partial coefficient r_a	Center of slipping circular arc X (m)	Center of slipping circular arc Y (m)	Radius of circular arc(m)	Resistance Moment (kNm)	Sliding Moment (kNm)
1	3.690	1.00	40.00	4.50	9.500	8593.7	2329.1
2	1.886	1.00	40.00	4.50	9.500	8366.5	4435.0

// Check Result chart //



3. Action01 (normal)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	1	24.00	24.00	14.00	1000.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.
0	2	1 24.0	0 24.0	0 14.0	01000.	00 0.	00 0.	00 0.	00 0.	00 0
0.0	3	1 24.	00 24.	00 14.	001000	0.00	0.00	0.00	0.00	0.00
0.0	4	2 77	0.00 7	0.00 6	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	5	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	6	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	7	4 2	4.00 2	4.00 1	4.00	1.00	0.003	0.00	0.00	0.00
0.0	8	5 1	9.00 1	8.00	9.00	1.00	0.003	0.00	0.00	0.00
0.0	9	6 1	8.50 1	7.50	8.50	0.00	0.002	7.00	0.00	0.00
0.0	10	7 1	9.00 1	8.00	9.0010	0.00	0.00	0.00	0.00	0.00
0.0	11	7 1	9.00 1	8.00	9.0010	0.00	0.00	0.00	0.00	0.00
0.0	12	2 7	7.00 7	7.00 6	7.0010	00.00	0.00	0.00	0.00	0.00
0.	0									

// Distribution load that considers partial coefficient //

Load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
1	47.50	4.32	10.0	50.28	4.32	10.0	0.000	0.000	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	-2.30	
2	100.00	-2.30	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
30.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	999.000	904.7	0.0	
		15.50	999.000	2771.2	-0.0	
		16.50	999.000	5156.1	0.0	
		17.50	999.000	7727.2	0.0	
		18.50	999.000	21702.8	0.0	
30.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	999.000	811.3	0.0	
		14.50	-1823800.250	2499.5	-0.0	
		15.50	999.000	4674.2	-0.0	
		16.50	999.000	7036.4	0.0	
		17.50	999.000	19912.7	0.0	
30.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	999.000	721.3	0.0	
		13.50	999.000	2237.3	-0.0	
		14.50	999.000	4208.3	0.0	
		15.50	999.000	6367.6	0.0	
		16.50	999.000	18175.0	0.0	
30.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	999.000	635.0	0.0	
		12.50	999.000	1985.1	-0.0	
		13.50	999.000	3759.1	0.0	
		14.50	-3232485.000	5721.6	-0.0	
		15.50	999.000	16491.4	0.0	
30.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
		11.50	999.000	1743.1	0.0	
		12.50	999.000	3327.2	-0.0	
		13.50	999.000	5099.2	0.0	
		14.50	-9019524.000	14863.7	-0.0	
30.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
		11.50	999.000	2913.4	0.0	
		12.50	999.000	4501.4	0.0	
		13.50	999.000	13293.9	-0.0	
30.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
		9.50	999.000	1291.9	-0.0	
		10.50	999.000	2518.4	0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
30.00	7.50	11.50	999.000	3929.3	-0.0	
		12.50	999.000	11784.3	-0.0	
30.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	-0.0	
		8.50	999.000	1083.9	0.0	
		9.50	999.000	2143.2	0.0	
		10.50	999.000	3384.0	-0.0	
		11.50	999.000	10337.3	0.0	
30.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	-0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
		10.50	999.000	8956.0	-0.0	
30.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	
		8.50	999.000	2380.0	0.0	
		9.50	999.000	7643.5	-0.0	
31.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	999.000	904.7	0.0	
		15.50	999.000	2771.2	-0.0	
		16.50	999.000	5156.1	0.0	
		17.50	999.000	7727.2	0.0	
31.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	999.000	811.3	0.0	
		14.50	-1823800.250	2499.5	-0.0	
		15.50	999.000	4674.2	-0.0	
		16.50	999.000	7036.4	0.0	
		17.50	999.000	19912.7	0.0	
31.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	999.000	721.3	0.0	
		13.50	999.000	2237.3	-0.0	
		14.50	999.000	4208.3	0.0	
		15.50	999.000	6367.6	0.0	
		16.50	999.000	18175.0	0.0	
31.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	999.000	635.0	0.0	
		12.50	999.000	1985.1	-0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
31.00	10.50	13.50	999.000	3759.1	0.0	
		14.50	-3232485.000	5721.6	-0.0	
		15.50	999.000	16491.4	0.0	
31.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
		11.50	999.000	1743.1	0.0	
		12.50	999.000	3327.2	-0.0	
		13.50	999.000	5099.2	0.0	
		14.50	-9019524.000	14863.7	-0.0	
31.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
		11.50	999.000	2913.4	0.0	
		12.50	999.000	4501.4	0.0	
		13.50	999.000	13293.9	-0.0	
31.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
		9.50	999.000	1291.9	-0.0	
		10.50	999.000	2518.4	0.0	
		11.50	999.000	3929.3	-0.0	
		12.50	999.000	11784.3	-0.0	
31.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	-0.0	
		8.50	999.000	1083.9	0.0	
		9.50	999.000	2143.2	0.0	
		10.50	999.000	3384.0	-0.0	
		11.50	999.000	10337.3	0.0	
31.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	-0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
		10.50	999.000	8956.0	-0.0	
31.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	
		8.50	999.000	2380.0	0.0	
		9.50	999.000	7643.5	-0.0	
32.00	13.50	13.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
32.00	13.50	14.50	999.000	904.7	0.0	
		15.50	999.000	2771.2	-0.0	
		16.50	999.000	5156.1	0.0	
		17.50	999.000	7727.2	0.0	
32.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	999.000	811.3	0.0	
		14.50	-1823800.250	2499.5	-0.0	
		15.50	999.000	4674.2	-0.0	
32.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	999.000	721.3	0.0	
		13.50	999.000	2237.3	-0.0	
		14.50	999.000	4208.3	0.0	
		15.50	999.000	6367.6	0.0	
32.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	999.000	635.0	0.0	
		12.50	999.000	1985.1	-0.0	
		13.50	999.000	3759.1	0.0	
		14.50	-3232485.000	5721.6	-0.0	
		15.50	999.000	16491.4	0.0	
32.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
		11.50	999.000	1743.1	0.0	
		12.50	999.000	3327.2	-0.0	
		13.50	999.000	5099.2	0.0	
		14.50	-9019524.000	14863.7	-0.0	
32.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
		11.50	999.000	2913.4	0.0	
		12.50	999.000	4501.4	0.0	
		13.50	999.000	13293.9	-0.0	
32.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
		9.50	999.000	1291.9	-0.0	
		10.50	999.000	2518.4	0.0	
		11.50	999.000	3929.3	-0.0	
		12.50	999.000	11784.3	-0.0	
32.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	-0.0	
		8.50	999.000	1083.9	0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
32.00	6.50	9.50	999.000	2143.2	0.0	
		10.50	999.000	3384.0	-0.0	
		11.50	999.000	10337.3	0.0	
32.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	-0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
		10.50	999.000	8956.0	-0.0	
32.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	
		8.50	999.000	2380.0	0.0	
		9.50	999.000	7643.5	-0.0	
33.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	999.000	904.7	0.0	
		15.50	999.000	2771.2	-0.0	
		16.50	999.000	5156.1	0.0	
33.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	999.000	811.3	0.0	
		14.50	-1823800.250	2499.5	-0.0	
		15.50	999.000	4674.2	-0.0	
33.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	999.000	721.3	0.0	
		13.50	999.000	2237.3	-0.0	
		14.50	999.000	4208.3	0.0	
		15.50	999.000	6367.6	0.0	
33.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	999.000	635.0	0.0	
		12.50	999.000	1985.1	-0.0	
		13.50	999.000	3759.1	0.0	
		14.50	-3232485.000	5721.6	-0.0	
33.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
		11.50	999.000	1743.1	0.0	
		12.50	999.000	3327.2	-0.0	
		13.50	999.000	5099.2	0.0	
		14.50	-9019524.000	14863.7	-0.0	
33.00	8.50	8.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	8.50	9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
		11.50	999.000	2913.4	0.0	
		12.50	999.000	4501.4	0.0	
		13.50	999.000	13293.9	-0.0	
33.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
		9.50	999.000	1291.9	-0.0	
		10.50	999.000	2518.4	0.0	
		11.50	999.000	3929.3	-0.0	
		12.50	999.000	11784.3	-0.0	
33.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	-0.0	
		8.50	999.000	1083.9	0.0	
		9.50	999.000	2143.2	0.0	
		10.50	999.000	3384.0	-0.0	
		11.50	999.000	10337.3	0.0	
33.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	-0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
		10.50	999.000	8956.0	-0.0	
33.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	
		8.50	999.000	2380.0	0.0	
		9.50	999.000	7643.5	-0.0	
34.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	999.000	904.7	0.0	
		15.50	999.000	2771.2	-0.0	
34.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	999.000	811.3	0.0	
		14.50	-1823800.250	2499.5	-0.0	
34.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	999.000	721.3	0.0	
		13.50	999.000	2237.3	-0.0	
		14.50	999.000	4208.3	0.0	
34.00	10.50	10.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	10.50	11.50	999.000	635.0	0.0	
		12.50	999.000	1985.1	-0.0	
		13.50	999.000	3759.1	0.0	
34.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
		11.50	999.000	1743.1	0.0	
		12.50	999.000	3327.2	-0.0	
		13.50	999.000	5099.2	0.0	
34.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
		11.50	999.000	2913.4	0.0	
		12.50	999.000	4501.4	0.0	
		13.50	999.000	13293.9	-0.0	
34.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
		9.50	999.000	1291.9	-0.0	
		10.50	999.000	2518.4	0.0	
		11.50	999.000	3929.3	-0.0	
		12.50	999.000	11784.3	-0.0	
34.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	-0.0	
		8.50	999.000	1083.9	0.0	
		9.50	999.000	2143.2	0.0	
		10.50	999.000	3384.0	-0.0	
		11.50	999.000	10337.3	0.0	
34.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	-0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
		10.50	999.000	8956.0	-0.0	
34.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	
		8.50	999.000	2380.0	0.0	
		9.50	999.000	7643.5	-0.0	
35.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	999.000	904.7	0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	999.000	811.3	0.0	
		14.50	-1823800.250	2499.5	-0.0	
35.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	999.000	721.3	0.0	
		13.50	999.000	2237.3	-0.0	
35.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	999.000	635.0	0.0	
		12.50	999.000	1985.1	-0.0	
		13.50	999.000	3759.1	0.0	
35.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
		11.50	999.000	1743.1	0.0	
		12.50	999.000	3327.2	-0.0	
35.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
		11.50	999.000	2913.4	0.0	
		12.50	999.000	4501.4	0.0	
35.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
		9.50	999.000	1291.9	-0.0	
		10.50	999.000	2518.4	0.0	
		11.50	999.000	3929.3	-0.0	
35.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	-0.0	
		8.50	999.000	1083.9	0.0	
		9.50	999.000	2143.2	0.0	
		10.50	999.000	3384.0	-0.0	
		11.50	999.000	10337.3	0.0	
35.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	-0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
		10.50	999.000	8956.0	-0.0	
35.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	4.50	8.50	999.000	2380.0	0.0	
		9.50	999.000	7643.5	-0.0	
36.00	13.50	13.50	999.000	0.0	0.0	***6
36.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	999.000	811.3	0.0	
36.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	999.000	721.3	0.0	
36.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	999.000	635.0	0.0	
		12.50	999.000	1985.1	-0.0	
36.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
		11.50	999.000	1743.1	0.0	
36.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
		11.50	999.000	2913.4	0.0	
36.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
		9.50	999.000	1291.9	-0.0	
		10.50	999.000	2518.4	0.0	
36.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	0.0	
		8.50	999.000	1083.9	0.0	
		9.50	999.000	2143.2	0.0	
		10.50	999.000	3384.0	-0.0	
36.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
36.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	
		8.50	999.000	2380.0	0.0	
		9.50	999.000	7643.5	-0.0	
37.00	13.50	13.50	999.000	0.0	0.0	***6
37.00	12.50	0.00	0.001	0.0	0.0	***5
37.00	11.50	11.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	999.000	635.0	0.0	
37.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	999.000	552.4	0.0	
37.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
		10.50	999.000	1511.9	0.0	
37.00	7.50	0.00	0.001	0.0	0.0	***5
37.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	0.0	
		8.50	999.000	1083.9	0.0	
		9.50	999.000	2143.2	0.0	
37.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
		9.50	999.000	2867.0	0.0	
37.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
		7.50	999.000	1457.0	-0.0	
		8.50	999.000	2380.0	0.0	
38.00	13.50	12.89	999.000	0.0	0.0	***6
38.00	12.50	0.00	0.001	0.0	0.0	***5
38.00	11.50	11.50	999.000	0.0	0.0	***6
38.00	10.50	10.50	999.000	0.0	0.0	***6
38.00	9.50	9.50	999.000	0.0	0.0	***6
38.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	999.000	473.7	0.0	
38.00	7.50	0.00	0.001	0.0	0.0	***5
38.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	0.0	
		8.50	999.000	1083.9	0.0	
38.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	0.0	
		7.50	999.000	888.4	0.0	
		8.50	999.000	1788.9	-0.0	
38.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	4.50	7.50	999.000	1457.0	0.0	
39.00	13.50	12.21	999.000	0.0	0.0	***6
39.00	12.50	0.00	0.001	0.0	0.0	***5
39.00	11.50	10.79	999.000	0.0	0.0	***6
39.00	10.50	10.15	999.000	0.0	0.0	***6
39.00	9.50	9.50	999.000	0.0	0.0	***6
39.00	8.50	8.50	999.000	0.0	0.0	***6
39.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	999.000	399.1	0.0	
39.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	999.000	329.0	0.0	
39.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	0.0	
		7.50	999.000	888.4	0.0	
39.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		6.50	999.000	706.5	0.0	
40.00	13.50	11.57	999.000	0.0	0.0	***6
40.00	12.50	10.80	999.000	0.0	0.0	***6
40.00	11.50	10.06	999.000	0.0	0.0	***6
40.00	10.50	9.38	999.000	0.0	0.0	***6
40.00	9.50	8.75	999.000	0.0	0.0	***6
40.00	8.50	8.20	999.000	0.0	0.0	***6
40.00	7.50	7.50	999.000	0.0	0.0	***6
40.00	6.50	6.50	999.000	0.0	0.0	***6
40.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	999.000	263.5	0.0	
40.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	999.000	203.1	0.0	
		9.50	3.690	8593.7	2329.1	
41.00	13.50	10.99	999.000	0.0	0.0	***6
41.00	12.50	10.17	999.000	0.0	0.0	***6
41.00	11.50	9.39	999.000	0.0	0.0	***6
41.00	10.50	8.65	999.000	0.0	0.0	***6
41.00	9.50	7.96	999.000	0.0	0.0	***6
41.00	8.50	7.35	999.000	0.0	0.0	***6
41.00	7.50	6.83	999.000	0.0	0.0	***6
41.00	6.50	6.39	999.000	0.0	0.0	***6
41.00	5.50	5.50	999.000	0.0	0.0	***6
41.00	4.50	4.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	13.50	10.48	999.000	0.0	0.0	***6
42.00	12.50	0.00	0.001	0.0	0.0	***5
42.00	11.50	0.00	0.001	0.0	0.0	***5
42.00	10.50	7.98	999.000	0.0	0.0	***6
42.00	9.50	7.23	999.000	0.0	0.0	***6
42.00	8.50	6.56	999.000	0.0	0.0	***6
42.00	7.50	0.00	0.001	0.0	0.0	***5
42.00	6.50	5.49	999.000	0.0	0.0	***6
42.00	5.50	5.04	999.000	0.0	0.0	***6
42.00	4.50	4.50	999.000	0.0	0.0	***6
43.00	13.50	10.03	999.000	0.0	0.0	***6
43.00	12.50	9.13	999.000	0.0	0.0	***6
43.00	11.50	8.24	999.000	0.0	0.0	***6
43.00	10.50	7.39	999.000	0.0	0.0	***6
43.00	9.50	6.58	999.000	0.0	0.0	***6
43.00	8.50	5.82	999.000	0.0	0.0	***6
43.00	7.50	0.00	0.001	0.0	0.0	***5
43.00	6.50	4.60	999.000	0.0	0.0	***6
43.00	5.50	4.15	999.000	0.0	0.0	***6
43.00	4.50	3.70	999.000	0.0	0.0	***6
44.00	13.50	9.67	999.000	0.0	0.0	***6
44.00	12.50	8.73	999.000	0.0	0.0	***6
44.00	11.50	7.80	999.000	0.0	0.0	***6
44.00	10.50	6.89	999.000	0.0	0.0	***6
44.00	9.50	6.01	999.000	0.0	0.0	***6
44.00	8.50	5.17	999.000	0.0	0.0	***6
44.00	7.50	0.00	0.001	0.0	0.0	***5
44.00	6.50	3.75	999.000	0.0	0.0	***6
44.00	5.50	3.26	999.000	0.0	0.0	***6
44.00	4.50	2.81	999.000	0.0	0.0	***6
45.00	13.50	9.41	999.000	0.0	0.0	***6
45.00	12.50	8.43	999.000	0.0	0.0	***6
45.00	11.50	7.47	999.000	0.0	0.0	***6
45.00	10.50	6.51	999.000	0.0	0.0	***6
45.00	9.50	5.57	999.000	0.0	0.0	***6
45.00	8.50	4.66	999.000	0.0	0.0	***6
45.00	7.50	0.00	0.001	0.0	0.0	***5
45.00	6.50	2.99	999.000	0.0	0.0	***6
45.00	5.50	2.37	999.000	0.0	0.0	***6
45.00	4.50	1.91	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
46.00	13.50	9.24	999.000	0.0	0.0	***6
46.00	12.50	8.25	999.000	0.0	0.0	***6
46.00	11.50	7.26	999.000	0.0	0.0	***6
46.00	10.50	6.27	999.000	0.0	0.0	***6
46.00	9.50	5.29	999.000	0.0	0.0	***6
46.00	8.50	4.31	999.000	0.0	0.0	***6
46.00	7.50	3.35	999.000	0.0	0.0	***6
46.00	6.50	0.00	0.001	0.0	0.0	***5
46.00	5.50	1.58	999.000	0.0	0.0	***6
46.00	4.50	0.00	0.001	0.0	0.0	***5
47.00	13.50	9.18	999.000	0.0	0.0	***6
47.00	12.50	0.00	0.001	0.0	0.0	***5
47.00	11.50	0.00	0.001	0.0	0.0	***5
47.00	10.50	6.18	999.000	0.0	0.0	***6
47.00	9.50	5.18	999.000	0.0	0.0	***6
47.00	8.50	4.18	999.000	0.0	0.0	***6
47.00	7.50	0.00	0.001	0.0	0.0	***5
47.00	6.50	2.18	999.000	0.0	0.0	***6
47.00	5.50	1.18	999.000	0.0	0.0	***6
47.00	4.50	0.00	0.001	0.0	0.0	***5
48.00	13.50	9.18	999.000	0.0	0.0	***6
48.00	12.50	0.00	0.001	0.0	0.0	***5
48.00	11.50	0.00	0.001	0.0	0.0	***5
48.00	10.50	6.18	999.000	0.0	0.0	***6
48.00	9.50	5.18	999.000	0.0	0.0	***6
48.00	8.50	4.18	999.000	0.0	0.0	***6
48.00	7.50	0.00	0.001	0.0	0.0	***5
48.00	6.50	2.18	999.000	0.0	0.0	***6
48.00	5.50	1.18	999.000	0.0	0.0	***6
48.00	4.50	0.18	999.000	0.0	0.0	***6
49.00	13.50	9.18	999.000	0.0	0.0	***6
49.00	12.50	0.00	0.001	0.0	0.0	***5
49.00	11.50	7.18	999.000	0.0	0.0	***6
49.00	10.50	6.18	999.000	0.0	0.0	***6
49.00	9.50	5.18	999.000	0.0	0.0	***6
49.00	8.50	4.18	999.000	0.0	0.0	***6
49.00	7.50	3.18	999.000	0.0	0.0	***6
49.00	6.50	2.18	999.000	0.0	0.0	***6
49.00	5.50	1.18	999.000	0.0	0.0	***6
49.00	4.50	0.18	999.000	0.0	0.0	***6

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	30.00	31.00	32.00	33.00	34.00	35.00
13.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
12.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
11.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
10.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
9.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
8.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
7.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
6.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
5.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
4.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	36.00	37.00	38.00	39.00	40.00	41.00
13.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
12.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
11.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
10.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
9.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
8.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
7.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
6.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
5.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
4.50	Fs	999.000	999.000	999.000	999.000	3.690	999.000
	R(m)	0.00	0.00	0.00	0.00	9.50	0.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	42.00	43.00	44.00	45.00	46.00	47.00
13.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
12.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
11.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
10.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
9.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
8.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
7.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
6.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
5.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
4.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

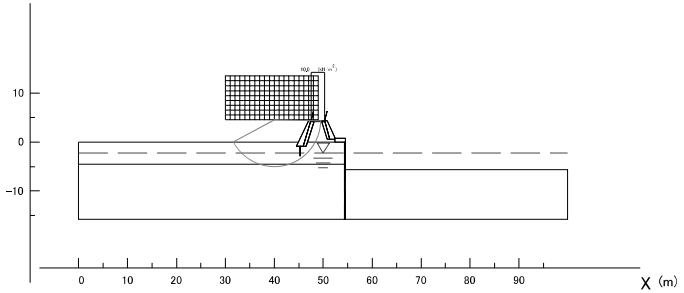
Y(m)	X(m)	48.00	49.00
13.50	Fs	999.000	999.000
	R(m)	0.00	0.00
12.50	Fs	999.000	999.000
	R(m)	0.00	0.00
11.50	Fs	999.000	999.000
	R(m)	0.00	0.00
10.50	Fs	999.000	999.000
	R(m)	0.00	0.00
9.50	Fs	999.000	999.000
	R(m)	0.00	0.00
8.50	Fs	999.000	999.000
	R(m)	0.00	0.00
7.50	Fs	999.000	999.000
	R(m)	0.00	0.00
6.50	Fs	999.000	999.000
	R(m)	0.00	0.00
5.50	Fs	999.000	999.000
	R(m)	0.00	0.00
4.50	Fs	999.000	999.000
	R(m)	0.00	0.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	3.690
Failure circle X(m)	=	40.00
Y(m)	=	4.50
R(m)	=	9.500
Resisting moment(kNm)	=	8593.7
Sliding moment(kNm)	=	2329.1
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



WARNING ***5 There are no arc contacting with base line.
count = 21

WARNING ***6 An arc does not cut the ground,
or An arc cuts the side of a model. count =179

4. Action02 (seismic)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	1	24.00	24.00	14.00	1000.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.
0	2	1 24.0	0 24.0	0 14.0	01000.	00 0.	00 0.	00 0.	00 0.	00 0
0.0	3	1 24.	00 24.	00 14.	001000	0.00	0.00	0.00	0.00	0.00
0.0	4	2 77	0.00 7	0.00 6	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	5	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	6	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	7	4 2	4.00 2	4.00 1	4.00	1.00	0.003	0.00	0.00	0.00
0.0	8	5 1	9.00 1	8.00	9.00	1.00	0.003	0.00	0.00	0.00
0.0	9	6 1	8.50 1	7.50	8.50	0.00	0.002	7.00	0.00	0.00
0.0	10	7 1	9.00 1	8.00	9.0010	0.00	0.00	0.00	0.00	0.00
0.0	11	7 1	9.00 1	8.00	9.0010	0.00	0.00	0.00	0.00	0.00
0.0	12	2 7	7.00 7	7.00 6	7.0010	00.00	0.00	0.00	0.00	0.00
0.	0									

// Distribution load that considers partial coefficient //

Load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
2	47.50	4.32	5.0	50.28	4.32	5.0	0.000	0.200	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	-2.30	
2	100.00	-2.30	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
30.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	2.548	904.7	355.1	
		15.50	2.548	2771.2	1087.7	
		16.50	2.377	5156.1	2169.4	
		17.50	2.132	7727.2	3624.0	
		18.50	3.969	21702.8	5468.0	
30.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	2.548	811.3	318.5	
		14.50	2.548	2499.5	981.1	
		15.50	2.376	4674.2	1967.1	
		16.50	2.131	7036.4	3301.8	
		17.50	3.980	19912.7	5003.6	
30.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	2.548	721.3	283.1	
		13.50	2.548	2237.3	878.2	
		14.50	2.376	4208.3	1771.5	
		15.50	2.130	6367.6	2989.8	
		16.50	3.992	18175.0	4553.3	
30.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	2.548	635.0	249.2	
		12.50	2.548	1985.1	779.2	
		13.50	2.375	3759.1	1582.9	
		14.50	2.128	5721.6	2688.3	
		15.50	4.005	16491.4	4117.4	
30.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
		11.50	2.548	1743.1	684.2	
		12.50	2.374	3327.2	1401.5	
		13.50	2.127	5099.2	2397.9	
		14.50	4.021	14863.7	3696.6	
30.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
		11.50	2.373	2913.4	1227.7	
		12.50	2.125	4501.4	2118.7	
		13.50	4.039	13293.9	3291.3	
30.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
		9.50	2.548	1291.9	507.1	
		10.50	2.372	2518.4	1061.8	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
30.00	7.50	11.50	2.122	3929.3	1851.5	
		12.50	4.060	11784.3	2902.3	
30.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
		9.50	2.370	2143.2	904.1	
		10.50	2.119	3384.0	1596.7	
		11.50	4.086	10337.3	2530.2	
30.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
		10.50	4.116	8956.0	2175.8	
30.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	
		8.50	2.112	2380.0	1127.1	
		9.50	4.154	7643.5	1840.1	
31.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	2.548	904.7	355.1	
		15.50	2.548	2771.2	1087.7	
		16.50	2.377	5156.1	2169.4	
		17.50	2.132	7727.2	3624.0	
31.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	2.548	811.3	318.5	
		14.50	2.548	2499.5	981.1	
		15.50	2.376	4674.2	1967.1	
		16.50	2.131	7036.4	3301.8	
		17.50	3.980	19912.7	5003.6	
31.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	2.548	721.3	283.1	
		13.50	2.548	2237.3	878.2	
		14.50	2.376	4208.3	1771.5	
		15.50	2.130	6367.6	2989.8	
		16.50	3.992	18175.0	4553.3	
31.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	2.548	635.0	249.2	
		12.50	2.548	1985.1	779.2	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
31.00	10.50	13.50	2.375	3759.1	1582.9	
		14.50	2.128	5721.6	2688.3	
		15.50	4.005	16491.4	4117.4	
31.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
		11.50	2.548	1743.1	684.2	
		12.50	2.374	3327.2	1401.5	
		13.50	2.127	5099.2	2397.9	
		14.50	4.021	14863.7	3696.6	
31.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
		11.50	2.373	2913.4	1227.7	
		12.50	2.125	4501.4	2118.7	
		13.50	4.039	13293.9	3291.3	
31.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
		9.50	2.548	1291.9	507.1	
		10.50	2.372	2518.4	1061.8	
		11.50	2.122	3929.3	1851.5	
		12.50	4.060	11784.3	2902.3	
31.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
		9.50	2.370	2143.2	904.1	
		10.50	2.119	3384.0	1596.7	
		11.50	4.086	10337.3	2530.2	
31.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
		10.50	4.116	8956.0	2175.8	
31.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	
		8.50	2.112	2380.0	1127.1	
		9.50	4.154	7643.5	1840.1	
32.00	13.50	13.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
32.00	13.50	14.50	2.548	904.7	355.1	
		15.50	2.548	2771.2	1087.7	
		16.50	2.377	5156.1	2169.4	
		17.50	2.132	7727.2	3624.0	
32.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	2.548	811.3	318.5	
		14.50	2.548	2499.5	981.1	
		15.50	2.376	4674.2	1967.1	
32.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	2.548	721.3	283.1	
		13.50	2.548	2237.3	878.2	
		14.50	2.376	4208.3	1771.5	
		15.50	2.130	6367.6	2989.8	
32.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	2.548	635.0	249.2	
		12.50	2.548	1985.1	779.2	
		13.50	2.375	3759.1	1582.9	
		14.50	2.128	5721.6	2688.3	
		15.50	4.005	16491.4	4117.4	
32.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
		11.50	2.548	1743.1	684.2	
		12.50	2.374	3327.2	1401.5	
		13.50	2.127	5099.2	2397.9	
		14.50	4.021	14863.7	3696.6	
32.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
		11.50	2.373	2913.4	1227.7	
		12.50	2.125	4501.4	2118.7	
		13.50	4.039	13293.9	3291.3	
32.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
		9.50	2.548	1291.9	507.1	
		10.50	2.372	2518.4	1061.8	
		11.50	2.122	3929.3	1851.5	
		12.50	4.060	11784.3	2902.3	
32.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
32.00	6.50	9.50	2.370	2143.2	904.1	
		10.50	2.119	3384.0	1596.7	
		11.50	4.086	10337.3	2530.2	
32.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
		10.50	4.116	8956.0	2175.8	
32.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	
		8.50	2.112	2380.0	1127.1	
		9.50	4.154	7643.5	1840.1	
33.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	2.548	904.7	355.1	
		15.50	2.548	2771.2	1087.7	
		16.50	2.377	5156.1	2169.4	
33.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	2.548	811.3	318.5	
		14.50	2.548	2499.5	981.1	
		15.50	2.376	4674.2	1967.1	
33.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	2.548	721.3	283.1	
		13.50	2.548	2237.3	878.2	
		14.50	2.376	4208.3	1771.5	
		15.50	2.130	6367.6	2989.8	
33.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	2.548	635.0	249.2	
		12.50	2.548	1985.1	779.2	
		13.50	2.375	3759.1	1582.9	
		14.50	2.128	5721.6	2688.3	
33.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
		11.50	2.548	1743.1	684.2	
		12.50	2.374	3327.2	1401.5	
		13.50	2.127	5099.2	2397.9	
		14.50	4.021	14863.7	3696.6	
33.00	8.50	8.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
33.00	8.50	9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
		11.50	2.373	2913.4	1227.7	
		12.50	2.125	4501.4	2118.7	
		13.50	4.039	13293.9	3291.3	
33.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
		9.50	2.548	1291.9	507.1	
		10.50	2.372	2518.4	1061.8	
		11.50	2.122	3929.3	1851.5	
		12.50	4.060	11784.3	2902.3	
33.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
		9.50	2.370	2143.2	904.1	
		10.50	2.119	3384.0	1596.7	
		11.50	4.086	10337.3	2530.2	
33.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
		10.50	4.116	8956.0	2175.8	
33.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	
		8.50	2.112	2380.0	1127.1	
		9.50	4.154	7643.5	1840.1	
34.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	2.548	904.7	355.1	
		15.50	2.548	2771.2	1087.7	
34.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	2.548	811.3	318.5	
		14.50	2.548	2499.5	981.1	
34.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	2.548	721.3	283.1	
		13.50	2.548	2237.3	878.2	
		14.50	2.376	4208.3	1771.5	
34.00	10.50	10.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
34.00	10.50	11.50	2.548	635.0	249.2	
		12.50	2.548	1985.1	779.2	
		13.50	2.375	3759.1	1582.9	
34.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
		11.50	2.548	1743.1	684.2	
		12.50	2.374	3327.2	1401.5	
		13.50	2.127	5099.2	2397.9	
34.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
		11.50	2.373	2913.4	1227.7	
		12.50	2.125	4501.4	2118.7	
		13.50	4.039	13293.9	3291.3	
34.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
		9.50	2.548	1291.9	507.1	
		10.50	2.372	2518.4	1061.8	
		11.50	2.122	3929.3	1851.5	
		12.50	4.060	11784.3	2902.3	
34.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
		9.50	2.370	2143.2	904.1	
		10.50	2.119	3384.0	1596.7	
		11.50	4.086	10337.3	2530.2	
34.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
		10.50	4.116	8956.0	2175.8	
34.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	
		8.50	2.112	2380.0	1127.1	
		9.50	4.154	7643.5	1840.1	
35.00	13.50	13.50	999.000	0.0	0.0	***6
		14.50	2.548	904.7	355.1	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	2.548	811.3	318.5	
		14.50	2.548	2499.5	981.1	
35.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	2.548	721.3	283.1	
		13.50	2.548	2237.3	878.2	
35.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	2.548	635.0	249.2	
		12.50	2.548	1985.1	779.2	
		13.50	2.375	3759.1	1582.9	
35.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
		11.50	2.548	1743.1	684.2	
		12.50	2.374	3327.2	1401.5	
35.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
		11.50	2.373	2913.4	1227.7	
		12.50	2.125	4501.4	2118.7	
35.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
		9.50	2.548	1291.9	507.1	
		10.50	2.372	2518.4	1061.8	
		11.50	2.122	3929.3	1851.5	
35.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
		9.50	2.370	2143.2	904.1	
		10.50	2.119	3384.0	1596.7	
		11.50	4.086	10337.3	2530.2	
35.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
		10.50	4.116	8956.0	2175.8	
35.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
35.00	4.50	8.50	2.112	2380.0	1127.1	
		9.50	4.154	7643.5	1840.1	
36.00	13.50	13.50	999.000	0.0	0.0	***6
36.00	12.50	12.50	999.000	0.0	0.0	***6
		13.50	2.548	811.3	318.5	
36.00	11.50	11.50	999.000	0.0	0.0	***6
		12.50	2.548	721.3	283.1	
36.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	2.548	635.0	249.2	
		12.50	2.548	1985.1	779.2	
36.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
		11.50	2.548	1743.1	684.2	
36.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
		11.50	2.373	2913.4	1227.7	
36.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
		9.50	2.548	1291.9	507.1	
		10.50	2.372	2518.4	1061.8	
36.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
		9.50	2.370	2143.2	904.1	
		10.50	2.119	3384.0	1596.7	
36.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
36.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	
		8.50	2.112	2380.0	1127.1	
		9.50	4.154	7643.5	1840.1	
37.00	13.50	13.50	999.000	0.0	0.0	***6
37.00	12.50	0.00	0.001	0.0	0.0	***5
37.00	11.50	11.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
37.00	10.50	10.50	999.000	0.0	0.0	***6
		11.50	2.548	635.0	249.2	
37.00	9.50	9.50	999.000	0.0	0.0	***6
		10.50	2.548	552.4	216.8	
37.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
		10.50	2.548	1511.9	593.5	
37.00	7.50	0.00	0.001	0.0	0.0	***5
37.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
		9.50	2.370	2143.2	904.1	
37.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
		9.50	2.116	2867.0	1355.0	
37.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
		7.50	2.366	1457.0	615.7	
		8.50	2.112	2380.0	1127.1	
38.00	13.50	12.89	999.000	0.0	0.0	***6
38.00	12.50	0.00	0.001	0.0	0.0	***5
38.00	11.50	11.50	999.000	0.0	0.0	***6
38.00	10.50	10.50	999.000	0.0	0.0	***6
38.00	9.50	9.50	999.000	0.0	0.0	***6
38.00	8.50	8.50	999.000	0.0	0.0	***6
		9.50	2.548	473.7	185.9	
38.00	7.50	0.00	0.001	0.0	0.0	***5
38.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
		8.50	2.548	1083.9	425.4	
38.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
		8.50	2.369	1788.9	755.3	
38.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
38.00	4.50	7.50	2.366	1457.0	615.7	
39.00	13.50	12.21	999.000	0.0	0.0	***6
39.00	12.50	0.00	0.001	0.0	0.0	***5
39.00	11.50	10.79	999.000	0.0	0.0	***6
39.00	10.50	10.15	999.000	0.0	0.0	***6
39.00	9.50	9.50	999.000	0.0	0.0	***6
39.00	8.50	8.50	999.000	0.0	0.0	***6
39.00	7.50	7.50	999.000	0.0	0.0	***6
		8.50	2.548	399.1	156.7	
39.00	6.50	6.50	999.000	0.0	0.0	***6
		7.50	2.548	329.0	129.1	
39.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
		7.50	2.548	888.4	348.7	
39.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		6.50	2.548	706.5	277.3	
40.00	13.50	11.57	999.000	0.0	0.0	***6
40.00	12.50	10.80	999.000	0.0	0.0	***6
40.00	11.50	10.06	999.000	0.0	0.0	***6
40.00	10.50	9.38	999.000	0.0	0.0	***6
40.00	9.50	8.75	999.000	0.0	0.0	***6
40.00	8.50	8.20	999.000	0.0	0.0	***6
40.00	7.50	7.50	999.000	0.0	0.0	***6
40.00	6.50	6.50	999.000	0.0	0.0	***6
40.00	5.50	5.50	999.000	0.0	0.0	***6
		6.50	2.548	263.5	103.4	
40.00	4.50	4.50	999.000	0.0	0.0	***6
		5.50	2.548	203.1	79.7	
		9.50	1.886	8366.5	4435.0	
41.00	13.50	10.99	999.000	0.0	0.0	***6
41.00	12.50	10.17	999.000	0.0	0.0	***6
41.00	11.50	9.39	999.000	0.0	0.0	***6
41.00	10.50	8.65	999.000	0.0	0.0	***6
41.00	9.50	7.96	999.000	0.0	0.0	***6
41.00	8.50	7.35	999.000	0.0	0.0	***6
41.00	7.50	6.83	999.000	0.0	0.0	***6
41.00	6.50	6.39	999.000	0.0	0.0	***6
41.00	5.50	5.50	999.000	0.0	0.0	***6
41.00	4.50	4.50	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
42.00	13.50	10.48	999.000	0.0	0.0	***6
42.00	12.50	0.00	0.001	0.0	0.0	***5
42.00	11.50	0.00	0.001	0.0	0.0	***5
42.00	10.50	7.98	999.000	0.0	0.0	***6
42.00	9.50	7.23	999.000	0.0	0.0	***6
42.00	8.50	6.56	999.000	0.0	0.0	***6
42.00	7.50	0.00	0.001	0.0	0.0	***5
42.00	6.50	5.49	999.000	0.0	0.0	***6
42.00	5.50	5.04	999.000	0.0	0.0	***6
42.00	4.50	4.50	999.000	0.0	0.0	***6
43.00	13.50	10.03	999.000	0.0	0.0	***6
43.00	12.50	9.13	999.000	0.0	0.0	***6
43.00	11.50	8.24	999.000	0.0	0.0	***6
43.00	10.50	7.39	999.000	0.0	0.0	***6
43.00	9.50	6.58	999.000	0.0	0.0	***6
43.00	8.50	5.82	999.000	0.0	0.0	***6
43.00	7.50	0.00	0.001	0.0	0.0	***5
43.00	6.50	4.60	999.000	0.0	0.0	***6
43.00	5.50	4.15	999.000	0.0	0.0	***6
43.00	4.50	3.70	999.000	0.0	0.0	***6
44.00	13.50	9.67	999.000	0.0	0.0	***6
44.00	12.50	8.73	999.000	0.0	0.0	***6
44.00	11.50	7.80	999.000	0.0	0.0	***6
44.00	10.50	6.89	999.000	0.0	0.0	***6
44.00	9.50	6.01	999.000	0.0	0.0	***6
44.00	8.50	5.17	999.000	0.0	0.0	***6
44.00	7.50	0.00	0.001	0.0	0.0	***5
44.00	6.50	3.75	999.000	0.0	0.0	***6
44.00	5.50	3.26	999.000	0.0	0.0	***6
44.00	4.50	2.81	999.000	0.0	0.0	***6
45.00	13.50	9.41	999.000	0.0	0.0	***6
45.00	12.50	8.43	999.000	0.0	0.0	***6
45.00	11.50	7.47	999.000	0.0	0.0	***6
45.00	10.50	6.51	999.000	0.0	0.0	***6
45.00	9.50	5.57	999.000	0.0	0.0	***6
45.00	8.50	4.66	999.000	0.0	0.0	***6
45.00	7.50	0.00	0.001	0.0	0.0	***5
45.00	6.50	2.99	999.000	0.0	0.0	***6
45.00	5.50	2.37	999.000	0.0	0.0	***6
45.00	4.50	1.91	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
46.00	13.50	9.24	999.000	0.0	0.0	***6
46.00	12.50	8.25	999.000	0.0	0.0	***6
46.00	11.50	7.26	999.000	0.0	0.0	***6
46.00	10.50	6.27	999.000	0.0	0.0	***6
46.00	9.50	5.29	999.000	0.0	0.0	***6
46.00	8.50	4.31	999.000	0.0	0.0	***6
46.00	7.50	3.35	999.000	0.0	0.0	***6
46.00	6.50	0.00	0.001	0.0	0.0	***5
46.00	5.50	1.58	999.000	0.0	0.0	***6
46.00	4.50	0.00	0.001	0.0	0.0	***5
47.00	13.50	9.18	999.000	0.0	0.0	***6
47.00	12.50	0.00	0.001	0.0	0.0	***5
47.00	11.50	0.00	0.001	0.0	0.0	***5
47.00	10.50	6.18	999.000	0.0	0.0	***6
47.00	9.50	5.18	999.000	0.0	0.0	***6
47.00	8.50	4.18	999.000	0.0	0.0	***6
47.00	7.50	0.00	0.001	0.0	0.0	***5
47.00	6.50	2.18	999.000	0.0	0.0	***6
47.00	5.50	1.18	999.000	0.0	0.0	***6
47.00	4.50	0.00	0.001	0.0	0.0	***5
48.00	13.50	9.18	999.000	0.0	0.0	***6
48.00	12.50	0.00	0.001	0.0	0.0	***5
48.00	11.50	0.00	0.001	0.0	0.0	***5
48.00	10.50	6.18	999.000	0.0	0.0	***6
48.00	9.50	5.18	999.000	0.0	0.0	***6
48.00	8.50	4.18	999.000	0.0	0.0	***6
48.00	7.50	0.00	0.001	0.0	0.0	***5
48.00	6.50	2.18	999.000	0.0	0.0	***6
48.00	5.50	1.18	999.000	0.0	0.0	***6
48.00	4.50	0.18	999.000	0.0	0.0	***6
49.00	13.50	9.18	999.000	0.0	0.0	***6
49.00	12.50	0.00	0.001	0.0	0.0	***5
49.00	11.50	7.18	999.000	0.0	0.0	***6
49.00	10.50	6.18	999.000	0.0	0.0	***6
49.00	9.50	5.18	999.000	0.0	0.0	***6
49.00	8.50	4.18	999.000	0.0	0.0	***6
49.00	7.50	3.18	999.000	0.0	0.0	***6
49.00	6.50	2.18	999.000	0.0	0.0	***6
49.00	5.50	1.18	999.000	0.0	0.0	***6
49.00	4.50	0.18	999.000	0.0	0.0	***6

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	30.00	31.00	32.00	33.00	34.00	35.00
13.50	Fs	2.132	2.132	2.132	2.377	2.548	2.548
	R(m)	17.50	17.50	17.50	16.50	14.50	14.50
12.50	Fs	2.131	2.131	2.376	2.376	2.548	2.548
	R(m)	16.50	16.50	15.50	15.50	13.50	13.50
11.50	Fs	2.130	2.130	2.130	2.130	2.376	2.548
	R(m)	15.50	15.50	15.50	15.50	14.50	12.50
10.50	Fs	2.128	2.128	2.128	2.128	2.375	2.375
	R(m)	14.50	14.50	14.50	14.50	13.50	13.50
9.50	Fs	2.127	2.127	2.127	2.127	2.127	2.374
	R(m)	13.50	13.50	13.50	13.50	13.50	12.50
8.50	Fs	2.125	2.125	2.125	2.125	2.125	2.125
	R(m)	12.50	12.50	12.50	12.50	12.50	12.50
7.50	Fs	2.122	2.122	2.122	2.122	2.122	2.122
	R(m)	11.50	11.50	11.50	11.50	11.50	11.50
6.50	Fs	2.119	2.119	2.119	2.119	2.119	2.119
	R(m)	10.50	10.50	10.50	10.50	10.50	10.50
5.50	Fs	2.116	2.116	2.116	2.116	2.116	2.116
	R(m)	9.50	9.50	9.50	9.50	9.50	9.50
4.50	Fs	2.112	2.112	2.112	2.112	2.112	2.112
	R(m)	8.50	8.50	8.50	8.50	8.50	8.50

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	36.00	37.00	38.00	39.00	40.00	41.00
13.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
12.50	Fs	2.548	999.000	999.000	999.000	999.000	999.000
	R(m)	13.50	0.00	0.00	0.00	0.00	0.00
11.50	Fs	2.548	999.000	999.000	999.000	999.000	999.000
	R(m)	12.50	0.00	0.00	0.00	0.00	0.00
10.50	Fs	2.548	2.548	999.000	999.000	999.000	999.000
	R(m)	11.50	11.50	0.00	0.00	0.00	0.00
9.50	Fs	2.548	2.548	999.000	999.000	999.000	999.000
	R(m)	10.50	10.50	0.00	0.00	0.00	0.00
8.50	Fs	2.373	2.548	2.548	999.000	999.000	999.000
	R(m)	11.50	10.50	9.50	0.00	0.00	0.00
7.50	Fs	2.372	999.000	999.000	2.548	999.000	999.000
	R(m)	10.50	0.00	0.00	8.50	0.00	0.00
6.50	Fs	2.119	2.370	2.548	2.548	999.000	999.000
	R(m)	10.50	9.50	7.50	7.50	0.00	0.00
5.50	Fs	2.116	2.116	2.369	2.548	2.548	999.000
	R(m)	9.50	9.50	8.50	7.50	6.50	0.00
4.50	Fs	2.112	2.112	2.366	2.548	1.886	999.000
	R(m)	8.50	8.50	7.50	5.50	9.50	0.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	42.00	43.00	44.00	45.00	46.00	47.00
13.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
12.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
11.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
10.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
9.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
8.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
7.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
6.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
5.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
4.50	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

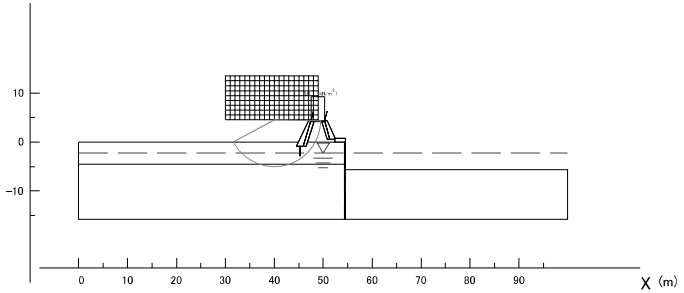
Y(m)	X(m)	48.00	49.00
13.50	Fs	999.000	999.000
	R(m)	0.00	0.00
12.50	Fs	999.000	999.000
	R(m)	0.00	0.00
11.50	Fs	999.000	999.000
	R(m)	0.00	0.00
10.50	Fs	999.000	999.000
	R(m)	0.00	0.00
9.50	Fs	999.000	999.000
	R(m)	0.00	0.00
8.50	Fs	999.000	999.000
	R(m)	0.00	0.00
7.50	Fs	999.000	999.000
	R(m)	0.00	0.00
6.50	Fs	999.000	999.000
	R(m)	0.00	0.00
5.50	Fs	999.000	999.000
	R(m)	0.00	0.00
4.50	Fs	999.000	999.000
	R(m)	0.00	0.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	1.886
Failure circle X(m)	=	40.00
Y(m)	=	4.50
R(m)	=	9.500
Resisting moment(kNm)	=	8366.5
Sliding moment(kNm)	=	4435.0
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



WARNING ***5 There are no arc contacting with base line.
count = 21

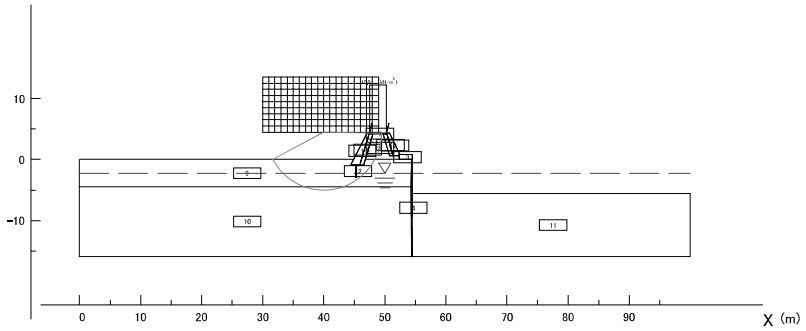
WARNING ***6 An arc does not cut the ground,
or An arc cuts the side of a model. count =179

Test of Embankment Stability

Action number = 1
Action name : normal
Examination at earthquake : It doesn't do.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	3.690	≧ 1.0 (OK)
Center of arc	X	=	40.00	(m)
	Y	=	4.50	(m)
Radius	R	=	9.500	(m)
Resisting moment	M_R	=	8593.7	(kNm)
Sliding moment	M_D	=	2329.1	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	24.00	24.00	0.00	1000.00	0.00	0.000	0.000
2	24.00	24.00	0.00	1000.00	0.00	0.000	0.000
3	24.00	24.00	0.00	1000.00	0.00	0.000	0.000
4	77.00	77.00	0.00	1000.00	0.00	0.000	0.000
5	20.00	19.00	35.00	0.00	0.00	0.000	0.000
6	20.00	19.00	35.00	0.00	0.00	0.000	0.000
7	24.00	24.00	30.00	1.00	0.00	0.000	0.000
8	19.00	18.00	30.00	1.00	0.00	0.000	0.000
9	18.50	17.50	27.00	0.00	0.00	0.000	0.000
10	19.00	18.00	0.00	100.00	0.00	0.000	0.000
11	19.00	18.00	0.00	100.00	0.00	0.000	0.000
12	77.00	77.00	0.00	1000.00	0.00	0.000	0.000

Water unit weight = 10.00 (kN/m³)

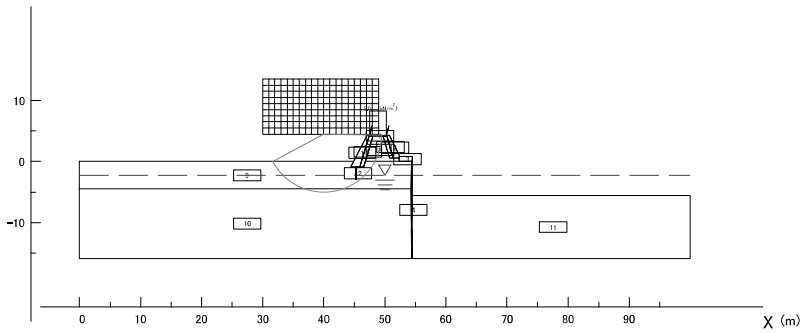
Safety Factor (Ordinary Condition)

Test of Embankment Stability

Action number = 2
Action name : seismic
Examination at earthquake : It does.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	1.886	≧ 1.0 (OK)
Center of arc	X	=	40.00	(m)
	Y	=	4.50	(m)
Radius	R	=	9.500	(m)
Resisting moment	M_R	=	8366.5	(kNm)
Sliding moment	M_D	=	4435.0	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
2	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
3	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
4	77.00	77.00	0.00	1000.00	0.00	0.200	0.000
5	20.00	19.00	35.00	0.00	0.00	0.200	0.000
6	20.00	19.00	35.00	0.00	0.00	0.200	0.000
7	24.00	24.00	30.00	1.00	0.00	0.200	0.000
8	19.00	18.00	30.00	1.00	0.00	0.200	0.000
9	18.50	17.50	27.00	0.00	0.00	0.200	0.000
10	19.00	18.00	0.00	100.00	0.00	0.200	0.000
11	19.00	18.00	0.00	100.00	0.00	0.200	0.000
12	77.00	77.00	0.00	1000.00	0.00	0.200	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Seismic Condition)

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.1　Normal and Seismic Conditions

(5)　R6+060

Circular Slip Surface

R+6060

Contents

Page

1. Input Data 1

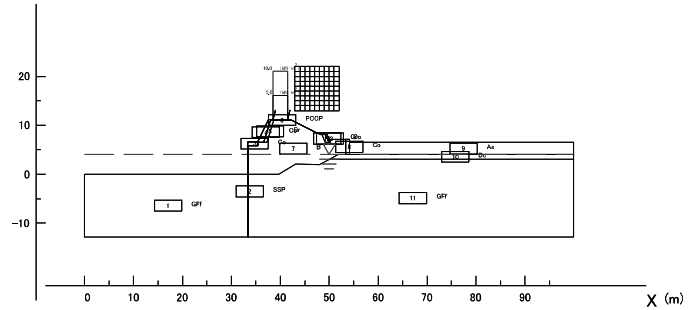
2. Check list 14

3. Action 01 Result list ... 15

4. Action 02 Result list ... 23

1. Input data list

// Design section //



// Design level of reliability design method //

Level of reliability design ..... Level 1(Design for value, part coefficient method)

// Combination of action //

// Setting of action //

Action	Action name	Seismic inertia	Newmark No.	Same hydraul-ic line
1	normal			
2	seismic	○		

// Partial coefficient concerning analytical technique γ_α //

Action No.	Partial coefficient concerning analytical technique γ_α
1	1.00
2	1.00

// Partial coefficient concerning W,C,ϕ $\gamma w, \gamma c, \gamma \tan\phi$ //

No.	Action 1			Action 2											
	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$			
1	1.00	1.00	1.00	1.00	1.00	1.00									
2	1.00	1.00	1.00	1.00	1.00	1.00									
3	1.00	1.00	1.00	1.00	1.00	1.00									
4	1.00	1.00	1.00	1.00	1.00	1.00									
5	1.00	1.00	1.00	1.00	1.00	1.00									
6	1.00	1.00	1.00	1.00	1.00	1.00									
7	1.00	1.00	1.00	1.00	1.00	1.00									
8	1.00	1.00	1.00	1.00	1.00	1.00									
9	1.00	1.00	1.00	1.00	1.00	1.00									
10	1.00	1.00	1.00	1.00	1.00	1.00									
11	1.00	1.00	1.00	1.00	1.00	1.00									
12	1.00	1.00	1.00	1.00	1.00	1.00									
13	1.00	1.00	1.00	1.00	1.00	1.00									

$$M = \Sigma [C_d l + \{ (W_d' + q_d) \cos\theta - K_k W_d \sin\theta \} \tan\phi_d]$$

$$W_d' = \gamma_w W_k'$$

$$C_d = \gamma_c C_k$$

$$\tan\phi_d = \gamma_{\tan\phi} \tan\phi_k$$

- M : Resistance moment
- γ_w : Partial coefficient concerning weight
- W_d' : Effective weight of slice of amount for each unit length splinter (value for design) (kN/m)
- W_k' : Effective weight of slice of amount for each unit length splinter (characteristic value)(kN/m)
- q_d : Perpendicular action because of the upper part of amount of slice (kN/m)
- γ_c : Partial coefficient concerning Cohesion
- C_d : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (value for design) (kN/m²)
- C_k : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (characteristic value) (kN/m²)
- l : Length in base of amount of Slice (m)
- $\gamma_{\tan\phi}$: Partial coefficient concerning shearing resistance angle
- ϕ_d : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(value for design)(°)
- ϕ_k : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(characteristic value)(°)

// Partial coefficient of partial coefficient γ_{vl} to distribution load (Think as well as the ground) and inertia force γ_{vlEQ} //

Action No.	Load1		Load2							
	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force
1	1.00	1.00	−	−						
2	−	−	1.00	1.00						

$$M_{r,vl} = K \cdot r \Sigma (FR \cdot \gamma_{vl,i} - K_{hp} \cdot FO \cdot \gamma_{vlEQ,i}) \cdot \tan\phi$$

$$M_{d,vl} = r \Sigma (FO \cdot \gamma_{vl,i} + K_{hp} \cdot FR \cdot \gamma_{vlEQ,i})$$

$$FR = F \cdot \cos\theta$$

$$FO = F \cdot \sin\theta$$

- $M_{r,vl}$: Resistance moment of distribution load (Think as well as the ground)
- $M_{d,vl}$: Sliding moment of distribution load (Think as well as the ground)
- K : Resistance power coefficient
- r : Radius of slipping circular arc
- F : Distribution load i
- FR : Slipping line orthogonalization direction load value of load i
- FO : Slipping line direction load value of load i
- θ : Angle that slice bottom (slide surface) does to the horizontal
- $\gamma_{vl,i}$: Partial coefficient of distribution load i (Think as well as the ground).
- K_{hp} : The horizontal seismic intensity
- $\gamma_{vlEQ,i}$: Partial coefficient of inertia force of distribution load i (Think as well as the ground).
- ϕ : Internal friction angle of soil

// Partial coefficient to residual water level //

Action number	rRWL
1	1.00
2	1.00

$$RWL_d = \gamma_{RWL} RWL_k$$

- γ_{RWL} : Partial coefficient concerning residual water level
- RWL_d : Difference between residual water level and water level line (value for design) (m)
- RWL_k : Difference between residual water level and water level line (input value) (m)

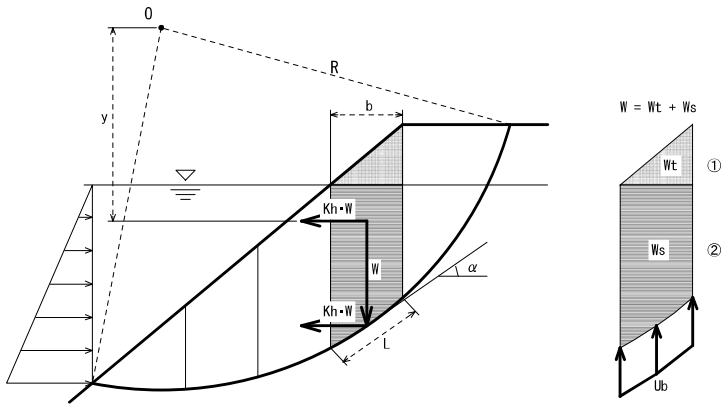
(DATA 01.)　// ANALYSIS //

Title　.....　Test of Embankment Stability
Analysis type　.....　Analysis of Bearing force Action ratio
Calculation method .....　Revised Feleniu s (Total stress)

Expression

$$\frac{R\Sigma[C_d l+\{((1+K_v)W_d-u\,b)\cos\theta-K_h W_d\sin\theta\}\tan\phi_d]}{\gamma_a R\Sigma\{(1+K_v)W_d\sin\theta+K_h W_d\cos\theta\}} \geqq 1.0$$

R　: Radius of slipping circle of circular arc (m)
C_d　: Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (kN/m²)
l　: Length in base of amount of crack splinter (m)
q_d　: Perpendicular action because of the upper part of amount of crack splinter (kN/m)
θ　: Angle that amount of crack splinter bottom does to a horizontal plane (degree)
ϕ_d　: 0 in case of viscous land board. Shearing resistance in drain condition in case of the sandy soil ground etc.(°)
W_d　: Full weight of crack of amount for each unit length splinter (full weight of soil and water) (kN/m)
γ_a　: Partial coefficient concerning analytical technique
K_h　: The horizontal seismic intensity
K_v　: Vertical seismic coefficient
u　: Pore pressure (kN/m²)
b　: Width of slice (m)



Treatment of its own weight W of the resistance force
　Above the water level.....Calculate the weight Wt in Wet weight γt　①
　Below the water level.....Calculate weight Ws in Saturated weight γsat　②
Treatment of its own weight W of impetus
　Above the water level.....Calculate the weight Wt in Wet weight γt
　Below the water level.....Calculate weight in Saturated weight γsat
Water pressure acting on the slip plane.....Consider in the Ubcosα
　(Modify Fereniusu method)
Lateral hydrostatic pressure due to water storage.....Including

(DATA 02.)　// CONTROL //

Second pursuit　.....　0 (=0 No)
　(>0 Yes　)
Run　.....　0 (=0 Input data check + Analysis)
　(=1 Input data check　)

(DATA 04.) // SEISMIC LOAD //

```
Seismic load                .....  0 ( =0 Same for the whole model )
                                     ( =1 Different on each layer  )
Condition                   .....  1 ( =0 Acts on only sliding force )
                                     ( =1 Sliding + Resisting force  )
Acting point                .....  0 ( =0 On the slip surface              )
                                     ( =1 Center of gravity of sliding mass )
                                     ( =2 Resisting:on the slip surface
                                          Sliding  :Center of gravity of sliding mass )
Unit weight                 .....  0 ( =0 Saturated weight )
                                     ( =1 Submerged weight )
Horizontal seismic coefficient.....  0.200
Vertical seismic coefficient  .....  0.000
```


(DATA 06.) // NODAL POINT //

No.	Coordinate		Y-coordinate
	x (m)	y (m)	before settlement (m)
1	0.00	0.00	0.00
2	33.34	0.00	0.00
3	33.34	5.85	0.00
4	33.34	6.65	0.00
5	33.49	5.85	0.00
6	35.34	6.65	0.00
7	35.49	6.50	0.00
8	37.59	11.15	0.00
9	38.04	11.15	0.00
10	37.98	10.95	0.00
11	38.61	10.95	0.00
12	42.04	11.15	0.00
13	42.04	10.95	0.00
14	35.49	5.85	0.00
15	36.65	6.50	0.00
16	37.27	6.50	0.00
17	50.00	7.17	0.00
18	53.36	7.17	0.00
19	54.15	7.17	0.00
20	100.00	6.50	0.00
21	100.00	4.03	0.00
22	54.15	4.03	0.00
23	53.36	4.03	0.00
24	51.88	4.03	0.00
25	50.04	3.08	0.00
26	47.97	2.01	0.00
27	43.17	2.04	0.00
28	39.74	0.00	0.00
29	33.49	0.00	0.00
30	100.00	3.08	0.00
31	100.00	-12.83	0.00
32	33.49	-12.83	0.00
33	33.34	-12.83	0.00
34	0.00	-12.83	0.00
35	54.15	6.50	0.00
36	48.20	8.07	0.00
37	48.49	8.07	0.00
38	49.16	8.07	0.00
39	49.55	8.07	0.00
40	50.25	6.67	0.00
41	50.25	6.52	0.00
42	49.93	6.52	0.00

(DATA 06.) // NODAL POINT //

No.	Coordinate		Y-coordinate
	x (m)	y (m)	before settlement (m)
43	49.17	6.52	0.00

(DATA 07.) // WATER LEVEL //

Unit weight of water (kN/m³) = 10.00

Action No.	Water level line number
1	1
2	1

Water level line number: 1

No.	Coordinate	
	X (m)	Y (m)
1	0.00	4.03
2	100.00	4.03

Water level line number: 2

No.	Coordinate	
	X (m)	Y (m)
1	0.00	0.00
2	150.00	0.00

(DATA 08.) // LAYER //

No.	material property No.	The name of the strata
1	8	GFf
2	2	SSP

No.	material property No.	The name of the strata
3	1	Co
4	1	Co
5	3	Gr
6	4	PCCP
7	5	B
8	1	Co
9	6	As
10	7	Dc
11	8	GFf
12	1	Co
13	3	Gr

No.	Num of Node	Node numbers composing a layer											Slip existence
1	4	1	34	33	2								Slip
2	6	2	33	32	29	5	3						Not Slip
3	6	3	5	14	7	6	4						Not Slip
4	6	6	7	15	10	9	8						Not Slip
5	4	10	15	16	11								Slip
6	5	9	10	11	13	12							Slip
7	23	5	29	28	27	26	25	24	23	18	17	40	Slip
		41	42	43	37	36	12	13	11	16	15	7	
		14											
8	4	18	23	22	19								Not Slip
9	4	35	22	21	20								Slip
10	6	21	22	23	24	25	30						Slip
11	8	25	26	27	28	29	32	31	30				Slip
12	6	38	42	41	40	17	39						Not Slip
13	4	37	43	42	38								Slip

(DATA 09.1) // MATERIAL PROPERTIES //

No.	Nature of soil division	Saturated weight (kN/m³)	Wet weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	Co	24.00	24.00	******	0.00	0.00	0.00	0.000	0.0
2	SSP	77.00	77.00	******	0.00	0.00	0.00	0.000	0.0
3	Gr	20.00	19.00	0.00	0.00	35.00	0.00	0.000	0.0
4	PCCP	24.00	24.00	1.00	0.00	30.00	0.00	0.000	0.0
5	B	19.00	18.00	1.00	0.00	30.00	0.00	0.000	0.0
6	As	18.50	17.50	0.00	0.00	27.00	0.00	0.000	0.0

(DATA 09.1)　// MATERIAL PROPERTIES //

No.	Nature of soil division	Saturated weight (kN/m³)	Wet weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
7	Dc	19.00	18.00	50.00	0.00	0.00	0.00	0.000	0.0
8	GFf	18.00	17.00	******	0.00	30.00	0.00	0.000	0.0

(DATA 09.2)　// Characteristic of soil //

No.	Action Number									
	Act 1	Act 2								
1	8	8								
2	2	2								
3	1	1								
4	1	1								
5	3	3								
6	4	4								
7	5	5								
8	1	1								
9	6	6								
10	7	7								
11	8	8								
12	1	1								
13	3	3								

(DATA 11.)　// GRID POINT //

No.	Slip direction	Double cutting	GX (m)	GY (m)	X-point	Y-point	X-pitch (m)	Y-pitch (m)	Dx/Dy	NEXCO Radius
1	Downstream	Rigtlump	43.00	22.00	10	10	1.00	1.00	0.000	0.000

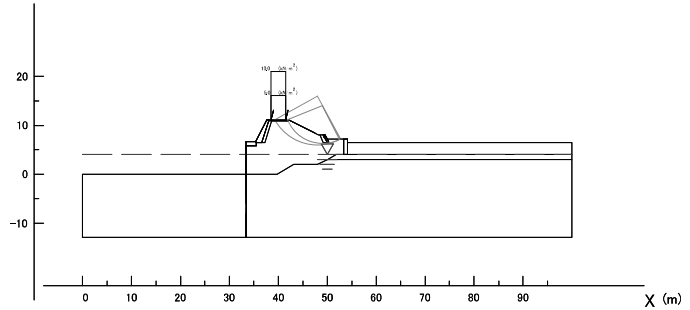
2. Check list

// Check of circular arc //

Action No.	Action name	Bearing force Action ratio	Judgment
1	normal	1.682	OK
2	seismic	1.033	OK

Action No.	Bearing force Action ratio	Partial coefficient r_a	Center of slipping circular arc X (m)	Center of slipping circular arc Y (m)	Radius of circular arc(m)	Resistance Moment (kNm)	Sliding Moment (kNm)
1	1.682	1.00	48.00	16.00	10.003	2867.1	1705.1
2	1.033	1.00	49.00	14.00	7.662	1123.6	1087.5

// Check Result chart //



3. Action01 (normal)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0	2	2 77.0	0 77.0	0 67.0	01000.	00 0.	00 0.	00 0.	00 0.	00 0
0.0	3	1 24.	00 24.	00 14.	001000	0.00	0.00	0.00	0.00	0.00
0.0	4	1 24	0.00 2	0.00 1	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	5	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	6	4 2	4.00 2	4.00 1	4.00	1.00	0.003	0.00	0.00	0.00
0.0	7	5 1	9.00 1	8.00	9.00	1.00	0.003	0.00	0.00	0.00
0.0	8	1 2	4.00 2	4.00 1	4.0010	00.00	0.00	0.00	0.00	0.00
0.	0 9	6	18.50	17.50	8.50	0.00	0.00	27.00	0.00	0.00
0.	0 10	7	19.00	18.00	9.00	50.00	0.00	0.00	0.00	0.00
0.	0 11	8	18.00	17.00	8.001	000.00	0.0	030.00	0.00	0.00
0	0.0 1	1	24.00	24.00	14.00	1000.0	0 0.	00 0.0	0 0.00	0.0
0	0.0 1	3	3 20.0	0 19.0	0 10.0	0 0.0	0 0.	0035.0	0 0.00	0.0
0	0.0									

// Distribution load that considers partial coefficient //

Load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
1	38.50	11.15	10.0	41.50	11.15	10.0	0.000	0.000	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	4.03	
2	100.00	4.03	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
43.00	22.00	0.00	0.001	0.0	0.0	***5
43.00	21.00	0.00	0.001	0.0	0.0	***5
43.00	20.00	0.00	0.001	0.0	0.0	***5
43.00	19.00	0.00	0.001	0.0	0.0	***5
43.00	18.00	0.00	0.001	0.0	0.0	***5
43.00	17.00	0.00	0.001	0.0	0.0	***5
43.00	16.00	0.00	0.001	0.0	0.0	***5
43.00	15.00	0.00	0.001	0.0	0.0	***5
43.00	14.00	0.00	0.001	0.0	0.0	***5
43.00	13.00	0.00	0.001	0.0	0.0	***5
44.00	22.00	0.00	0.001	0.0	0.0	***5
44.00	21.00	0.00	0.001	0.0	0.0	***5
44.00	20.00	0.00	0.001	0.0	0.0	***5
44.00	19.00	0.00	0.001	0.0	0.0	***5
44.00	18.00	0.00	0.001	0.0	0.0	***5
44.00	17.00	0.00	0.001	0.0	0.0	***5
44.00	16.00	0.00	0.001	0.0	0.0	***5
44.00	15.00	0.00	0.001	0.0	0.0	***5
44.00	14.00	0.00	0.001	0.0	0.0	***5
44.00	13.00	0.00	0.001	0.0	0.0	***5
45.00	22.00	0.00	0.001	0.0	0.0	***5
45.00	21.00	0.00	0.001	0.0	0.0	***5
45.00	20.00	0.00	0.001	0.0	0.0	***5
45.00	19.00	0.00	0.001	0.0	0.0	***5
45.00	18.00	0.00	0.001	0.0	0.0	***5
45.00	17.00	0.00	0.001	0.0	0.0	***5
45.00	16.00	0.00	0.001	0.0	0.0	***5
45.00	15.00	0.00	0.001	0.0	0.0	***5
45.00	14.00	0.00	0.001	0.0	0.0	***5
45.00	13.00	0.00	0.001	0.0	0.0	***5
46.00	22.00	0.00	0.001	0.0	0.0	***5
46.00	21.00	0.00	0.001	0.0	0.0	***5
46.00	20.00	0.00	0.001	0.0	0.0	***5
46.00	19.00	0.00	0.001	0.0	0.0	***5
46.00	18.00	0.00	0.001	0.0	0.0	***5
46.00	17.00	0.00	0.001	0.0	0.0	***5
46.00	16.00	0.00	0.001	0.0	0.0	***5
46.00	15.00	0.00	0.001	0.0	0.0	***5
46.00	14.00	0.00	0.001	0.0	0.0	***5
46.00	13.00	0.00	0.001	0.0	0.0	***5

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
47.00	22.00	0.00	0.001	0.0	0.0	***5
47.00	21.00	0.00	0.001	0.0	0.0	***5
47.00	20.00	0.00	0.001	0.0	0.0	***5
47.00	19.00	0.00	0.001	0.0	0.0	***5
47.00	18.00	0.00	0.001	0.0	0.0	***5
47.00	17.00	0.00	0.001	0.0	0.0	***5
47.00	16.00	0.00	0.001	0.0	0.0	***5
47.00	15.00	0.00	0.001	0.0	0.0	***5
47.00	14.00	8.77	1.872	3414.7	1824.3	
47.00	13.00	7.87	1.891	2921.9	1545.3	
48.00	22.00	0.00	0.001	0.0	0.0	***5
48.00	21.00	0.00	0.001	0.0	0.0	***5
48.00	20.00	0.00	0.001	0.0	0.0	***5
48.00	19.00	0.00	0.001	0.0	0.0	***5
48.00	18.00	0.00	0.001	0.0	0.0	***5
48.00	17.00	10.90	1.684	3189.2	1893.5	
48.00	16.00	10.00	1.682	2867.1	1705.1	
48.00	15.00	9.11	1.689	2533.7	1500.2	
48.00	14.00	8.21	1.715	2193.0	1278.6	
48.00	13.00	7.32	1.778	1850.3	1040.6	
49.00	22.00	0.00	0.001	0.0	0.0	***5
49.00	21.00	0.00	0.001	0.0	0.0	***5
49.00	20.00	0.00	0.001	0.0	0.0	***5
49.00	19.00	0.00	0.001	0.0	0.0	***5
49.00	18.00	0.00	0.001	0.0	0.0	***5
49.00	17.00	0.00	0.001	0.0	0.0	***5
49.00	16.00	0.00	0.001	0.0	0.0	***5
49.00	15.00	0.00	0.001	0.0	0.0	***5
49.00	14.00	7.66	1.712	1204.9	703.8	
49.00	13.00	0.00	0.001	0.0	0.0	***5
50.00	22.00	0.00	0.001	0.0	0.0	***5
50.00	21.00	0.00	0.001	0.0	0.0	***5
50.00	20.00	0.00	0.001	0.0	0.0	***5
50.00	19.00	0.00	0.001	0.0	0.0	***5
50.00	18.00	0.00	0.001	0.0	0.0	***5
50.00	17.00	0.00	0.001	0.0	0.0	***5
50.00	16.00	0.00	0.001	0.0	0.0	***5
50.00	15.00	11.94	4.790	17854.0	3727.2	
		12.00	7.067	26789.7	3791.0	
50.00	14.00	10.95	5.047	15915.6	3153.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
50.00	14.00	11.00	7.278	23358.4	3209.6	
50.00	13.00	9.95	5.473	14123.8	2580.7	
		10.00	7.647	20096.7	2628.1	
51.00	22.00	0.00	0.001	0.0	0.0	***5
51.00	21.00	0.00	0.001	0.0	0.0	***5
51.00	20.00	0.00	0.001	0.0	0.0	***5
51.00	19.00	0.00	0.001	0.0	0.0	***5
51.00	18.00	0.00	0.001	0.0	0.0	***5
51.00	17.00	0.00	0.001	0.0	0.0	***5
51.00	16.00	13.00	10.386	41859.0	4030.3	
51.00	15.00	12.00	10.823	37326.2	3448.9	
51.00	14.00	11.00	11.493	32957.5	2867.5	
51.00	13.00	10.00	12.582	28762.5	2286.1	
52.00	22.00	0.00	0.001	0.0	0.0	***5
52.00	21.00	0.00	0.001	0.0	0.0	***5
52.00	20.00	0.00	0.001	0.0	0.0	***5
52.00	19.00	15.20	2.365	9789.5	4138.5	
52.00	18.00	14.23	2.396	8792.5	3670.2	
		15.00	12.269	58339.3	4755.0	
52.00	17.00	13.26	2.449	7848.2	3204.0	
		14.00	12.549	52375.3	4173.6	
52.00	16.00	12.30	2.540	6961.0	2740.8	
		13.00	12.984	46639.9	3592.2	
52.00	15.00	11.35	2.690	6136.7	2281.6	
		12.00	13.665	41143.2	3010.8	
52.00	14.00	11.00	14.779	35902.2	2429.3	
52.00	13.00	0.00	0.001	0.0	0.0	***5

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	43.00	44.00	45.00	46.00	47.00	48.00
22.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
21.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
20.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
19.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
18.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
17.00	Fs	999.000	999.000	999.000	999.000	999.000	1.684
	R(m)	0.00	0.00	0.00	0.00	0.00	10.90
16.00	Fs	999.000	999.000	999.000	999.000	999.000	1.682
	R(m)	0.00	0.00	0.00	0.00	0.00	10.00
15.00	Fs	999.000	999.000	999.000	999.000	999.000	1.689
	R(m)	0.00	0.00	0.00	0.00	0.00	9.11
14.00	Fs	999.000	999.000	999.000	999.000	1.872	1.715
	R(m)	0.00	0.00	0.00	0.00	8.77	8.21
13.00	Fs	999.000	999.000	999.000	999.000	1.891	1.778
	R(m)	0.00	0.00	0.00	0.00	7.87	7.32

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

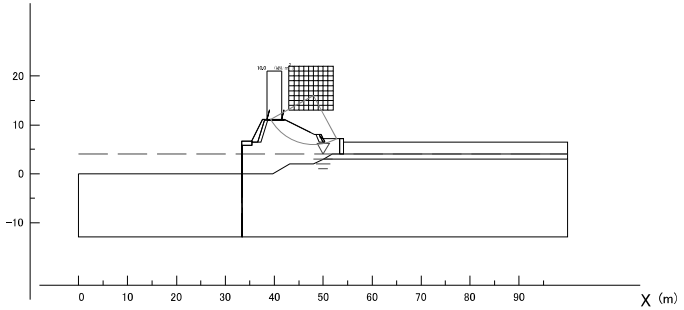
Y(m)	X(m)	49.00	50.00	51.00	52.00
22.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
21.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
20.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
19.00	Fs	999.000	999.000	999.000	2.365
	R(m)	0.00	0.00	0.00	15.20
18.00	Fs	999.000	999.000	999.000	2.396
	R(m)	0.00	0.00	0.00	14.23
17.00	Fs	999.000	999.000	999.000	2.449
	R(m)	0.00	0.00	0.00	13.26
16.00	Fs	999.000	999.000	10.386	2.540
	R(m)	0.00	0.00	13.00	12.30
15.00	Fs	999.000	4.790	10.823	2.690
	R(m)	0.00	11.94	12.00	11.35
14.00	Fs	1.712	5.047	11.493	14.779
	R(m)	7.66	10.95	11.00	11.00
13.00	Fs	999.000	5.473	12.582	999.000
	R(m)	0.00	9.95	10.00	0.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)	
Bearing force Action ratio =	1.682
Failure circle X(m) =	48.00
Y(m) =	16.00
R(m) =	10.003
Resisting moment(kNm) =	2867.1
Sliding moment(kNm) =	1705.1
Partial coefficient concerning analytical technique =	1.0

// Check Result chart //



WARNING ***5 There are no arc contacting with base line.
count = 79

4. Action02 (seismic)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	8	18.00	17.00	8.00	1000.0	0 0.0	030.0	0 0.0	0 0.0	0 0.
0	2	2 77.0	0 77.0	0 67.0	01000.	00 0.	00 0.	00 0.	00 0.	00 0
0.0	3	1 24.	00 24.	00 14.	001000	0.00	0.00	0.00	0.00	0.00
0.0	4	1 24	0.00 2	0.00 1	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	5	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	6	4 2	4.00 2	4.00 1	4.00	1.00	0.003	0.00	0.00	0.00
0.0	7	5 1	9.00 1	8.00	9.00	1.00	0.003	0.00	0.00	0.00
0.0	8	1 2	4.00 2	4.00 1	4.0010	00.00	0.00	0.00	0.00	0.00
0.	0 9	6	18.50	17.50	8.50	0.00	0.00	27.00	0.00	0.00
0.	0 10	7	19.00	18.00	9.00	50.00	0.00	0.00	0.00	0.00
0.	0 11	8	18.00	17.00	8.001	000.00	0.0	030.00	0.00	0.00
0	0.0 1	1	24.00	24.00	14.00	1000.0	0 0.	00 0.0	0 0.00	0.0
0	0.0 1	3	3 20.0	0 19.0	0 10.0	0 0.0	0 0.	0035.0	0 0.00	0.0
0	0.0									

// Distribution load that considers partial coefficient //

Load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
2	38.50	11.15	5.0	41.50	11.15	5.0	0.000	0.200	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	4.03	
2	100.00	4.03	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
43.00	22.00	0.00	0.001	0.0	0.0	***5
43.00	21.00	0.00	0.001	0.0	0.0	***5
43.00	20.00	0.00	0.001	0.0	0.0	***5
43.00	19.00	0.00	0.001	0.0	0.0	***5
43.00	18.00	0.00	0.001	0.0	0.0	***5
43.00	17.00	0.00	0.001	0.0	0.0	***5
43.00	16.00	0.00	0.001	0.0	0.0	***5
43.00	15.00	0.00	0.001	0.0	0.0	***5
43.00	14.00	0.00	0.001	0.0	0.0	***5
43.00	13.00	0.00	0.001	0.0	0.0	***5
44.00	22.00	0.00	0.001	0.0	0.0	***5
44.00	21.00	0.00	0.001	0.0	0.0	***5
44.00	20.00	0.00	0.001	0.0	0.0	***5
44.00	19.00	0.00	0.001	0.0	0.0	***5
44.00	18.00	0.00	0.001	0.0	0.0	***5
44.00	17.00	0.00	0.001	0.0	0.0	***5
44.00	16.00	0.00	0.001	0.0	0.0	***5
44.00	15.00	0.00	0.001	0.0	0.0	***5
44.00	14.00	0.00	0.001	0.0	0.0	***5
44.00	13.00	0.00	0.001	0.0	0.0	***5
45.00	22.00	0.00	0.001	0.0	0.0	***5
45.00	21.00	0.00	0.001	0.0	0.0	***5
45.00	20.00	0.00	0.001	0.0	0.0	***5
45.00	19.00	0.00	0.001	0.0	0.0	***5
45.00	18.00	0.00	0.001	0.0	0.0	***5
45.00	17.00	0.00	0.001	0.0	0.0	***5
45.00	16.00	0.00	0.001	0.0	0.0	***5
45.00	15.00	0.00	0.001	0.0	0.0	***5
45.00	14.00	0.00	0.001	0.0	0.0	***5
45.00	13.00	0.00	0.001	0.0	0.0	***5
46.00	22.00	0.00	0.001	0.0	0.0	***5
46.00	21.00	0.00	0.001	0.0	0.0	***5
46.00	20.00	0.00	0.001	0.0	0.0	***5
46.00	19.00	0.00	0.001	0.0	0.0	***5
46.00	18.00	0.00	0.001	0.0	0.0	***5
46.00	17.00	0.00	0.001	0.0	0.0	***5
46.00	16.00	0.00	0.001	0.0	0.0	***5
46.00	15.00	0.00	0.001	0.0	0.0	***5
46.00	14.00	0.00	0.001	0.0	0.0	***5
46.00	13.00	0.00	0.001	0.0	0.0	***5

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
47.00	22.00	0.00	0.001	0.0	0.0	***5
47.00	21.00	0.00	0.001	0.0	0.0	***5
47.00	20.00	0.00	0.001	0.0	0.0	***5
47.00	19.00	0.00	0.001	0.0	0.0	***5
47.00	18.00	0.00	0.001	0.0	0.0	***5
47.00	17.00	0.00	0.001	0.0	0.0	***5
47.00	16.00	0.00	0.001	0.0	0.0	***5
47.00	15.00	0.00	0.001	0.0	0.0	***5
47.00	14.00	8.77	1.128	3226.3	2860.0	
47.00	13.00	7.87	1.130	2759.8	2442.3	
48.00	22.00	0.00	0.001	0.0	0.0	***5
48.00	21.00	0.00	0.001	0.0	0.0	***5
48.00	20.00	0.00	0.001	0.0	0.0	***5
48.00	19.00	0.00	0.001	0.0	0.0	***5
48.00	18.00	0.00	0.001	0.0	0.0	***5
48.00	17.00	10.90	1.057	2994.9	2832.9	
48.00	16.00	10.00	1.051	2690.1	2558.8	
48.00	15.00	9.11	1.049	2375.4	2265.1	
48.00	14.00	8.21	1.052	2055.2	1953.4	
48.00	13.00	7.32	1.067	1734.7	1625.3	
49.00	22.00	0.00	0.001	0.0	0.0	***5
49.00	21.00	0.00	0.001	0.0	0.0	***5
49.00	20.00	0.00	0.001	0.0	0.0	***5
49.00	19.00	0.00	0.001	0.0	0.0	***5
49.00	18.00	0.00	0.001	0.0	0.0	***5
49.00	17.00	0.00	0.001	0.0	0.0	***5
49.00	16.00	0.00	0.001	0.0	0.0	***5
49.00	15.00	0.00	0.001	0.0	0.0	***5
49.00	14.00	7.66	1.033	1123.6	1087.5	
49.00	13.00	0.00	0.001	0.0	0.0	***5
50.00	22.00	0.00	0.001	0.0	0.0	***5
50.00	21.00	0.00	0.001	0.0	0.0	***5
50.00	20.00	0.00	0.001	0.0	0.0	***5
50.00	19.00	0.00	0.001	0.0	0.0	***5
50.00	18.00	0.00	0.001	0.0	0.0	***5
50.00	17.00	0.00	0.001	0.0	0.0	***5
50.00	16.00	0.00	0.001	0.0	0.0	***5
50.00	15.00	11.94	2.677	17363.3	6485.6	
		12.00	3.977	26293.5	6611.8	
50.00	14.00	10.95	2.801	15488.3	5530.3	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
50.00	14.00	11.00	4.066	22926.2	5639.1	
50.00	13.00	9.95	2.990	13759.9	4601.9	
		10.00	4.204	19728.6	4692.7	
51.00	22.00	0.00	0.001	0.0	0.0	***5
51.00	21.00	0.00	0.001	0.0	0.0	***5
51.00	20.00	0.00	0.001	0.0	0.0	***5
51.00	19.00	0.00	0.001	0.0	0.0	***5
51.00	18.00	0.00	0.001	0.0	0.0	***5
51.00	17.00	0.00	0.001	0.0	0.0	***5
51.00	16.00	13.00	5.817	41335.2	7105.9	
51.00	15.00	12.00	6.017	36866.4	6127.4	
51.00	14.00	11.00	6.293	32561.7	5174.1	
51.00	13.00	10.00	6.693	28430.8	4247.9	
52.00	22.00	0.00	0.001	0.0	0.0	***5
52.00	21.00	0.00	0.001	0.0	0.0	***5
52.00	20.00	0.00	0.001	0.0	0.0	***5
52.00	19.00	15.20	1.307	9311.9	7122.8	
52.00	18.00	14.23	1.316	8360.9	6353.0	
		15.00	6.788	57737.9	8505.8	
52.00	17.00	13.26	1.332	7462.3	5603.7	
		14.00	6.912	51838.2	7499.9	
52.00	16.00	12.30	1.357	6620.4	4877.2	
		13.00	7.084	46167.1	6516.9	
52.00	15.00	11.35	1.399	5840.9	4176.5	
		12.00	7.329	40734.6	5558.2	
52.00	14.00	11.00	7.687	35558.1	4625.5	
52.00	13.00	0.00	0.001	0.0	0.0	***5

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	43.00	44.00	45.00	46.00	47.00	48.00
22.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
21.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
20.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
19.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
18.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
17.00	Fs	999.000	999.000	999.000	999.000	999.000	1.057
	R(m)	0.00	0.00	0.00	0.00	0.00	10.90
16.00	Fs	999.000	999.000	999.000	999.000	999.000	1.051
	R(m)	0.00	0.00	0.00	0.00	0.00	10.00
15.00	Fs	999.000	999.000	999.000	999.000	999.000	1.049
	R(m)	0.00	0.00	0.00	0.00	0.00	9.11
14.00	Fs	999.000	999.000	999.000	999.000	1.128	1.052
	R(m)	0.00	0.00	0.00	0.00	8.77	8.21
13.00	Fs	999.000	999.000	999.000	999.000	1.130	1.067
	R(m)	0.00	0.00	0.00	0.00	7.87	7.32

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

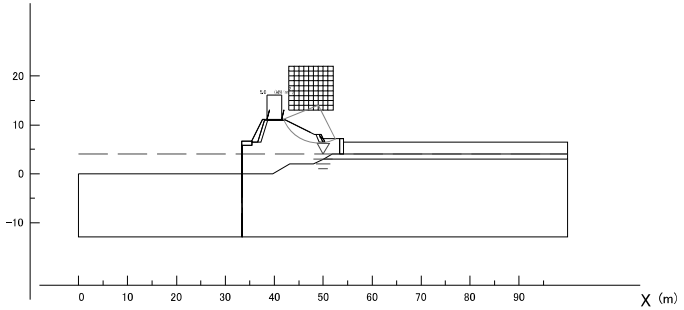
Y(m)	X(m)	49.00	50.00	51.00	52.00
22.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
21.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
20.00	Fs	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00
19.00	Fs	999.000	999.000	999.000	1.307
	R(m)	0.00	0.00	0.00	15.20
18.00	Fs	999.000	999.000	999.000	1.316
	R(m)	0.00	0.00	0.00	14.23
17.00	Fs	999.000	999.000	999.000	1.332
	R(m)	0.00	0.00	0.00	13.26
16.00	Fs	999.000	999.000	5.817	1.357
	R(m)	0.00	0.00	13.00	12.30
15.00	Fs	999.000	2.677	6.017	1.399
	R(m)	0.00	11.94	12.00	11.35
14.00	Fs	1.033	2.801	6.293	7.687
	R(m)	7.66	10.95	11.00	11.00
13.00	Fs	999.000	2.990	6.693	999.000
	R(m)	0.00	9.95	10.00	0.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)	
Bearing force Action ratio =	1.033
Failure circle X(m) =	49.00
Y(m) =	14.00
R(m) =	7.662
Resisting moment(kNm) =	1123.6
Sliding moment(kNm) =	1087.5
Partial coefficient concerning analytical technique =	1.0

// Check Result chart //



WARNING ***5 There are no arc contacting with base line.

count = 79

Test of Embankment Stability

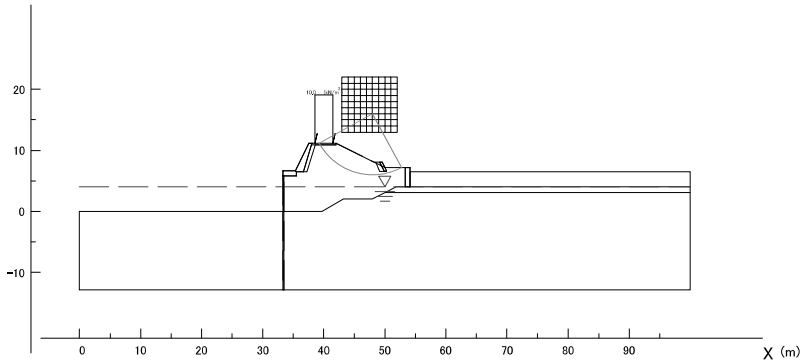
Action number = 1

Action name : normal

Examination at earthquake : It doesn't do.

Scale : 1/ 792

Required Bearing force Action ratio	F S	=	1.000	
Bearing force Action ratio		=	1.682	≧ 1.0 (OK)
Center of arc	X	=	48.00	(m)
	Y	=	16.00	(m)
Radius	R	=	10.003	(m)
Resisting moment	M R	=	2867.1	(kNm)
Sliding moment	M D	=	1705.1	(kNm)
Partial coefficient concerning	γ α	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	18.00	17.00	30.00	1000.00	0.00	0.200	0.000
2	77.00	77.00	0.00	1000.00	0.00	0.200	0.000
3	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
4	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
5	20.00	19.00	35.00	0.00	0.00	0.200	0.000
6	24.00	24.00	30.00	1.00	0.00	0.200	0.000
7	19.00	18.00	30.00	1.00	0.00	0.200	0.000
8	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
9	18.50	17.50	27.00	0.00	0.00	0.200	0.000
10	19.00	18.00	0.00	59.00	0.00	0.200	0.000
11	18.00	17.00	30.00	1000.00	0.00	0.200	0.000
12	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
13	20.00	19.00	35.00	0.00	0.00	0.200	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Ordinary Condition)

Test of Embankment Stability

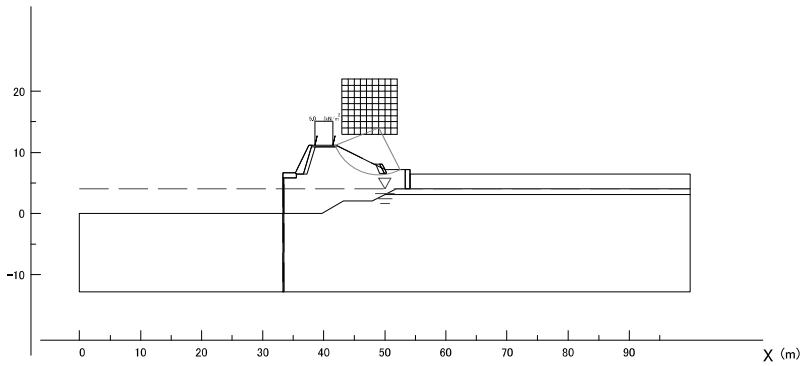
Action number = 2

Action name : seismic

Examination at earthquake : It does.

Scale : 1/ 792

Required Bearing force Action ratio	F S	=	1.000	
Bearing force Action ratio		=	1.033	≧ 1.0 (OK)
Center of arc	X	=	49.00	(m)
	Y	=	14.00	(m)
Radius	R	=	7.662	(m)
Resisting moment	M R	=	1123.6	(kNm)
Sliding moment	M D	=	1087.5	(kNm)
Partial coefficient concerning	γ α	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	18.00	17.00	30.00	1000.00	0.00	0.200	0.000
2	77.00	77.00	0.00	1000.00	0.00	0.200	0.000
3	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
4	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
5	20.00	19.00	35.00	0.00	0.00	0.200	0.000
6	24.00	24.00	30.00	1.00	0.00	0.200	0.000
7	19.00	18.00	30.00	1.00	0.00	0.200	0.000
8	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
9	18.50	17.50	27.00	0.00	0.00	0.200	0.000
10	19.00	18.00	0.00	59.00	0.00	0.200	0.000
11	18.00	17.00	30.00	1000.00	0.00	0.200	0.000
12	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
13	20.00	19.00	35.00	0.00	0.00	0.200	0.000

Water unit weight = 10.00 (kN/m³)

Safety Factor (Seismic Condition)

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.1　Normal and Seismic Conditions

(6)　R10+960

Circular Slip Surface

R+10960

Contents

Page

1. Input Data 1

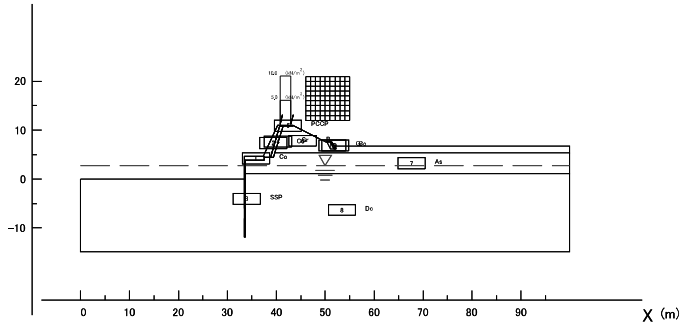
2. Check list 16

3. Action 01 Result list ... 17

4. Action 02 Result list ... 27

1. Input data list

// Design section //



// Design level of reliability design method //

Level of reliability design ..... Level 1(Design for value, part coefficient method)

// Combination of action //

// Setting of action //

Action	Action name	Seismic inertia	Newmark No.	Same hydraul-ic line
1	normal			
2	seismic	○		

// Partial coefficient concerning analytical technique γ_α //

Action No.	Partial coefficient concerning analytical technique γ_α
1	1.00
2	1.00

// Partial coefficient concerning W,C,ϕ $\gamma w, \gamma c, \gamma \tan\phi$ //

No.	Action 1			Action 2										
	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$	γw	γc	$\gamma \tan\phi$
1	1.00	1.00	1.00	1.00	1.00	1.00						
2	1.00	1.00	1.00	1.00	1.00	1.00						
3	1.00	1.00	1.00	1.00	1.00	1.00						
4	1.00	1.00	1.00	1.00	1.00	1.00						
5	1.00	1.00	1.00	1.00	1.00	1.00						
6	1.00	1.00	1.00	1.00	1.00	1.00						
7	1.00	1.00	1.00	1.00	1.00	1.00						
8	1.00	1.00	1.00	1.00	1.00	1.00						
9	1.00	1.00	1.00	1.00	1.00	1.00						
10	1.00	1.00	1.00	1.00	1.00	1.00						

$$M = \Sigma [C_d l + \{ (W_d' + q_d) \cos\theta - K_k W_d \sin\theta \} \tan\phi_d]$$

$$W_d' = \gamma_w W_k'$$

$$C_d = \gamma_c C_k$$

$$\tan\phi_d = \gamma_{\tan\phi} \tan\phi_k$$

M : Resistance moment

γ_w : Partial coefficient concerning weight

W_d' : Effective weight of slice of amount for each unit length splinter (value for design) (kN/m)

W_k' : Effective weight of slice of amount for each unit length splinter (characteristic value)(kN/m)

q_d : Perpendicular action because of the upper part of amount of slice (kN/m)

γ_c : Partial coefficient concerning Cohesion

C_d : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (value for design) (kN/m^2)

C_k : Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (characteristic value) (kN/m^2)

l : Length in base of amount of Slice (m)

$\gamma_{\tan\phi}$: Partial coefficient concerning shearing resistance angle

ϕ_d : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(value for design)(°)

ϕ_k : 0 in case of viscous land board. Shearing resistance angle in drain condition in case of the sandy soil ground etc.(characteristic value)(°)

// Partial coefficient of partial coefficient γ_{vl} to distribution load (Think as well as the ground) and inertia force γ_{vlEQ} //

Action No.	Load1		Load2							
	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force	Load	Inertia force
1	1.00	1.00	–	–						
2	–	–	1.00	1.00						

$$M_{r,vl} = K \cdot r \Sigma (FR \cdot \gamma_{vl,i} - K_{hp} \cdot FO \cdot \gamma_{vlEQ,i}) \cdot \tan\phi$$

$$M_{d,vl} = r \Sigma (FO \cdot \gamma_{vl,i} + K_{hp} \cdot FR \cdot \gamma_{vlEQ,i})$$

$$FR = F \cdot \cos\theta$$

$$FO = F \cdot \sin\theta$$

$M_{r,vl}$: Resistance moment of distribution load (Think as well as the ground)

$M_{d,vl}$: Sliding moment of distribution load (Think as well as the ground)

K : Resistance power coefficient

r : Radius of slipping circular arc

F : Distribution load i

FR : Slipping line orthogonalization direction load value of load i

FO : Slipping line direction load value of load i

θ : Angle that slice bottom (slide surface) does to the horizontal

$\gamma_{vl,i}$: Partial coefficient of distribution load i (Think as well as the ground).

K_{hp} : The horizontal seismic intensity

$\gamma_{vlEQ,i}$: Partial coefficient of inertia force of distribution load i (Think as well as the ground).

ϕ : Internal friction angle of soil

// Partial coefficient to residual water level //

Action number	rRWL
1	1.00
2	1.00

$$RWL_d = \gamma_{RWL} RWL_k$$

γ_{RWL} : Partial coefficient concerning residual water level

RWL_d : Difference between residual water level and water level line (value for design) (m)

RWL_k : Difference between residual water level and water level line (input value) (m)

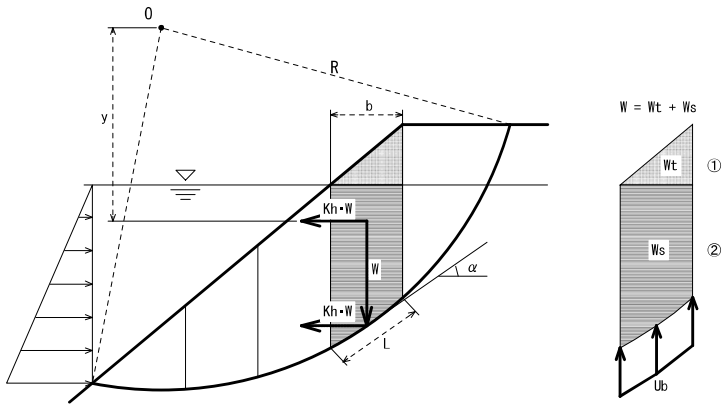
(DATA 01.)　// ANALYSIS //

Title　.....　Test of Embankment Stability
Analysis type　.....　Analysis of Bearing force Action ratio
Calculation method .....　Revised Feleniu s (Total stress)

Expression

$$\frac{R\Sigma[C_d l+\{((1+K_v)W_d-u\,b)\cos\theta-K_h W_d\sin\theta\}\tan\phi_d]}{\gamma_a R\Sigma\{(1+K_v)W_d\sin\theta+K_h W_d\cos\theta\}} \geqq 1.0$$

R	:	Radius of slipping circle of circular arc (m)
C_d	:	Cohesion of looking multiplication in drain condition in case of the sandy soil ground in case of viscous land board more non-drain shearing (kN/m²)
l	:	Length in base of amount of crack splinter (m)
q_d	:	Perpendicular action because of the upper part of amount of crack splinter (kN/m)
θ	:	Angle that amount of crack splinter bottom does to a horizontal plane (degree)
ϕ_d	:	0 in case of viscous land board. Shearing resistance in drain condition in case of the sandy soil ground etc.(°)
W_d	:	Full weight of crack of amount for each unit length splinter (full weight of soil and water) (kN/m)
γ_a	:	Partial coefficient concerning analytical technique
K_h	:	The horizontal seismic intensity
K_v	:	Vertical seismic coefficient
u	:	Pore pressure (kN/m²)
b	:	Width of slice (m)



Treatment of its own weight W of the resistance force
　Above the water level.....Calculate the weight Wt in Wet weight γt　①
　Below the water level.....Calculate weight Ws in Saturated weight γsat　②
Treatment of its own weight W of impetus
　Above the water level.....Calculate the weight Wt in Wet weight γt
　Below the water level.....Calculate weight in Saturated weight γsat
Water pressure acting on the slip plane.....Consider in the Ubcosα
　(Modify Fereniusu method)
Lateral hydrostatic pressure due to water storage.....Including

(DATA 02.)　// CONTROL //

Second pursuit　.....　0 (=0 No)
　(>0 Yes　)
Run　.....　0 (=0 Input data check + Analysis)
　(=1 Input data check　)

(DATA 04.) // SEISMIC LOAD //

```
Seismic load                    .....  0 ( =0 Same for the whole model )
                                       ( =1 Different on each layer  )
Condition                       .....  1 ( =0 Acts on only sliding force )
                                       ( =1 Sliding + Resisting force  )
Acting point                    .....  0 ( =0 On the slip surface              )
                                       ( =1 Center of gravity of sliding mass )
                                       ( =2 Resisting:on the slip surface
                                            Sliding  :Center of gravity of sliding mass )
Unit weight                     .....  0 ( =0 Saturated weight )
                                       ( =1 Submerged weight )
Horizontal seismic coefficient.....  0.200
Vertical seismic coefficient  .....  0.000
```


(DATA 06.) // NODAL POINT //

No.	Coordinate		Y-coordinate
	x (m)	y (m)	before settlement (m)
1	0.00	0.00	0.00
2	33.49	0.00	0.00
3	33.49	3.83	0.00
4	33.49	4.63	0.00
5	37.34	4.63	0.00
6	37.49	4.63	0.00
7	37.49	4.48	0.00
8	37.49	3.83	0.00
9	33.64	3.83	0.00
10	33.64	1.13	0.00
11	40.33	11.03	0.00
12	40.78	11.03	0.00
13	40.72	10.83	0.00
14	41.34	10.83	0.00
15	43.33	10.83	0.00
16	43.33	11.03	0.00
17	38.82	4.48	0.00
18	39.44	4.48	0.00
19	39.70	5.36	0.00
20	50.05	7.67	0.00
21	50.34	7.67	0.00
22	51.03	6.12	0.00
23	51.78	6.12	0.00
24	51.01	7.67	0.00
25	51.40	7.67	0.00
26	52.00	6.47	0.00
27	52.10	6.47	0.00
28	52.10	6.12	0.00
29	51.85	6.77	0.00
30	100.00	6.77	0.00
31	100.00	5.36	0.00
32	100.00	1.13	0.00
33	100.00	-14.85	0.00
34	33.64	-11.87	0.00
35	33.49	-11.87	0.00
36	0.00	-14.85	0.00

(DATA 07.) // WATER LEVEL //

Unit weight of water (kN/m³) = 10.00

Action No.	Water level line number
1	1
2	1

Water level line number: 1

No.	Coordinate	
	X (m)	Y (m)
1	0.00	2.77
2	100.00	2.77

Water level line number: 2

No.	Coordinate	
	X (m)	Y (m)
1	0.00	0.00
2	150.00	0.00

(DATA 08.) // LAYER //

No.	material property No.	The name of the strata
1	1	Co
2	1	Co
3	2	SSP
4	3	Gr
5	4	POCP
6	5	B
7	6	As

No.	material property No.	The name of the strata
8	7	Dc
9	1	Co
10	3	Gr

No.	Num of Node	Node numbers composing a layer	Slip existence
1	7	3 9 8 7 6 5 4	Not Slip
2	7	5 6 7 17 13 12 11	Not Slip
3	6	2 35 34 10 9 3	Not Slip
4	5	13 17 18 19 14	Not Slip
5	5	12 13 14 15 16	Slip
6	14	14 19 31 30 29 26 27 28 23 22 21	Slip
		20 16 15	
7	9	10 32 31 19 18 17 7 8 9	Slip
8	8	1 36 33 32 10 34 35 2	Slip
9	7	23 28 27 26 29 25 24	Not Slip
10	4	21 22 23 24	Slip

(DATA 09.1) // MATERIAL PROPERTIES //

No.	Nature of soil division	Saturated weight (kN/m³)	Wet weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	1	24.00	24.00	******	0.00	0.00	0.00	0.000	0.0
2	2	77.00	77.00	******	0.00	0.00	0.00	0.000	0.0
3	3	20.00	19.00	0.00	0.00	35.00	0.00	0.000	0.0
4	4	24.00	24.00	1.00	0.00	30.00	0.00	0.000	0.0
5	5	19.00	18.00	1.00	0.00	30.00	0.00	0.000	0.0
6	6	18.50	17.50	0.00	0.00	27.00	0.00	0.000	0.0
7	7	19.00	18.00	100.00	0.00	0.00	0.00	0.000	0.0

(DATA 09.2) // Characteristic of soil //

No.	Action Number									
	Act 1	Act 2								
1	1	1								
2	1	1								
3	2	2								
4	3	3								
5	4	4								
6	5	5								

No.	Action Number									
	Act 1	Act 2								
7	6	6								
8	7	7								
9	1	1								
10	3	3								

(DATA 11.) // GRID POINT //

No.	Slip direction	Double cutting	GX (m)	GY (m)	X-point	Y-point	X-pitch (m)	Y-pitch (m)	Dx/Dy	NEXCO Radius
1	Downstream	Rigt lump	46.00	21.00	10	10	1.00	1.00	0.000	0.000

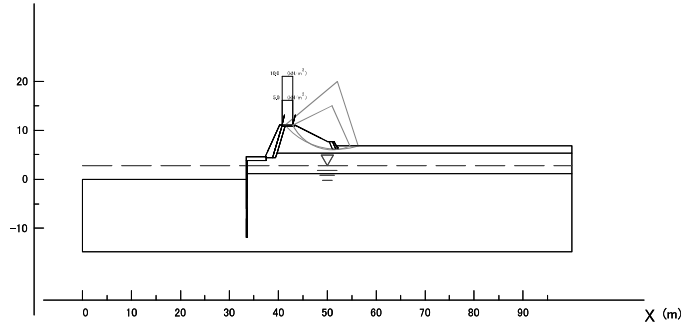
2. Check list

// Check of circular arc //

Action No.	Action name	Bearing force Action ratio	Judgment
1	normal	1.593	OK
2	seismic	1.006	OK

Action No.	Bearing force Action ratio	Partial coefficient r_a	Center of slipping circular arc X (m)	Center of slipping circular arc Y (m)	Radius of circular arc(m)	Resistance Moment (kNm)	Sliding Moment (kNm)
1	1.593	1.00	52.00	20.00	13.900	2931.6	1840.1
2	1.006	1.00	51.00	15.00	8.981	1428.9	1421.0

// Check Result chart //



3. Action01 (normal)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	1	24.00	24.00	14.00	1000.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.
0	2	1 24.0	0 24.0	0 14.0	01000.	00 0.	00 0.	00 0.	00 0.	00 0
0.0	3	2 77.	00 77.	00 67.	001000	0.00	0.00	0.00	0.00	0.00
0.0	4	3 20	0.00 1	0.00 1	0.00	0.00	0.003	0.00	0.00	0.00
0.0	5	4 24	0.00 2	0.00 1	0.00	0.00	0.003	0.00	0.00	0.00
0.0	6	5 19	0.00 1	0.00	0.00	0.00	0.003	0.00	0.00	0.00
0.0	7	6 18	0.50 1	0.50	0.50	0.00	0.002	0.00	0.00	0.00
0.0	8	7 19	0.00 1	0.00	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	9	1 24	0.00 2	0.00 1	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	10	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	@06	@06	@06	@06	@06	@06	@05	@06	@07	@06

// Distribution load that considers partial coefficient //

Load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
1	40.80	11.15	10.0	43.00	11.15	10.0	0.000	0.000	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	2.77	
2	100.00	2.77	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
46.00	21.00	10.32	999.000	0.0	0.0	***6
46.00	20.00	9.36	999.000	0.0	0.0	***6
46.00	19.00	8.41	999.000	0.0	0.0	***6
46.00	18.00	7.46	999.000	0.0	0.0	***6
46.00	17.00	6.54	999.000	0.0	0.0	***6
46.00	16.00	5.64	999.000	0.0	0.0	***6
46.00	15.00	4.74	999.000	0.0	0.0	***6
46.00	14.00	3.85	999.000	0.0	0.0	***6
46.00	13.00	2.96	999.000	0.0	0.0	***6
46.00	12.00	2.06	999.000	0.0	0.0	***6
47.00	21.00	10.62	999.000	0.0	0.0	***6
47.00	20.00	9.69	999.000	0.0	0.0	***6
47.00	19.00	8.77	999.000	0.0	0.0	***6
47.00	18.00	7.88	999.000	0.0	0.0	***6
47.00	17.00	6.98	999.000	0.0	0.0	***6
47.00	16.00	6.09	999.000	0.0	0.0	***6
47.00	15.00	5.19	999.000	0.0	0.0	***6
47.00	14.00	4.30	999.000	0.0	0.0	***6
47.00	13.00	3.40	999.000	0.0	0.0	***6
47.00	12.00	2.51	999.000	0.0	0.0	***6
48.00	21.00	11.01	999.000	0.0	0.0	***6
48.00	20.00	10.11	999.000	0.0	0.0	***6
48.00	19.00	9.22	999.000	0.0	0.0	***6
48.00	18.00	8.32	999.000	0.0	0.0	***6
48.00	17.00	7.43	999.000	0.0	0.0	***6
48.00	16.00	6.53	999.000	0.0	0.0	***6
48.00	15.00	5.64	999.000	0.0	0.0	***6
48.00	14.00	4.74	999.000	0.0	0.0	***6
48.00	13.00	3.85	999.000	0.0	0.0	***6
48.00	12.00	2.96	999.000	0.0	0.0	***6
49.00	21.00	11.45	999.000	0.0	0.0	***6
49.00	20.00	10.56	999.000	0.0	0.0	***6
49.00	19.00	9.66	999.000	0.0	0.0	***6
49.00	18.00	8.77	999.000	0.0	0.0	***6
49.00	17.00	7.88	999.000	0.0	0.0	***6
49.00	16.00	6.98	999.000	0.0	0.0	***6
49.00	15.00	6.09	999.000	0.0	0.0	***6
49.00	14.00	5.19	999.000	0.0	0.0	***6
49.00	13.00	4.30	999.000	0.0	0.0	***6
49.00	12.00	3.40	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
49.00	12.00	7.40	1.708	2448.2	1433.6	
50.00	21.00	11.90	999.000	0.0	0.0	***6
50.00	20.00	11.01	999.000	0.0	0.0	***6
50.00	19.00	10.11	999.000	0.0	0.0	***6
50.00	18.00	9.22	999.000	0.0	0.0	***6
50.00	17.00	8.32	999.000	0.0	0.0	***6
50.00	16.00	7.43	999.000	0.0	0.0	***6
50.00	15.00	6.53	999.000	0.0	0.0	***6
		9.53	1.651	2764.5	1674.3	
50.00	14.00	5.64	999.000	0.0	0.0	***6
		8.64	1.683	2404.9	1428.5	
50.00	13.00	4.74	999.000	0.0	0.0	***6
		7.74	1.684	1962.7	1165.2	
		8.74	1.745	3297.4	1889.7	
50.00	12.00	3.85	999.000	0.0	0.0	***6
		6.85	1.768	1589.9	899.4	
		7.85	1.808	2766.1	1530.2	
51.00	21.00	12.35	999.000	0.0	0.0	***6
51.00	20.00	11.45	999.000	0.0	0.0	***6
51.00	19.00	10.56	999.000	0.0	0.0	***6
51.00	18.00	9.66	999.000	0.0	0.0	***6
51.00	17.00	8.77	999.000	0.0	0.0	***6
51.00	16.00	7.88	999.000	0.0	0.0	***6
		10.88	1.681	3412.7	2030.0	
51.00	15.00	6.98	999.000	0.0	0.0	***6
		8.98	1.645	1536.2	933.6	
		9.98	1.696	2996.1	1766.7	
51.00	14.00	6.09	999.000	0.0	0.0	***6
		9.09	1.741	2586.1	1485.8	
		10.09	1.862	4335.9	2328.2	
51.00	13.00	5.19	999.000	0.0	0.0	***6
		8.19	1.835	2186.5	1191.3	
		9.19	1.917	3740.6	1951.1	
51.00	12.00	4.30	999.000	0.0	0.0	***6
		8.30	2.030	3160.3	1556.4	
		9.30	2.162	5036.7	2329.5	
52.00	21.00	12.79	999.000	0.0	0.0	***6
52.00	20.00	11.90	999.000	0.0	0.0	***6
		13.90	1.593	2931.6	1840.1	
52.00	19.00	11.01	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
52.00	19.00	13.01	1.618	2735.9	1690.5	
52.00	18.00	10.11	999.000	0.0	0.0	***6
		12.11	1.662	2531.6	1523.3	
52.00	17.00	9.22	999.000	0.0	0.0	***6
		11.22	1.727	2311.7	1338.6	
		12.22	1.811	4289.7	2368.2	
52.00	16.00	8.32	999.000	0.0	0.0	***6
		10.32	1.830	2079.4	1136.3	
		11.32	1.841	3843.5	2087.3	
52.00	15.00	7.35	999.000	0.0	0.0	***6
		10.35	1.893	3259.5	1721.5	
		11.35	2.022	5409.1	2675.3	
52.00	14.00	6.36	999.000	0.0	0.0	***6
		9.36	1.992	2666.8	1338.5	
		10.36	2.069	4539.0	2193.4	
52.00	13.00	5.36	999.000	0.0	0.0	***6
		9.36	2.182	3734.8	1712.0	
		10.36	2.287	5897.7	2578.7	
52.00	12.00	4.37	999.000	0.0	0.0	***6
		9.37	2.420	4866.1	2011.0	
		10.37	2.435	7009.0	2878.4	
53.00	21.00	13.24	999.000	0.0	0.0	***6
		15.24	1.784	3739.0	2095.5	
53.00	20.00	12.35	999.000	0.0	0.0	***6
		14.35	1.833	3535.3	1928.3	
53.00	19.00	11.44	999.000	0.0	0.0	***6
		13.44	1.896	3281.0	1730.9	
53.00	18.00	10.45	999.000	0.0	0.0	***6
		12.45	1.972	2810.0	1425.3	
		13.45	1.988	5097.3	2563.5	
53.00	17.00	9.47	999.000	0.0	0.0	***6
		11.47	2.080	2373.9	1141.0	
		12.47	2.029	4405.6	2171.6	
53.00	16.00	8.48	999.000	0.0	0.0	***6
		11.48	2.112	3760.0	1780.4	
		12.48	2.206	6251.6	2833.4	
53.00	15.00	7.50	999.000	0.0	0.0	***6
		10.50	2.232	3164.6	1417.9	
		11.50	2.278	5370.4	2357.2	
53.00	14.00	6.53	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
53.00	14.00	10.53	2.418	4554.6	1883.3	
		11.53	2.474	7058.1	2852.4	
53.00	13.00	5.56	999.000	0.0	0.0	***6
		10.56	2.616	6008.2	2297.1	
		11.56	2.589	8465.4	3269.4	
53.00	12.00	4.62	999.000	0.0	0.0	***6
		10.62	2.740	7225.9	2637.3	
		11.62	4.140	14960.8	3614.1	
54.00	21.00	13.58	999.000	0.0	0.0	***6
		15.58	2.100	4200.4	2000.2	
54.00	20.00	12.60	999.000	0.0	0.0	***6
		14.60	2.184	3705.1	1696.2	
		15.60	2.173	6568.5	3023.2	
54.00	19.00	11.62	999.000	0.0	0.0	***6
		13.62	2.327	3241.3	1392.8	
		14.62	2.215	5833.2	2633.9	
54.00	18.00	10.65	999.000	0.0	0.0	***6
		13.65	2.289	5140.1	2245.9	
54.00	17.00	9.69	999.000	0.0	0.0	***6
		12.69	2.416	4492.0	1859.3	
		13.69	2.454	7407.0	3017.9	
54.00	16.00	8.73	999.000	0.0	0.0	***6
		12.73	2.556	6515.3	2549.0	
54.00	15.00	7.78	999.000	0.0	0.0	***6
		11.78	2.730	5688.6	2083.7	
		12.78	2.707	8560.1	3162.6	
54.00	14.00	6.84	999.000	0.0	0.0	***6
		11.84	2.859	7490.5	2620.3	
		12.84	2.783	10312.2	3704.9	
54.00	13.00	5.93	999.000	0.0	0.0	***6
		10.93	3.082	6517.0	2114.6	
		11.93	3.451	10669.9	3091.9	
54.00	12.00	5.05	999.000	0.0	0.0	***6
		11.05	4.180	10434.1	2496.3	
		12.00	4.989	17252.2	3457.7	
55.00	21.00	13.81	999.000	0.0	0.0	***6
		15.81	2.487	4152.2	1669.8	
		16.81	2.439	7566.7	3102.8	
55.00	20.00	12.84	999.000	0.0	0.0	***6
		14.84	2.655	3689.1	1389.5	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
55.00	20.00	15.84	2.513	6829.5	2717.3	
55.00	19.00	11.89	999.000	0.0	0.0	***6
		14.89	2.629	6133.6	2333.3	
		15.89	2.674	9856.0	3685.5	
55.00	18.00	10.94	999.000	0.0	0.0	***6
		13.94	2.809	5482.0	1951.4	
		14.94	2.762	8893.9	3220.3	
55.00	17.00	10.00	999.000	0.0	0.0	***6
		14.00	2.897	7991.0	2758.5	
55.00	16.00	9.07	999.000	0.0	0.0	***6
		13.07	3.108	7152.8	2301.3	
		14.07	2.972	10383.5	3494.1	
55.00	15.00	8.17	999.000	0.0	0.0	***6
		13.17	3.135	9289.7	2963.3	
		14.17	4.122	17166.7	4164.2	
55.00	14.00	7.23	999.000	0.0	0.0	***6
		12.23	3.390	8147.2	2403.3	
		13.23	4.478	15698.8	3505.5	
		14.00	5.021	22225.8	4426.7	
55.00	13.00	6.23	999.000	0.0	0.0	***6
		12.23	4.923	13625.2	2767.4	
		13.00	5.399	19548.0	3621.0	
55.00	12.00	5.23	999.000	0.0	0.0	***6
		12.00	6.032	17009.4	2820.0	

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	46.00	47.00	48.00	49.00	50.00	51.00
21.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
20.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
19.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
18.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
17.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
16.00	Fs	999.000	999.000	999.000	999.000	999.000	1.681
	R(m)	0.00	0.00	0.00	0.00	0.00	10.88
15.00	Fs	999.000	999.000	999.000	999.000	1.651	1.645
	R(m)	0.00	0.00	0.00	0.00	9.53	8.98
14.00	Fs	999.000	999.000	999.000	999.000	1.683	1.741
	R(m)	0.00	0.00	0.00	0.00	8.64	9.09
13.00	Fs	999.000	999.000	999.000	999.000	1.684	1.835
	R(m)	0.00	0.00	0.00	0.00	7.74	8.19
12.00	Fs	999.000	999.000	999.000	1.708	1.768	2.030
	R(m)	0.00	0.00	0.00	7.40	6.85	8.30

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

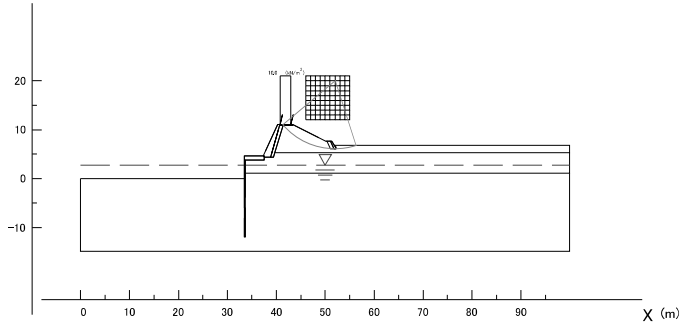
Y(m)	X(m)	52.00	53.00	54.00	55.00
21.00	Fs	999.000	1.784	2.100	2.439
	R(m)	0.00	15.24	15.58	16.81
20.00	Fs	1.593	1.833	2.173	2.513
	R(m)	13.90	14.35	15.60	15.84
19.00	Fs	1.618	1.896	2.215	2.629
	R(m)	13.01	13.44	14.62	14.89
18.00	Fs	1.662	1.972	2.289	2.762
	R(m)	12.11	12.45	13.65	14.94
17.00	Fs	1.727	2.029	2.416	2.897
	R(m)	11.22	12.47	12.69	14.00
16.00	Fs	1.830	2.112	2.556	2.972
	R(m)	10.32	11.48	12.73	14.07
15.00	Fs	1.893	2.232	2.707	3.135
	R(m)	10.35	10.50	12.78	13.17
14.00	Fs	1.992	2.418	2.783	3.390
	R(m)	9.36	10.53	12.84	12.23
13.00	Fs	2.182	2.589	3.082	4.923
	R(m)	9.36	11.56	10.93	12.23
12.00	Fs	2.420	2.740	4.180	6.032
	R(m)	9.37	10.62	11.05	12.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	1.593
Failure circle X(m)	=	52.00
Y(m)	=	20.00
R(m)	=	13.900
Resisting moment(kNm)	=	2931.6
Sliding moment(kNm)	=	1840.1
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



WARNING ***6 An arc does not cut the ground,
or An arc cuts the side of a model. count =100

4. Action02 (seismic)

Value list for design

// Characteristic of soil that considers partial coefficient //

Lay No.	Chara No.	Saturated weight (kN/m³)	Wet weight (kN/m³)	Underwaterunit weight (kN/m³)	Cohesion C (kN/m²)	Cohesion coefficient	friction angle φ (°)	Unit weight calculation pore water (kN/m³)	Alpha	TAU (kN/m²)
1	1	24.00	24.00	14.00	1000.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.
0	2	1 24.0	0 24.0	0 14.0	01000.	00 0.	00 0.	00 0.	00 0.	00 0
0.0	3	2 77.	00 77.	00 67.	001000	0.00	0.00	0.00	0.00	0.00
0.0	4	3 20	0.00 1	0.00 1	0.00	0.00	0.003	0.00	0.00	0.00
0.0	5	4 24	0.00 2	0.00 1	0.00	0.00	0.003	0.00	0.00	0.00
0.0	6	5 19	0.00 1	0.00	0.00	0.00	0.003	0.00	0.00	0.00
0.0	7	6 18	0.50 1	0.50	0.50	0.00	0.002	0.00	0.00	0.00
0.0	8	7 19	0.00 1	0.00	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	9	1 24	0.00 2	0.00 1	0.0010	0.00	0.00	0.00	0.00	0.00
0.0	10	3 2	0.00 1	9.00 1	0.00	0.00	0.003	5.00	0.00	0.00
0.0	@06	@06	@06	@06	@06	@06	@05	@06	@07	@06

// Distribution load that considers partial coefficient //

load No.	Left			Right			Resisting coefficient of load	H.seismic intensity Khp	P.seismic intensity Kvp
	X (m)	Y (m)	Load Value(kN)	X (m)	Y (m)	Load Value(kN)			
2	40.80	11.15	5.0	43.00	11.15	5.0	0.000	0.200	0.000

// Water level line where partial coefficient of residual water level was considered //

No.	Coordinate		Residual water level
	X (m)	Y (m)	
1	0.00	2.77	
2	100.00	2.77	

Bearing force Action ratio

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
46.00	21.00	10.32	999.000	0.0	0.0	***6
46.00	20.00	9.36	999.000	0.0	0.0	***6
46.00	19.00	8.41	999.000	0.0	0.0	***6
46.00	18.00	7.46	999.000	0.0	0.0	***6
46.00	17.00	6.54	999.000	0.0	0.0	***6
46.00	16.00	5.64	999.000	0.0	0.0	***6
46.00	15.00	4.74	999.000	0.0	0.0	***6
46.00	14.00	3.85	999.000	0.0	0.0	***6
46.00	13.00	2.96	999.000	0.0	0.0	***6
46.00	12.00	2.06	999.000	0.0	0.0	***6
47.00	21.00	10.62	999.000	0.0	0.0	***6
47.00	20.00	9.69	999.000	0.0	0.0	***6
47.00	19.00	8.77	999.000	0.0	0.0	***6
47.00	18.00	7.88	999.000	0.0	0.0	***6
47.00	17.00	6.98	999.000	0.0	0.0	***6
47.00	16.00	6.09	999.000	0.0	0.0	***6
47.00	15.00	5.19	999.000	0.0	0.0	***6
47.00	14.00	4.30	999.000	0.0	0.0	***6
47.00	13.00	3.40	999.000	0.0	0.0	***6
47.00	12.00	2.51	999.000	0.0	0.0	***6
48.00	21.00	11.01	999.000	0.0	0.0	***6
48.00	20.00	10.11	999.000	0.0	0.0	***6
48.00	19.00	9.22	999.000	0.0	0.0	***6
48.00	18.00	8.32	999.000	0.0	0.0	***6
48.00	17.00	7.43	999.000	0.0	0.0	***6
48.00	16.00	6.53	999.000	0.0	0.0	***6
48.00	15.00	5.64	999.000	0.0	0.0	***6
48.00	14.00	4.74	999.000	0.0	0.0	***6
48.00	13.00	3.85	999.000	0.0	0.0	***6
48.00	12.00	2.96	999.000	0.0	0.0	***6
49.00	21.00	11.45	999.000	0.0	0.0	***6
49.00	20.00	10.56	999.000	0.0	0.0	***6
49.00	19.00	9.66	999.000	0.0	0.0	***6
49.00	18.00	8.77	999.000	0.0	0.0	***6
49.00	17.00	7.88	999.000	0.0	0.0	***6
49.00	16.00	6.98	999.000	0.0	0.0	***6
49.00	15.00	6.09	999.000	0.0	0.0	***6
49.00	14.00	5.19	999.000	0.0	0.0	***6
49.00	13.00	4.30	999.000	0.0	0.0	***6
49.00	12.00	3.40	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
49.00	12.00	7.40	1.006	2295.3	2281.1	
50.00	21.00	11.90	999.000	0.0	0.0	***6
50.00	20.00	11.01	999.000	0.0	0.0	***6
50.00	19.00	10.11	999.000	0.0	0.0	***6
50.00	18.00	9.22	999.000	0.0	0.0	***6
50.00	17.00	8.32	999.000	0.0	0.0	***6
50.00	16.00	7.43	999.000	0.0	0.0	***6
50.00	15.00	6.53	999.000	0.0	0.0	***6
		9.53	1.029	2586.2	2514.1	
50.00	14.00	5.64	999.000	0.0	0.0	***6
		8.64	1.035	2249.7	2173.1	
50.00	13.00	4.74	999.000	0.0	0.0	***6
		7.74	1.010	1832.3	1814.9	
		8.74	1.017	3097.6	3044.5	
50.00	12.00	3.85	999.000	0.0	0.0	***6
		6.85	1.025	1486.2	1449.6	
		7.85	1.030	2600.8	2524.5	
51.00	21.00	12.35	999.000	0.0	0.0	***6
51.00	20.00	11.45	999.000	0.0	0.0	***6
51.00	19.00	10.56	999.000	0.0	0.0	***6
51.00	18.00	9.66	999.000	0.0	0.0	***6
51.00	17.00	8.77	999.000	0.0	0.0	***6
51.00	16.00	7.88	999.000	0.0	0.0	***6
		10.88	1.020	3196.0	3134.7	
51.00	15.00	6.98	999.000	0.0	0.0	***6
		8.98	1.006	1428.9	1421.0	
		9.98	1.015	2804.5	2763.3	
51.00	14.00	6.09	999.000	0.0	0.0	***6
		9.09	1.020	2421.4	2373.5	
		10.09	1.058	4090.8	3865.2	
51.00	13.00	5.19	999.000	0.0	0.0	***6
		8.19	1.041	2050.4	1969.2	
		9.19	1.069	3531.6	3303.8	
51.00	12.00	4.30	999.000	0.0	0.0	***6
		8.30	1.095	2989.1	2729.4	
		9.30	1.142	4793.4	4197.4	
52.00	21.00	12.79	999.000	0.0	0.0	***6
52.00	20.00	11.90	999.000	0.0	0.0	***6
		13.90	1.016	2737.3	2694.0	
52.00	19.00	11.01	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
52.00	19.00	13.01	1.021	2554.9	2503.0	
52.00	18.00	10.11	999.000	0.0	0.0	***6
		12.11	1.033	2365.6	2289.4	
52.00	17.00	9.22	999.000	0.0	0.0	***6
		11.22	1.053	2162.4	2054.1	
		12.22	1.060	4037.2	3807.8	
52.00	16.00	8.32	999.000	0.0	0.0	***6
		10.32	1.084	1948.6	1798.0	
		11.32	1.063	3617.9	3404.2	
52.00	15.00	7.35	999.000	0.0	0.0	***6
		10.35	1.072	3069.0	2862.8	
		11.35	1.112	5127.3	4612.8	
52.00	14.00	6.36	999.000	0.0	0.0	***6
		9.36	1.096	2514.1	2294.4	
		10.36	1.119	4303.2	3844.9	
52.00	13.00	5.36	999.000	0.0	0.0	***6
		9.36	1.143	3545.1	3101.7	
		10.36	1.178	5626.6	4774.4	
52.00	12.00	4.37	999.000	0.0	0.0	***6
		9.37	1.205	4648.8	3857.1	
		10.37	1.186	6711.6	5657.3	
53.00	21.00	13.24	999.000	0.0	0.0	***6
		15.24	1.095	3516.0	3210.0	
53.00	20.00	12.35	999.000	0.0	0.0	***6
		14.35	1.110	3327.2	2997.4	
53.00	19.00	11.44	999.000	0.0	0.0	***6
		13.44	1.128	3091.0	2739.2	
53.00	18.00	10.45	999.000	0.0	0.0	***6
		12.45	1.149	2649.1	2306.1	
		13.45	1.118	4822.8	4312.3	
53.00	17.00	9.47	999.000	0.0	0.0	***6
		11.47	1.183	2242.1	1895.5	
		12.47	1.125	4168.9	3705.6	
53.00	16.00	8.48	999.000	0.0	0.0	***6
		11.48	1.143	3560.9	3116.1	
		12.48	1.169	5951.2	5091.3	
53.00	15.00	7.50	999.000	0.0	0.0	***6
		10.50	1.173	3003.0	2559.2	
		11.50	1.183	5115.5	4325.3	
53.00	14.00	6.53	999.000	0.0	0.0	***6

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
53.00	14.00	10.53	1.212	4345.1	3585.4	
		11.53	1.227	6757.0	5505.4	
53.00	13.00	5.56	999.000	0.0	0.0	***6
		10.56	1.254	5759.9	4594.9	
		11.56	1.218	8126.9	6669.9	
53.00	12.00	4.62	999.000	0.0	0.0	***6
		10.62	1.242	6946.9	5592.9	
		11.62	1.866	14607.6	7826.5	
54.00	21.00	13.58	999.000	0.0	0.0	***6
		15.58	1.210	3982.4	3290.4	
54.00	20.00	12.60	999.000	0.0	0.0	***6
		14.60	1.233	3516.0	2851.0	
		15.60	1.181	6246.9	5289.9	
54.00	19.00	11.62	999.000	0.0	0.0	***6
		13.62	1.272	3081.1	2422.7	
		14.62	1.188	5549.1	4670.2	
54.00	18.00	10.65	999.000	0.0	0.0	***6
		13.65	1.203	4893.3	4066.6	
54.00	17.00	9.69	999.000	0.0	0.0	***6
		12.69	1.230	4282.5	3480.4	
		13.69	1.239	7085.4	5718.4	
54.00	16.00	8.73	999.000	0.0	0.0	***6
		12.73	1.259	6238.5	4955.6	
54.00	15.00	7.78	999.000	0.0	0.0	***6
		11.78	1.293	5456.4	4220.1	
		12.78	1.279	8225.8	6431.8	
54.00	14.00	6.84	999.000	0.0	0.0	***6
		11.84	1.304	7207.7	5529.4	
		12.84	1.253	9928.5	7926.2	
54.00	13.00	5.93	999.000	0.0	0.0	***6
		10.93	1.341	6285.1	4687.7	
		11.93	1.507	10344.0	6865.0	
54.00	12.00	5.05	999.000	0.0	0.0	***6
		11.05	1.730	10164.5	5876.6	
		12.00	2.080	16914.6	8130.8	
55.00	21.00	13.81	999.000	0.0	0.0	***6
		15.81	1.300	3963.1	3047.6	
		16.81	1.256	7234.7	5760.7	
55.00	20.00	12.84	999.000	0.0	0.0	***6
		14.84	1.340	3528.7	2633.7	

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Coordinate at center of circle		Radius	Bear force Action ratio	Resisting moment	Sliding moment	
X (m)	Y (m)	R (m)		(kNm)	(kNm)	
55.00	20.00	15.84	1.270	6534.5	5143.5	
55.00	19.00	11.89	999.000	0.0	0.0	***6
		14.89	1.293	5875.5	4542.5	
		15.89	1.301	9467.0	7278.2	
55.00	18.00	10.94	999.000	0.0	0.0	***6
		13.94	1.329	5260.7	3959.2	
		14.94	1.317	8549.5	6493.0	
55.00	17.00	10.00	999.000	0.0	0.0	***6
		14.00	1.342	7690.9	5732.8	
55.00	16.00	9.07	999.000	0.0	0.0	***6
		13.07	1.379	6896.6	5000.8	
		14.07	1.328	10014.0	7542.3	
55.00	15.00	8.17	999.000	0.0	0.0	***6
		13.17	1.350	8970.7	6646.0	
		14.17	1.780	16735.7	9402.6	
55.00	14.00	7.23	999.000	0.0	0.0	***6
		12.23	1.387	7883.1	5684.1	
		13.23	1.868	15330.0	8208.5	
		14.00	2.085	21790.1	10450.4	
55.00	13.00	6.23	999.000	0.0	0.0	***6
		12.23	1.941	13326.0	6864.0	
		13.00	2.155	19185.4	8902.6	
55.00	12.00	5.23	999.000	0.0	0.0	***6
		12.00	2.258	16720.3	7404.0	

Table of B.A.

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

Y(m)	X(m)	46.00	47.00	48.00	49.00	50.00	51.00
21.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
20.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
19.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
18.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
17.00	Fs	999.000	999.000	999.000	999.000	999.000	999.000
	R(m)	0.00	0.00	0.00	0.00	0.00	0.00
16.00	Fs	999.000	999.000	999.000	999.000	999.000	1.020
	R(m)	0.00	0.00	0.00	0.00	0.00	10.88
15.00	Fs	999.000	999.000	999.000	999.000	1.029	1.006
	R(m)	0.00	0.00	0.00	0.00	9.53	8.98
14.00	Fs	999.000	999.000	999.000	999.000	1.035	1.020
	R(m)	0.00	0.00	0.00	0.00	8.64	9.09
13.00	Fs	999.000	999.000	999.000	999.000	1.010	1.041
	R(m)	0.00	0.00	0.00	0.00	7.74	8.19
12.00	Fs	999.000	999.000	999.000	1.006	1.025	1.095
	R(m)	0.00	0.00	0.00	7.40	6.85	8.30

Bearing force Action ratio (Group number = 1 ; LOOP = 0)

Center X(m),Y(m)

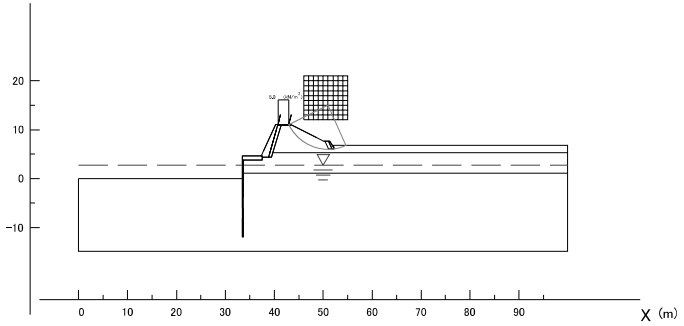
Y(m)	X(m)	52.00	53.00	54.00	55.00
21.00	Fs	999.000	1.095	1.210	1.256
	R(m)	0.00	15.24	15.58	16.81
20.00	Fs	1.016	1.110	1.181	1.270
	R(m)	13.90	14.35	15.60	15.84
19.00	Fs	1.021	1.128	1.188	1.293
	R(m)	13.01	13.44	14.62	14.89
18.00	Fs	1.033	1.118	1.203	1.317
	R(m)	12.11	13.45	13.65	14.94
17.00	Fs	1.053	1.125	1.230	1.342
	R(m)	11.22	12.47	12.69	14.00
16.00	Fs	1.063	1.143	1.259	1.328
	R(m)	11.32	11.48	12.73	14.07
15.00	Fs	1.072	1.173	1.279	1.350
	R(m)	10.35	10.50	12.78	13.17
14.00	Fs	1.096	1.212	1.253	1.387
	R(m)	9.36	10.53	12.84	12.23
13.00	Fs	1.143	1.218	1.341	1.941
	R(m)	9.36	11.56	10.93	12.23
12.00	Fs	1.186	1.242	1.730	2.258
	R(m)	10.37	10.62	11.05	12.00

Bearing force Action ratio

Bearing force Action ratio (Group number = 1)

(Loop = 0)		
Bearing force Action ratio	=	1.006
Failure circle X(m)	=	51.00
Y(m)	=	15.00
R(m)	=	8.981
Resisting moment(kNm)	=	1428.9
Sliding moment(kNm)	=	1421.0
Partial coefficient concerning analytical technique	=	1.0

// Check Result chart //



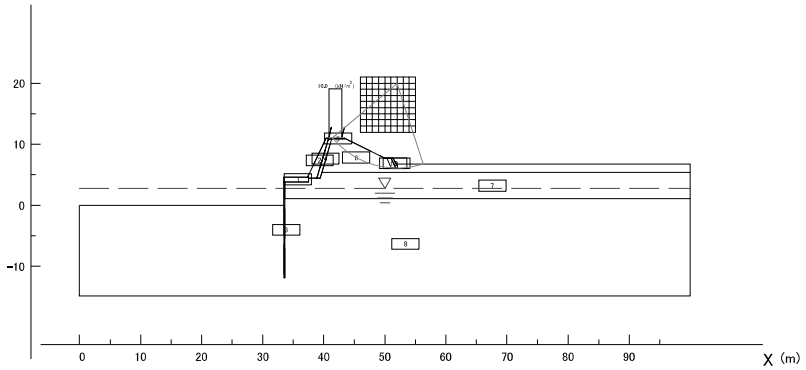
WARNING ***6 An arc does not cut the ground,
or An arc cuts the side of a model. count =100

Test of Embankment Stability

Action number = 1
Action name : normal
Examination at earthquake : It doesn't do.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	1.593	≧ 1.0 (OK)
Center of arc	X	=	52.00	(m)
	Y	=	20.00	(m)
Radius	R	=	13.900	(m)
Resisting moment	M_R	=	2931.6	(kNm)
Sliding moment	M_D	=	1840.1	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	24.00	24.00	0.00	1000.00	0.00	0.000	0.000
2	24.00	24.00	0.00	1000.00	0.00	0.000	0.000
3	77.00	77.00	0.00	1000.00	0.00	0.000	0.000
4	20.00	19.00	35.00	0.00	0.00	0.000	0.000
5	24.00	24.00	30.00	1.00	0.00	0.000	0.000
6	19.00	18.00	30.00	1.00	0.00	0.000	0.000
7	18.50	17.50	27.00	0.00	0.00	0.000	0.000
8	19.00	18.00	0.00	100.00	0.00	0.000	0.000
9	24.00	24.00	0.00	1000.00	0.00	0.000	0.000
10	20.00	19.00	35.00	0.00	0.00	0.000	0.000

Water unit weight = 10.00 (kN/m³)

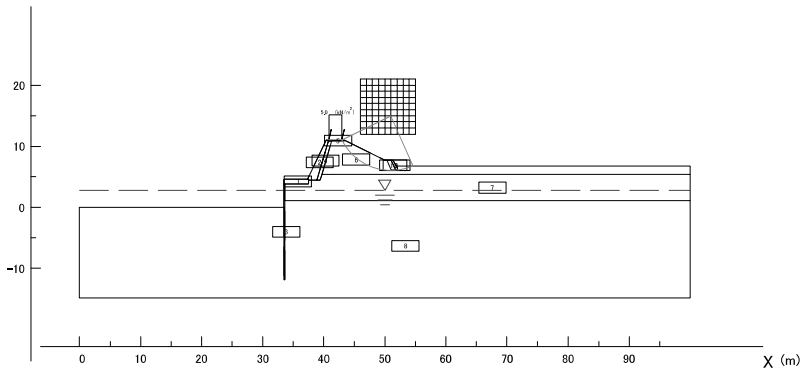
Safety Factor (Ordinary Condition)

Test of Embankment Stability

Action number = 2
Action name : seismic
Examination at earthquake : It does.

Scale : 1/ 792

Required Bearing force Action ratio	F_S	=	1.000	
Bearing force Action ratio		=	1.006	≧ 1.0 (OK)
Center of arc	X	=	51.00	(m)
	Y	=	15.00	(m)
Radius	R	=	8.981	(m)
Resisting moment	M_R	=	1428.9	(kNm)
Sliding moment	M_D	=	1421.0	(kNm)
Partial coefficient concerning	$\gamma\alpha$	=	1.00	



【Nature of soil condition table(Input value)】

Layer Number	Saturated Unit Weight (kN/m³)	Wet Unit Weight (kN/m³)	Friction Angle (Degree)	Cohesion (kN/m²)	Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
2	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
3	77.00	77.00	0.00	1000.00	0.00	0.200	0.000
4	20.00	19.00	35.00	0.00	0.00	0.200	0.000
5	24.00	24.00	30.00	1.00	0.00	0.200	0.000
6	19.00	18.00	30.00	1.00	0.00	0.200	0.000
7	18.50	17.50	27.00	0.00	0.00	0.200	0.000
8	19.00	18.00	0.00	100.00	0.00	0.200	0.000
9	24.00	24.00	0.00	1000.00	0.00	0.200	0.000
10	20.00	19.00	35.00	0.00	0.00	0.200	0.000

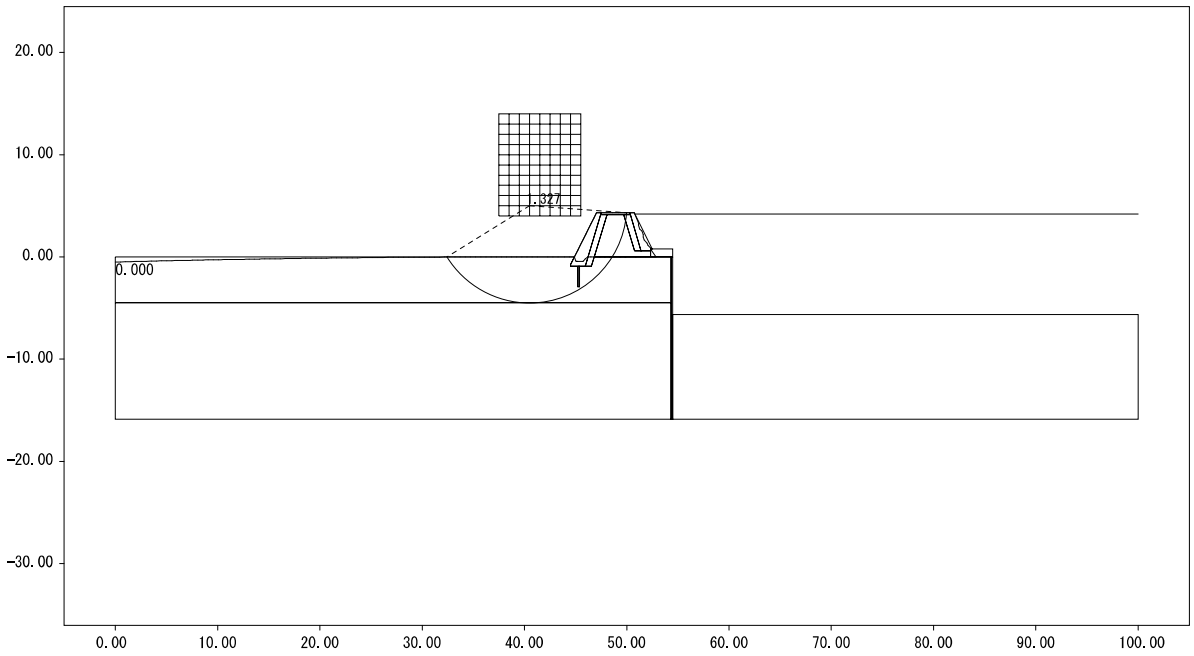
Water unit weight = 10.00 (kN/m³)

Safety Factor (Seismic Condition)

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.2　Flood Conditions (Seepage)

(1)　L7+820



(Calculation Result)

Title	L7+820				
Note					
Calculation Method	Slope Stability Calculation+ Seepage Analysis	Output Time	226.000 (hr)	Safety Factor	1.327
Output Items	Soil Layer Diagram, Water Level, Slip Surface				

Slope Stability Analysis considering Seepage

Input Data Sheet

◆ Basic Calculation Conditions

○Title : L7+820

○Note :

○Calculation Type : Seepage Analysis + Slope Stability
○Seepage Type Calculation : Nonstationary Seepage
○ Time Unit : hour
○ Stress Type : Total Stress
○ Safety Factor Formula : Modified Fellenius' Method
○Unit : SI Unit
○Unsaturated Permeability : θ-Kr, θ-ψ

◆ Node

○No. of Nodes : 40

○Node axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	0.000	2	44.889	0.000
3	44.514	-0.752	4	44.514	-0.902
5	45.932	-0.902	6	46.558	-0.902
7	48.063	4.115	8	47.437	4.115
9	47.047	4.315	10	47.497	4.315
11	50.279	4.315	12	50.732	4.315
13	49.716	4.115	14	50.342	4.115
15	50.770	0.600	16	51.396	0.600
17	52.339	0.600	18	52.339	0.800
19	52.489	0.800	20	54.489	0.800
21	54.489	0.000	22	54.339	0.000
23	52.339	0.000	24	54.327	-4.496
25	54.489	-5.616	26	100.000	-5.616
27	100.000	-15.860	28	54.489	-15.860
29	54.339	-15.860	30	0.000	-15.860
31	0.000	-4.496	32	46.829	0.000
33	45.223	-0.902	34	45.223	-2.902
35	45.373	-2.902	36	45.373	-0.902
37	44.400	0.000	38	44.400	-0.500
39	43.900	-0.500	40	43.900	0.000

◆ Soil Layer

○No. of Soil Layers : 12

○Layer No. : 1
○Layer Name : Co
○Nodes : 9, 10, 8, 5, 36, 33, 4, 3, 2

○Layer No. : 2
○Layer Name : Co
○Nodes : 11, 12, 19, 18, 17, 16, 14

○Layer No. : 3
○Layer Name : Co
○Nodes : 17, 18, 19, 20, 21, 22, 23

○Layer No. : 4
○Layer Name : SSP
○Nodes : 25, 28, 29, 24, 22, 21

○Layer No. : 5
○Layer Name : Gr
○Nodes : 8, 7, 32, 6, 5

○Layer No. : 6
○Layer Name : Gr
○Nodes : 13, 14, 16, 15

○Layer No. : 7
○Layer Name : PCCP
○Nodes : 10, 11, 14, 13, 7, 8

○Layer No. : 8
○Layer Name : B
○Nodes : 32, 7, 13, 15, 16, 17, 23

○Layer No. : 9
○Layer Name : As
○Nodes : 1, 2, 3, 4, 33, 34, 35, 36, 5, 6,
: 32, 23, 22, 24, 31

○Layer No. : 10
○Layer Name : Dc
○Nodes : 24, 29, 30, 31

○Layer No. : 11
○Layer Name : Dc
○Nodes : 25, 26, 27, 28

○Layer No. : 12
○Layer Name : SSP
○Nodes : 36, 35, 34, 33

◆ Hole

○No of Holes : 0

◆ Soil Constants

○Layer No. : 1
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c (kN/m2) : 1000.000
○Friction Angle φ (°) : 0.000
○Wet Weight (kN/m3) : 24.000
○Sat. Unit Weight (kN/m3) : 24.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 2
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c (kN/m2) : 1000.000
○Friction Angle φ (°) : 0.000
○Wet Weight (kN/m3) : 24.000
○Sat. Unit Weight (kN/m3) : 24.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 3
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)

1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c (kN/m2) : 1000.000
○Friction Angle φ (°) : 0.000
○Wet Weight (kN/m3) : 24.000
○Sat. Unit Weight (kN/m3) : 24.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 4
○Layer Name : SSP
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 2.000E-006
○Saturated h.c. ky (cm/s) : 2.000E-006
○Specific Storage Coef. Ss (1/m) : 2.000E-008

○Cohesion c (kN/m2) : 1000.000
○Friction Angle φ (°) : 0.000
○Wet Weight (kN/m3) : 77.000
○Sat. Unit Weight (kN/m3) : 77.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 5
○Layer Name : Gr
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100

16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle φ(°) : 35.000
○Wet Weight(kN/m3) : 19.000
○Sat. Unit Weight(kN/m3) : 20.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 6
○Layer Name : Gr
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle φ(°) : 35.000
○Wet Weight(kN/m3) : 19.000
○Sat. Unit Weight(kN/m3) : 20.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 7
○Layer Name : PCCP
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1.000
○Friction Angle φ(°) : 30.000
○Wet Weight(kN/m3) : 24.000
○Sat. Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 8
○Layer Name : B
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)

1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-003
○Saturated h.c. ky (cm/s) : 1.000E-003
○Specific Storage Coef. Ss (1/m) : 1.000E-005

○Cohesion c(kN/m2) : 1.000
○Friction Angle φ(°) : 30.000
○Wet Weight(kN/m3) : 18.000
○Sat. Unit Weight(kN/m3) : 19.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 9
○Layer Name : As
○Unsaturated Permeability : silty sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.119	-12.000
3	0.020	0.020	3	0.120	-1.900
4	0.030	0.030	4	0.123	-1.500
5	0.040	0.040	5	0.129	-1.000
6	0.050	0.050	6	0.135	-0.800
7	0.060	0.060	7	0.138	-0.700
8	0.070	0.080	8	0.141	-0.600
9	0.080	0.090	9	0.146	-0.500
10	0.090	0.110	10	0.153	-0.400
11	0.100	0.130	11	0.160	-0.300
12	0.110	0.160	12	0.166	-0.250
13	0.120	0.190	13	0.173	-0.200
14	0.130	0.230	14	0.181	-0.150
15	0.140	0.290	15	0.188	-0.100
16	0.150	0.360	16	0.195	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef.Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle φ(°) : 27.000
○Wet Weight(kN/m3) : 17.500
○Sat. Unit Weight(kN/m3) : 18.500
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 10
○Layer Name : Dc
○Unsaturated Permeability : diluvial clay
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.135	0.000	1	0.135	-900.000
2	0.153	0.000	2	0.153	-300.000
3	0.177	0.000	3	0.177	-100.000
4	0.226	0.000	4	0.226	-20.000
5	0.285	0.000	5	0.285	-5.000
6	0.313	0.000	6	0.313	-3.000
7	0.336	0.000	7	0.336	-2.000
8	0.354	0.000	8	0.354	-1.500
9	0.380	0.001	9	0.380	-1.000
10	0.404	0.001	10	0.404	-0.700
11	0.426	0.003	11	0.426	-0.500
12	0.440	0.004	12	0.440	-0.400
13	0.448	0.006	13	0.448	-0.350
14	0.457	0.008	14	0.457	-0.300
15	0.465	0.011	15	0.465	-0.260
16	0.472	0.013	16	0.472	-0.230
17	0.479	0.017	17	0.479	-0.200
18	0.484	0.020	18	0.484	-0.180
19	0.489	0.024	19	0.489	-0.160
20	0.494	0.030	20	0.494	-0.140
21	0.500	0.037	21	0.500	-0.120
22	0.506	0.047	22	0.506	-0.100
23	0.512	0.062	23	0.512	-0.080
24	0.518	0.085	24	0.518	-0.060
25	0.524	0.123	25	0.524	-0.040
26	0.530	0.199	26	0.530	-0.020
27	0.533	0.283	27	0.533	-0.010
28	0.535	1.000	28	0.535	0.000

○Saturated h.c. kx (cm/s) : 1.000E-006
○Saturated h.c. ky (cm/s) : 1.000E-006
○Specific Storage Coef. Ss (1/m) : 1.000E-008

○Cohesion c(kN/m2) : 100.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 18.000
○Sat. Unit Weight(kN/m3) : 19.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 11
○Layer Name : Dc
○Unsaturated Permeability : diluvial clay
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.135	0.000	1	0.135	-900.000
2	0.153	0.000	2	0.153	-300.000
3	0.177	0.000	3	0.177	-100.000
4	0.226	0.000	4	0.226	-20.000
5	0.285	0.000	5	0.285	-5.000
6	0.313	0.000	6	0.313	-3.000
7	0.336	0.000	7	0.336	-2.000
8	0.354	0.000	8	0.354	-1.500
9	0.380	0.001	9	0.380	-1.000
10	0.404	0.001	10	0.404	-0.700
11	0.426	0.003	11	0.426	-0.500
12	0.440	0.004	12	0.440	-0.400
13	0.448	0.006	13	0.448	-0.350
14	0.457	0.008	14	0.457	-0.300
15	0.465	0.011	15	0.465	-0.260
16	0.472	0.013	16	0.472	-0.230
17	0.479	0.017	17	0.479	-0.200
18	0.484	0.020	18	0.484	-0.180
19	0.489	0.024	19	0.489	-0.160
20	0.494	0.030	20	0.494	-0.140
21	0.500	0.037	21	0.500	-0.120
22	0.506	0.047	22	0.506	-0.100
23	0.512	0.062	23	0.512	-0.080
24	0.518	0.085	24	0.518	-0.060
25	0.524	0.123	25	0.524	-0.040
26	0.530	0.199	26	0.530	-0.020
27	0.533	0.283	27	0.533	-0.010
28	0.535	1.000	28	0.535	0.000

○Saturated h.c. kx (cm/s) : 1.000E-006
○Saturated h.c. ky (cm/s) : 1.000E-006
○Specific Storage Coef. Ss (1/m) : 1.000E-008

○Cohesion c(kN/m2) : 100.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 18.000
○Sat. Unit Weight(kN/m3) : 19.000

○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 12
○Layer Name : SSP
○Unsaturated Permeability mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 2.000E-006
○Saturated h.c. ky (cm/s) : 2.000E-006
○Specific Storage Coef. Ss (1/m) : 2.000E-008

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 77.000
○Sat. Unit Weight(kN/m3) : 77.000
○Water Unit Weight(kN/m3) : 9.807

◆ FEM Elements

○Soil Layer
Elements Size

Layer No.	xDirection(m)	yDirection(m)
1	0.500	0.500
2	0.500	0.500
3	0.500	0.500
4	0.500	0.500
5	0.500	0.500
6	0.500	0.500
7	0.500	0.500
8	0.500	0.500
9	0.500	0.500
10	1.000	1.000
11	1.000	1.000
12	0.500	0.500

○Element Shape : Triangle + Square

○Partial Area

No	Min. x axis(m)	Min. y axis(m)	Max. x axis(m)	Max. y axis(m)	Element Size xDirection(m)	Element Size yDirection(m)
1	44.000	-0.500	44.500	0.000	0.500	0.500

○Internal Node : 37, 38, 39, 40

◆ Initial Water Level

○ Water Level : 4

No.	x axis(m)	y axis(m)
1	0.000	-0.500
2	54.339	-0.500
3	54.339	-2.300
4	100.000	-2.300

◆ Seepage Surface

○SNo. of eepage Surface : 1

○Seepage Surface No : 1
○Nodes : 1, 2, 9, 10, 11, 12, 19, 20, 21, 25,
: 26

◆ Water Level Fix

○ Water Level Fixed : 1

○ Water Level Fix No : 1
○ Water Level(m) : -0.500
○Nodes : 1, 31, 30

◆ Water Level Changing Point

○ No. of Water Level Changing Points

○ Water Level Changing Point :
○Nodes : 11, 12, 19, 20, 21, 25, 26

○temporal variation

No	Time(hr)	Water Level(m)
1	0.000	-2.300
2	210.000	-2.000
3	225.000	4.190
4	226.000	4.190
5	253.000	-2.300
6	270.000	-2.300

◆ Rain Penetration Line

○No. of Rain Penetration Line 1

○Rain Penetration Line No. : 1
○Nodes : 1, 2, 9, 10, 11, 12, 19, 20, 21, 25,
: 26

○temporal variation

No	Time(hr)	Rainfall(mm)
1	200.000	1.000
2	226.000	10.000
3	270.000	0.000

◆ Repeat Calculation

○Timestep
- Min. : 0.010
- Max. : 10.000
- Allowable Error(m) : 0.100
- Max. Repeat : 10

◆ Slip Surface Conditions

○Merginal Slip Surface (Center・Dianeter)

○No. of Search Area : 1

No	x axis Min.(m)	x axis Max.(m)	x axis Variation(m)	y axis Min.(m)	y axis Max.(m)	y axis Variation(m)
1	37.500	45.500	1.000	4.000	14.000	1.000

No	Dianeter Min.(m)	Dianeter Max.(m)	Dianeter Variation(m)
1	5.000	25.000	1.000

○Slip Surface Limit

	x axis(m)	y axis(m)
must cut line [ON]		
1	47.497	4.315
2	50.279	4.315
must not cut line [ON]		
1	45.223	-0.902
2	45.223	-2.902

○Max. Depth(m) : 0.000
○Search Time : 1
○Slice Width(m) : 1.000

◆ Load

○No. of Loads : 1

No	Left end(m)	Right end(m)	Load(kN/m2)
1	48.000	50.000	5.000

◆ Tension Crack

○No. of Tension Cracks : 0

◆ Seismic Force

○Horizontal Seismic Coef. : 0.000
○Vertical Seismic Coef. : 0.000

◆ Output Time

: 7

○Output Time

No	Seepage Cal.	Stability Cal.
1	10.000	◎
2	100.000	◎
3	210.000	◎
4	225.000	◎
5	226.000	◎
6	253.000	◎
7	270.000	◎

Slope Stability Analysis considering Seepage

Slope Stability Calculation

○ 1. Input Data

◆ Title

L7+820

◆ Calculation Type

Seepage Analysis + Slope Stability Calculation

◆ Safety Factor Formula

Modified Fellenius' Method

◆ Unit

SI Unit

◆ Node

○No. of Nodes : 40

○Node axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	0.000	0.000	2	44.889	0.000
3	44.514	-0.752	4	44.514	-0.902
5	45.932	-0.902	6	46.558	-0.902
7	48.063	4.115	8	47.437	4.115
9	47.047	4.315	10	47.497	4.315
11	50.279	4.315	12	50.732	4.315
13	49.716	4.115	14	50.342	4.115
15	50.770	0.600	16	51.396	0.600
17	52.339	0.600	18	52.339	0.800
19	52.489	0.800	20	54.489	0.800
21	54.489	0.000	22	54.339	0.000
23	52.339	0.000	24	54.327	-4.496
25	54.489	-5.616	26	100.000	-5.616
27	100.000	-15.860	28	54.489	-15.860
29	54.339	-15.860	30	0.000	-15.860
31	0.000	-4.496	32	46.829	0.000
33	45.223	-0.902	34	45.223	-2.902
35	45.373	-2.902	36	45.373	-0.902
37	44.400	0.000	38	44.400	-0.500
39	43.900	-0.500	40	43.900	0.000

◆ Soil Layer

○No. of Soil Layers : 12

○Layer No. : 1
○Layer Name : Co
○Nodes : 9, 10, 8, 5, 36, 33, 4, 3, 2

○Layer No. : 2
○Layer Name : Co
○Nodes : 11, 12, 19, 18, 17, 16, 14

○Layer No. : 3
○Layer Name : Co
○Nodes : 17, 18, 19, 20, 21, 22, 23

: 4
: SSP
: 25, 28, 29, 24, 22, 21

○Layer No. Layer : 5
○Name : Gr
○Nodes : 8, 7, 32, 6, 5

○Layer No. Layer : 6
○Name : Gr
: 13, 14, 16, 15
○Nodes

: 7
○Layer No. Layer : PCCP
○Name : 10, 11, 14, 13, 7, 8

○Nodes : 8
: B
○Layer No. : 32, 7, 13, 15, 16, 17, 23
○Layer Name
○Nodes : 9

○Layer Name : As
○Nodes : 1, 2, 3, 4, 33, 34, 35, 36, 5, 6,
: 32, 23, 22, 24, 31

○Layer No. : 10
○Layer Name : Dc
○Nodes : 24, 29, 30, 31

○Layer No. : 11
○Layer Name : Dc
○Nodes : 25, 26, 27, 28

○Layer No. : 12
○Layer Name : SSP
○Nodes : 36, 35, 34, 33

◆ Hole

○No. of Holes : 0

◆ Soil Constants

○Soil Layer :Layer 1
Cohesion (kN/m2) : Co
: 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer :Layer 2
: Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer :Layer 3
Cohesion (kN/m2) : Co
Friction Angle (°) : 1000.00
: 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer :Layer 4
: SSP
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 77.00
Sat. Unit Weight (kN/m3) : 77.00

○Soil Layer :Layer 5
Cohesion (kN/m2) : Gr
Friction Angle (°) : 0.00
: 35.00
Wet Weight (kN/m3) : 19.00
Sat. Unit Weight (kN/m3) : 20.00

○Soil Layer :Layer 6
Cohesion (kN/m2) : Gr
Friction Angle (°) : 0.00
: 35.00
Wet Weight (kN/m3) : 19.00
Sat. Unit Weight (kN/m3) : 20.00

○Soil Layer :Layer 7
Cohesion (kN/m2) : PCCP
: 1.00
Friction Angle (°) : 30.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer :Layer 8
Cohesion (kN/m2) : B
Friction Angle (°) : 1.00
: 30.00
Wet Weight (kN/m3) : 18.00
Sat. Unit Weight (kN/m3) : 19.00

○Soil Layer :Layer 9
Cohesion (kN/m2) : As
Friction Angle (°) : 0.00
: 27.00
Wet Weight (kN/m3) : 17.50
Sat. Unit Weight (kN/m3) : 18.50

○Soil Layer :Layer 10
Cohesion (kN/m2) : Dc
: 100.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 18.00
Sat. Unit Weight (kN/m3) : 19.00

○Soil Layer :Layer 11
Cohesion (kN/m2) : Dc
: 100.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 18.00
Sat. Unit Weight (kN/m3) : 19.00

○Soil Layer :Layer 12
Cohesion (kN/m2) : SSP
Friction Angle (°) : 1000.00
Wet Weight (kN/m3) : 77.00 : 0.00

Sat. Unit Weight (kN/m3) : 77.00

◆ Slip SurfaceConditions

○Merginal Slip Surface (Center・Dianeter)

○Search Area : 1

No	x axis Min. (m)	x axis Max. (m)	x axis Variation (m)	y axis Min. (m)	y axis Max. (m)	y axis Variation (m)
1	37.500	45.500	1.000	4.000	14.000	1.000

No	Dianeter Min. (m)	Dianeter Max. (m)	Dianeter Variation (m)
1	5.000	25.000	1.000

○Slip Surface
Limit x axis (m) y axis (m) Search Area 1
must cut line [ON]
1 47.497 4.315
2 50.279 4.315
must not cut line [ON]
1 45.223 -0.902
2 45.223 -2.902

◆ Calculation Time

○Time to conduct Stability Cal. : 7

no	Time (hour)	no	Time (hour)	no	Time (hour)	no	Time (hour)	no	Time (hour)
1	10.000	2	100.000	3	210.000	4	225.000	5	226.000

◆ Load

○No. of Loads : 1

No	Left end (m)	Right end (m)	Load (kN/m2)
1	48.000	50.000	5.000

◆ Tension Crack

○No. of Tension Crack : 0

◆ Seismic Force

○Horizontal Seismic Coef. : 0.000
○Vertical Seismic Coef. : 0.000

..

==========
○2. Calculation Result
==========

◆ Min.Safety Factor and Slip Surface

◆ At 10.000 (hr) Calculation Result

○Safety Factor and Slip Surface
・Safety Factor : 1.609
・Resistance Force (kN) : 395.403
・Sliding : 245.682 (= 236.858 + 83.827 / 9.500)
○ Slip Surface axis
axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	32.422	0.000	2	32.644	-0.341	3	32.720	-0.451
4	33.138	-1.004	5	33.633	-1.564	6	34.127	-2.046
7	34.622	-2.463	8	35.117	-2.827	9	35.611	-3.146
10	36.106	-3.423	11	36.600	-3.663	12	37.095	-3.869
13	37.590	-4.043	14	38.084	-4.188	15	38.579	-4.304
16	39.073	-4.392	17	39.568	-4.454	18	40.063	-4.490
19	40.224	-4.496	20	40.557	-4.500	21	40.776	-4.496
22	41.052	-4.484	23	41.546	-4.442	24	42.041	-4.374
25	42.536	-4.279	26	43.030	-4.157	27	43.525	-4.006
28	44.019	-3.824	29	44.514	-3.610	30	44.659	-3.541
31	44.889	-3.425	32	45.223	-3.243	33	45.373	-3.155
34	45.653	-2.981	35	45.932	-2.794	36	46.064	-2.700
37	46.245	-2.566	38	46.558	-2.318	39	46.693	-2.204
40	46.829	-2.085	41	47.047	-1.884	42	47.437	-1.491

43	47.497	-1.426	44	47.780	-1.103	45	48.000	-0.831
46	48.063	-0.749	47	48.279	-0.453	48	48.476	-0.160
49	48.578	0.000	50	48.890	0.543	51	49.303	1.428
52	49.716	2.694	53	49.888	3.543	54	49.959	4.115
55	49.975	4.315						

○Arc Center(m) : (40.500, 5.000)
○Arc Diameter(m) : 9.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle(°)	Slice Bottom Pressure(kN/m2)	Slice Bottom Water Length(m)
0.221	0.661	-57.017	0.000	0.407
0.076	0.527	-55.387	0.000	0.134
0.419	5.448	-52.891	2.714	0.694
0.495	11.530	-48.545	8.175	0.747
0.495	16.293	-44.210	13.282	0.690
0.495	20.405	-40.176	17.691	0.647
0.495	23.982	-36.371	21.526	0.614
0.495	27.104	-32.745	24.874	0.588
0.495	29.827	-29.262	27.793	0.567
0.495	32.193	-25.893	30.331	0.550
0.495	34.235	-22.619	32.519	0.536
0.495	35.975	-19.422	34.386	0.524
0.495	37.434	-16.286	35.950	0.515
0.495	38.626	-13.200	37.228	0.508
0.495	39.562	-10.152	38.232	0.502
0.495	40.251	-7.133	38.970	0.498
0.495	40.697	-4.135	39.449	0.496
0.162	13.372	-2.151	39.654	0.162
0.333	27.548	-0.659	39.702	0.333
0.218	18.080	1.004	39.702	0.218
0.276	22.814	2.496	39.624	0.276
0.495	40.615	4.827	39.360	0.496
0.495	40.113	7.830	38.822	0.499
0.495	39.368	10.854	38.023	0.504
0.495	38.374	13.910	36.956	0.510
0.495	37.121	17.006	35.613	0.517
0.495	35.598	20.155	33.981	0.527
0.495	33.790	23.369	32.043	0.539
0.145	9.788	25.480	30.603	0.161
0.230	15.591	26.741	29.562	0.257
0.334	24.935	28.664	27.955	0.381
0.150	30.115	30.336	26.566	0.174
0.280	25.618	31.853	25.284	0.329
0.279	28.433	33.860	23.617	0.337
0.132	14.269	35.363	22.375	0.162
0.181	20.119	36.531	21.337	0.225
0.313	36.103	38.415	19.508	0.399
0.135	16.016	40.152	17.732	0.177
0.136	16.336	41.230	16.589	0.181
0.218	26.588	42.669	15.019	0.296
0.390	45.091	45.234	12.105	0.554
0.060	6.443	47.170	9.860	0.088
0.283	29.214	48.730	7.961	0.429
0.220	21.315	51.080	5.043	0.350
0.063	5.868	52.448	3.305	0.103
0.216	19.350	53.865	1.452	0.366
0.197	16.607	56.034	0.000	0.353
0.101	8.148	57.671	0.000	0.190
0.312	23.065	60.131	0.000	0.626
0.413	25.264	64.965	0.000	0.977
0.413	17.262	71.933	0.000	1.333
0.172	3.950	78.566	0.000	0.865
0.071	0.728	82.916	0.000	0.577
0.017	0.040	85.260	0.000	0.201

○ Water Level axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	0.000	-0.500	2	0.495	-0.499	3	0.989	-0.497
4	1.484	-0.496	5	1.978	-0.495	6	2.473	-0.494
7	2.968	-0.492	8	3.462	-0.491	9	3.957	-0.490
10	4.451	-0.489	11	4.946	-0.488	12	5.441	-0.487
13	5.935	-0.486	14	6.430	-0.485	15	6.924	-0.484
16	7.419	-0.483	17	7.914	-0.482	18	8.408	-0.481
19	8.903	-0.480	20	9.397	-0.479	21	9.892	-0.478
22	10.387	-0.477	23	10.881	-0.476	24	11.376	-0.475
25	11.870	-0.474	26	12.365	-0.473	27	12.860	-0.472
28	13.354	-0.472	29	13.849	-0.471	30	14.343	-0.470
31	14.838	-0.469	32	15.333	-0.468	33	15.827	-0.468
34	16.322	-0.467	35	16.816	-0.466	36	17.311	-0.466
37	17.806	-0.465	38	18.300	-0.464	39	18.795	-0.463
40	19.289	-0.463	41	19.784	-0.462	42	20.279	-0.462
43	20.773	-0.461	44	21.268	-0.460	45	21.762	-0.460
46	22.257	-0.459	47	22.752	-0.459	48	23.246	-0.458
49	23.741	-0.458	50	24.235	-0.457	51	24.730	-0.457
52	25.225	-0.456	53	25.719	-0.456	54	26.214	-0.455
55	26.708	-0.455	56	27.203	-0.455	57	27.698	-0.454
58	28.192	-0.454	59	28.687	-0.453	60	29.181	-0.453
61	29.676	-0.453	62	30.171	-0.452	63	30.665	-0.452
64	31.160	-0.452	65	31.654	-0.452	66	32.149	-0.451
67	32.644	-0.451	68	33.138	-0.451	69	33.633	-0.451
70	34.127	-0.451	71	34.622	-0.450	72	35.117	-0.450
73	35.611	-0.450	74	36.106	-0.450	75	36.600	-0.450
76	37.095	-0.450	77	37.590	-0.450	78	38.084	-0.450
79	38.579	-0.450	80	39.073	-0.450	81	39.568	-0.450
82	40.063	-0.450	83	40.557	-0.450	84	41.052	-0.450
85	41.546	-0.450	86	42.041	-0.450	87	42.536	-0.450
88	43.030	-0.450	89	43.525	-0.450	90	44.019	-0.450
91	44.514	-0.450	92	44.889	-0.477	93	45.223	-0.490
94	45.373	-0.490	95	45.653	-0.490	96	45.932	-0.469
97	46.245	-0.453	98	46.558	-0.453	99	46.829	-0.453
100	47.047	-0.453	101	47.437	-0.453	102	47.497	-0.453
103	47.780	-0.453	104	48.063	-0.453	105	48.476	-0.453

106	48.890	-0.453	107	49.303	-0.453	108	49.716	-0.453
109	49.998	-0.453	110	50.279	-0.453	111	50.342	-0.453
112	50.732	-0.454	113	50.770	-0.454	114	51.083	-0.454
115	51.396	-0.454	116	51.868	-0.454	117	52.339	-0.454
118	52.489	-0.454	119	52.949	-0.454	120	53.408	-0.454
121	53.868	-0.454	122	54.327	-0.454	123	54.339	-0.466
124	54.489	-2.286	125	100.000	-2.286			

..

◆ At 100.000(hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.608
- Resistance Force(kN) : 394.989
- Sliding Force(kN) : 245.683 (= 236.859 + 83.827 / 9.500)

○Slip Surface axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	32.422	0.000	2	32.644	-0.341	3	32.715	-0.445
4	33.138	-1.004	5	33.633	-1.564	6	34.127	-2.046
7	34.622	-2.463	8	35.117	-2.827	9	35.611	-3.146
10	36.106	-3.423	11	36.600	-3.663	12	37.095	-3.869
13	37.590	-4.043	14	38.084	-4.188	15	38.579	-4.304
16	39.073	-4.392	17	39.568	-4.454	18	40.063	-4.490
19	40.224	-4.496	20	40.557	-4.500	21	40.776	-4.496
22	41.052	-4.484	23	41.546	-4.442	24	42.041	-4.374
25	42.536	-4.279	26	43.030	-4.157	27	43.525	-4.006
28	44.019	-3.824	29	44.514	-3.610	30	44.662	-3.540
31	44.889	-3.425	32	45.223	-3.243	33	45.373	-3.155
34	45.653	-2.981	35	45.932	-2.794	36	46.066	-2.699
37	46.245	-2.566	38	46.558	-2.318	39	46.696	-2.202
40	46.829	-2.085	41	47.047	-1.884	42	47.437	-1.491
43	47.497	-1.426	44	47.780	-1.103	45	48.000	-0.831
46	48.063	-0.749	47	48.285	-0.444	48	48.476	-0.160
49	48.578	0.000	50	48.890	0.543	51	49.303	1.428
52	49.716	2.694	53	49.888	3.543	54	49.959	4.115
55	49.975	4.315						

○Arc Center(m) : (40.500, 5.000)
○Arc Diameter(m) : 9.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle(°)	Slice Bottom Pressure(kN/m2)	Slice Bottom Water Length(m)
0.221	0.661	-57.017	0.000	0.407
0.072	0.493	-55.410	0.000	0.126
0.423	5.483	-52.914	2.745	0.701
0.495	11.533	-48.545	8.237	0.747
0.495	16.296	-44.210	13.344	0.690
0.495	20.408	-40.176	17.754	0.647
0.495	23.985	-36.371	21.590	0.614
0.495	27.107	-32.745	24.939	0.588
0.495	29.830	-29.262	27.859	0.567
0.495	32.197	-25.893	30.397	0.550
0.495	34.238	-22.619	32.587	0.536
0.495	35.979	-19.422	34.454	0.524
0.495	37.438	-16.286	36.019	0.515
0.495	38.630	-13.200	37.298	0.508
0.495	39.566	-10.152	38.302	0.502
0.495	40.254	-7.133	39.041	0.498
0.495	40.701	-4.135	39.521	0.496
0.162	13.373	-2.151	39.726	0.162
0.333	27.550	-0.659	39.775	0.333
0.218	18.081	1.004	39.776	0.218
0.276	22.816	2.496	39.698	0.276
0.495	40.619	4.827	39.435	0.496
0.495	40.117	7.830	38.897	0.499
0.495	39.372	10.854	38.098	0.504
0.495	38.378	13.910	37.033	0.510
0.495	37.125	17.006	35.691	0.517
0.495	35.602	20.155	34.059	0.527
0.495	33.794	23.369	32.121	0.539
0.148	9.991	25.490	30.665	0.164
0.227	15.389	26.751	29.602	0.254
0.334	24.935	28.664	27.981	0.381
0.150	30.115	30.336	26.583	0.174
0.280	25.618	31.853	25.301	0.329
0.279	28.433	33.860	23.654	0.337
0.134	14.509	35.371	22.431	0.165
0.179	19.880	36.539	21.410	0.223
0.313	36.105	38.415	19.597	0.399
0.138	16.344	40.163	17.810	0.180
0.133	16.011	41.241	16.667	0.177
0.218	26.590	42.669	15.108	0.296
0.390	45.095	45.234	12.195	0.554
0.060	6.443	47.170	9.949	0.088
0.283	29.216	48.730	8.050	0.429
0.220	21.317	51.080	5.132	0.350
0.063	5.868	52.448	3.394	0.103
0.222	19.905	53.899	1.496	0.378
0.191	16.053	56.068	0.000	0.342
0.101	8.148	57.671	0.000	0.190
0.312	23.065	60.131	0.000	0.626
0.413	25.264	64.965	0.000	0.977
0.413	17.262	71.933	0.000	1.333
0.172	3.950	78.566	0.000	0.865
0.071	0.728	82.916	0.000	0.577
0.017	0.040	85.260	0.000	0.201

○ Water Level axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	0.000	-0.500	2	0.495	-0.499	3	0.989	-0.497
4	1.484	-0.496	5	1.978	-0.494	6	2.473	-0.493
7	2.968	-0.492	8	3.462	-0.491	9	3.957	-0.489
10	4.451	-0.488	11	4.946	-0.487	12	5.441	-0.486
13	5.935	-0.485	14	6.430	-0.483	15	6.924	-0.482
16	7.419	-0.481	17	7.914	-0.480	18	8.408	-0.479
19	8.903	-0.478	20	9.397	-0.477	21	9.892	-0.476
22	10.387	-0.475	23	10.881	-0.474	24	11.376	-0.473
25	11.870	-0.472	26	12.365	-0.471	27	12.860	-0.470
28	13.354	-0.469	29	13.849	-0.468	30	14.343	-0.467
31	14.838	-0.466	32	15.333	-0.465	33	15.827	-0.465
34	16.322	-0.464	35	16.816	-0.463	36	17.311	-0.462
37	17.806	0.461	38	18.300	-0.461	39	18.795	-0.460
40	19.289	-0.459	41	19.784	-0.458	42	20.279	-0.458
43	20.773	-0.457	44	21.268	-0.456	45	21.762	-0.456
46	22.257	-0.455	47	22.752	-0.454	48	23.246	-0.454
49	20.741	-0.453	50	24.235	-0.453	51	24.730	-0.452
52	25.225	-0.451	53	25.719	-0.451	54	26.214	-0.450
55	26.708	-0.450	56	27.203	-0.449	57	27.698	-0.449
58	28.192	-0.448	59	28.687	-0.448	60	29.181	-0.448
61	29.676	-0.447	62	30.171	-0.447	63	30.665	-0.446
64	31.160	-0.446	65	31.654	-0.446	66	32.149	-0.445
67	32.644	-0.445	68	33.138	-0.445	69	33.633	-0.444
70	34.127	-0.444	71	34.622	-0.444	72	35.117	-0.444
73	35.611	-0.443	74	36.106	-0.443	75	36.600	-0.443
76	37.095	-0.443	77	37.590	-0.443	78	38.084	-0.443
79	38.579	-0.442	80	39.073	-0.442	81	39.568	-0.442
82	40.063	-0.442	83	40.557	-0.442	84	41.052	-0.442
85	41.546	-0.442	86	42.041	-0.442	87	42.536	-0.442
88	43.030	-0.442	89	43.525	-0.442	90	44.019	-0.442
91	44.514	-0.442	92	44.889	-0.474	93	45.223	-0.488
94	45.373	-0.488	95	45.653	-0.488	96	45.932	-0.463
97	46.245	-0.444	98	46.558	-0.444	99	46.829	-0.444
100	47.047	-0.444	101	47.437	-0.444	102	47.497	-0.444
103	47.780	-0.444	104	48.063	-0.444	105	48.476	-0.444
106	48.890	-0.444	107	49.303	-0.444	108	49.716	-0.444
109	49.998	-0.444	110	50.279	-0.444	111	50.342	-0.444
112	50.732	-0.444	113	50.770	-0.444	114	51.083	-0.444
115	51.396	-0.444	116	51.868	-0.444	117	52.339	-0.445
118	52.489	-0.445	119	52.949	-0.445	120	53.408	-0.445
121	53.868	-0.445	122	54.327	-0.445	123	54.339	-0.448
124	54.489	-2.157	125	100.000	-2.157			

..

◆ At 210.000(hr) Calculation Result

○Safety Factor and Slip Surface

- Safety Factor : 1.525
- Resistance Force(kN) : 374.164
- Sliding Force(kN) : 245.359 (= 236.535 + 83.827 / 9.500)

○Slip Surface axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	32.422	0.000	2	32.470	-0.076	3	32.644	-0.341
4	33.138	-1.004	5	33.633	-1.564	6	34.127	-2.046
7	34.622	-2.463	8	35.117	-2.827	9	35.611	-3.146
10	36.106	-3.423	11	36.600	-3.663	12	37.095	-3.869
13	37.590	-4.043	14	38.084	-4.188	15	38.579	-4.304
16	39.073	-4.392	17	39.568	-4.454	18	40.063	-4.490
19	40.224	-4.496	20	40.557	-4.500	21	40.776	-4.496
22	41.052	-4.484	23	41.546	-4.442	24	42.041	-4.374
25	42.536	-4.279	26	43.030	-4.157	27	43.525	-4.006
28	44.019	-3.824	29	44.514	-3.610	30	44.823	-3.460
31	44.889	-3.425	32	45.223	-3.243	33	45.373	-3.155
34	45.653	-2.981	35	45.932	-2.794	36	46.159	-2.631
37	46.245	-2.566	38	46.558	-2.318	39	46.798	-2.112
40	46.829	-2.085	41	47.047	-1.884	42	47.437	-1.491
43	47.497	-1.426	44	47.780	-1.103	45	48.000	-0.831
46	48.063	-0.749	47	48.476	-0.160	48	48.513	-0.104
49	48.578	0.000	50	48.890	0.543	51	49.303	1.428
52	49.716	2.694	53	49.888	3.543	54	49.959	4.115
55	49.975	4.315						

○Arc Center(m) : (40.500, 5.000)
○Arc Diameter(m) : 9.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle(°)	Slice Bottom Pressure(kN/m2)	Slice Bottom Water Length(m)
0.048	0.032	-57.972	0.000	0.090
0.174	0.657	-56.746	1.302	0.317
0.495	6.119	-53.295	5.865	0.828
0.495	11.717	-48.545	11.879	0.747
0.495	16.480	-44.210	16.997	0.690
0.495	20.593	-40.176	21.417	0.647
0.495	24.171	-36.371	25.262	0.614
0.495	27.293	-32.745	28.618	0.588
0.495	30.016	-29.262	31.545	0.567
0.495	32.383	-25.893	34.088	0.550
0.495	34.425	-22.619	36.282	0.536
0.495	36.165	-19.422	38.152	0.524
0.495	37.625	-16.286	39.719	0.515
0.495	38.816	-13.200	40.999	0.508
0.495	39.752	-10.152	42.003	0.502
0.495	40.441	-7.133	42.740	0.498
0.495	40.887	-4.135	43.218	0.496
0.162	13.434	-2.151	43.421	0.162
0.333	27.676	-0.659	43.468	0.333
0.218	18.164	1.004	43.466	0.218
0.276	22.920	2.496	43.386	0.276
0.495	40.805	4.827	43.118	0.496
0.495	40.302	7.830	42.575	0.499
0.495	39.557	10.854	41.770	0.504
0.495	38.562	13.910	40.698	0.510
0.495	37.310	17.006	39.349	0.517
0.495	35.787	20.155	37.711	0.527
0.495	33.978	23.369	35.769	0.539
0.309	20.939	26.030	33.672	0.344
0.066	4.521	27.291	32.391	0.075
0.334	24.935	28.664	29.784	0.381
0.150	30.115	30.336	26.981	0.174
0.280	25.618	31.853	25.699	0.329
0.279	28.433	33.860	24.827	0.337
0.227	24.732	35.717	24.586	0.279
0.086	9.698	36.884	24.267	0.108
0.313	36.212	38.415	22.951	0.399
0.240	28.749	40.574	20.724	0.317
0.031	3.695	41.652	19.581	0.041
0.218	26.665	42.669	18.462	0.296
0.390	45.228	45.234	15.547	0.554
0.060	6.464	47.170	13.300	0.088
0.283	29.313	48.730	11.399	0.429
0.220	21.392	51.080	8.479	0.350
0.063	5.890	52.448	6.739	0.103
0.413	36.027	54.929	3.447	0.719
0.036	2.963	57.302	0.279	0.068
0.065	5.186	57.874	0.000	0.122
0.312	23.065	60.131	0.000	0.626
0.413	25.264	64.965	0.000	0.977
0.413	17.262	71.933	0.000	1.333
0.172	3.950	78.566	0.000	0.865
0.071	0.728	82.916	0.000	0.577
0.017	0.040	85.260	0.000	0.201

○ Water Level axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	0.000	-0.500	2	0.495	-0.488	3	0.989	-0.476
4	1.484	-0.464	5	1.978	-0.453	6	2.473	-0.442
7	2.968	-0.431	8	3.462	-0.421	9	3.957	-0.411
10	4.451	-0.401	11	4.946	-0.391	12	5.441	-0.381
13	5.935	-0.371	14	6.430	-0.362	15	6.924	-0.352
16	7.419	-0.343	17	7.914	-0.334	18	8.408	-0.326
19	8.903	-0.317	20	9.397	-0.308	21	9.892	-0.300
22	10.387	-0.292	23	10.881	-0.284	24	11.376	-0.276
25	11.870	-0.268	26	12.365	-0.260	27	12.860	-0.253
28	13.354	-0.246	29	13.849	-0.239	30	14.343	-0.232
31	14.838	-0.225	32	15.333	-0.218	33	15.827	-0.212
34	16.322	-0.205	35	16.816	-0.199	36	17.311	-0.193
37	17.806	-0.187	38	18.300	-0.181	39	18.795	-0.176
40	19.289	-0.170	41	19.784	-0.165	42	20.279	-0.160
43	20.773	-0.155	44	21.268	-0.150	45	21.762	-0.145

46	22.257	-0.140	47	22.752	-0.136	48	23.246	-0.132
49	23.741	-0.127	50	24.235	-0.123	51	24.730	-0.119
52	25.225	-0.116	53	25.719	-0.112	54	26.214	-0.108
55	26.708	-0.105	56	27.203	-0.102	57	27.698	-0.099
58	28.192	-0.096	59	28.687	-0.093	60	29.181	-0.090
61	29.676	-0.088	62	30.171	-0.086	63	30.665	-0.083
64	31.160	-0.081	65	31.654	-0.079	66	32.149	-0.077
67	32.644	-0.076	68	33.138	-0.074	69	33.633	-0.072
70	34.127	-0.071	71	34.622	-0.070	72	35.117	-0.069
73	35.611	-0.068	74	36.106	-0.067	75	36.600	-0.066
76	37.095	-0.066	77	37.590	-0.065	78	38.084	-0.065
79	38.579	-0.065	80	39.073	-0.065	81	39.568	-0.065
82	40.063	-0.065	83	40.557	-0.066	84	41.052	-0.066
85	41.546	-0.067	86	42.041	-0.067	87	42.536	-0.068
88	43.030	-0.069	89	43.525	-0.069	90	44.019	-0.070
91	44.514	-0.070	92	44.889	-0.146	93	45.223	-0.448
94	45.653	-0.448	95	45.932	-0.264	96	46.245	-0.102
97	46.558	-0.102	98	46.829	-0.102	99	47.047	-0.102
100	47.437	-0.102	101	47.780	-0.102	102	48.063	-0.103
103	48.476	-0.103	104	48.890	-0.104	105	49.303	-0.105
106	49.716	-0.106	107	49.998	-0.106	108	50.279	-0.106
109	50.342	-0.106	110	50.732	-0.107	111	50.770	-0.107
112	51.083	-0.108	113	51.396	-0.108	114	51.868	-0.109
115	52.339	-0.109	116	52.489	-0.109	117	52.949	-0.110
118	53.408	-0.110	119	53.868	-0.111	120	54.327	-0.111
121	54.339	-0.112	122	54.489	-2.000	123	100.000	-2.000

..

◆ At 225.000(hr) Calculation Result

○Safety Factor and Slip Surface

- Safety Factor : 1.327
- Resistance Force(kN) : 325.707
- Sliding Force(kN) : 245.432 (= 236.608 + 83.827 / 9.500)

○Slip Surface axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	32.422	0.000	2	32.431	-0.014	3	32.644	-0.341
4	33.138	-1.004	5	33.633	-1.564	6	34.127	-2.046
7	34.622	-2.463	8	35.117	-2.827	9	35.611	-3.146
10	36.106	-3.423	11	36.600	-3.663	12	37.095	-3.869
13	37.590	-4.043	14	38.084	-4.188	15	38.798	-4.346
16	39.511	-4.448	17	40.224	-4.496	18	40.776	-4.496
19	41.710	-4.423	20	42.645	-4.255	21	43.579	-3.987
22	44.514	-3.610	23	44.889	-3.425	24	45.223	-3.243
25	45.373	-3.155	26	45.653	-2.981	27	45.932	-2.794
28	46.192	-2.606	29	46.245	-2.566	30	46.558	-2.318
31	46.829	-2.085	32	46.829	-2.085	33	47.047	-1.884
34	47.437	-1.491	35	47.497	-1.426	36	47.780	-1.103

37	48.000	−0.831	38	48.063	−0.749	39	48.476	−0.160
40	48.578	0.000	41	48.579	0.001	42	48.890	0.543
43	49.303	1.428	44	49.716	2.694	45	49.888	3.543
46	49.959	4.115	47	49.975	4.315			

○Arc Center(m) : (40.500, 5.000)
○Arc Diameter(m) : 9.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle(°)	Slice Bottom Water Pressure (kN/m2)	Slice Bottom Length (m)
0.009	0.001	−58.194	0.000	0.016
0.213	0.696	−56.968	1.609	0.390
0.495	6.150	−53.295	6.481	0.828
0.495	11.748	−48.545	12.499	0.747
0.495	16.512	−44.210	17.622	0.690
0.495	20.625	−40.176	22.045	0.647
0.495	24.202	−36.371	25.894	0.614
0.495	27.325	−32.745	29.253	0.588
0.495	30.049	−29.262	32.183	0.567
0.495	32.415	−25.893	34.728	0.550
0.495	34.457	−22.619	36.924	0.536
0.495	36.198	−19.422	38.794	0.524
0.495	37.657	−16.286	40.360	0.515
0.713	56.314	−12.528	41.846	0.731
0.713	58.034	−8.150	43.124	0.721
0.713	59.022	−3.819	43.859	0.715
0.551	45.855	0.000	44.092	0.551
0.935	77.101	4.491	43.732	0.937
0.935	75.015	10.184	42.549	0.950
0.935	71.250	15.981	40.414	0.972
0.935	65.679	21.954	37.254	1.008
0.375	25.490	26.255	34.500	0.418
0.334	24.935	28.664	30.534	0.381
0.150	30.115	30.336	27.046	0.174
0.280	25.618	31.853	25.764	0.329
0.279	28.433	33.860	25.153	0.337
0.260	28.517	35.844	25.309	0.321
0.053	5.918	37.012	25.198	0.066
0.313	36.245	38.415	23.956	0.399
0.271	32.470	40.697	21.596	0.357
0.000	0.032	41.776	20.453	0.000
0.218	26.655	42.670	19.468	0.296
0.390	45.268	45.234	16.556	0.554
0.060	6.470	47.170	14.311	0.088
0.283	29.342	48.730	12.413	0.429
0.220	21.415	51.080	9.496	0.350
0.063	5.896	52.448	7.758	0.103
0.413	36.070	54.929	4.471	0.719
0.101	8.156	57.671	0.798	0.190
0.001	0.060	58.247	0.006	0.001
0.311	23.005	60.136	0.000	0.625
0.413	25.264	64.965	0.000	0.977
0.413	17.262	71.933	0.000	1.333
0.172	3.950	78.566	0.000	0.865
0.071	0.728	82.916	0.000	0.577
0.017	0.040	85.260	0.000	0.201

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	−0.500	2	0.495	−0.486	3	0.989	−0.473
4	1.484	−0.460	5	1.978	−0.448	6	2.473	−0.436
7	2.968	−0.424	8	3.462	−0.412	9	3.957	−0.401
10	4.451	−0.389	11	4.946	−0.378	12	5.441	−0.367
13	5.935	−0.356	14	6.430	−0.346	15	6.924	−0.335
16	7.419	−0.325	17	7.914	−0.315	18	8.408	−0.305
19	8.903	−0.295	20	9.397	−0.285	21	9.892	−0.276
22	10.387	−0.267	23	10.881	−0.257	24	11.376	−0.248
25	11.870	−0.240	26	12.365	−0.231	27	12.860	−0.222
28	13.354	−0.214	29	13.849	−0.206	30	14.343	−0.198
31	14.838	−0.190	32	15.333	−0.182	33	15.827	−0.175
34	16.322	−0.167	35	16.816	−0.160	36	17.311	−0.153
37	17.806	−0.146	38	18.300	−0.140	39	18.795	−0.133
40	19.289	−0.127	41	19.784	−0.120	42	20.279	−0.114
43	20.773	−0.108	44	21.268	−0.103	45	21.762	−0.097
46	22.257	−0.092	47	22.752	−0.086	48	23.246	−0.081
49	23.741	−0.076	50	24.235	−0.071	51	24.730	−0.067
52	25.225	−0.062	53	25.719	−0.058	54	26.214	−0.054
55	26.708	−0.050	56	27.203	−0.046	57	27.698	−0.042
58	28.192	−0.038	59	28.687	−0.035	60	29.181	−0.032
61	29.676	−0.028	62	30.171	−0.026	63	30.665	−0.023
64	31.160	−0.020	65	31.654	−0.018	66	32.149	−0.015
67	32.644	−0.013	68	33.138	−0.011	69	33.633	−0.009
70	34.127	−0.007	71	34.622	−0.006	72	35.117	−0.004
73	35.611	−0.003	74	36.106	−0.002	75	36.600	−0.001
76	37.095	0.000	77	37.590	0.000	78	38.084	0.000
79	44.889	0.000	80	45.223	−0.441	81	45.653	−0.441
82	45.932	−0.204	83	46.245	0.001	84	46.558	0.001
85	46.829	0.001	86	47.047	0.001	87	47.437	0.001
88	47.780	0.001	89	48.063	0.001	90	48.476	0.001
91	48.890	0.001	92	49.303	0.001	93	49.716	0.002
94	49.998	0.002	95	50.279	0.002	96	50.342	0.002
97	50.770	0.002	98	50.794	4.190	99	100.000	4.190

..

◆ At 226.000(hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.327
- Resistance Force(kN) : 325.688
- Sliding Force(kN) : 245.436 (= 236.612 + 83.827 / 9.500)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	32.422	0.000	2	32.431	−0.014	3	32.644	−0.341
4	33.138	−1.004	5	33.633	−1.564	6	34.127	−2.046
7	34.622	−2.463	8	35.117	−2.827	9	35.611	−3.146
10	36.106	−3.423	11	36.600	−3.663	12	37.095	−3.869
13	37.590	−4.043	14	38.084	−4.188	15	38.798	−4.346
16	39.511	−4.448	17	40.224	−4.496	18	40.776	−4.496
19	41.710	−4.423	20	42.645	−4.255	21	43.579	−3.987
22	44.514	−3.610	23	44.889	−3.425	24	45.223	−3.243
25	45.373	−3.155	26	45.653	−2.981	27	45.932	−2.794
28	46.193	−2.605	29	46.245	−2.566	30	46.558	−2.318
31	46.829	−2.085	32	46.830	−2.084	33	47.047	−1.884
34	47.437	−1.491	35	47.497	−1.426	36	47.780	−1.103
37	48.000	−0.831	38	48.063	−0.749	39	48.476	−0.160
40	48.578	0.000	41	48.580	0.003	42	48.890	0.543
43	49.303	1.428	44	49.716	2.694	45	49.888	3.543
46	49.959	4.115	47	49.975	4.315			

○Arc Center(m) : (40.500, 5.000)
○Arc Diameter(m) : 9.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle(°)	Slice Bottom Water Pressure (kN/m2)	Slice Bottom Length (m)
0.009	0.001	−58.194	0.000	0.016
0.213	0.696	−56.968	1.609	0.390
0.495	6.150	−53.295	6.482	0.828
0.495	11.748	−48.545	12.500	0.747
0.495	16.512	−44.210	17.623	0.690
0.495	20.625	−40.176	22.046	0.647
0.495	24.203	−36.371	25.895	0.614
0.495	27.325	−32.745	29.253	0.588
0.495	30.049	−29.262	32.183	0.567
0.495	32.415	−25.893	34.729	0.550
0.495	34.457	−22.619	36.924	0.536
0.495	36.198	−19.422	38.794	0.524
0.495	37.657	−16.286	40.360	0.515
0.713	56.314	−12.528	41.846	0.731
0.713	58.034	−8.150	43.124	0.721
0.713	59.022	−3.819	43.859	0.715
0.551	45.855	0.000	44.092	0.551
0.935	77.101	4.491	43.732	0.937
0.935	75.015	10.184	42.549	0.950
0.935	71.250	15.981	40.414	0.972
0.935	65.679	21.954	37.254	1.008
0.375	25.490	26.255	34.500	0.418
0.334	24.935	28.664	30.535	0.381
0.150	30.115	30.336	27.047	0.174
0.280	25.618	31.853	25.765	0.329
0.279	28.433	33.860	25.159	0.337
0.261	28.595	35.847	25.323	0.322
0.052	5.840	37.014	25.217	0.065
0.313	36.245	38.415	23.976	0.399
0.271	32.470	40.697	21.616	0.357
0.001	0.106	41.779	20.470	0.001
0.217	26.582	42.673	19.485	0.295
0.390	45.269	45.234	16.576	0.554
0.060	6.470	47.170	14.331	0.088
0.283	29.343	48.730	12.433	0.429
0.220	21.415	51.080	9.517	0.350
0.063	5.896	52.448	7.779	0.103
0.413	36.071	54.929	4.492	0.719
0.101	8.156	57.671	0.820	0.190
0.002	0.168	58.255	0.017	0.004
0.310	22.898	60.143	0.000	0.622
0.413	25.264	64.965	0.000	0.977
0.413	17.262	71.933	0.000	1.333
0.172	3.950	78.566	0.000	0.865
0.071	0.728	82.916	0.000	0.577
0.017	0.040	85.260	0.000	0.201

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	−0.500	2	0.495	−0.486	3	0.989	−0.473
4	1.484	−0.460	5	1.978	−0.448	6	2.473	−0.436
7	2.968	−0.424	8	3.462	−0.412	9	3.957	−0.401
10	4.451	−0.389	11	4.946	−0.378	12	5.441	−0.367
13	5.935	−0.356	14	6.430	−0.346	15	6.924	−0.335
16	7.419	−0.325	17	7.914	−0.315	18	8.408	−0.305
19	8.903	−0.295	20	9.397	−0.285	21	9.892	−0.276
22	10.387	−0.267	23	10.881	−0.257	24	11.376	−0.248
25	11.870	−0.240	26	12.365	−0.231	27	12.860	−0.222
28	13.354	−0.214	29	13.849	−0.206	30	14.343	−0.198
31	14.838	−0.190	32	15.333	−0.182	33	15.827	−0.175
34	16.322	−0.167	35	16.816	−0.160	36	17.311	−0.153
37	17.806	−0.146	38	18.300	−0.139	39	18.795	−0.133
40	19.289	−0.126	41	19.784	−0.120	42	20.279	−0.114
43	20.773	−0.108	44	21.268	−0.102	45	21.762	−0.097
46	22.257	−0.091	47	22.752	−0.086	48	23.246	−0.081
49	23.741	−0.076	50	24.235	−0.071	51	24.730	−0.066
52	25.225	−0.062	53	25.719	−0.058	54	26.214	−0.053
55	26.708	−0.049	56	27.203	−0.046	57	27.698	−0.042
58	28.192	−0.038	59	28.687	−0.035	60	29.181	−0.031
61	29.676	−0.028	62	30.171	−0.025	63	30.665	−0.023
64	31.160	−0.020	65	31.654	−0.017	66	32.149	−0.015
67	32.644	−0.013	68	33.138	−0.011	69	33.633	−0.009
70	34.127	−0.007	71	34.622	−0.006	72	35.117	−0.004
73	35.611	−0.003	74	36.106	−0.002	75	36.600	−0.001
76	37.095	0.000	77	37.590	0.000	78	38.084	0.000
79	44.889	0.000	80	45.223	−0.441	81	45.653	−0.441

82	45.932	-0.203	83	46.245	0.003	84	46.558	0.003
85	46.829	0.003	86	47.047	0.003	87	47.437	0.003
88	47.780	0.003	89	48.063	0.003	90	48.476	0.003
91	48.890	0.004	92	49.303	0.004	93	49.716	0.004
94	49.998	0.004	95	50.279	0.004	96	50.342	0.004
97	50.770	0.004	98	50.794	4.190	99	100.000	4.190

..

◆ At 253.000 (hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.616
- Resistance Force (kN) : 397.031
- Sliding Force (kN) : 245.718 (= 236.894 + 83.827 / 9.500)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	32.422	0.000	2	32.644	-0.341	3	32.742	-0.483
4	33.138	-1.004	5	33.633	-1.564	6	34.127	-2.046
7	34.622	-2.463	8	35.117	-2.827	9	35.611	-3.146
10	36.106	-3.423	11	36.600	-3.663	12	37.095	-3.869
13	37.590	-4.043	14	38.084	-4.188	15	38.579	-4.304
16	39.073	-4.392	17	39.568	-4.454	18	40.063	-4.490
19	40.224	-4.496	20	40.557	-4.500	21	40.776	-4.496
22	41.052	-4.484	23	41.546	-4.442	24	42.041	-4.374
25	42.536	-4.279	26	43.030	-4.157	27	43.525	-4.006
28	44.019	-3.824	29	44.514	-3.610	30	44.648	-3.546
31	44.889	-3.425	32	45.223	-3.243	33	45.373	-3.155
34	45.653	-2.981	35	45.932	-2.794	36	46.059	-2.704
37	46.245	-2.566	38	46.558	-2.318	39	46.686	-2.210
40	46.829	-2.085	41	47.047	-1.884	42	47.437	-1.491
43	47.497	-1.426	44	47.780	-1.103	45	48.000	-0.831
46	48.063	-0.749	47	48.263	-0.476	48	48.476	-0.160
49	48.578	0.000	50	48.890	0.543	51	49.303	1.428
52	49.716	2.694	53	49.888	3.543	54	49.959	4.115
55	49.975	4.315						

○Arc Center (m) : (40.500, 5.000)
○Arc Diameter (m) : 9.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length (m)
0.221	0.661	-57.017	0.000	0.407
0.099	0.711	-55.269	0.000	0.173
0.396	5.258	-52.773	2.556	0.655
0.495	11.514	-48.545	7.860	0.747
0.495	16.277	-44.210	12.967	0.690
0.495	20.389	-40.176	17.376	0.647
0.495	23.966	-36.371	21.212	0.614
0.495	27.088	-32.745	24.560	0.588
0.495	29.811	-29.262	27.481	0.567
0.495	32.178	-25.893	30.019	0.550
0.495	34.219	-22.619	32.209	0.536
0.495	35.960	-19.422	34.077	0.524
0.495	37.419	-16.286	35.643	0.515
0.495	38.611	-13.200	36.922	0.508
0.495	39.547	-10.152	37.927	0.502
0.495	40.235	-7.133	38.667	0.498
0.495	40.682	-4.135	39.148	0.496
0.162	13.367	-2.151	39.355	0.162
0.333	27.538	-0.659	39.404	0.333
0.218	18.073	1.004	39.405	0.218
0.276	22.806	2.496	39.328	0.276
0.495	40.600	4.827	39.066	0.496
0.495	40.098	7.830	38.530	0.499
0.495	39.353	10.854	37.733	0.504
0.495	38.359	13.910	36.669	0.510
0.495	37.107	17.006	35.328	0.517
0.495	35.584	20.155	33.698	0.527
0.495	33.776	23.369	31.761	0.539
0.134	9.043	25.443	30.381	0.149
0.241	16.333	26.704	29.419	0.269
0.334	24.935	28.664	27.873	0.381
0.150	30.115	30.336	26.525	0.174
0.280	25.618	31.853	25.243	0.329
0.279	28.433	33.860	23.526	0.337
0.127	13.676	35.343	22.235	0.155
0.186	20.708	36.510	21.156	0.232
0.313	36.095	38.415	19.285	0.399
0.128	15.200	40.125	17.539	0.168
0.143	17.146	41.203	16.396	0.190
0.218	26.583	42.669	14.797	0.296
0.390	45.082	45.234	11.883	0.554
0.060	6.442	47.170	9.637	0.088
0.283	29.207	48.730	7.738	0.429
0.220	21.310	51.080	4.821	0.350
0.063	5.866	52.448	3.083	0.103
0.200	17.968	53.782	1.341	0.339
0.213	17.984	55.951	0.000	0.380
0.101	8.148	57.671	0.000	0.190
0.312	23.065	60.131	0.000	0.626
0.413	25.264	64.965	0.000	0.977
0.413	17.262	71.933	0.000	1.333
0.172	3.950	78.566	0.000	0.865
0.071	0.728	82.916	0.000	0.577
0.017	0.040	85.260	0.000	0.201

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)

1	0.000	-0.500	2	0.495	-0.500	3	0.989	-0.499
4	1.484	-0.499	5	1.978	-0.499	6	2.473	-0.499
7	2.968	-0.498	8	3.462	-0.498	9	3.957	-0.498
10	4.451	-0.498	11	4.946	-0.497	12	5.441	-0.497
13	5.935	-0.497	14	6.430	-0.497	15	6.924	-0.496
16	7.419	-0.496	17	7.914	-0.496	18	8.408	-0.496
19	8.903	-0.495	20	9.397	-0.495	21	9.892	-0.495
22	10.387	-0.494	23	10.881	-0.494	24	11.376	-0.494
25	11.870	-0.494	26	12.365	-0.493	27	12.860	-0.493
28	13.354	-0.493	29	13.849	-0.493	30	14.343	-0.492
31	14.838	-0.492	32	15.333	-0.492	33	15.827	-0.492
34	16.322	-0.491	35	16.816	-0.491	36	17.311	-0.491
37	17.806	-0.491	38	18.300	-0.490	39	18.795	-0.490
40	19.289	-0.490	41	19.784	-0.490	42	20.279	-0.489
43	20.773	-0.489	44	21.268	-0.489	45	21.762	-0.489
46	22.257	-0.488	47	22.752	-0.488	48	23.246	-0.488
49	23.741	-0.488	50	24.235	-0.487	51	24.730	-0.487
52	25.225	-0.487	53	25.719	-0.487	54	26.214	-0.486
55	26.708	-0.486	56	27.203	-0.486	57	27.698	-0.486
58	28.192	-0.485	59	28.687	-0.485	60	29.181	-0.485
61	29.676	-0.485	62	30.171	-0.485	63	30.665	-0.484
64	31.160	-0.484	65	31.654	-0.484	66	32.149	-0.484
67	32.644	-0.483	68	33.138	-0.483	69	33.633	-0.483
70	34.127	-0.483	71	34.622	-0.482	72	35.117	-0.482
73	35.611	-0.482	74	36.106	-0.482	75	36.600	-0.482
76	37.095	-0.481	77	37.590	-0.481	78	38.084	-0.481
79	38.579	-0.481	80	39.073	-0.481	81	39.568	-0.480
82	40.063	-0.480	83	40.557	-0.480	84	41.052	-0.480
85	41.546	-0.479	86	42.041	-0.479	87	42.536	-0.479
88	43.030	-0.479	89	43.525	-0.479	90	44.019	-0.479
91	44.514	-0.479	92	44.889	-0.490	93	45.223	-0.494
94	45.373	-0.494	95	45.653	-0.494	96	45.932	-0.483
97	46.245	-0.475	98	46.558	-0.475	99	46.829	-0.475
100	47.047	-0.476	101	47.437	-0.476	102	47.497	-0.476
103	47.780	-0.476	104	48.063	-0.476	105	48.476	-0.476
106	48.890	-0.476	107	49.303	-0.475	108	49.716	-0.475
109	49.998	-0.475	110	50.279	-0.475	111	50.342	-0.475
112	50.732	-0.475	113	50.770	-0.475	114	51.083	-0.475
115	51.396	-0.475	116	51.868	-0.475	117	52.339	-0.475
118	52.489	-0.475	119	52.949	-0.475	120	53.408	-0.476
121	53.868	-0.476	122	54.327	-0.476	123	54.339	-0.476
124	54.489	-2.300	125	100.000	-2.300			

..

◆ At 270.000 (hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.620
- Resistance Force (kN) : 398.172
- Sliding Force (kN) : 245.716 (= 236.892 + 83.827 / 9.500)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	32.422	0.000	2	32.644	-0.341	3	32.754	-0.500
4	33.138	-1.004	5	33.633	-1.564	6	34.127	-2.046
7	34.622	-2.463	8	35.117	-2.827	9	35.611	-3.146
10	36.106	-3.423	11	36.600	-3.663	12	37.095	-3.869
13	37.590	-4.043	14	38.084	-4.188	15	38.579	-4.304
16	39.073	-4.392	17	39.568	-4.454	18	40.063	-4.490
19	40.224	-4.496	20	40.557	-4.500	21	40.776	-4.496
22	41.052	-4.484	23	41.546	-4.442	24	42.041	-4.374
25	42.536	-4.279	26	43.030	-4.157	27	43.525	-4.006
28	44.019	-3.824	29	44.514	-3.610	30	44.640	-3.551
31	44.889	-3.425	32	45.223	-3.243	33	45.373	-3.155
34	45.653	-2.981	35	45.932	-2.794	36	46.052	-2.708
37	46.245	-2.566	38	46.558	-2.318	39	46.679	-2.216
40	46.829	-2.085	41	47.047	-1.884	42	47.437	-1.491
43	47.497	-1.426	44	47.780	-1.103	45	48.000	-0.831
46	48.063	-0.749	47	48.245	-0.501	48	48.476	-0.160
49	48.578	0.000	50	48.890	0.543	51	49.303	1.428
52	49.716	2.694	53	49.888	3.543	54	49.959	4.115
55	49.975	4.315						

○Arc Center (m) : (40.500, 5.000)
○Arc Diameter (m) : 9.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length (m)
0.221	0.661	-57.017	0.000	0.407
0.111	0.815	-55.206	0.000	0.194
0.384	5.152	-52.710	2.472	0.634
0.495	11.505	-48.545	7.690	0.747
0.495	16.268	-44.210	12.795	0.690
0.495	20.380	-40.176	17.202	0.647
0.495	23.957	-36.371	21.036	0.614
0.495	27.079	-32.745	24.382	0.588
0.495	29.802	-29.262	27.300	0.567
0.495	32.169	-25.893	29.836	0.550
0.495	34.210	-22.619	32.024	0.536
0.495	35.950	-19.422	33.889	0.524
0.495	37.409	-16.286	35.453	0.515
0.495	38.601	-13.200	36.730	0.508
0.495	39.537	-10.152	37.733	0.502
0.495	40.225	-7.133	38.471	0.498
0.495	40.672	-4.135	38.950	0.496
0.162	13.364	-2.151	39.155	0.162
0.333	27.531	-0.659	39.203	0.333
0.218	18.069	1.004	39.203	0.218
0.276	22.800	2.496	39.125	0.276

0.495	40.590	4.827	38.861	0.496
0.495	40.088	7.830	38.323	0.499
0.495	39.343	10.854	37.524	0.504
0.495	38.349	13.910	36.459	0.510
0.495	37.096	17.006	35.116	0.517
0.495	35.573	20.155	33.484	0.527
0.495	33.765	23.369	31.546	0.539
0.126	8.442	25.413	30.207	0.139
0.249	16.930	26.674	29.303	0.279
0.334	24.935	28.664	27.796	0.381
0.150	30.115	30.336	26.472	0.174
0.280	25.618	31.853	25.190	0.329
0.279	28.433	33.860	23.416	0.337
0.120	13.013	35.320	22.074	0.148
0.193	21.367	36.488	20.955	0.239
0.313	36.088	38.415	19.039	0.399
0.121	14.296	40.095	17.324	0.158
0.150	18.043	41.173	16.181	0.200
0.218	26.578	42.669	14.550	0.296
0.390	45.073	45.234	11.636	0.554
0.060	6.440	47.170	9.391	0.088
0.283	29.200	48.730	7.492	0.429
0.220	21.305	51.080	4.574	0.350
0.063	5.865	52.448	2.836	0.103
0.182	16.404	53.689	1.217	0.308
0.231	19.542	55.858	0.000	0.411
0.101	8.148	57.671	0.000	0.190
0.312	23.065	60.131	0.000	0.626
0.413	25.264	64.965	0.000	0.977
0.413	17.262	71.933	0.000	1.333
0.172	3.950	78.566	0.000	0.865
0.071	0.728	82.916	0.000	0.577
0.017	0.040	85.260	0.000	0.201

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	-0.500	2	0.495	-0.500	3	0.989	-0.500
4	1.484	-0.500	5	1.978	-0.500	6	2.473	-0.500
7	2.968	-0.500	8	3.462	-0.500	9	3.957	-0.500
10	4.451	-0.500	11	4.946	-0.500	12	5.441	-0.500
13	5.935	-0.500	14	6.430	-0.500	15	6.924	-0.500
16	7.419	-0.500	17	7.914	-0.500	18	8.408	-0.500
19	8.903	-0.500	20	9.397	-0.500	21	9.892	-0.500
22	10.387	-0.500	23	10.881	-0.500	24	11.376	-0.500
25	11.870	-0.500	26	12.365	-0.500	27	12.860	-0.500
28	13.354	-0.500	29	13.849	-0.500	30	14.343	-0.500
31	14.838	-0.500	32	15.333	-0.500	33	15.827	-0.500
34	16.322	-0.500	35	16.816	-0.500	36	17.311	-0.500
37	17.806	-0.500	38	18.300	-0.500	39	18.795	-0.500
40	19.289	-0.500	41	19.784	-0.500	42	20.279	-0.500
43	20.773	-0.500	44	21.268	-0.500	45	21.762	-0.500
46	22.257	-0.500	47	22.752	-0.500	48	23.246	-0.500
49	23.741	-0.500	50	24.235	-0.500	51	24.730	-0.500
52	25.225	-0.500	53	25.719	-0.500	54	26.214	-0.500
55	26.708	-0.500	56	27.203	-0.500	57	27.698	-0.500
58	28.192	-0.500	59	28.687	-0.500	60	29.181	-0.500
61	29.676	-0.500	62	30.171	-0.500	63	30.665	-0.500
64	31.160	-0.500	65	31.654	-0.500	66	32.149	-0.500
67	32.644	-0.500	68	33.138	-0.500	69	33.633	-0.500
70	34.127	-0.500	71	34.622	-0.500	72	35.117	-0.500
73	35.611	-0.500	74	36.106	-0.500	75	36.600	-0.500
76	37.095	-0.500	77	37.590	-0.500	78	38.084	-0.500
79	38.579	-0.500	80	39.073	-0.500	81	39.568	-0.500
82	40.063	-0.500	83	40.557	-0.500	84	41.052	-0.500
85	41.546	-0.500	86	42.041	-0.500	87	42.536	-0.500
88	43.030	-0.500	89	43.525	-0.501	90	44.019	-0.500
91	44.514	-0.500	92	44.889	-0.500	93	45.223	-0.500
94	45.373	-0.500	95	45.653	-0.500	96	45.932	-0.500
97	46.245	-0.501	98	46.558	-0.501	99	46.829	-0.501
100	47.047	-0.501	101	47.437	-0.501	102	47.497	-0.501
103	47.780	-0.501	104	48.063	-0.501	105	48.476	-0.501
106	48.890	-0.501	107	49.303	-0.501	108	49.716	-0.501
109	49.998	-0.501	110	50.279	-0.501	111	50.342	-0.501
112	50.732	-0.501	113	50.770	-0.501	114	51.083	-0.501
115	51.396	-0.501	116	51.868	-0.501	117	52.339	-0.501
118	52.489	-0.501	119	52.949	-0.501	120	53.408	-0.501
121	53.868	-0.501	122	54.327	-0.501	123	54.339	-0.502
124	54.489	-2.300	125	100.000	-2.300			

..

==========

○3. Slip Surface with the minimum Safety Factor

..

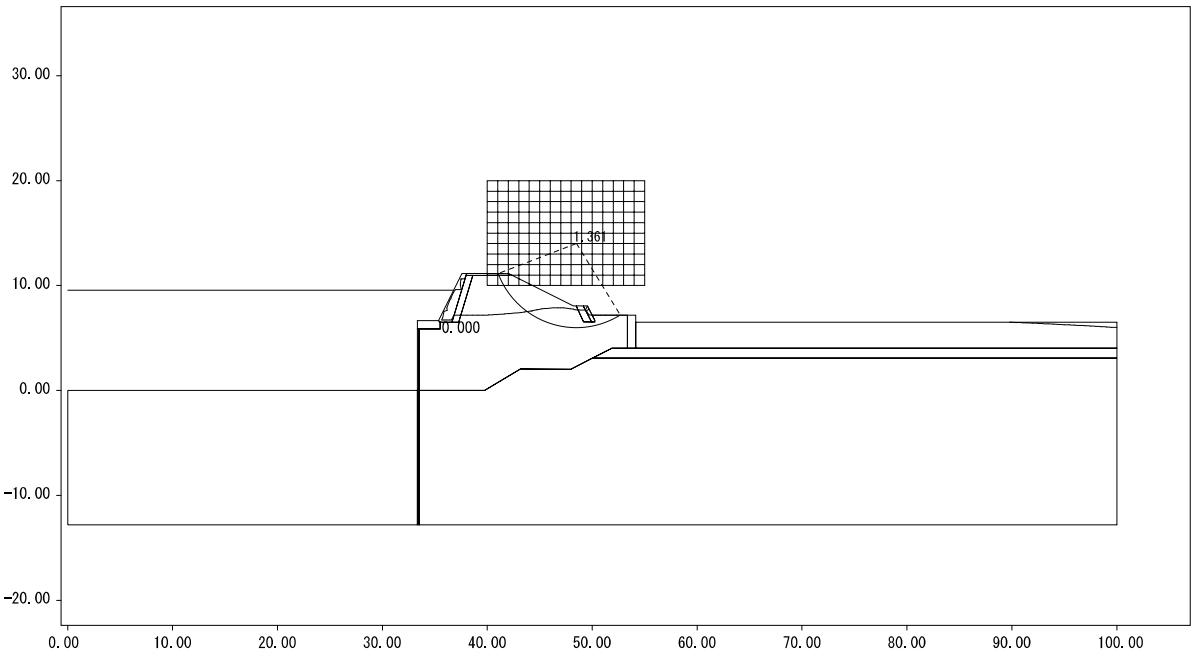
==========

○ Time(hr) : 226.000
○Safety Factor : 1.327
○Search Area : 1
○Center (m) : (40.500, 5.000)
○Dianeter (m) : 9.5

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.2　Flood Conditions (Seepage)

(2)　R6+060



(Calculation Result)

Title	R6+060				
Note					
Calculation Method	Slope Stability Calculation+ Seepage Analysis	Output Time	226.000 (hr)	Safety Factor	1.361
Output Items	Diagram of Soil Layer, Water Level and Slip Surface				

Slip (Flood)

Slope Stability Analysis considering Seepage

Input Data Sheet

◆ Basic Calculation Conditions

○Title : R6+060

○Note :

○Calculation Type : Seepage Analysis + Slope Stability Calculation
○Seepage Type : Non stationary Seepage
○Time Unit : hr
○Stress Type : Total Stress
○Safety Factor Formula : Modified Fellenius' Method
○Unit : SI Unit
○Unsaturated Permeability : θ-Kr, θ-ψ

◆ Node

○Node : 47

○Node axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	0.000	2	33.342	0.000
3	33.342	5.849	4	33.342	6.649
5	33.492	5.849	6	35.342	6.649
7	35.492	6.502	8	37.592	11.149
9	38.042	11.149	10	37.982	10.949
11	38.608	10.949	12	42.042	11.149
13	42.042	10.949	14	35.492	5.849
15	36.647	6.502	16	37.274	6.502
17	50.000	7.170	18	53.356	7.170
19	54.152	7.170	20	100.000	6.502
21	100.000	4.035	22	54.152	4.035
23	53.356	4.035	24	51.877	4.035
25	50.042	3.085	26	47.968	2.011
27	43.173	2.039	28	39.744	-0.001
29	33.492	-0.001	30	100.000	3.085
31	100.000	-12.830	32	33.492	-12.830
33	33.342	-12.830	34	0.000	-12.830
35	54.152	6.502	36	48.200	8.070
37	48.486	8.070	38	49.159	8.070
39	49.550	8.070	40	50.250	6.669
41	50.250	6.520	42	49.934	6.520
43	49.175	6.520	44	50.300	7.170
45	50.300	6.670	46	50.800	6.670
47	50.800	7.170			

◆ Soil Layer

○No. of Soil Layers : 13

○Layer No. : 1
○Layer Name : GFf
○Nodes : 1, 2, 33, 34

○Layer No. : 2
○Layer Name : SSP
○Nodes : 2, 3, 5, 29, 32, 33

○Layer No. : 3
○Layer Name : Co
○Nodes : 3, 4, 6, 7, 14, 5

○Layer No. : 4
○Layer Name : Co
○Nodes : 6, 8, 9, 10, 15, 7

○Layer No. : 5
○Layer Name : Gr
○Nodes : 10, 11, 16, 15

○Layer No. : 6
○Layer Name : PCCP
○Nodes : 12, 13, 11, 10, 9

○Layer No. : 7
○Layer Name : B
○Nodes : 5, 14, 7, 15, 16, 11, 13, 12, 36, 37,
: 43, 42, 41, 40, 17, 18, 23, 24, 25, 26,
: 27, 28, 29

○Layer No. : 8
○Layer Name : Co
○Nodes : 18, 19, 35, 22, 23

○Layer No. : 9
○Layer Name : As
○Nodes : 35, 20, 21, 22

○Layer No. : 10
○Layer Name : Dc
○Nodes : 30, 25, 24, 23, 22, 21

○Layer No. : 11
○Layer Name : GFf
○Nodes : 30, 31, 32, 29, 28, 27, 26, 25

○Layer No. : 12
○Layer Name : Co
○Nodes : 38, 39, 17, 40, 41, 42

○Layer No. : 13
○Layer Name : Gr
○Nodes : 37, 38, 42, 43

◆ Hole

○No of Holes : 0

◆ Soil Constants

○Layer No. : 1
○Layer Name : GFf
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-005
○Saturated h.c. ky (cm/s) : 1.000E-005
○Specific Storage Coef. Ss (1/m) : 1.000E-007

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 30.000
○Wet Weight(kN/m3) : 17.000
○Sat. Unit Weight(kN/m3) : 18.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 2
○Layer Name : SSP
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 2.000E-006
○Saturated h.c. ky (cm/s) : 2.000E-006
○Specific Storage Coef. Ss (1/m) : 2.000E-008

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 77.000

Slip(Flood)

○Sat. Unit Weight(kN/m3) : 77.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 3
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 24.000
○Sat. Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 4
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

Slip(Flood)

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 24.000
○Sat. Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 5
○Layer Name : Gr
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800

7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle ϕ (°) : 35.000
○Wet Weight(kN/m3) : 19.000
○Sat. Unit Weight(kN/m3) : 20.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 6
○Layer Name : PCCP
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1.000
○Friction Angle ϕ (°) : 30.000
○Wet Weight(kN/m3) : 24.000
○Sat. Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 7
○Layer Name : B
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-003
○Saturated h.c. ky (cm/s) : 1.000E-003
○Specific Storage Coef. Ss (1/m) : 1.000E-005

○Cohesion c(kN/m2) : 1.000
○Friction Angle ϕ (°) : 30.000
○Wet Weight(kN/m3) : 18.000

○Sat. Unit Weight(kN/m3) : 19.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 8
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1000.000
○Friction Angle ϕ (°) : 0.000
○Wet Weight(kN/m3) : 24.000
○Sat. Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 9
○Layer Name : As
○Unsaturated Permeability : silty sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.119	-12.000
3	0.020	0.020	3	0.120	-1.900
4	0.030	0.030	4	0.123	-1.500
5	0.040	0.040	5	0.129	-1.000
6	0.050	0.050	6	0.135	-0.800
7	0.060	0.060	7	0.138	-0.700
8	0.070	0.080	8	0.141	-0.600
9	0.080	0.090	9	0.146	-0.500
10	0.090	0.110	10	0.153	-0.400
11	0.100	0.130	11	0.160	-0.300
12	0.110	0.160	12	0.166	-0.250
13	0.120	0.190	13	0.173	-0.200
14	0.130	0.230	14	0.181	-0.150
15	0.140	0.290	15	0.188	-0.100
16	0.150	0.360	16	0.195	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle ϕ (°) : 27.000
○Wet Weight(kN/m3) : 17.500
○Sat. Unit Weight(kN/m3) : 18.500
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 10
○Layer Name : Dc
○Unsaturated Permeability : diluvial clay
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.135	0.000	1	0.135	-900.000
2	0.153	0.000	2	0.153	-300.000
3	0.177	0.000	3	0.177	-100.000
4	0.226	0.000	4	0.226	-20.000
5	0.285	0.000	5	0.285	-5.000
6	0.313	0.000	6	0.313	-3.000
7	0.336	0.000	7	0.336	-2.000
8	0.354	0.000	8	0.354	-1.500
9	0.380	0.001	9	0.380	-1.000
10	0.404	0.001	10	0.404	-0.700
11	0.426	0.003	11	0.426	-0.500
12	0.440	0.004	12	0.440	-0.400
13	0.448	0.006	13	0.448	-0.350

14	0.457	0.008	14	0.457	-0.300
15	0.465	0.011	15	0.465	-0.260
16	0.472	0.013	16	0.472	-0.230
17	0.479	0.017	17	0.479	-0.200
18	0.484	0.020	18	0.484	-0.180
19	0.489	0.024	19	0.489	-0.160
20	0.494	0.030	20	0.494	-0.140
21	0.500	0.037	21	0.500	-0.120
22	0.506	0.047	22	0.506	-0.100
23	0.512	0.062	23	0.512	-0.080
24	0.518	0.085	24	0.518	-0.060
25	0.524	0.123	25	0.524	-0.040
26	0.530	0.199	26	0.530	-0.020
27	0.533	0.283	27	0.533	-0.010
28	0.535	1.000	28	0.535	0.000

○Saturated h.c. kx (cm/s) : 1.000E-006
○Saturated h.c. ky (cm/s) : 1.000E-006
○Specific Storage Coef. Ss (1/m) : 1.000E-008

○Cohesion c(kN/m2) : 100.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 18.000
○Sat. Unit Weight(kN/m3) : 19.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 11
○Layer Name : GFf
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-005
○Saturated h.c. ky (cm/s) : 1.000E-005
○Specific Storage Coef. Ss (1/m) : 1.000E-007

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 30.000
○Wet Weight(kN/m3) : 17.000
○Sat. Unit Weight(kN/m3) : 18.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 12
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 24.000
○Sat. Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 13
○Layer Name : Gr
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle φ(°) : 35.000
○Wet Weight(kN/m3) : 19.000
○Sat. Unit Weight(kN/m3) : 20.000
○Water Unit Weight(kN/m3) : 9.807

◆ FEM Elements

○Soil Layer
Elements Size

Layer No.	x Direction(m)	yDirection(m)
1	1.000	1.000
2	0.500	0.500
3	0.500	0.500
4	0.500	0.500
5	0.500	0.500
6	0.500	0.500
7	0.500	0.500
8	0.500	0.500
9	0.500	0.500
10	0.500	0.500
11	1.000	1.000
12	0.500	0.500
13	0.500	0.500

○Element Shape : Triangle + Square

○Partial Area

No	Min. x axis(m)	Min. y axis(m)	Max. x axis(m)	Max. y axis(m)	Element Size xDirection(m)	Element Size yDirection(m)

○Internal Node : 44, 46, 45, 47

◆ Initial Water Level

○ Water Level : 4

No	x axis(m)	y axis(m)
1	0.000	4.035
2	33.492	4.035
3	33.492	6.002
4	100.000	6.002

◆ Seepage Surface

○No. of Seepage Surface : 2

○Seepage Surface No. : 1
○Nodes : 9, 12, 17, 18

○Seepage Surface No. : 2
○Nodes : 1, 2

◆ Water Level Fixed Point

○ No. of Water Level Fixed Point : 1

○ Water Level Fixed No. : 1
○ Water Level (m) : 6.002
○ Nodes : 20, 21, 30, 31

◆ Water Level Changing Point

○ No. of Water LevelChanging Point : 1

○ Water LevelChanging Point No. : 1
○ Nodes : 1, 2, 3, 4, 6, 8

○ temporal variation

No	Time (hr)	Water Level (m)
1	0.000	5.920
2	213.000	5.920
3	224.000	9.550
4	226.000	9.550
5	238.000	5.920
6	270.000	5.920

◆ Rain Penetration Line

○ No. of Rain Penetration Line : 1

○ Rain Penetration Line No : 1
○ Nodes : 4, 6, 8, 9, 12, 36, 37, 38, 39, 17,
: 18, 19, 35, 20

○ temporal variation

No	Time (hr)	Rainfall (mm)
1	200.000	1.000
2	226.000	10.000
3	270.000	0.000

◆ Repeat Calculation

○ Time step
- Min. : 0.010
- Max. : 10.000
- Allowable Error (m) : 0.010
- Max. Repeat : 10

◆ Slip Surface Conditions

○ Merginal Slip Surface (Center - Diameter)

○ Search Area : 1

No	x axis Min. (m)	x axis Max. (m)	x axis Variation (m)	y axis Min. (m)	y axis Max. (m)	y axis Variation (m)
1	40.000	55.000	1.000	10.000	20.000	1.000

No	Diameter Min. (m)	Diameter Max. (m)	Diameter Variation (m)
1	5.000	25.000	1.000

○ Slip Surface Limit

	x axis (m)	y axis (m)
must cut line [ON]		
1	38.042	11.149
2	42.042	11.149
must not cut line [ON]		
1	42.042	11.149
2	50.000	7.170

◆ Load

○ Load No : 1

	Left end (m)	Right end (m)	Load (kN/m2)
1	38.500	41.500	5.000

◆ Tension Crack

○ Tension Crack : 0

◆ Seismic Force

Slip(Flood)

○ Horizontal Seismic Coef. : 0.000
○ Vertical Seismic Coef. : 0.000

◆ Output Time

○ Output Time : 7

No	Seepage Cal.	Stability Cal.
1	1.000	
2	10.000	◎
3	200.000	◎
4	224.000	◎
5	226.000	◎
6	238.000	◎
7	270.000	

Slope Stability Analysis considering Seepage

Slope Stability Calculation

1. Input Data

Title

R6+060

Calculation Type

Seepage Analysis + Slope Stability Calculation

Safety Factor Formula

Modified Fellenius' Method

Unit

SI Unit

Node

○Node : 47

○Node axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	0.000	2	33.342	0.000
3	33.342	5.849	4	33.342	6.649
5	33.492	5.849	6	35.342	6.649
7	35.492	6.502	8	37.592	11.149
9	38.042	11.149	10	37.982	10.949
11	38.608	10.949	12	42.042	11.149
13	42.042	10.949	14	35.492	5.849
15	36.647	6.502	16	37.274	6.502
17	50.000	7.170	18	53.356	7.170
19	54.152	7.170	20	100.000	6.502
21	100.000	4.035	22	54.152	4.035
23	53.356	4.035	24	51.877	4.035
25	50.042	3.085	26	47.968	2.011
27	43.173	2.039	28	39.744	-0.001
29	33.492	-0.001	30	100.000	3.085
31	100.000	-12.830	32	33.492	-12.830
33	33.342	-12.830	34	0.000	-12.830
35	54.152	6.502	36	48.200	8.070
37	48.486	8.070	38	49.159	8.070
39	49.550	8.070	40	50.250	6.669
41	50.250	6.520	42	49.934	6.520
43	49.175	6.520	44	50.300	7.170
45	50.300	6.670	46	50.800	6.670
47	50.800	7.170			

Soil Layer

○No. of Soil Layers : 13

○Layer No. : 1
○Layer Name : GFf
○Nodes : 1, 2, 33, 34

○Layer No. : 2
○Layer Name : SSP
○Nodes : 2, 3, 5, 29, 32, 33

○Layer No. : 3
○Layer Name : Co
○Nodes : 3, 4, 6, 7, 14, 5

○Layer No. : 4
○Layer Name : Co
○Nodes : 6, 8, 9, 10, 15, 7

○Layer No. : 5
○Layer Name : Gr
○Nodes : 10, 11, 16, 15

○Layer No. : 6
○Layer Name : PCCP
○Nodes : 12, 13, 11, 10, 9

○Layer No. : 7
○Layer Name : B
○Nodes : 5, 14, 7, 15, 16, 11, 13, 12, 36, 37,
: 43, 42, 41, 40, 17, 18, 23, 24, 25, 26,
: 27, 28, 29

○Layer No. : 8
○Layer Name : Co
○Nodes : 18, 19, 35, 22, 23

○Layer No. : 9
○Layer Name : As
○Nodes : 35, 20, 21, 22

○Layer No. : 10
○Layer Name : Dc
○Nodes : 30, 25, 24, 23, 22, 21

○Layer No. : 11
○Layer Name : GFf
○Nodes : 30, 31, 32, 29, 28, 27, 26, 25

○Layer No. : 12
○Layer Name : Co
○Nodes : 38, 39, 17, 40, 41, 42

○Layer No. : 13
○Layer Name : Gr
○Nodes : 37, 38, 42, 43

Hole

○No. of Holes : 0

Soil Constants

○Soil Layer : 1
Layer Name : GFf
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 30.00
Wet Weight (kN/m3) : 17.00
Sat. Unit Weight (kN/m3) : 18.00

○Soil Layer : 2
Layer Name : SSP
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 77.00
Sat. Unit Weight (kN/m3) : 77.00

○Soil Layer : 3
Layer Name : Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 4
Layer Name : Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 5
Layer Name : Gr
Cohesion (kN/m2) : 0.00
Friction Angle (°) : 35.00
Wet Weight (kN/m3) : 19.00
Sat. Unit Weight (kN/m3) : 20.00

○Soil Layer : 6
Layer Name : PCCP
Cohesion (kN/m2) : 1.00
Friction Angle (°) : 30.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 7
Layer Name : B
Cohesion (kN/m2) : 1.00
Friction Angle (°) : 30.00
Wet Weight (kN/m3) : 18.00
Sat. Unit Weight (kN/m3) : 19.00

○Soil Layer : 8
Layer Name : Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 9
Layer Name : As
Cohesion (kN/m2) : 0.00
Friction Angle (°) : 27.00
Wet Weight (kN/m3) : 17.50
Sat. Unit Weight (kN/m3) : 18.50

○Soil Layer : 10
Layer Name : Dc
Cohesion (kN/m2) : 100.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 18.00
Sat. Unit Weight (kN/m3) : 19.00

○Soil Layer : 11
Layer Name : GFf
Cohesion (kN/m2) : 1000.00

Friction Angle (°) : 30.00
Wet Weight (kN/m3) : 17.00
Sat. Unit Weight (kN/m3) : 18.00

○Soil Layer : 12
Layer Name : Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 13
○Layer Name : Gr
Cohesion (kN/m2) : 0.00
Friction Angle (°) : 35.00
Wet Weight (kN/m3) : 19.00
Sat. Unit Weight (kN/m3) : 20.00

◆ Slip SurfaceConditions

○Merginal Slip Surface (Center・Diameter)

○Search Area : 1

No	x axis Min.(m)	x axis Max.(m)	x axis Variation(m)	y axis Min.(m)	y axis Max.(m)	y axis Variation(m)
1	40.000	55.000	1.000	10.000	20.000	1.000

No	Diameter Min.(m)	Diameter Max.(m)	Diameter Variation(m)
1	5.000	25.000	1.000

○Slip Surface Limit

	x axis(m)	y axis(m)	Search
must cut line [ON]			
1	38.042	11.149	
2	42.042	11.149	
must not cut line [ON]			
1	42.042	11.149	
2	50.000	7.170	

◆ Calculation Time

○ Time to conduct stability Cal. : 5

no	Time (hour)	no	Time (hour)	no	Time (hour)	no	Time (hour)	no	Time (hour)
2	10.000	3	200.000	4	224.000	5	226.000	6	238.000

◆ Load

○Load : 1

No	Left end(m)	Right end(m)	Load(kN/m2)
1	38.500	41.500	5.000

◆ Tension Crack

○Tension Crack : 0

◆ Seismic Force

○Horizontal Seismic Coef. : 0.000
○Vertical Seismic Coef. : 0.000

..

==========
○2. Calculation Result
==========

◆ Min.Safety Factor and Slip Surface

◆ At 10.000 (hr) Calculation Result

○Safety Factor and Slip Surface

- Safety Factor : 1.734
- Resistance Force (kN) : 231.673
- Sliding Force (kN) : 133.608 (= 130.073 + 30.052 / 8.500)

○Slip Surface axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	40.688	11.149	2	40.777	10.949	3	41.123	10.278
4	41.500	9.678	5	41.582	9.561	6	42.042	8.973
7	42.419	8.561	8	42.796	8.198	9	43.173	7.876
10	43.653	7.518	11	44.132	7.208	12	44.612	6.942
13	45.091	6.714	14	45.571	6.521	15	46.050	6.361
16	46.530	6.232	17	47.009	6.132	18	47.489	6.060
19	47.968	6.017	20	47.968	6.017	21	48.200	6.005
22	48.486	6.000	23	48.823	6.006	24	49.159	6.026
25	49.175	6.027	26	49.185	6.028	27	49.550	6.065
28	49.934	6.122	29	50.000	6.133	30	50.042	6.141
31	50.250	6.182	32	50.657	6.278	33	51.064	6.396
34	51.470	6.536	35	51.877	6.700	36	52.370	6.932
37	52.804	7.170						

○Arc Center (m) : (48.500, 14.500)
○Arc Diameter (m) : 8.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length (m)
0.089	0.213	-66.044	0.000	0.219
0.346	3.746	-62.761	0.000	0.755
0.377	8.403	-57.828	0.000	0.708
0.082	2.368	-54.956	0.000	0.144
0.460	16.121	-51.958	0.000	0.746
0.377	15.524	-47.560	0.000	0.559
0.377	16.875	-43.913	0.000	0.523
0.377	17.919	-40.478	0.000	0.496
0.480	23.878	-36.789	0.000	0.599
0.480	24.692	-32.847	0.000	0.571
0.479	25.110	-29.073	0.000	0.549
0.480	25.175	-25.434	0.000	0.531
0.480	24.922	-21.902	0.000	0.517
0.480	24.375	-18.456	0.000	0.506
0.480	23.554	-15.078	0.000	0.497
0.479	22.473	-11.754	0.000	0.490
0.480	21.142	-8.469	0.000	0.485
0.480	19.569	-5.211	0.000	0.481
0.000	0.010	-3.588	0.000	0.000
0.232	8.832	-2.805	0.061	0.232
0.286	10.647	-1.058	0.159	0.286
0.337	12.653	1.040	0.180	0.337
0.337	12.827	3.310	0.092	0.337
0.016	0.614	4.501	0.013	0.016
0.010	0.404	4.590	0.004	0.011
0.365	14.604	5.861	0.000	0.366
0.384	12.957	8.404	0.000	0.388
0.066	1.600	9.938	0.000	0.067
0.042	0.870	10.308	0.000	0.043
0.208	4.222	11.167	0.000	0.212
0.407	6.881	13.290	0.000	0.418
0.407	6.099	16.126	0.000	0.423
0.407	5.156	19.003	0.000	0.430
0.407	4.043	21.931	0.000	0.438
0.493	3.143	25.246	0.000	0.545
0.434	0.928	28.751	0.000	0.495

○ Water Level axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	0.000	5.920	2	33.342	5.920	3	33.492	5.709
4	33.955	5.755	5	34.417	5.807	6	34.880	5.845
7	35.342	5.885	8	35.492	5.898	9	35.877	5.912
10	36.262	5.926	11	36.647	5.938	12	36.961	5.945
13	37.274	5.950	14	37.592	5.955	15	37.982	5.958
16	38.042	5.959	17	38.325	5.962	18	38.608	5.965
19	38.987	5.969	20	39.365	5.972	21	39.744	5.976
22	40.204	5.980	23	40.663	5.983	24	41.123	5.987
25	41.582	5.990	26	42.042	5.993	27	42.419	5.995
28	42.796	5.997	29	43.173	5.999	30	43.653	6.001
31	44.132	6.004	32	44.612	6.006	33	45.091	6.007
34	45.571	6.009	35	46.050	6.011	36	46.530	6.012
37	47.009	6.013	38	47.489	6.015	39	47.968	6.017
40	48.200	6.018	41	48.486	6.020	42	48.823	6.023
43	49.159	6.027	44	49.175	6.028	45	49.550	6.030
46	49.934	6.031	47	50.250	6.032	48	50.657	6.032
49	51.064	6.033	50	51.470	6.033	51	51.877	6.032
52	52.370	6.030	53	52.863	6.026	54	53.356	6.019
55	53.754	6.070	56	54.152	6.122	57	54.650	6.122
58	55.149	6.122	59	55.647	6.122	60	56.145	6.122
61	56.644	6.122	62	57.142	6.122	63	57.640	6.122
64	58.139	6.122	65	58.637	6.121	66	59.135	6.121
67	59.634	6.121	68	60.132	6.121	69	60.631	6.120
70	61.129	6.120	71	61.627	6.120	72	62.126	6.119
73	62.624	6.119	74	63.122	6.118	75	63.621	6.118
76	64.119	6.117	77	64.617	6.117	78	65.116	6.116
79	65.614	6.115	80	66.112	6.115	81	66.611	6.114
82	67.109	6.113	83	67.607	6.113	84	68.106	6.112
85	68.604	6.111	86	69.102	6.110	87	69.601	6.109
88	70.099	6.109	89	70.597	6.108	90	71.096	6.107
91	71.594	6.106	92	72.093	6.105	93	72.591	6.104
94	73.089	6.103	95	73.588	6.102	96	74.086	6.101
97	74.584	6.099	98	75.083	6.098	99	75.581	6.097
100	76.079	6.096	101	76.578	6.095	102	77.076	6.093
103	77.574	6.092	104	78.073	6.091	105	78.571	6.089
106	79.069	6.088	107	79.568	6.086	108	80.066	6.085
109	80.564	6.084	110	81.063	6.082	111	81.561	6.080
112	82.059	6.079	113	82.558	6.077	114	83.056	6.076
115	83.555	6.074	116	84.053	6.072	117	84.551	6.071
118	85.050	6.069	119	85.548	6.067	120	86.046	6.065
121	86.545	6.063	122	87.043	6.061	123	87.541	6.060
124	88.040	6.058	125	88.538	6.056	126	89.036	6.054
127	89.535	6.052	128	90.033	6.050	129	90.531	6.048

130	91.030	6.045	131	91.528	6.043	132	92.026	6.041
133	92.525	6.039	134	93.023	6.037	135	93.521	6.034
136	94.020	6.032	137	94.518	6.030	138	95.017	6.027
139	95.515	6.025	140	96.013	6.023	141	96.512	6.020
142	97.010	6.018	143	97.508	6.015	144	98.007	6.013
145	98.505	6.010	146	99.003	6.007	147	99.502	6.005
148	100.000	6.002						

..

◆ At 200.000 (hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.575
- Resistance Force (kN) : 210.323
- Sliding Force (kN) : 133.571 (= 130.036 + 30.052 / 8.500)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	40.688	11.149	2	40.777	10.949	3	41.123	10.278
4	41.500	9.678	5	41.582	9.561	6	42.042	8.973
7	42.419	8.561	8	42.796	8.198	9	43.173	7.876
10	43.653	7.518	11	44.132	7.208	12	44.612	6.942
13	44.930	6.786	14	45.091	6.714	15	45.571	6.521
16	46.050	6.361	17	46.530	6.232	18	47.009	6.132
19	47.489	6.060	20	47.968	6.017	21	48.200	6.005
22	48.486	6.000	23	48.823	6.006	24	49.023	6.016
25	49.159	6.026	26	49.175	6.027	27	49.550	6.065
28	49.754	6.093	29	49.934	6.122	30	50.000	6.133
31	50.042	6.141	32	50.132	6.158	33	50.250	6.182
34	50.657	6.278	35	51.064	6.396	36	51.470	6.536
37	51.877	6.700	38	52.368	6.931	39	52.370	6.932
40	52.804	7.170						

○Arc Center (m) : (48.500, 14.500)
○Arc Diameter (m) : 8.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length (m)
0.089	0.213	−66.044	0.000	0.219
0.346	3.746	−62.761	0.000	0.755
0.377	8.403	−57.828	0.000	0.708
0.082	2.368	−54.956	0.000	0.144
0.460	16.121	−51.958	0.000	0.746
0.377	15.524	−47.560	0.000	0.559
0.377	16.875	−43.913	0.000	0.523
0.377	17.919	−40.478	0.000	0.496
0.480	23.878	−36.789	0.000	0.599
0.480	24.692	−32.847	0.000	0.571
0.479	25.110	−29.073	0.000	0.549
0.319	16.760	−26.028	0.000	0.355
0.161	8.439	−24.238	0.372	0.176
0.480	25.007	−21.902	1.737	0.517
0.480	24.549	−18.456	3.561	0.506
0.480	23.802	−15.078	5.067	0.497
0.479	22.779	−11.754	6.268	0.490
0.480	21.493	−8.469	7.182	0.485
0.480	19.952	−5.211	7.821	0.481
0.232	9.033	−2.806	8.142	0.232
0.286	10.884	−1.058	8.267	0.286
0.337	12.933	1.040	8.337	0.337
0.201	7.815	2.852	8.319	0.201
0.136	5.299	3.989	8.249	0.136
0.016	0.628	4.501	8.207	0.016
0.375	15.313	5.825	8.013	0.377
0.204	7.811	7.791	7.767	0.206
0.180	5.422	9.100	7.636	0.182
0.066	1.626	9.938	7.548	0.067
0.042	0.886	10.308	7.507	0.043
0.090	1.951	10.762	7.401	0.092
0.118	2.360	11.477	7.209	0.120
0.407	7.157	13.290	6.645	0.418
0.407	6.333	16.126	5.641	0.423
0.407	5.339	19.003	4.429	0.430
0.407	4.167	21.931	2.988	0.438
0.491	3.188	25.238	1.104	0.543
0.002	0.010	27.075	0.000	0.003
0.434	0.928	28.751	0.000	0.495

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	5.920	2	33.342	5.920	3	35.877	6.575
4	36.262	6.572	5	36.647	6.603	6	36.961	6.655
7	37.274	6.655	8	37.592	6.656	9	37.982	6.658
10	38.042	6.658	11	38.325	6.660	12	38.608	6.662
13	38.987	6.665	14	39.365	6.670	15	39.744	6.675
16	40.204	6.682	17	40.663	6.690	18	41.123	6.699
19	41.582	6.708	20	42.042	6.718	21	42.419	6.727
22	42.796	6.736	23	43.173	6.745	24	43.653	6.757
25	44.132	6.768	26	44.612	6.779	27	45.091	6.789
28	45.571	6.799	29	46.050	6.809	30	46.530	6.817
31	47.009	6.825	32	47.489	6.832	33	47.968	6.840
34	48.200	6.843	35	48.486	6.848	36	48.823	6.858
37	49.159	6.863	38	49.175	6.863	39	49.550	6.863
40	49.934	6.893	41	50.000	6.901	42	50.042	6.904
43	50.250	6.906	44	50.657	6.910	45	51.064	6.915
46	51.470	6.920	47	51.877	6.925	48	52.370	6.931
49	52.863	6.935	50	53.356	6.947	51	53.754	6.526
52	54.152	6.131	53	54.650	6.131	54	55.149	6.131

55	55.647	6.131	56	56.145	6.131	57	56.644	6.131
58	57.142	6.131	59	57.640	6.131	60	58.139	6.130
61	58.637	6.130	62	59.135	6.130	63	59.634	6.129
64	60.132	6.129	65	60.631	6.129	66	61.129	6.128
67	61.627	6.128	68	62.126	6.127	69	62.624	6.127
70	63.122	6.126	71	63.621	6.126	72	64.119	6.125
73	64.617	6.125	74	65.116	6.124	75	65.614	6.123
76	66.112	6.123	77	66.611	6.122	78	67.109	6.121
79	67.607	6.120	80	68.106	6.119	81	68.604	6.118
82	69.102	6.118	83	69.601	6.117	84	70.099	6.116
85	70.597	6.115	86	71.096	6.114	87	71.594	6.113
88	72.093	6.112	89	72.591	6.110	90	73.089	6.109
91	73.588	6.108	92	74.086	6.107	93	74.584	6.106
94	75.083	6.104	95	75.581	6.103	96	76.079	6.102
97	76.578	6.100	98	77.076	6.099	99	77.574	6.098
100	78.073	6.096	101	78.571	6.095	102	79.069	6.093
103	79.568	6.092	104	80.066	6.090	105	80.564	6.088
106	81.063	6.087	107	81.561	6.085	108	82.059	6.084
109	82.558	6.082	110	83.056	6.080	111	83.555	6.078
112	84.053	6.076	113	84.551	6.075	114	85.050	6.073
115	85.548	6.071	116	86.046	6.069	117	86.545	6.067
118	87.043	6.065	119	87.541	6.063	120	88.040	6.061
121	88.538	6.059	122	89.036	6.057	123	89.535	6.054
124	90.033	6.052	125	90.531	6.050	126	91.030	6.048
127	91.528	6.046	128	92.026	6.043	129	92.525	6.041
130	93.023	6.039	131	93.521	6.036	132	94.020	6.034
133	94.518	6.031	134	95.017	6.029	135	95.515	6.026
136	96.013	6.024	137	96.512	6.021	138	97.010	6.018
139	97.508	6.016	140	98.007	6.013	141	98.505	6.010
142	99.003	6.008	143	99.502	6.005	144	100.000	6.002

..

◆ At 224.000 (hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.377
- Resistance Force (kN) : 173.965
- Sliding Force (kN) : 126.348 (= 124.204 + 17.153 / 8.000)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	41.025	11.149	2	41.105	10.949	3	41.123	10.905
4	41.500	10.127	5	41.582	9.982	6	42.042	9.278
7	42.419	8.802	8	42.796	8.391	9	43.173	8.031
10	43.653	7.636	11	43.946	7.422	12	44.132	7.298
13	44.612	7.009	14	45.091	6.763	15	45.571	6.556
16	46.050	6.384	17	46.530	6.246	18	47.009	6.140
19	47.489	6.064	20	47.968	6.018	21	48.200	6.006
22	48.486	6.000	23	48.710	6.003	24	48.823	6.007
25	49.159	6.027	26	49.175	6.029	27	49.497	6.062
28	49.550	6.069	29	49.934	6.130	30	50.000	6.142
31	50.042	6.150	32	50.250	6.194	33	51.064	6.422
34	51.877	6.748	35	51.996	6.804	36	52.665	7.170

○Arc Center (m) : (48.500, 14.000)
○Arc Diameter (m) : 8.000

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length (m)
0.079	0.191	−68.352	0.000	0.215
0.018	0.094	−67.412	0.000	0.047
0.377	4.749	−64.144	0.000	0.865
0.082	1.722	−60.447	0.000	0.167
0.460	13.118	−56.838	0.000	0.840
0.377	13.672	−51.652	0.000	0.608
0.377	15.404	−47.477	0.000	0.558
0.377	16.739	−43.615	0.000	0.521
0.480	22.699	−39.523	0.000	0.622
0.294	14.499	−35.996	0.000	0.363
0.186	9.337	−33.894	0.707	0.224
0.479	24.586	−31.088	3.098	0.560
0.480	24.982	−27.152	6.310	0.539
0.480	25.007	−23.351	9.160	0.522
0.480	24.692	−19.657	11.659	0.509
0.480	24.058	−16.046	13.712	0.499
0.479	23.114	−12.500	15.178	0.491
0.480	21.874	−9.003	16.052	0.485
0.480	20.343	−5.538	16.259	0.482
0.232	9.218	−2.981	16.088	0.232
0.286	11.102	−1.125	15.774	0.286
0.224	8.752	0.702	15.441	0.224
0.112	4.426	1.907	15.263	0.113
0.337	13.336	3.518	15.088	0.337
0.016	0.638	4.783	14.973	0.016
0.322	13.283	6.001	14.008	0.324
0.053	2.235	7.352	12.887	0.053
0.384	13.225	8.934	11.473	0.389
0.066	1.616	10.567	10.152	0.067
0.042	0.846	10.960	10.043	0.043
0.208	4.316	11.874	9.789	0.213
0.814	13.327	15.663	8.456	0.845
0.813	9.046	21.829	5.739	0.876
0.119	0.892	25.442	3.863	0.132
0.669	2.324	28.646	1.793	0.763

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	9.550	2	36.793	9.550	3	36.961	7.100

4	37.274	7.100	5	37.592	7.093	6	37.982	7.076
7	38.042	7.073	8	38.325	7.068	9	38.608	7.064
10	38.987	7.063	11	39.365	7.067	12	39.744	7.073
13	40.204	7.087	14	40.663	7.108	15	41.123	7.138
16	41.582	7.176	17	42.042	7.223	18	42.419	7.261
19	42.796	7.301	20	43.173	7.342	21	43.653	7.392
22	44.132	7.442	23	44.612	7.496	24	45.091	7.562
25	45.571	7.625	26	46.050	7.693	27	46.530	7.734
28	47.009	7.748	29	47.489	7.730	30	47.968	7.667
31	48.200	7.637	32	48.486	7.586	33	48.823	7.556
34	49.175	7.555	35	49.550	7.367	36	49.934	7.172
37	50.000	7.170	38	53.356	7.170	39	90.033	6.492
40	90.531	6.472	41	91.030	6.451	42	91.528	6.430
43	92.026	6.408	44	92.525	6.386	45	93.023	6.363
46	93.521	6.340	47	94.020	6.317	48	94.518	6.293
49	95.017	6.268	50	95.515	6.244	51	96.013	6.218
52	96.512	6.193	53	97.010	6.167	54	97.508	6.141
55	98.007	6.114	56	98.505	6.087	57	99.003	6.059
58	99.502	6.031	59	100.000	6.002			

..

◆ At 226.000 (hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.346
- Resistance Force (kN): 170.306
- Sliding Force (kN) : 126.545 (= 124.401 + 17.153 / 8.000)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	41.025	11.149	2	41.105	10.949	3	41.123	10.905
4	41.500	10.127	5	41.582	9.982	6	42.042	9.278
7	42.419	8.802	8	42.796	8.391	9	43.173	8.031
10	43.653	7.636	11	43.811	7.518	12	44.132	7.298
13	44.612	7.009	14	45.091	6.763	15	45.571	6.556
16	46.050	6.384	17	46.530	6.246	18	47.009	6.140
19	47.489	6.064	20	47.968	6.018	21	48.200	6.006
22	48.486	6.000	23	48.665	6.002	24	48.823	6.007
25	49.159	6.027	26	49.175	6.029	27	49.470	6.059
28	49.550	6.069	29	49.934	6.130	30	50.000	6.142
31	50.042	6.150	32	50.250	6.194	33	51.064	6.422
34	51.877	6.748	35	52.336	6.980	36	52.665	7.170

○Arc Center (m) : (48.500, 14.000)
○Arc Diameter (m) : 8.000

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Water Pressure (kN/m2)	Slice Bottom Length (m)
0.079	0.191	-68.352	0.000	0.215
0.018	0.094	-67.412	0.000	0.047
0.377	4.749	-64.144	0.000	0.865
0.082	1.722	-60.447	0.000	0.167
0.460	13.118	-56.838	0.000	0.840
0.377	13.672	-51.652	0.000	0.608
0.377	15.404	-47.477	0.000	0.558
0.377	16.739	-43.615	0.000	0.521
0.480	22.699	-39.523	0.000	0.622
0.159	7.799	-36.588	0.000	0.198
0.321	16.066	-34.486	1.327	0.389
0.479	24.658	-31.088	4.584	0.560
0.480	25.071	-27.152	8.123	0.539
0.480	25.098	-23.351	11.016	0.522
0.480	24.775	-19.657	13.341	0.509
0.480	24.130	-16.046	15.186	0.499
0.479	23.177	-12.500	16.471	0.491
0.480	21.930	-9.003	17.199	0.485
0.480	20.398	-5.538	17.382	0.482
0.232	9.246	-2.981	17.244	0.232
0.286	11.132	-1.125	16.818	0.286
0.179	7.015	0.542	16.399	0.179
0.157	6.197	1.747	16.249	0.157
0.337	13.369	3.518	16.063	0.337
0.016	0.640	4.783	15.950	0.016
0.295	12.151	5.903	14.781	0.297
0.080	3.390	7.254	13.294	0.080
0.384	13.225	8.934	11.617	0.389
0.066	1.616	10.567	10.173	0.067
0.042	0.846	10.960	10.043	0.043
0.208	4.316	11.874	9.789	0.213
0.814	13.327	15.663	8.456	0.845
0.813	9.046	21.829	5.739	0.876
0.459	2.672	26.811	3.004	0.514
0.329	0.596	30.016	0.933	0.380

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	9.550	2	36.793	9.550	3	36.961	7.170
4	37.274	7.170	5	37.592	7.169	6	37.982	7.167
7	38.042	7.165	8	38.325	7.162	9	38.608	7.161
10	38.987	7.166	11	39.365	7.172	12	39.744	7.183
13	40.204	7.201	14	40.663	7.224	15	41.123	7.251
16	41.582	7.284	17	42.042	7.319	18	42.419	7.350
19	42.796	7.386	20	43.173	7.430	21	43.653	7.493
22	44.132	7.568	23	44.612	7.673	24	45.091	7.755
25	45.571	7.810	26	46.050	7.851	27	46.530	7.877
28	47.009	7.869	29	47.489	7.843	30	47.968	7.784
31	48.200	7.756	32	48.486	7.679	33	48.823	7.655
34	49.175	7.654	35	49.550	7.392	36	49.934	7.176

37	50.000	7.170	38	53.356	7.170	39	90.033	6.492
40	90.531	6.472	41	91.030	6.451	42	91.528	6.430
43	92.026	6.408	44	92.525	6.386	45	93.023	6.363
46	93.521	6.340	47	94.020	6.317	48	94.518	6.293
49	95.017	6.268	50	95.515	6.244	51	96.013	6.219
52	96.512	6.193	53	97.010	6.167	54	97.508	6.141
55	98.007	6.114	56	98.505	6.087	57	99.003	6.059
58	99.502	6.031	59	100.000	6.002			

..

◆ At 238.000 (hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.361
- Resistance Force (kN): 172.415
- Sliding Force (kN) : 126.645 (= 124.501 + 17.153 / 8.000)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	41.025	11.149	2	41.105	10.949	3	41.123	10.905
4	41.500	10.127	5	41.582	9.982	6	42.042	9.278
7	42.419	8.802	8	42.796	8.391	9	43.173	8.031
10	43.482	7.769	11	43.653	7.636	12	44.132	7.298
13	44.612	7.009	14	45.091	6.763	15	45.571	6.556
16	46.050	6.384	17	46.530	6.246	18	47.009	6.140
19	47.489	6.064	20	47.968	6.018	21	48.200	6.006
22	48.486	6.000	23	48.748	6.004	24	48.823	6.007
25	49.159	6.027	26	49.175	6.029	27	49.514	6.065
28	49.550	6.069	29	49.934	6.130	30	50.000	6.142
31	50.042	6.150	32	50.250	6.194	33	51.064	6.422
34	51.877	6.748	35	52.665	7.170			

○Arc Center (m) : (48.500, 14.000)
○Arc Diameter (m) : 8.000

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Water Pressure (kN/m2)	Slice Bottom Length (m)
0.079	0.191	-68.352	0.000	0.215
0.018	0.094	-67.412	0.000	0.047
0.377	4.749	-64.144	0.000	0.865
0.082	1.722	-60.447	0.000	0.167
0.460	13.118	-56.838	0.000	0.840
0.377	13.672	-51.652	0.000	0.608
0.377	15.404	-47.477	0.000	0.558
0.377	16.739	-43.615	0.000	0.521
0.309	14.497	-40.298	0.000	0.405
0.170	8.245	-38.072	0.729	0.216
0.480	23.956	-35.195	3.267	0.587
0.479	24.754	-31.088	6.537	0.560
0.480	25.122	-27.152	9.162	0.539
0.480	25.109	-23.351	11.240	0.522
0.480	24.750	-19.657	12.831	0.509
0.480	24.070	-16.046	13.958	0.499
0.479	23.089	-12.500	14.669	0.491
0.480	21.826	-9.003	15.059	0.485
0.480	20.290	-5.538	15.170	0.482
0.232	9.195	-2.981	15.091	0.232
0.286	11.076	-1.125	14.881	0.286
0.262	10.209	0.837	14.611	0.262
0.075	2.940	2.042	14.447	0.075
0.337	13.309	3.518	14.300	0.337
0.016	0.637	4.783	14.190	0.016
0.339	13.986	6.063	13.439	0.341
0.036	1.513	7.414	12.613	0.036
0.384	13.225	8.934	11.362	0.389
0.066	1.616	10.567	10.138	0.067
0.042	0.846	10.960	10.043	0.043
0.208	4.316	11.874	9.789	0.213
0.814	13.327	15.663	8.456	0.845
0.813	9.046	21.829	5.739	0.876
0.788	3.163	28.173	2.071	0.894

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	5.920	2	33.342	5.920	3	33.492	6.649
4	35.342	6.649	5	35.492	6.692	6	35.877	6.744
7	36.262	6.740	8	36.647	6.920	9	36.961	7.365
10	37.274	7.365	11	37.592	7.366	12	37.982	7.368
13	38.042	7.368	14	38.325	7.372	15	38.608	7.374
16	38.987	7.383	17	39.365	7.395	18	39.744	7.411
19	40.204	7.437	20	40.663	7.469	21	41.123	7.509
22	41.582	7.557	23	42.042	7.606	24	42.419	7.654
25	42.796	7.702	26	43.173	7.742	27	43.653	7.785
28	44.132	7.815	29	44.612	7.824	30	45.091	7.815
31	45.571	7.795	32	46.050	7.762	33	46.530	7.716
34	47.009	7.662	35	47.489	7.613	36	47.968	7.563
37	48.200	7.538	38	48.486	7.502	39	48.823	7.475
40	49.175	7.475	41	49.550	7.347	42	49.934	7.169
43	50.000	7.170	44	53.356	7.170	45	53.754	6.985
46	54.152	6.049	47	54.650	6.048	48	55.149	6.048
49	55.647	6.048	50	56.145	6.048	51	56.644	6.048
52	57.142	6.048	53	57.640	6.047	54	58.139	6.047
55	58.637	6.047	56	59.135	6.047	57	59.634	6.047
58	60.132	6.046	59	60.631	6.046	60	61.129	6.046
61	61.627	6.046	62	62.126	6.045	63	62.624	6.045
64	63.122	6.045	65	63.621	6.044	66	64.119	6.044
67	64.617	6.044	68	65.116	6.043	69	65.614	6.043
70	66.112	6.043	71	66.611	6.042	72	67.109	6.042

73	67.607	6.042	74	68.106	6.041	75	68.604	6.041
76	69.102	6.040	77	69.601	6.040	78	70.099	6.040
79	70.597	6.039	80	71.096	6.039	81	71.594	6.038
82	72.093	6.038	83	72.591	6.037	84	73.089	6.037
85	73.588	6.036	86	74.086	6.036	87	74.584	6.035
88	75.083	6.035	89	75.581	6.034	90	76.079	6.034
91	76.578	6.033	92	77.076	6.033	93	77.574	6.032
94	78.073	6.032	95	78.571	6.031	96	79.069	6.030
97	79.568	6.030	98	80.066	6.029	99	80.564	6.029
100	81.063	6.028	101	81.561	6.028	102	82.059	6.027
103	82.558	6.026	104	83.056	6.026	105	83.555	6.025
106	84.053	6.024	107	84.551	6.024	108	85.050	6.023
109	85.548	6.022	110	86.046	6.022	111	86.545	6.021
112	87.043	6.020	113	87.541	6.020	114	88.040	6.019
115	88.538	6.018	116	89.036	6.018	117	89.535	6.017
118	90.033	6.016	119	90.531	6.016	120	91.030	6.015
121	91.528	6.014	122	92.026	6.014	123	92.525	6.013
124	93.023	6.012	125	93.521	6.011	126	94.020	6.011
127	94.518	6.010	128	95.017	6.009	129	95.515	6.009
130	96.013	6.008	131	96.512	6.007	132	97.010	6.006
133	97.508	6.006	134	98.007	6.005	135	98.505	6.004
136	99.003	6.003	137	99.502	6.003	138	100.000	6.002

..

==========

○3. Slip Surface with the minimum Safety Factor

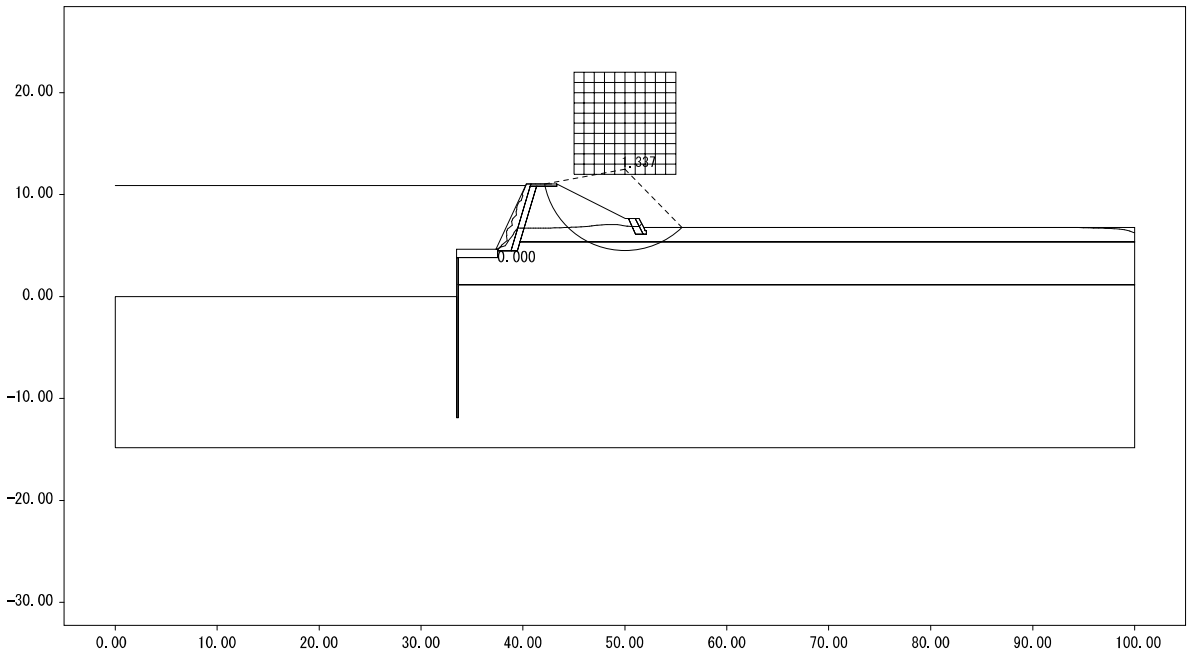
==========

○ Time (hr) : 226.000
○Safety Factor : 1.346
○Search Area : 1
○Center (m) : (48.500, 14.000)
○ Diameter (m) : 8

1.2.1 SLOPE STABILITY　ANALYSIS

1.2.1.2　Flood Conditions (Seepage)

(3)　R10+960



(Calculation Result)

Title	R10+960				
Note					
Calculation Method	Slope Stability Calculation+ Seepage Analysis	Output Time	226.000 (hr)	Safety Factor	1.337
Output Items	Soil Layer Diagram, Water Level, Slip Surface				

Slope Stability Analysis considering Seepage

Data Sheet

◆ Basic Calculation Conditions

○Title : R10+960

○Note :

○Calculation Type : Seepage Analysis + Slope Stability Calculation
○Seepage Type : Nonstationary Seepage
○Time Unit : hr
○Stress Type : Total Stress
○Safety Factor Formula : Modified Fellenius' Method
○Unit : SI Unit
○Unsaturated Permeability : θ-Kr, θ-ψ

◆ Node

○Node : 40

○Node axis No

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	0.000	2	33.492	0.000
3	33.492	3.831	4	33.492	4.631
5	37.342	4.631	6	37.492	4.631
7	37.492	4.484	8	37.492	3.831
9	33.642	3.831	10	33.642	1.131
11	40.328	11.027	12	40.778	11.027
13	40.718	10.827	14	41.345	10.827
15	43.328	10.827	16	43.328	11.027
17	38.815	4.484	18	39.442	4.484
19	39.705	5.360	20	50.051	7.666
21	50.336	7.666	22	51.025	6.116
23	51.785	6.116	24	51.010	7.666
25	51.401	7.666	26	52.001	6.466
27	52.101	6.466	28	52.101	6.116
29	51.851	6.766	30	100.000	6.766
31	100.000	5.360	32	100.000	1.131
33	100.000	-14.848	34	33.642	-11.869
35	33.492	-11.869	36	0.000	-14.848
37	52.300	6.766	38	52.300	6.266
39	52.800	6.266	40	52.800	6.766

◆ Soil Layer

○No. of Soil Layers : 10

○Layer No. : 1
○Layer Name : Co
○Nodes : 3, 4, 5, 6, 7, 8, 9

○Layer No. : 2
○Layer Name : Co
○Nodes : 11, 12, 13, 17, 7, 6, 5

○Layer No. : 3
○Layer Name : SSP
○Nodes : 2, 3, 9, 10, 34, 35

○Layer No. : 4
○Layer Name : Gr
○Nodes : 13, 14, 19, 18, 17

○Layer No. : 5
○Layer Name : PCCP
○Nodes : 16, 15, 14, 13, 12

○Layer No. : 6
○Layer Name : B
○Nodes : 14, 15, 16, 20, 21, 22, 23, 28, 27, 26,
: 29, 30, 31, 19

○Layer No. : 7
○Layer Name : As
○Nodes : 10, 9, 8, 7, 17, 18, 19, 31, 32

○Layer No. : 8
○Layer Name : Dc
○Nodes : 1, 2, 35, 34, 10, 32, 33, 36

○Layer No. : 9
○Layer Name : Co
○Nodes : 23, 24, 25, 29, 26, 27, 28

○Layer No. : 10
○Layer Name : Gr
○Nodes : 24, 23, 22, 21

◆ Hole

○Hole : 0

◆ Soil Constants

○Layer No. : 1
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c (kN/m2) : 1000.000
○Friction Angle φ (°) : 0.000
○Wet Weight (kN/m3) : 24.000
○Sat. Unit Weight (kN/m3) : 24.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 2
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c (kN/m2) : 1000.000
○Friction Angle φ (°) : 0.000
○Wet Weight (kN/m3) : 24.000
○Sat. Unit Weight (kN/m3) : 24.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 3
○Layer Name : SSP
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000

No	θ	kr	No	θ	ψ (m)
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 2.000E-006
○Saturated h.c. ky (cm/s) : 2.000E-006
○Specific Storage Coef. Ss (1/m) : 2.000E-008

○Cohesion c (kN/m2) : 1000.000
○Friction Angle φ (°) : 0.000
○Wet Weight (kN/m3) : 77.000
○Sat. Unit Weight (kN/m3) : 77.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 4
○Layer Name : Gr
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c (kN/m2) : 0.000
○Friction Angle φ (°) : 35.000
○Wet Weight (kN/m3) : 19.000
○Sat. Unit Weight (kN/m3) : 20.000
○Water Unit Weight (kN/m3) : 9.807

○Layer No. : 5
○Layer Name : PCCP
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ (m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007

○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1.000
○Friction Angle φ(°) : 30.000
○Wet Weight(kN/m3) : 24.000
○Sat.Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 6
○Layer Name : B
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-003
○Saturated h.c. ky (cm/s) : 1.000E-003
○Specific Storage Coef. Ss (1/m) : 1.000E-005

○Cohesion c(kN/m2) : 1.000
○Friction Angle φ(°) : 30.000
○Wet Weight(kN/m3) : 18.000
○Sat. Unit Weight(kN/m3) : 19.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 7
○Layer Name : As
○Unsaturated Permeability : silty sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.119	-12.000
3	0.020	0.020	3	0.120	-1.900
4	0.030	0.030	4	0.123	-1.500
5	0.040	0.040	5	0.129	-1.000
6	0.050	0.050	6	0.135	-0.800
7	0.060	0.060	7	0.138	-0.700
8	0.070	0.080	8	0.141	-0.600
9	0.080	0.090	9	0.146	-0.500
10	0.090	0.110	10	0.153	-0.400
11	0.100	0.130	11	0.160	-0.300
12	0.110	0.160	12	0.166	-0.250
13	0.120	0.190	13	0.173	-0.200
14	0.130	0.230	14	0.181	-0.150
15	0.140	0.290	15	0.188	-0.100
16	0.150	0.360	16	0.195	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle φ(°) : 27.000
○Wet Weight(kN/m3) : 17.500
○Sat. Unit Weight(kN/m3) : 18.500
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 8
○Layer Name : Dc
○Unsaturated Permeability : diluvial clay
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.135	0.000	1	0.135	-900.000
2	0.153	0.000	2	0.153	-300.000
3	0.177	0.000	3	0.177	-100.000
4	0.226	0.000	4	0.226	-20.000
5	0.285	0.000	5	0.285	-5.000
6	0.313	0.000	6	0.313	-3.000
7	0.336	0.000	7	0.336	-2.000
8	0.354	0.000	8	0.354	-1.500
9	0.380	0.001	9	0.380	-1.000
10	0.404	0.001	10	0.404	-0.700
11	0.426	0.003	11	0.426	-0.500
12	0.440	0.004	12	0.440	-0.400
13	0.448	0.006	13	0.448	-0.350
14	0.457	0.008	14	0.457	-0.300

15	0.465	0.011	15	0.465	-0.260
16	0.472	0.013	16	0.472	-0.230
17	0.479	0.017	17	0.479	-0.200
18	0.484	0.020	18	0.484	-0.180
19	0.489	0.024	19	0.489	-0.160
20	0.494	0.030	20	0.494	-0.140
21	0.500	0.037	21	0.500	-0.120
22	0.506	0.047	22	0.506	-0.100
23	0.512	0.062	23	0.512	-0.080
24	0.518	0.085	24	0.518	-0.060
25	0.524	0.123	25	0.524	-0.040
26	0.530	0.199	26	0.530	-0.020
27	0.533	0.283	27	0.533	-0.010
28	0.535	1.000	28	0.535	0.000

○Saturated h.c. kx (cm/s) : 1.000E-006
○Saturated h.c. ky (cm/s) : 1.000E-006
○Specific Storage Coef. Ss (1/m) : 1.000E-008

○Cohesion c(kN/m2) : 100.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 18.000
○Sat. Unit Weight(kN/m3) : 19.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 9
○Layer Name : Co
○Unsaturated Permeability : mudstone
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.031	0.000	1	0.031	-900.000
2	0.038	0.000	2	0.038	-300.000
3	0.048	0.000	3	0.048	-100.000
4	0.078	0.000	4	0.078	-20.000
5	0.128	0.000	5	0.128	-5.000
6	0.155	0.000	6	0.155	-3.000
7	0.182	0.000	7	0.182	-2.000
8	0.204	0.000	8	0.204	-1.500
9	0.240	0.000	9	0.240	-1.000
10	0.276	0.000	10	0.276	-0.700
11	0.313	0.001	11	0.313	-0.500
12	0.340	0.002	12	0.340	-0.400
13	0.356	0.003	13	0.356	-0.350
14	0.375	0.005	14	0.375	-0.300
15	0.393	0.007	15	0.393	-0.260
16	0.408	0.010	16	0.408	-0.230
17	0.425	0.014	17	0.425	-0.200
18	0.437	0.018	18	0.437	-0.180
19	0.450	0.023	19	0.450	-0.160
20	0.465	0.030	20	0.465	-0.140
21	0.480	0.041	21	0.480	-0.120
22	0.497	0.057	22	0.497	-0.100
23	0.515	0.082	23	0.515	-0.080
24	0.534	0.123	24	0.534	-0.060
25	0.552	0.195	25	0.552	-0.040
26	0.569	0.338	26	0.569	-0.020
27	0.576	0.478	27	0.576	-0.010
28	0.580	1.000	28	0.580	0.000

○Saturated h.c. kx (cm/s) : 1.000E-007
○Saturated h.c. ky (cm/s) : 1.000E-007
○Specific Storage Coef. Ss (1/m) : 1.000E-009

○Cohesion c(kN/m2) : 1000.000
○Friction Angle φ(°) : 0.000
○Wet Weight(kN/m3) : 24.000
○Sat. Unit Weight(kN/m3) : 24.000
○Water Unit Weight(kN/m3) : 9.807

○Layer No. : 10
○Layer Name : Gr
○Unsaturated Permeability : gravel/sand
○Table of Unsaturated Permeability

No	θ	kr	No	θ	ψ(m)
1	0.000	0.000	1	0.000	-500.000
2	0.010	0.010	2	0.049	-12.000
3	0.020	0.020	3	0.050	-1.900
4	0.030	0.030	4	0.056	-1.500
5	0.040	0.040	5	0.068	-1.000
6	0.050	0.050	6	0.078	-0.800
7	0.060	0.060	7	0.084	-0.700
8	0.070	0.080	8	0.090	-0.600
9	0.080	0.090	9	0.100	-0.500
10	0.090	0.110	10	0.112	-0.400
11	0.100	0.130	11	0.126	-0.300
12	0.110	0.160	12	0.136	-0.250
13	0.120	0.190	13	0.150	-0.200
14	0.130	0.230	14	0.164	-0.150
15	0.140	0.290	15	0.178	-0.100
16	0.150	0.360	16	0.190	-0.050
17	0.160	0.450	17	0.200	0.000
18	0.170	0.550			
19	0.180	0.650			
20	0.190	0.800			
21	0.200	1.000			

○Saturated h.c. kx (cm/s) : 1.000E-001
○Saturated h.c. ky (cm/s) : 1.000E-001
○Specific Storage Coef. Ss (1/m) : 1.000E-003

○Cohesion c(kN/m2) : 0.000
○Friction Angle φ(°) : 35.000
○Wet Weight(kN/m3) : 19.000
○Sat. Unit Weight(kN/m3) : 20.000

○Water Unit Weight (kN/m3) : 9.807

◆ FEM Elements

○Soil Layer Elements Size

Layer No.	xDirection (m)	yDirection (m)
1	0.500	0.500
2	0.500	0.500
3	0.500	0.500
4	0.500	0.500
5	0.500	0.500
6	0.500	0.500
7	0.500	0.500
8	0.500	0.500
9	0.500	0.500
10	0.500	0.500

○Element Shape : Triangle + Square

○Partial Area

No	Min. x axis (m)	Min. y axis (m)	Max. x axis (m)	Max. y axis (m)	Element Size xDirection (m) yDirection (m)

○Internal Node : 37, 38, 39, 40

◆ Initial Water Level

○ Water Level : 6

N	x axis (m)	y axis (m)
1	0.000	2.777
2	33.600	2.770
3	33.600	4.000
4	37.600	4.000
5	39.200	6.266
6	100.000	6.266

◆ Seepage Surface

○Seepage Surface : 1

○Seepage Surface No : 1
○Nodes : 1, 2, 3, 4, 5, 11, 12, 16, 20, 21,
: 24, 25, 29, 30

◆ Water Level Fix

○ Water Level Fixed : 1

○ Water Level Fix No : 1
○ Water Level (m) : 6.265
○ Nodes : 30, 31, 32

◆ Water Level Changing Point

○ No. of Water Level Changing Point : 1

○ Water Level Changing Point No. :
○Nodes : 1, 2, 3, 4, 5, 11

○temporal variation

No	Time (hr)	Water Level (m)
1	0.000	2.771
2	206.000	2.771
3	225.000	10.894
4	226.000	10.894
5	248.000	2.771
6	270.000	2.771

◆ Rain Penetration Line

○No. of Rain Penetration Line : 1

○Rain Penetration Line No : 1
○Nodes : 4, 5, 11, 12, 16, 20, 21, 24, 25, 29,
: 30

○temporal variation

No	Time (hr)	Rainfall (mm)
1	200.000	1.000
2	226.000	10.000
3	270.000	0.000

◆ Repeat Calculation

○Timestep

- Min. : 0.010
- Max. : 10.000
- Allowable Error (m) : 0.100
- Max. Repeat : 10

◆ Slip Surface Conditions

○ Merginal Slip Surface (Center ・ Diameter)

○No. of Search Area : 1

No	x axis Min. (m)	x axis Max. (m)	x axis Variation (m)	y axis Min. (m)	y axis Max. (m)	y axis Variation (m)
1	45.000	55.000	1.000	12.000	22.000	1.000

No	Diameter Min. (m)	Diameter Max. (m)	Diameter Variation (m)
1	5.000	25.000	1.000

○Slip Surface Limit

	x axis (m)	y axis (m)
must cut line [OFF] —		
must not cut line [ON]		
1	43.328	11.027
2	50.051	7.666

○Max. Depth (m) : 0.000
○Search Time : 1
○Slice Width (m) : 1.000

◆ Load

○No. of Loads : 1

	Left end (m)	Right end (m)	Load (kN/m2)
1	40.800	42.800	5.000

◆ Tension Crack

○Tension Crack : 0

◆ Seismic Force

○Horizontal Seismic Coef. : 0.000
○Vertical Seismic Coef. : 0.000

◆ Output Time

○Output Time : 6

No	Seepage Cal.	Stability Cal.
1	1.000	◎
2	10.000	◎
3	225.000	◎
4	226.000	◎
5	248.000	◎
6	270.000	

Slope Stability Analysis considering Seepage

Slope Stability Calculation

○ 1. Input Data

◆ Title

R10+960

◆ Calculation Type

Seepage Analysis + Slope Stability Calculation

◆ Safety Factor Formula

Modified Fellenius' Method

◆ Unit

SI Unit

◆ Node

○No. of Nodes : 40

○Node axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	0.000	2	33.492	0.000
3	33.492	3.831	4	33.492	4.631
5	37.342	4.631	6	37.492	4.631
7	37.492	4.484	8	37.492	3.831
9	33.642	3.831	10	33.642	1.131
11	40.328	11.027	12	40.778	11.027
13	40.718	10.827	14	41.345	10.827
15	43.328	10.827	16	43.328	11.027
17	38.815	4.484	18	39.442	4.484
19	39.705	5.360	20	50.051	7.666
21	50.336	7.666	22	51.025	6.116
23	51.785	6.116	24	51.010	7.666
25	51.401	7.666	26	52.001	6.466
27	52.101	6.466	28	52.101	6.116
29	51.851	6.766	30	100.000	6.766
31	100.000	5.360	32	100.000	1.131
33	100.000	-14.848	34	33.642	-11.869
35	33.492	-11.869	36	0.000	-14.848
37	52.300	6.766	38	52.300	6.266
39	52.800	6.266	40	52.800	6.766

◆ Soil Layer

○No. of Soil Layers : 10

○Layer No. : 1
○Layer Name : Co
○Nodes : 3, 4, 5, 6, 7, 8, 9

○Layer No. : 2
○Layer Name : Co
○Nodes : 11, 12, 13, 17, 7, 6, 5

○Layer No. : 3
○Layer Name : SSP
○Nodes : 2, 3, 9, 10, 34, 35

○Layer No. : 4
○Layer Name : Gr
○Nodes : 13, 14, 19, 18, 17

○Layer No. : 5
○Layer Name : PCCP
○Nodes : 16, 15, 14, 13, 12

○Layer No. : 6
○Layer Name : B
○Nodes : 14, 15, 16, 20, 21, 22, 23, 28, 27, 26,
: 29, 30, 31, 19

○Layer No. : 7
○Layer Name : As
○Nodes : 10, 9, 8, 7, 17, 18, 19, 31, 32

○Layer No. : 8
○Layer Name : Dc
○Nodes : 1, 2, 35, 34, 10, 32, 33, 36

○Layer No. : 9
○Layer Name : Co
○Nodes : 23, 24, 25, 29, 26, 27, 28

○Layer No. : 10
○Layer Name : Gr
○Nodes : 24, 23, 22, 21

◆ Hole

○Hole : 0

◆ Soil Constants

○Soil Layer : 1
Layer Name : Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 2
Layer Name : Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : Soil 3
Cohesion (kN/m2) : SSP
: 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 77.00
Sat. Unit Weight (kN/m3) : 77.00

○Soil Layer : 4
Layer Name : Gr
Cohesion (kN/m2) : 0.00
Friction Angle (°) : 35.00
Wet Weight (kN/m3) : 19.00
Sat. Unit Weight (kN/m3) : 20.00

○Soil Layer : 5
Layer Name : PCCP
Cohesion (kN/m2) : 1.00
Friction Angle (°) : 30.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 6
Layer Name : B
Cohesion (kN/m2) : 1.00
Friction Angle (°) : 30.00
Wet Weight (kN/m3) : 18.00
Sat. Unit Weight (kN/m3) : 19.00

○Soil Layer : 7
Layer Name : As
Cohesion (kN/m2) : 0.00
Friction Angle (°) : 27.00
Wet Weight (kN/m3) : 17.50
Sat. Unit Weight (kN/m3) : 18.50

○Soil Layer : 8
Layer Name : Dc
Cohesion (kN/m2) : 100.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 18.00
Sat. Unit Weight (kN/m3) : 19.00

○Soil Layer : 9
Layer Name : Co
Cohesion (kN/m2) : 1000.00
Friction Angle (°) : 0.00
Wet Weight (kN/m3) : 24.00
Sat. Unit Weight (kN/m3) : 24.00

○Soil Layer : 10
Layer Name : Gr
Cohesion (kN/m2) : 0.00
Friction Angle (°) : 35.00
Wet Weight (kN/m3) : 19.00
Sat. Unit Weight (kN/m3) : 20.00

◆ Slip Surface Conditions

○Merginal Slip Surface (Center - Diameter)

○ Search Area : 1

No	x axis Min. (m)	x axis Max. (m)	x axis Variation (m)	y axis Min. (m)	y axis Max. (m)	y axis Variation (m)
1	45.000	55.000	1.000	12.000	22.000	1.000

No	Diameter Min. (m)	Diameter Max. (m)	Diameter Variation (m)
1	5.000	25.000	1.000

○Slip Surface Limit
x axis (m) y axis (m)

Search Area1
must cut line
[OFF] —
must not cut line [ON]

1	43.328	11.027
2	50.051	7.666

○Max. Depth (m) : 0.000
○Search Time : 1
○Slice Width (m) : 1.000

◆ Calculation Time

○Tame to conduct Stability Cal. : 5

no	Time (hour)	no	Time (hour)	no	Time (hour)	no	Time (hour)	no	Time (hour)
1	1.000	2	10.000	3	225.000	4	226.000	5	248.000

◆ Load

○No. of Load : 1

	Left end (m)	Right end (m)	Load (kN/m2)
1	40.800	42.800	5.000

◆ Tension Crack

○Tension Crack : 0

◆ Seismic Force

○Horizontal Seismic Coef. : 0.000
○Vertical Seismic Coef. : 0.000

..

==========
○2. Calculation Result
==========

◆ Min.Safety Factor and Slip Surface

◆ At 1.000(hr) Calculation Result

○Safety Factor and Slip Surface
・Safety Factor : 1.508
・Resistance Force (kN) : 291.555
・Sliding Force (kN) : 193.329 (= 188.471 + 41.293 / 8.500)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	41.732	11.027	2	41.782	10.827	3	41.841	10.617
4	42.337	9.323	5	42.800	8.482	6	42.832	8.431
7	43.328	7.734	8	43.808	7.177	9	44.288	6.705
10	44.769	6.301	11	44.914	6.190	12	45.249	5.952
13	45.729	5.651	14	46.209	5.392	15	46.274	5.360
16	46.690	5.171	17	47.170	4.985	18	47.650	4.831
19	48.130	4.708	20	48.610	4.614	21	49.091	4.549
22	49.571	4.511	23	50.051	4.500	24	50.336	4.507
25	50.673	4.527	26	50.981	4.557	27	51.010	4.560
28	51.025	4.562	29	51.401	4.616	30	51.732	4.678
31	51.785	4.690	32	51.851	4.704	33	52.001	4.739
34	52.101	4.764	35	52.600	4.907	36	53.099	5.085
37	53.598	5.299	38	53.726	5.360	39	54.097	5.552
40	54.596	5.850	41	55.095	6.196	42	55.129	6.222
43	55.594	6.600	44	55.778	6.766			

○Arc Center (m) : (50.000, 13.000)
○Arc Diameter (m) : 8.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length (m)
0.050	0.121	−75.883	0.000	0.206
0.058	0.390	−74.455	0.000	0.218
0.496	10.025	−69.045	0.000	1.386
0.463	18.280	−61.130	0.000	0.960
0.032	1.531	−57.690	0.000	0.060
0.496	26.871	−54.601	0.000	0.856
0.480	29.837	−49.236	0.000	0.735
0.480	32.208	−44.487	0.000	0.673
0.480	33.919	−40.101	0.000	0.628
0.145	10.514	−37.370	0.000	0.183
0.335	24.649	−35.369	1.173	0.411
0.480	36.019	−32.073	3.830	0.567
0.480	36.498	−28.324	6.592	0.546

0.065	4.966	−26.241	8.028	0.073
0.415	31.637	−24.459	9.119	0.456
0.480	36.327	−21.185	10.973	0.515
0.480	35.763	−17.750	12.654	0.504
0.480	34.918	−14.379	14.024	0.496
0.480	33.807	−11.059	15.097	0.489
0.480	32.440	−7.776	15.893	0.485
0.480	30.826	−4.518	16.424	0.482
0.480	28.968	−1.275	16.685	0.480
0.285	16.588	1.305	16.722	0.285
0.337	19.660	3.403	16.588	0.338
0.308	18.027	5.583	16.375	0.309
0.029	1.724	6.724	16.258	0.030
0.015	0.870	6.875	16.236	0.015
0.376	22.637	8.207	15.960	0.380
0.331	18.136	10.624	15.410	0.337
0.053	2.452	11.941	15.078	0.054
0.066	2.892	12.350	14.994	0.068
0.150	6.132	13.097	14.756	0.154
0.100	3.942	13.963	14.388	0.103
0.499	17.894	16.061	13.511	0.519
0.499	16.411	19.596	11.937	0.530
0.499	14.605	23.212	10.040	0.543
0.128	3.416	25.519	8.706	0.142
0.371	9.033	27.405	7.473	0.418
0.499	9.824	30.772	5.086	0.581
0.499	6.774	34.777	1.942	0.607
0.034	0.341	36.968	0.125	0.042
0.465	2.974	39.132	0.000	0.600
0.185	0.276	41.990	0.000	0.248

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	2.771	2	33.492	2.771	3	33.642	4.317
4	34.105	4.461	5	34.567	4.459	6	35.030	4.462
7	35.492	4.460	8	35.955	4.462	9	36.417	4.460
10	36.880	4.461	11	37.342	4.550	12	37.492	4.590
13	37.933	4.861	14	38.374	5.096	15	38.815	5.714
16	39.129	6.073	17	39.442	6.083	18	39.705	6.082
19	40.017	6.089	20	40.328	6.116	21	40.718	6.152
22	40.778	6.154	23	41.062	6.166	24	41.345	6.172
25	41.841	6.175	26	42.337	6.179	27	42.832	6.181
28	43.328	6.183	29	43.808	6.185	30	44.288	6.187
31	44.769	6.189	32	45.249	6.191	33	45.729	6.193
34	46.209	6.195	35	46.690	6.196	36	47.170	6.198
37	47.650	6.199	38	48.130	6.200	39	48.610	6.201
40	49.091	6.203	41	49.571	6.206	42	50.051	6.208
43	50.336	6.209	44	50.673	6.207	45	51.010	6.217
46	51.025	6.217	47	51.401	6.216	48	51.785	6.222
49	51.851	6.229	50	52.001	6.223	51	52.101	6.214
52	52.600	6.212	53	53.099	6.215	54	53.598	6.217
55	54.097	6.219	56	54.596	6.220	57	55.095	6.221

58	55.594	6.223	59	56.093	6.224	60	56.592	6.225
61	57.090	6.226	62	57.589	6.227	63	58.088	6.228
64	58.587	6.229	65	59.086	6.230	66	59.585	6.231
67	60.084	6.232	68	60.583	6.233	69	61.082	6.234
70	61.581	6.235	71	62.080	6.236	72	62.579	6.236
73	63.078	6.237	74	63.577	6.238	75	64.076	6.239
76	64.575	6.240	77	65.074	6.240	78	65.573	6.241
79	66.072	6.242	80	66.570	6.242	81	67.069	6.243
82	67.568	6.244	83	68.067	6.244	84	68.566	6.245
85	69.065	6.246	86	69.564	6.246	87	70.063	6.247
88	70.562	6.248	89	71.061	6.248	90	71.560	6.249
91	72.059	6.249	92	72.558	6.250	93	73.057	6.250
94	73.556	6.251	95	74.055	6.251	96	74.554	6.252
97	75.053	6.252	98	75.552	6.253	99	76.051	6.253
100	76.549	6.254	101	77.048	6.254	102	77.547	6.255
103	78.046	6.255	104	78.545	6.255	105	79.044	6.256
106	79.543	6.256	107	80.042	6.257	108	80.541	6.257
109	81.040	6.257	110	81.539	6.258	111	82.038	6.258
112	82.537	6.258	113	83.036	6.259	114	83.535	6.259
115	84.034	6.260	116	84.533	6.260	117	85.032	6.260
118	85.531	6.261	119	86.029	6.261	120	86.528	6.261
121	87.027	6.261	122	87.526	6.262	123	88.025	6.262
124	88.524	6.262	125	89.023	6.263	126	89.522	6.263
127	90.021	6.263	128	90.520	6.264	129	91.019	6.264
130	91.518	6.264	131	92.017	6.264	132	92.516	6.265
133	93.015	6.265	134	93.514	6.265	135	94.013	6.266
136	94.512	6.266	137	95.011	6.266	138	95.509	6.266
139	96.008	6.267	140	96.507	6.267	141	97.006	6.267
142	97.505	6.267	143	98.004	6.268	144	98.503	6.268
145	99.002	6.268	146	99.501	6.268	147	100.000	6.265

..

◆ At 10.000(hr) Calculation Result

○Safety Factor and Slip Surface
・Safety Factor : 1.495
・Resistance Force (kN) : 288.932
・Sliding Force (kN) : 193.330 (= 188.472 + 41.293 / 8.500)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	41.732	11.027	2	41.782	10.827	3	41.841	10.617
4	42.337	9.323	5	42.800	8.482	6	42.832	8.431
7	43.328	7.734	8	43.808	7.177	9	44.288	6.705
10	44.769	6.301	11	44.831	6.253	12	45.249	5.952
13	45.729	5.651	14	46.209	5.392	15	46.274	5.360
16	46.690	5.171	17	47.170	4.985	18	47.650	4.831
19	48.130	4.708	20	48.610	4.614	21	49.091	4.549
22	49.571	4.511	23	50.051	4.500	24	50.336	4.507

25	50.673	4.527	26	50.957	4.554	27	51.010	4.560
28	51.025	4.562	29	51.401	4.616	30	51.707	4.673
31	51.785	4.690	32	51.851	4.704	33	52.001	4.739
34	52.101	4.764	35	52.600	4.907	36	53.099	5.085
37	53.598	5.299	38	53.726	5.360	39	54.097	5.552
40	54.596	5.850	41	55.095	6.196	42	55.204	6.279
43	55.594	6.600	44	55.778	6.766			

○Arc Center (m) : (50.000, 13.000)
○Arc Diameter (m) : 8.500

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length(m)
0.050	0.121	-75.883	0.000	0.206
0.058	0.390	-74.455	0.000	0.218
0.496	10.025	-69.045	0.000	1.386
0.463	18.280	-61.130	0.000	0.960
0.032	1.531	-57.690	0.000	0.060
0.496	26.871	-54.601	0.000	0.856
0.480	29.837	-49.236	0.000	0.735
0.480	32.208	-44.487	0.000	0.673
0.480	33.919	-40.101	0.000	0.628
0.062	4.475	-37.721	0.000	0.078
0.418	30.700	-35.721	1.479	0.515
0.480	36.049	-32.073	4.438	0.567
0.480	36.528	-28.324	7.191	0.546
0.065	4.970	-26.241	8.621	0.073
0.415	31.662	-24.459	9.708	0.456
0.480	36.356	-21.185	11.554	0.515
0.480	35.791	-17.750	13.228	0.504
0.480	34.946	-14.379	14.593	0.496
0.480	33.835	-11.059	15.665	0.489
0.480	32.468	-7.776	16.453	0.485
0.480	30.853	-4.518	16.962	0.482
0.480	28.994	-1.275	17.205	0.480
0.285	16.603	1.305	17.232	0.285
0.337	19.678	3.403	17.131	0.338
0.284	16.648	5.502	16.940	0.285
0.053	3.123	6.644	16.795	0.054
0.015	0.871	6.875	16.759	0.015
0.376	22.657	8.207	16.484	0.380
0.306	16.903	10.535	15.953	0.311
0.078	3.703	11.852	15.611	0.080
0.066	2.892	12.350	15.477	0.068
0.150	6.132	13.097	15.266	0.154
0.100	3.942	13.963	14.990	0.103
0.499	17.927	16.061	14.170	0.519
0.499	16.445	19.596	12.594	0.530
0.499	14.637	23.212	10.664	0.543
0.128	3.424	25.519	9.310	0.142
0.371	9.056	27.405	8.065	0.418
0.499	9.853	30.772	5.664	0.581
0.499	6.803	34.777	2.510	0.607
0.109	1.041	37.287	0.406	0.137
0.390	2.292	39.451	0.000	0.505
0.185	0.276	41.990	0.000	0.248

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	2.771	2	33.492	2.771	3	33.642	4.373
4	34.105	4.509	5	34.567	4.499	6	35.030	4.518
7	35.492	4.499	8	35.955	4.518	9	36.417	4.499
10	36.880	4.507	11	37.342	4.593	12	37.492	4.593
13	37.933	4.870	14	38.374	5.098	15	38.815	5.731
16	39.129	6.131	17	39.442	6.260	18	39.705	6.260
19	40.017	6.259	20	40.328	6.253	21	40.718	6.248
22	41.062	6.246	23	41.345	6.246	24	41.841	6.246
25	42.337	6.247	26	42.832	6.248	27	43.328	6.249
28	43.808	6.250	29	44.288	6.251	30	44.769	6.253
31	45.249	6.253	32	45.729	6.254	33	46.209	6.255
34	46.690	6.256	35	47.170	6.257	36	47.650	6.257
37	48.130	6.258	38	48.610	6.259	39	49.091	6.259
40	49.571	6.259	41	50.051	6.260	42	50.336	6.261
43	50.673	6.266	44	51.010	6.270	45	51.025	6.270
46	51.401	6.270	47	51.785	6.273	48	51.851	6.276
49	52.001	6.280	50	52.101	6.280	51	52.600	6.281
52	53.099	6.280	53	53.598	6.279	54	54.097	6.278
55	54.596	6.279	56	55.095	6.279	57	55.594	6.279
58	56.093	6.280	59	56.592	6.280	60	57.090	6.280
61	57.589	6.281	62	58.088	6.281	63	58.587	6.282
64	59.086	6.282	65	59.585	6.282	66	60.084	6.283
67	60.583	6.283	68	61.082	6.283	69	61.581	6.284
70	62.080	6.284	71	62.579	6.284	72	63.078	6.285
73	63.577	6.285	74	64.076	6.285	75	64.575	6.286
76	65.074	6.286	77	65.573	6.286	78	66.072	6.287
79	66.570	6.287	80	67.069	6.287	81	67.568	6.287
82	68.067	6.288	83	68.566	6.288	84	69.065	6.288
85	69.564	6.288	86	70.063	6.289	87	70.562	6.289
88	71.061	6.289	89	71.560	6.289	90	72.059	6.290
91	72.558	6.290	92	73.057	6.290	93	73.556	6.290
94	74.055	6.290	95	74.554	6.291	96	75.053	6.291
97	75.552	6.291	98	76.051	6.291	99	76.549	6.291
100	77.048	6.292	101	77.547	6.292	102	78.046	6.292
103	78.545	6.292	104	79.044	6.292	105	79.543	6.292
106	80.042	6.293	107	80.541	6.293	108	81.040	6.293
109	81.539	6.293	110	82.038	6.293	111	82.537	6.293
112	83.036	6.293	113	83.535	6.293	114	84.034	6.293
115	84.533	6.293	116	85.032	6.293	117	85.531	6.293
118	86.029	6.293	119	86.528	6.293	120	87.027	6.293
121	87.526	6.293	122	88.025	6.293	123	88.524	6.293
124	89.023	6.293	125	89.522	6.293	126	90.021	6.293
127	90.520	6.293	128	91.019	6.293	129	91.518	6.293
130	92.017	6.293	131	92.516	6.292	132	93.015	6.292

133	93.514	6.292	134	94.013	6.292	135	94.512	6.292
136	95.011	6.292	137	95.509	6.292	138	96.008	6.291
139	96.507	6.291	140	97.006	6.291	141	97.505	6.290
142	98.004	6.289	143	98.503	6.288	144	99.002	6.284
145	99.501	6.278	146	100.000	6.265			

..

◆ At 225.000(hr) Calculation Result

○Safety Factor and Slip Surface
- Safety Factor : 1.342
- Resistance Force (kN) 244.554
- Sliding Force (kN) : 182.224 (= 179.102 + 24.976 / 8.000)

○Slip Surface axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	42.137	11.027	2	42.177	10.827	3	42.337	10.204
4	42.800	9.013	5	42.832	8.947	6	43.328	8.086
7	43.808	7.434	8	44.288	6.898	9	44.429	6.758
10	44.769	6.447	11	45.249	6.064	12	45.729	5.735
13	46.209	5.455	14	46.392	5.360	15	46.690	5.217
16	47.170	5.017	17	47.650	4.853	18	48.130	4.722
19	48.610	4.622	20	49.091	4.552	21	49.571	4.512
22	50.051	4.500	23	50.336	4.507	24	50.673	4.528
25	50.695	4.530	26	51.010	4.564	27	51.025	4.566
28	51.401	4.624	29	51.415	4.626	30	51.785	4.702
31	51.851	4.717	32	52.001	4.754	33	52.101	4.781
34	52.855	5.027	35	53.608	5.360	36	54.594	5.950
37	55.579	6.766						

○Arc Center (m) : (50.000, 12.500)
○Arc Diameter (m) : 8.000

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle (°)	Slice Bottom Pressure (kN/m2)	Slice Bottom Water Length (m)
0.040	0.096	-78.659	0.000	0.204
0.160	1.661	-75.626	0.000	0.643
0.463	12.390	-68.741	0.000	1.278
0.032	1.227	-63.896	0.000	0.073
0.496	22.998	-60.072	0.000	0.994
0.480	27.201	-53.612	0.000	0.809
0.480	30.258	-48.134	0.000	0.720
0.141	9.330	-44.846	0.000	0.198
0.339	23.207	-42.487	1.590	0.460
0.480	34.233	-38.636	5.162	0.615
0.480	35.417	-34.350	8.872	0.582
0.480	36.131	-30.275	12.124	0.556
0.182	13.830	-27.547	14.175	0.206
0.298	22.618	-25.628	15.506	0.330
0.480	36.318	-22.582	17.492	0.520
0.480	35.883	-18.901	19.742	0.508
0.480	35.143	-15.300	21.632	0.498
0.480	34.110	-11.760	23.058	0.491
0.480	32.792	-8.265	23.961	0.485
0.480	31.193	-4.801	24.226	0.482
0.480	29.318	-1.355	23.895	0.480
0.285	16.782	1.386	23.445	0.285
0.337	19.876	3.616	23.073	0.338
0.022	1.288	4.904	22.847	0.022
0.315	18.663	6.118	22.658	0.317
0.015	0.879	7.307	22.469	0.015
0.376	22.838	8.724	22.170	0.380
0.014	0.853	10.136	21.877	0.014
0.370	19.774	11.540	21.706	0.378
0.066	2.877	13.135	20.817	0.068
0.150	6.115	13.931	19.911	0.155
0.100	3.942	14.855	19.599	0.103
0.754	26.496	18.066	18.263	0.793
0.754	22.458	23.858	15.423	0.824
0.985	20.793	30.927	10.895	1.148
0.985	7.635	39.628	4.000	1.279

○ Water Level axis

No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)	No	x axis (m)	y axis (m)
1	0.000	10.894	2	40.266	10.894	3	40.328	6.708
4	40.718	6.701	5	40.778	6.701	6	41.062	6.699
7	41.345	6.699	8	41.841	6.702	9	42.337	6.708
10	42.832	6.717	11	43.328	6.728	12	43.808	6.740
13	44.288	6.753	14	44.769	6.772	15	45.249	6.792
16	45.729	6.816	17	46.209	6.847	18	46.690	6.880
19	47.170	6.922	20	47.650	6.975	21	48.130	7.011
22	48.610	7.034	23	49.091	7.026	24	49.571	6.978
25	50.051	6.907	26	50.336	6.882	27	50.673	6.859
28	51.010	6.856	29	51.025	6.856	30	51.401	6.855
31	51.785	6.898	32	51.851	6.766	33	93.015	6.766
34	93.514	6.766	35	94.013	6.760	36	94.512	6.753
37	95.011	6.744	38	95.509	6.734	39	96.008	6.723
40	96.507	6.710	41	97.006	6.695	42	97.505	6.676
43	98.004	6.649	44	98.503	6.611	45	99.002	6.548
46	99.501	6.434	47	100.000	6.265			

..

◆ At 226.000 (hr) Calculation Result

○Safety Factor and Slip Surface

・Safety Factor : 1.337
・Resistance Force(kN) : 243.734
・Sliding Force(kN) : 182.282 (= 179.160 + 24.976 / 8.000)

○Slip Surface axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	42.137	11.027	2	42.177	10.827	3	42.337	10.204
4	42.800	9.013	5	42.832	8.947	6	43.328	8.086
7	43.808	7.434	8	44.288	6.898	9	44.415	6.772
10	44.769	6.447	11	45.249	6.064	12	45.729	5.735
13	46.209	5.455	14	46.392	5.360	15	46.690	5.217
16	47.170	5.017	17	47.650	4.853	18	48.130	4.722
19	48.610	4.622	20	49.091	4.552	21	49.571	4.512
22	50.051	4.500	23	50.336	4.507	24	50.673	4.528
25	50.691	4.530	26	51.010	4.564	27	51.025	4.566
28	51.401	4.624	29	51.411	4.625	30	51.785	4.702
31	51.851	4.717	32	52.001	4.754	33	52.101	4.781
34	52.855	5.027	35	53.608	5.360	36	54.594	5.950
37	55.579	6.766						

○Arc Center(m) : (50.000, 12.500)
○Arc Diameter(m) : 8.000

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle(°)	Slice Bottom Pressure(kN/m2)	Slice Bottom Water Length(m)
0.040	0.096	-78.659	0.000	0.204
0.160	1.661	-75.626	0.000	0.643
0.463	12.390	-68.741	0.000	1.278
0.032	1.227	-63.896	0.000	0.073
0.496	22.998	-60.072	0.000	0.994
0.480	27.201	-53.612	0.000	0.809
0.480	30.258	-48.134	0.000	0.720
0.126	8.377	-44.917	0.000	0.179
0.354	24.163	-42.558	1.672	0.480
0.480	34.242	-38.636	5.347	0.615
0.480	35.429	-34.350	9.103	0.582
0.480	36.145	-30.275	12.406	0.556
0.182	13.836	-27.547	14.502	0.206
0.298	22.629	-25.628	15.880	0.330
0.480	36.341	-22.582	17.975	0.520
0.480	35.909	-18.901	20.273	0.508
0.480	35.164	-15.300	22.068	0.498
0.480	34.126	-11.760	23.386	0.491
0.480	32.805	-8.265	24.217	0.485
0.480	31.204	-4.801	24.451	0.482
0.480	29.328	-1.355	24.084	0.480
0.285	16.786	1.386	23.573	0.285
0.337	19.879	3.616	23.163	0.338
0.018	1.079	4.891	22.927	0.018
0.319	18.875	6.105	22.738	0.321
0.015	0.879	7.307	22.548	0.015
0.376	22.841	8.724	22.249	0.380
0.010	0.627	10.123	21.955	0.010
0.374	20.000	11.526	21.745	0.382
0.066	2.877	13.135	20.817	0.068
0.150	6.115	13.931	19.911	0.155
0.100	3.942	14.855	19.599	0.103
0.754	26.496	18.066	18.263	0.793
0.754	22.458	23.858	15.423	0.824
0.985	20.793	30.927	10.895	1.148
0.985	7.635	39.628	4.000	1.279

○ Water Level axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	0.000	10.894	2	40.266	10.894	3	40.328	6.714
4	40.718	6.707	5	40.778	6.707	6	41.062	6.705
7	41.345	6.706	8	41.841	6.709	9	42.337	6.716
10	42.832	6.727	11	43.328	6.739	12	43.808	6.752
13	44.288	6.767	14	44.769	6.788	15	45.249	6.813
16	45.729	6.842	17	46.209	6.878	18	46.690	6.921
19	47.170	6.979	20	47.650	7.026	21	48.130	7.049
22	48.610	7.063	23	49.091	7.049	24	49.571	7.001
25	50.051	6.922	26	50.336	6.892	27	50.673	6.867
28	51.010	6.864	29	51.025	6.864	30	51.401	6.863
31	51.785	6.898	32	51.851	6.766	33	93.015	6.766
34	93.514	6.766	35	94.013	6.761	36	94.512	6.753
37	95.011	6.744	38	95.509	6.734	39	96.008	6.723
40	96.507	6.710	41	97.006	6.695	42	97.505	6.676
43	98.004	6.650	44	98.503	6.611	45	99.002	6.548
46	99.501	6.434	47	100.000	6.265			

..

◆ At 248.000 (hr) Calculation Result

○Safety Factor and Slip Surface
・Safety Factor : 1.429
・Resistance Force(kN) : 260.539
・Sliding Force(kN) : 182.271 (= 179.149 + 24.976 / 8.000)

○Slip Surface axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	42.137	11.027	2	42.177	10.827	3	42.337	10.204
4	42.800	9.013	5	42.832	8.947	6	43.328	8.086
7	43.808	7.434	8	44.288	6.898	9	44.586	6.610
10	44.769	6.447	11	45.249	6.064	12	45.729	5.735
13	46.209	5.455	14	46.392	5.360	15	46.690	5.217

16	47.170	5.017	17	47.650	4.853	18	48.130	4.722
19	48.610	4.622	20	49.091	4.552	21	49.571	4.512
22	50.051	4.500	23	50.336	4.507	24	50.673	4.528
25	50.865	4.547	26	51.010	4.564	27	51.025	4.566
28	51.401	4.624	29	51.606	4.663	30	51.785	4.702
31	51.851	4.717	32	52.000	4.754	33	52.001	4.754
34	52.031	4.762	35	52.101	4.781	36	52.600	4.934
37	53.099	5.125	38	53.598	5.355	39	53.608	5.360
40	54.097	5.629	41	54.596	5.952	42	55.095	6.332
43	55.202	6.422	44	55.579	6.766			

○Arc Center(m) : (50.000, 12.500)
○Arc Diameter(m) : 8.000

○Slice Property

Slice Width (m)	Slice Weight (kN)	Slice Bottom Angle(°)	Slice Bottom Pressure(kN/m2)	Slice Bottom Water Length(m)
0.040	0.096	-78.659	0.000	0.204
0.160	1.661	-75.626	0.000	0.643
0.463	12.390	-68.741	0.000	1.278
0.032	1.227	-63.896	0.000	0.073
0.496	22.998	-60.072	0.000	0.994
0.480	27.201	-53.612	0.000	0.809
0.480	30.258	-48.134	0.000	0.720
0.298	19.923	-44.073	0.000	0.414
0.183	12.578	-41.713	0.829	0.245
0.480	34.157	-38.636	3.599	0.615
0.480	35.334	-34.350	7.182	0.582
0.480	36.037	-30.275	10.197	0.556
0.182	13.790	-27.547	12.026	0.206
0.298	22.546	-25.628	13.164	0.330
0.480	36.185	-22.582	14.772	0.520
0.480	35.721	-18.901	16.432	0.508
0.480	34.951	-15.300	17.712	0.498
0.480	33.893	-11.760	18.634	0.491
0.480	32.562	-8.265	19.252	0.485
0.480	30.965	-4.801	19.572	0.482
0.480	29.108	-1.355	19.603	0.480
0.285	16.667	1.386	19.459	0.285
0.337	19.744	3.616	19.234	0.338
0.192	11.301	5.517	19.010	0.193
0.145	8.525	6.731	18.827	0.146
0.015	0.873	7.307	18.731	0.015
0.376	22.695	8.724	18.437	0.380
0.205	11.803	10.835	17.952	0.209
0.179	8.790	12.239	17.554	0.183
0.066	2.877	13.135	17.277	0.068
0.149	6.051	13.928	17.003	0.153
0.001	0.041	14.481	16.808	0.001
0.030	1.191	14.597	16.758	0.031
0.070	2.721	14.968	16.595	0.072
0.499	17.811	17.096	15.663	0.522
0.499	16.219	20.878	13.866	0.534
0.499	14.275	24.758	11.728	0.549
0.011	0.278	26.769	10.545	0.012
0.488	11.637	28.807	9.182	0.557
0.499	9.082	32.933	6.245	0.594
0.499	5.746	37.309	2.767	0.627
0.107	0.754	40.057	0.444	0.140
0.377	1.167	42.386	0.000	0.510

○ Water Level axis

No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)	No	x axis(m)	y axis(m)
1	0.000	2.771	2	33.492	2.771	3	33.642	4.631
4	37.342	4.631	5	37.492	4.610	6	37.933	4.884
7	38.374	5.148	8	38.815	5.750	9	39.129	6.198
10	39.442	6.443	11	39.705	6.443	12	40.017	6.444
13	40.328	6.454	14	40.718	6.465	15	40.778	6.468
16	41.062	6.476	17	41.345	6.486	18	41.841	6.502
19	42.337	6.521	20	42.832	6.541	21	43.328	6.562
22	43.808	6.582	23	44.288	6.600	24	44.769	6.617
25	45.249	6.629	26	45.729	6.635	27	46.209	6.635
28	46.690	6.629	29	47.170	6.618	30	47.650	6.603
31	48.130	6.583	32	48.610	6.560	33	49.091	6.540
34	49.571	6.515	35	50.051	6.494	36	50.336	6.482
37	50.673	6.476	38	51.010	6.475	39	51.025	6.475
40	51.401	6.475	41	51.785	6.472	42	51.851	6.470
43	52.001	6.468	44	52.101	6.461	45	52.600	6.448
46	53.099	6.438	47	53.598	6.433	48	54.097	6.429
49	54.596	6.425	50	55.095	6.423	51	55.594	6.420
52	56.093	6.418	53	56.592	6.416	54	57.090	6.414
55	57.589	6.413	56	58.088	6.411	57	58.587	6.410
58	59.086	6.408	59	59.585	6.407	60	60.084	6.405
61	60.583	6.403	62	61.082	6.402	63	61.581	6.400
64	62.080	6.399	65	62.579	6.397	66	63.078	6.396
67	63.577	6.394	68	64.076	6.392	69	64.575	6.391
70	65.074	6.389	71	65.573	6.388	72	66.072	6.386
73	66.570	6.384	74	67.069	6.383	75	67.568	6.381
76	68.067	6.380	77	68.566	6.378	78	69.065	6.376
79	69.564	6.375	80	70.063	6.373	81	70.562	6.372
82	71.061	6.370	83	71.560	6.369	84	72.059	6.367
85	72.558	6.367	86	73.057	6.366	87	73.556	6.366
88	74.055	6.367	89	74.554	6.366	90	75.053	6.365
91	75.552	6.364	92	76.051	6.362	93	76.549	6.360
94	77.048	6.359	95	77.547	6.357	96	78.046	6.355
97	78.545	6.353	98	79.044	6.351	99	79.543	6.349
100	80.042	6.347	101	80.541	6.345	102	81.040	6.343
103	81.539	6.342	104	82.038	6.340	105	82.537	6.338
106	83.036	6.336	107	83.535	6.335	108	84.034	6.333
109	84.533	6.332	110	85.032	6.330	111	85.531	6.329
112	86.029	6.327	113	86.528	6.326	114	87.027	6.324
115	87.526	6.323	116	88.025	6.321	117	88.524	6.319
118	89.023	6.317	119	89.522	6.315	120	90.021	6.313
121	90.520	6.311	122	91.019	6.309	123	91.518	6.306

124	92.017	6.304	125	92.516	6.302	126	93.015	6.300
127	93.514	6.298	128	94.013	6.296	129	94.512	6.293
130	95.011	6.291	131	95.509	6.289	132	96.008	6.287
133	96.507	6.285	134	97.006	6.283	135	97.505	6.281
136	98.004	6.278	137	98.503	6.276	138	99.002	6.273
139	99.501	6.269	140	100.000	6.265			

..
==========
O3. Slip Surface with the minimum Safety Factor
..
==========

O Time(hr) : 226.000
O Safety Factor : 1.337
O Search Area : 1
O Center(m) : (50.000, 12.500)
O Diameter(m) : 8

1.2.2 Gravity Wall

Structural calculations for the following types of gravity wall are shown in the following pages.

-Type I (the retaining wall of the maintenance road) (*the soil property near L5+400 is applied)

-Type II (the retaining wall of the maintenance road) (*the soil property near L6+560 is applied)

-Type A (the retaining wall at the left bank transition near 6+560) (*the soil property near L6+560 is applied)

-Type B (the retaining wall at the left bank transition near 6+560) (*the soil property near L6+560 is applied)

-Type C (the retaining wall at the left bank transition near 6+480) (*the soil property near L6+560 is applied)

1.2.2 GRAVITY　WALL
1.2.2.1 TYPE I , REPRESENTED BY L5+400

Table of Contents

1. Design Conditions 1
1.1 General 1
1.2 Applied Criteria 1
1.3 Format 1
1.4 Geometry 1
1.5 Ground Conditions 1
1.6 Materials Used 2
1.7 Soil 3
1.8 Load 3
1.9 Other Loads 4
1.10 Uplift 4
1.11 Earth Pressure 4
1.12 Water Pressure 5
1.13 Load Combination Case 5
1.14 Conditions of Foundation 5
1.14.1 Allowable Shear Resistance Calculation Data 5
1.15 Allowable Values for Stability Calculations and Allowable Stresses of Members 6
1.15.1 Tolerance for Stability Calculation 6
2. Stability Calculations 7
2.1 Block Data Not Considering Water Level 7
2.2 Body Weight, Earth and Sand Weight, Other Loads, Vertical Force and Horizontal Force Due to Uplift 7
2.3. Earth Pressure and Water Pressure 8
2.4 Aggregation of Acting Forces 11
2.5 Stability Calculation Results 13
2.5.1 Stability Against Overturning 13
2.5.2 Stability Against Sliding 14
2.5.3 Check of Bearing Capacity 14

1. Design Conditions

1.1 General

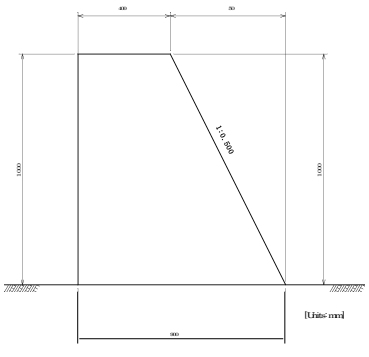
Title: Gravity Wall (TYPE I OF MAINTENANCE ROAD, REPRESENTED BY L5 + 400)

1.2 Applied Criteria

Japan Construction Technology Association, Civil Engineering Structure Standard Design Vol. 2, Manual (Retaining Wall) 2000

1.3 Format

'Gravity (direct foundation) '



Width in the depth direction (block length) B=5000

1.4 Geometry

1.5 Ground Conditions

Seismic scale: Medium
Region: A
Ground Type: TYPE I

Judgment of Ground Classification

$$TG = 4\Sigma\frac{Hi}{Vsi} = 0.158 \quad (TG < 0.2)$$

Here,

T_G: Ground property value (s)
Hi: Thickness of the ith stratum (m)

Vsi: Average shear elastic wave velocity of the i-th stratum (m/s)

Case of cohesive soil
Vsi = 100 Ni 1/3 (1 ≦ Ni ≦ 25)
In the case of sandy soil
Vsi = 80 Ni 1/3 (1 ≦ Ni ≦ 50)

Ni: Average N value of the i-th stratum by the standard penetration test
Vsi = 50 m/s when N value is 0, and Vsi = 50 m/s when Vsi < 50 m/s
i: Number of the i-th stratum from the ground surface when the ground is divided into n layers from the ground surface to the seismic design foundation surface

Geological Number	Layer Type	Layer Thickness Hi (m)	Mean N-Value	Vsi (m/s)
1	sandy soil	1.370	5.0	136.798
2	sandy soil	2.140	10.0	172.355
3	cohesive soil	3.700	10.0	215.443
4	cohesive soil	10.000	50.0	292.402

1.6 Materials Used

[Concrete]　Vertical wall (plain concrete) : σck = 18 (N/mm2)

[Soil]　Quality: Backside soil: sandy soil
Backfill soil: sandy soil
Foundation ground: gravel

[Internal friction angle]　Backside Soil: 30.00 (degrees)

[Unit volume weight]

(kN/m3)

Body	Plain Concrete	23.000	
Water	For Calculation of Uplift	10.000	
Soil		Wet Weight	Saturated Weight
Back surface		18.000	19.000
Front surface		18.000	19.000

[Design horizontal seismic coefficient] Body: Kh = 0.20
Soil (Front) : Kh = 0.20 (Back) : Kh = 0.20

1.7 Soil

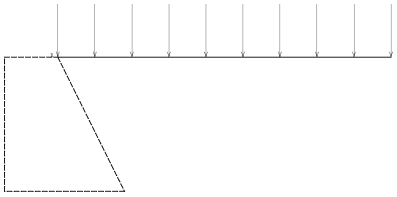
(1) Backside Soil Shape



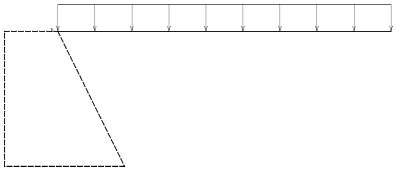
Level difference between retaining wall crown and backside ground	(m)	0.000
Height without considering Earth Pressure Hr	(m)	0.000

1.8 Load

[1] Normal



No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	Vertical Wall	Bottom Plate
1	0.000	infinity	10.000	10.000	○	-	-



[2] Seismic

No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	Vertical wall	Bottom Plate
1	0.000	infinity	5.000	5.000	○	-	-

1.9 Other Loads

Not considered

1.10 Uplift

- Consider the uplift equivalent as uplift pressure

1.11 Earth Pressure

- Earth Pressure formulas: trial wedges
- Angle of friction of Earth Pressure acting surface (degrees)

Load Condition	Active Earth Pressure		Passive Earth Pressure
	at the Stability Calculation	Cut	
Normal Earth Pressure	20.000		
Seismic Earth Pressure	15.000		

- The imaginary back surface of Earth Pressure for stability calculation is the back of the vertical wall.
- Angle between the surface at which earth pressure acts and the vertical plane at the time of stability calculation: 26.565(degrees)
- The design horizontal seismic intensity is applied to the inertia force at the time of earthquake when calculating the earth pressure below the water Level.
- Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal	1.000	0.000	0.000
Seismic	1.000	0.000	0.000

- Treatment of Earth Pressure different from the direction of Seismic motion

	Consider as	Availability Factor
Stability Calculation	Normal Earth Pressure	0.500
Vertical Wall Design		0.500

1.12 Water Pressure

- Concept of Hydrostatic Pressure Calculation

Load Condition	Back Surface	Front Surface
Normal	Consider	Consider
Seismic	Consider	Consider

- Hydrostatic pressure different from the direction of seismic motion

External Water Level	Stability Calculation	Consider
	Vertical Wall Design	Consider

1.13 Load Combination Case

No	Load Name	Comments
1	Normal	Normal
2	Seismic	Seismic

	Load Name	1	2
Soil	Soil 1	○	
	Soil 2		○
Water Level	Water Level 1	○	
	Water Level 2		○
Load	Load 1	○	
	Load 2		○
Active Earth Pressure	Not considered		
	Normal Earth Pressure	○	
	Seismic Earth Pressure		○
Passive Earth Pressure	Passive Earth Pressure 1		

1.14 Conditions of Foundation

1.14.1 Data for calculating allowable shear resistance

Bottom Plate width used for checking		Effective Loading Width
Cohesive force CB between base bottom surface and ground	(kN/m2)	0.000
Friction coefficient between base and ground tan φB		0.600

1.15 Allowable Values for Stability Calculation and Allowable Stress of Members

1.15.1 Tolerance for Stability Calculation

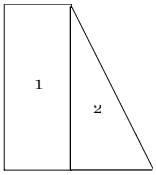
Load Condition	Allowable Eccentricity eB/B(m)	Safety Factor Against Overturning	Safety Factor Against Sliding	Allowable Bearing Capacity
Normal	1/6	1.500	1.500	200.000
Seismic	1/3	1.200	1.200	300.000

2. Stability Calculations

2.1 Block Data Not Considering Water Level

(1) Body weight

1) Block Division



2) Weight and Center of Gravity

Division	Equation Width x height x depth	Volume Vi (m3)	Center of Gravity (m) Xi	Yi	Vi Xi	Vi Yi	Remarks
1	0.400 x 1.000 x 1.000	0.400	0.200	0.500	0.080	0.200	
2	1/2 x 0.500 x1.000 x 1.000	0.250	0.567	0.333	0.142	0.083	
2		0.650			0.222	0.283	

Centroid position XG = 2 (Vi Xi) /2Vi = 0.222/0.650 = 0.341 (m)

YG = 2 (Vi Yi) /2Vi = 0.283/0.650 = 0.436 (m)

2.2 Body Weight, Earth and Sand Weight, Arbitrary Load, Vertical Force due to Uplift (Uplift Pressure) and Horizontal Force

(1) Acting Force Due to Dead Weight

[1] Normal

Location	Vertical Force W = γ ·V (kN)			Acting Position X (m)
Body	23.000 x	0.650 =	14.950	0.341

[2] Seismic

Location	Vertical Force W = γ ·V (kN)			Acting Position X (m)
Body	23.000 x	0.650 =	14.950	0.341

Location	Horizontal Force H = W kh (kN)			Acting Position Y (m)
Body	14.950 x	0.20 =	2.990	0.436

(2) Dead-Weight

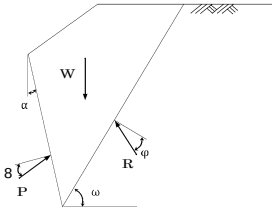
[1] Normal (Water Level 1)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position Xi	Yi	Moment (kNm) Ni Xi	Hi Yi
Body	14.950	0.000	0.341	0.000	5.099	0.000
Total	14.950	0.000			5.099	0.000

[2] Seismic (Water Level 2)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position Xi	Yi	Moment (kNm) Ni Xi	Hi Yi
Body	14.950	2.990	0.341	0.436	5.099	1.303
Total	14.950	2.990			5.099	1.303

2.3. Earth Pressure and Water Pressure



[1] Normal (Water Level 1)

The Earth Pressure is determined by the trial wedge method considering the cohesive force.

Imaginary Backside Position (distance from toe) xp = 0.900 m

yp = 0.000 m

Imaginary Backside Height H = 1.000 m

Angle between the Surface at which the Earth Pressure Acts and the Vertical Surface α = 26.565 °

Unit Volume Weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle δ = 2/3 φ = 20.000 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil Weight (W) against Slip Angle (ω) , soil pressure (P) , Water Level hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN) Above Water Level	Below Water Level	Surcharge	Total	Earth Pressure P (kN)
64.00	8.890	0.000	9.877	18.767	9.764
65.00	8.697	0.000	9.663	18.360	9.774

Soil weight (W) and soil pressure (P) Water Level with respect to Slip Angle (ω) hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN) Above Water Level	Below Water Level	Surcharge	Total	Earth Pressure P (kN)
66.00	8.507	0.000	9.452	17.959	9.773

The maximum soil pressure is

P = 9.774 kN when ω = 65.00 °

Cohesive force of sliding surface

Co = c · L = 1.000 x 1.103 = 1.103 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega-\varphi) - Co \cdot \cos\varphi}{\cos(\omega-\varphi-\alpha-\delta)}$$

$$= \frac{18.360 \times \sin(65.00° - 30.00°) - 1.103 \times \cos 30.00°}{\cos(65.00° - 30.00° - 26.565 - 20.000°)} = 9.774\ kN$$

The horizontal component, vertical component and working position of the Earth Pressure at this time are as follows.

horizontal component

Ph = P-cos (α + δ) = 9.774 x cos (26.565° + 20.000°) =6.720 kN

vertical component

Pv = P sin (α + δ) = 9.774 x sin (26.565° + 20.000°) =7.097 kN

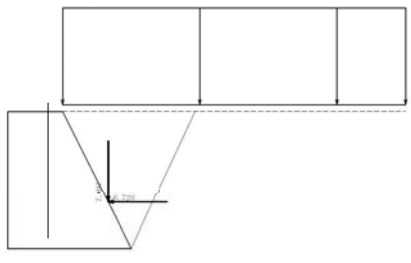
Acting position

$$Ho = \frac{H}{3} = \frac{1.000}{3} = 0.333\ m$$

x = xp-Ho · tan α = 0.900 -0.333 × tan 26.565 ° = 0.733 m

y = yp + Ho = 0.000 + 0.333 = 0.333 m

- Earth Pressure Diagram



[

2] Seismic (Water Level 2)

The earth pressure is obtained by the trial wedge method considering inertia force and Cohesion force at the earthquake.

Imaginary Backside Position (distance from toe) xp = 0.900 m

yp = 0.000 m

Imaginary Backside Height H = 1.000 m

Angle between the Surface at which the Earth Pressure Acts and the Vertical Surface α = 26.565 °

Unit volume weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle 6 = 1/2 φ = 15.000 °

Seismic Composite Angle θ = tan -1 kh = tan -10.20 = 11.310 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil weight (W) and soil pressure (P) Water Level with respect to Slip Angle (ω) hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN) Above Water Level	Below Water Level	Surcharge	Total	Earth Pressure P (kN)
52.00	11.532	0.000	6.406	17.938	9.495
53.00	11.282	0.000	6.268	17.550	9.498
54.00	11.039	0.000	6.133	17.172	9.494

The maximum soil pressure is

P = 9.498 kN when ω = 53.00 °

Cohesive force of sliding surface

Co = c · L = 1.000 x 1.252 = 1.252 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega-\varphi+\theta) - Co\cos\varphi}{\cos(\omega-\varphi-\alpha-\delta)}$$

$$= \frac{17.550/\cos 11.310° \times \sin(53.00° - 30.00° + 11.310°) - 1.252 \times \cos 30.00°}{\cos(53.00° - 30.00° - 26.565 - 15.000°)}$$

= 9.498 kN

The horizontal component, vertical component and working position of the Earth Pressure at this time are as follows.

horizontal component

Ph = P-cos (α + 6) = 9.498 x cos (26.565° + 15.000°) =7.106 kN vertical component

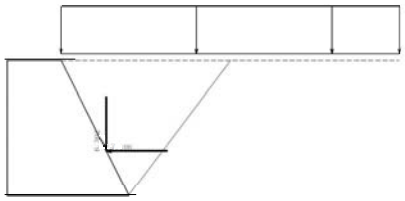
Pv = P sin (α + 6) = 9.498 x sin (26.565° + 15.000°) =6.302 kN working position

$$Ho = \frac{H}{3} = \frac{1.000}{3} = 0.333\ m$$

x = xp-Ho · tan α = 0.900 -0.333 × tan 26.565 ° = 0.733 m

y = yp + Ho = 0.000 + 0.333 = 0.333 m

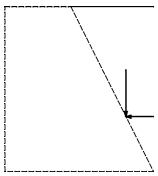
- Earth Pressure Diagram



2.4 Aggregation of Acting Forces

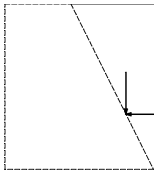
(1) Sum of Force at Front of Body

[1] Normal (Water Level 1)



Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length		Rotational Moment (kNm)	
			Xi (m)	Yi (m)	Mxi = Ni/Xi	Myi = Hi Yi
Dead Weight	14.950	0.000	0.341	0.000	5.099	0.000
Earth Pressure	7.097	6.720	0.733	0.333	5.202	2.238
Total	22.047	6.720			10.301	2.238

[2] Seismic (Water Level 2)



5	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length		Rotational Moment (kNm)	
			Xi (m)	Yi (m)	Mxi = Ni/Xi	Myi = Hi Yi
Dead Weight	14.950	2.990	0.341	0.436	5.099	1.303

Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length		Rotational Moment (kNm)	
			Xi (m)	Yi (m)	Mxi = Ni/Xi	Myi = Hi Yi
Earth Pressure	6.302	7.106	0.733	0.333	4.619	2.366
Total	21.252	10.096			9.718	3.670

Loading Conditions (Water Level)	No (kN)	Ho (kN)	Mo (kNm)
Normal (Water Level 1)	22.047	6.720	8.063
Seismic (Water Level 2)	21.252	10.096	6.048

(2) Aggregate Force at Body Center

Vertical Force : Nc = No (kN)
Horizontal Force : Hc = Ho (kN)
Rotational Moment: Mc = No Bj/2.0 - Mo (kNm) where:
Body Width in the Direction of Earth Pressure: Bj = 0.900 (m)

■ Per Unit Width

Loading Conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kNm)
Normal (Water Level 1)	22.04	6.720	1.858
Seismic (Water Level 2)	21.25	10.096	3.515

■ Per Full Width (5.000 m)

Loading Conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kNm)
Normal (Water Level 1)	110.2	33.600	9.292
Seismic (Water Level 2)	106.2	50.480	17.576

2.5 Stability Calculation Results

2.5.1 Stability against Overturning

(1) Calculation of Resultant Acting Point and Eccentricity

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,

d: Distance from toe of base plate to action point of resultant force (m)
ΣMr: Resistance moment around toe of base plate (kNm)
ΣMt: Fall moment around toe of base plate (kNm)
ΣV: Total vertical load at bottom of base plate (kN)

$$e = B/2 - d$$

Here,

e: Eccentric distance (m) from the center of the Base Plate of the point of action of the resultant force
B: Base Plate width (m) , B = 0.900

$$ea = B/n$$

Here,

ea: Allowable eccentric distance (m)
n: Safety factor

Loading conditions (Water Level)	ΣMr (kNm)	ΣMt (kNm)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal (Water Level 1)	10.301	2.238	22.047	0.366	0.084	<<	0.150
Seismic (Water Level 2)	9.718	3.670	21.252	0.285	0.165	<<	0.300

(2) Calculation of the Safety Factor

$$F = \left| \frac{Mr}{Mo} \right|$$

Here,

Mr: Moment of resistance
Mo: Moment of rotation

Loading Conditions (Water Level)	Mr. (kNm)	Mo (kNm)	Safety Factor		
			F = Mr/Mo		Tolerance
Normal (Water Level 1)	10.301	2.238	4.603	≧	1.500
Seismic (Water Level 2)	9.718	3.670	2.648	≧	1.200

2.5.2 Stability Against Sliding

$$Fs = \frac{\Sigma V \mu + C_B B}{\Sigma H}$$

Here,

ΣV: Total vertical load at Base Plate (kN)
ΣH: Total horizontal load on Base Plate (kN)
μ: Friction coefficient between bottom slab and Bearing capacity of foundation ground, μ = 0.600
C_B: Cohesion between slab and bearing capacity of foundation ground (kN/m2) , CB = 0.000
B: Bottom plate width (m) , B = 0.900

Loading Conditions (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Safety Factor Fs		Required Safety Factor Fsa
Normal (Water Level 1)	22.047	6.720	1.968	≧	1.500
Seismic (Water Level 2)	21.252	10.096	1.263	≧	1.200

2.5.3 Check of Bearing Capacity

1) When the resultant action point lies within the base plate width of 1/3 (middle third) at the center of the bottom plate

$$q_1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6e}{B}\right)$$

$$q_2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6e}{B}\right)$$

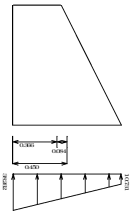
2) When the resultant force acting point is within the Base Plate width of 2/3 at the center of the Base Plate

$$q1 = \frac{2\Sigma V}{3(B/2 - e)}$$

Here,

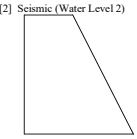
ΣV: Total vertical load acting on bottom of the bottom plate (kN)
B: Bottom plate width (m) , B = 0.900
e: Eccentricity (m)

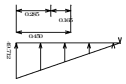
[1] Normal (Water Level 1)



Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction(kN/m2)			
		qmin	qmax		Tolerance
0.900	Trapezoid	10.731	38.262	≦	200.000

[2] Seismic (Water Level 2)





Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction (kN/m2)		
		qmin	qmax	Tolerance
0.855	Triangle	0.000	49.712 ≦	300.000

1.2.2 GRAVITY　WALL
1.2.2.2 TYPE A, REPRESENTED BY L6+560

Table of Contents

1. Design Conditions 1
1.1 General 1
1.2 Applied Criteria 1
1.3 Format 1
1.4 Geometry 1
1.5 Ground Conditions 1
1.6 Materials Used 2
1.7 Soil 3
1.8 Load 3
1.9 Other Loads 4
1.10 Uplift 4
1.11 Earth Pressure 4
1.12 Water Pressure 5
1.13 Load Combination Case 5
1.14 Conditions of Foundation 6
1.14.1 Allowable Shear Resistance Calculation Data 6
1.15 Allowable Values for Stability Calculations and Allowable Stresses of Members 6
1.15.1 Tolerance for Stable Calculation 6
2. Stability Calculations 7
2.1 Block Data Not Considering Water Level 7
2.2 Body Weight, Earth and Sand Weight, Other Loads, Vertical Force and Horizontal Force Due to Uplift 7
2.3. Earth Pressure and Water Pressure 8
2.4 Aggregation of Acting Forces 12
2.5 Stability Calculation Results 14
2.5.1 Stability Against Overturning 14
2.5.2 Stability Against Sliding 15
2.5.3 Check of Bearing Capacity 15

1. Design Conditions

1.1 General

Title: Gravity Wall (TYPE A, REPRESENTED BY R6 + 560)

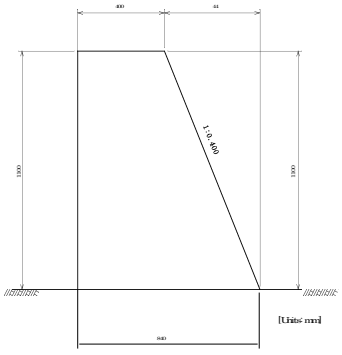
1.2 Applied Criteria

Japan Construction Technology Association, Civil Engineering Structure Standard Design Vol. 2, Manual (Retaining Wall) 2000

1.3 Format

'Gravity (direct foundation) '

1.4 Geometry



Width in the depth direction (block length) B=5000

1.5 Ground Conditions

Seismic scale: Medium scale

Region: A

Ground type: Type II

Judgment of Ground Classification

$$\frac{Hi}{Vsi} = 0.353 \quad (0.2 \leqq TG < 0.6)$$

Here,

TG: Ground property value (s)

Hi: Thickness of the ith stratum (m)

Vsi: average shear elastic wave velocity of the i-th stratum (m/s)

case of cohesive soil

Vsi = 100 Ni 1/3 (1 ≦ Ni ≦ 25)

In the case of sandy soil

Vsi = 80 Ni 1/3 (1 ≦ Ni ≦ 50)

Ni: Average N value of the i-th stratum by the standard penetration test

Vsi = 50 m/s when N value is 0, and Vsi = 50 m/s when Vsi < 50 m/s

i: Number of the i-th stratum from the ground surface when the ground is divided into n layers from the ground surface to the seismic design foundation surface

Geological Number	Layer Type	Layer Thickness Hi (m)	Mean N-Value	Vsi (m/s)
1	sandy soil	5.500	12.0	183.154
2	sandy soil	2.370	5.0	136.798
3	cohesive soil	3.630	8.0	200.000
4	sandy soil	2.000	33.0	256.603
5	cohesive soil	4.000	19.0	266.840
6	cohesive soil	10.000	50.0	292.402

1.6 Materials Used

[concrete]　Vertical wall (plain concrete) : σck = 18 (N/mm2)

[soil]　Quality: Backside soil: sandy soil
Backfill soil: sandy soil
Foundation ground: gravel

[internal friction angle]　Backside soil sand: 30.00 (degrees)

[unit volume weight]

(kN/m3)

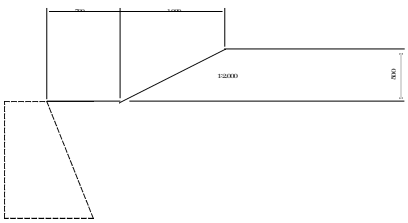
Body	Plain Concrete	23.000	
Water	For Calculation of	10.000	
Soil		Wet Weight	Saturated
Back surface		18.000	19.000
Front surface		18.000	19.000

[Design horizontal seismic coefficient]　Body: Kh = 0.20

Soil (Front) : Kh = 0.20 (Back) : Kh = 0.20

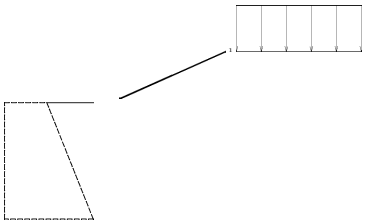
1.7 Soil

(1) Backside Soil Shape



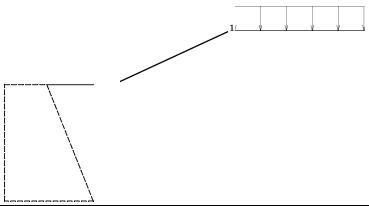
Level difference between retaining wall crown and backside ground (m)		0.000
Slope		2.000
Fill height	(m)	0.500
Horizontal length	(m)	0.700
Height without considering Earth Pressure Hr	(m)	0.000

1.8 Load [1] Normal



No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	Vertical wall	Bottom Plate
1	1.800	infinity	10.000	10.000	○	-	-

[2] Seismic



No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	Vertical wall	Bottom Plate
1	1.800	infinity	5.000	5.000	○	-	-

1.9 Other Loads

Not considered

1.10 Uplift

- Consider the Uplift equivalent as uplift pressure

1.11 Earth Pressure

Load Condition	Active Earth Pressure		Passive Earth Pressure
	at the Stability Calculation	Cut	
Normal Earth Pressure	20.000		
Seismic Earth Pressure	15.000		

- The imaginary back surface of Earth Pressure for stability calculation is the back of the vertical wall
- Angle between the surface at which earth pressure acts and the vertical plane at the time of stability calculation: 21.801 (deg)
- The design horizontal seismic intensity is applied to the inertia force at the time of earthquake when calculating the earth pressure below the water Level.
- When the height of the fill is up to 15.000 m, the ratio of the height of the raised fill is set to 1.0.

- Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal Earth Pressure	1.000	0.000	0.000
Seismic Earth Pressure	1.000	0.000	0.000

- Treatment of Earth Pressure different from the direction of Seismic motion

	Consider as	Availability Factor
Stability Calculation	Normal Earth Pressure	0.500
Vertical Wall Design		0.500

1.12 Water Pressure

- Concept of Hydrostatic Pressure Calculation

Load Condition	Back Surface	Front Surface
Normal	Consider	Consider
Seismic	Consider	Consider

- Treatment of hydrostatic pressure different from the direction of Seismic motion

	Stability Calculation	Consider
External Water Level	Vertical Wall Design	Consider

1.13 Load Combination Case

No	Load Name	Comments
1	Normal	Normal
2	Seismic	Seismic

	Load Name	1	2
Soil	Soil 1	○	
	Soil 2		○
Water Level	Water Level 1	○	
	Water Level 2		○
Load	Load 1	○	
	Load 2		○
Active Earth Pressure	Not considered		
	Normal Earth Pressure	○	
	Seismic Earth Pressure		○
Passive Earth Pressure	Passive Earth Pressure 1		

1.14 Conditions of Foundation

1.14.1 Calculation Data for Allowable Shear Resistance

Bottom Plate width used for checking	Effective Loading Width
Cohesive force CB between base bottom surface and ground (kN/m2)	0.000
Friction coefficient between base and ground tan φB	0.600

1.15 Allowable values for stability calculations and allowable stresses of members

1.15.1 Tolerance for stability calculation

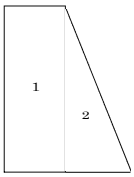
Load Condition	Allowable Eccentricity eB/B(m)	Safety Factor Against Overturning	Safety Factor Against Sliding	Allowable Bearing Capacity
Normal	1/6	1.500	1.500	200.000
Seismic	1/3	1.200	1.200	300.000

2. Stability Calculations

2.1 Block Data Not Considering Water Level

(1) Dead Weight

1) Block Division



2) weight and center of gravity

Division	Equation Width x height x depth	Volume Vi (m3)	Center of gravity (m)		Vi Xi	Vi Yi	Remarks
			Xi	Yi			
1	0.400 x 1.100 x 1.000	0.440	0.200	0.550	0.088	0.242	
2	1/2 x 0.440 x1.100 x 1.000	0.242	0.547	0.367	0.132	0.089	
2		0.682			0.220	0.331	

Centroid position XG=2(Vi Xi) / 2Vi = 0.220 / 0.682 = 0.323 (m)

YG=2(Vi Yi) / 2Vi = 0.331 / 0.682 = 0.485 (m)

2.2 Body weight, earth and sand weight, other loads, Vertical Force and Horizontal Force due to Uplift

(1) Acting force due to dead weight

[1] Normal

Location	Vertical Force W = γ ·V (kN)			Acting Position X (m)
Body	23.000 x	0.682 =	15.686	0.323

[2] Seismic

Location	Vertical Force W = γ ·V (kN)			Acting Position X (m)
Body	23.000 x	0.682 =	15.686	0.323

Location	Horizontal Force H = W kh (kN)			Acting Position Y (m)
Body	15.686 x	0.20 =	3.137	0.485

(2) Dead-Weight

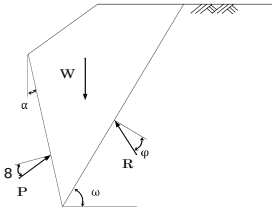
[1] Normal (Water Level 1)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position		Moment (kNm)	
			Xi	Yi	Ni Xi	Hi Yi
Body	15.686	0.000	0.323	0.000	5.067	0.000
Total	15.686	0.000			5.067	0.000

[2] Seismic (Water Level 2)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position		Moment (kNm)	
			Xi	Yi	Ni Xi	Hi Yi
Body	15.686	3.137	0.323	0.485	5.067	1.521
Total	15.686	3.137			5.067	1.521

2.3. Earth Pressure and Water Pressure



[1] Normal (Water Level 1)

The Earth Pressure is determined by the trial wedge method considering the cohesive force.

Imaginary Backside Position (distance from toe) xp = 0.840 m

yp = 0.000 m

Imaginary Backside Height H = 1.100 m

Angle between the Surface at which the Earth Pressure Acts and the Vertical Surface α = 21.801 °

Unit Volume Weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle δ = 2/3 φ = 20.000 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil Weight (W) against Slip Angle (ω) , soil pressure (P) , Water Level hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Surcharge	Total	
59.00	11.933	0.000	0.000	11.933	4.496
60.00	11.533	0.000	0.000	11.533	4.498

Soil weight (W) and soil pressure (P) Water Level with respect to Slip Angle (ω) hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Surcharge	Total	
61.00	11.154	0.000	0.000	11.154	4.496

The maximum soil pressure is

P = 4.498 kN when ω = 60.00 °

Cohesive force of sliding surface

Co = c · L = 1.000 x 1.575 = 1.575 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \varphi) - Co \cdot \cos\varphi}{\cos(\omega - \varphi - \alpha - \delta)}$$

$$= \frac{11.533 \times \sin(60.00° - 30.00°) - 1.575 \times \cos 30.00°}{\cos(60.00° - 30.00° - 21.801 - 20.000°)} = 4.498\ \text{kN}$$

The horizontal component, vertical component and working position of the Earth Pressure at this time are as follows.

horizontal component

Ph = P·cos (α + δ) = 4.498 x cos (21.801° + 20.000°) =3.353 kN

Vertical component

Pv = P sin (α + δ) = 4.498 x sin (21.801° + 20.000°) =2.998 kN

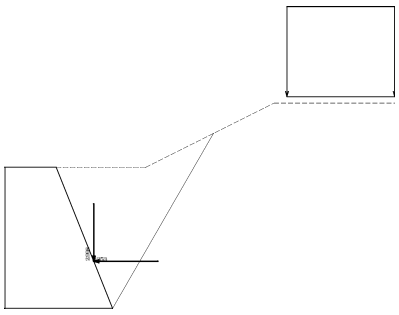
Acting position

$$Ho = \frac{H}{3} = \frac{1.100}{3} = 0.367\ \text{m}$$

x = xp-Ho · tan α = 0.840 -0.367 × tan 21.801 ° = 0.693 m

y = yp + Ho = 0.000 + 0.367 = 0.367 m

- Earth Pressure Diagram



[2] Seismic (Water Level 2)

The earth pressure is obtained by the trial wedge method considering inertia force and Cohesion force at the earthquake.

Imaginary Backside Position (distance from toe) xp = 0.840 m

yp = 0.000 m

Imaginary Backside Height H = 1.100 m

Angle between the Surface at which the Earth Pressure Acts and the Vertical Surface α = 21.801 °

Unit volume weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle δ = 1/2 φ = 15.000 °

Seismic Composite Angle θ = tan -1 kh = tan -10.20 = 11.310 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil weight (W) and soil pressure (P) Water Level with respect to Slip Angle (ω) hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Surcharge	Total	
37.00	28.091	0.000	3.816	31.907	9.126
38.00	27.006	0.000	3.439	30.445	9.148
39.00	25.968	0.000	3.079	29.047	9.135

The maximum soil pressure is determined by the following equation:

P = 9.148 kN when ω = 38.00 °

Cohesive force of sliding surface

Co = c · L = 1.000 x 2.599 = 2.599 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega-\varphi+0) - Co\cos\varphi}{\cos(\omega-\varphi-\alpha-\delta)}$$

$$= \frac{30.445/\cos 11.310° \times \sin(38.00° - 30.00° + 11.310°) - 2.599 \times \cos 30.00°}{\cos(38.00° - 30.00° - 21.801 - 15.000°)}$$

$$= 9.148 \text{ kN}$$

The horizontal component, vertical component and working position of the Earth Pressure at this time are as follows.

Horizontal component

$Ph = P \cdot \cos(\alpha + \delta) = 9.148 \times \cos(21.801° + 15.000°) =$ 7.325 kN

Vertical component

$Pv = P \sin(\alpha + \delta) = 9.148 \times \sin(21.801° + 15.000°) =$ 5.480 kN

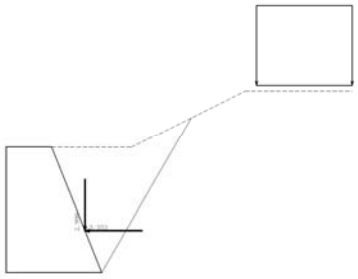
Acting position

$$Ho = \frac{H}{3} = \frac{1.100}{3} = 0.367 \text{ m}$$

$x = xp - Ho \cdot \tan\alpha = 0.840 - 0.367 \times \tan 21.801° = 0.693$ m

$y = yp + Ho = 0.000 + 0.367 = 0.367$ m

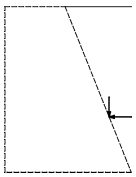
- Earth Pressure Diagram



2.4 Aggregation of Acting Forces

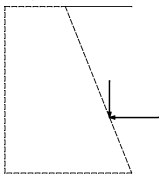
(1) Sum of Force at Front of Body

[1] Normal (Water Level 1)



Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length Xi (m)	Arm Length Yi (m)	Rotational Moment (kNm) Mxi = Ni/Xi	Rotational Moment (kNm) Myi = Hi Yi
Dead Weight	15.686	0.000	0.323	0.000	5.067	0.000
Earth Pressure	2.998	3.353	0.693	0.367	2.078	1.231
Total	18.684	3.353			7.144	1.231

[2] Seismic (Water Level 2)



Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length Xi (m)	Arm Length Yi (m)	Rotational Moment (kNm) Mxi = Ni/Xi	Rotational Moment (kNm) Myi = Hi Yi
Dead Weight	15.686	3.137	0.323	0.485	5.067	1.521
Earth Pressure	5.480	7.325	0.693	0.367	3.798	2.688
Total	21.166	10.462			8.864	4.210

Loading Conditions (Water Level)	No (kN)	Ho (kN)	Mo(kNm)
Normal (Water Level 1)	18.684	3.353	5.914
Seismic (Water Level 2)	21.166	10.462	4.655

(2) Aggregate Force at Body Center

Vertical Force : Nc = No (kN)

Horizontal Force : Hc = Ho (kN)

Rotational Moment: Mc = No Bj/2.0 - Mo (kNm) where:

Body Width in the Direction of Earth Pressure: Bj = 0.840 (m)

■ Per Unit Width

Loading Conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kNm)
Normal (Water Level 1)	18.684	3.353	1.933
Seismic (Water Level 2)	21.166	10.462	4.235

■ Per Full Width (5.000 m)

Loading Conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kNm)
Normal (Water Level 1)	93.420	16.765	9.667
Seismic (Water Level 2)	105.830	52.311	21.175

2.5 Stability Calculation Results

2.5.1 Stability against Overturning

(1) Calculation of Resultant Acting Point and Eccentricity

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,

d: Distance from toe of base plate to action point of resultant force (m)

ΣMr: Resistance moment around toe of base plate (kNm)

ΣMt: Fall moment around toe of base plate (kNm)

ΣV: Total vertical load at bottom of base plate (kN)

$$e = B/2 - d$$

Here,

e: Eccentric distance (m) from the center of the Base Plate of the point of action of the resultant force

B: Base Plate width (m) , B=0.840

$$ea = B/n$$

Here,

ea: Allowable eccentric distance (m)

n: Safety factor

Loading conditions (Water Level)	ΣMr (kNm)	ΣMt (kNm)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal (Water Level 1)	7.144	1.231	18.684	0.317	0.103	<<	0.140
Seismic (Water Level 2)	8.864	4.210	21.166	0.220	0.200	<<	0.280

(2) Calculation of the Safety Factor

$$F = \left| \frac{Mr}{Mo} \right|$$

Here,

Mr: Moment of resistance

Mo: Moment of rotation

Loading Conditions (Water Level)	Mr: (kNm)	Mo (kNm)	Safety Factor F=Mr/Mo		Tolerance
Normal (Water Level 1)	7.144	1.231	5.806	≧	1.500
Seismic (Water Level 2)	8.864	4.210	2.106	≧	1.200

2.5.2 Stability Against Sliding

$$R_S = \frac{\Sigma V \mu + C_B B}{\Sigma H}$$

Here,

ΣV: Total vertical load at Base Plate (kN)

ΣH: Total horizontal load on Base Plate (kN)

μ: Friction coefficient between bottom slab and Bearing capacity of foundation ground,, μ = 0.600

C_B: Cohesion between slab and bearing capacity of foundation ground (kN/m2) , CB = 0.000

B: Bottom plate width (m) , B = 0.900

Loading Conditions (Water Level)	Vertical Load	Horizontal Load ΣH (kN)	Safety Factor Fs		Required Safety Factor Fsa
Normal (Water Level 1)	18.684	3.353	3.343	≧	1.500
Seismic (Water Level 2)	21.166	10.462	1.214	≧	1.200

2.5.3 Check of Bearing Capacity

1) When the resultant action point lies within the base plate width of 1/3 (middle third) at the center of the bottom plate

$$q_1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6e}{B}\right)$$

$$q_2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6e}{B}\right)$$

2) When the resultant force acting point is within the Base Plate width of 2/3 at the center of the bottom plate

$$q1 = \frac{2\Sigma V}{3(B/2-e)}$$

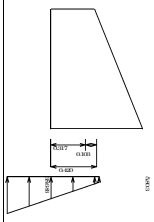
Here,

ΣV: Total vertical load acting on Base Plate bottom surface (kN)

B: Base Plate width (m) , B = 0.840

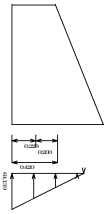
e: Eccentricity (m)

[1] Normal (Water Level 1)



Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction(kN/m2)		
		qmin	qmax	Tolerance
0.840	Trapezoid	5.803	38.683 ≦	200.000

[2] Seismic (Water Level 2)



Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction(kN/m2)		
		qmin	qmax	Tolerance
0.680	Triangle	0.000	64.139 ≦	300.000

1.2.2 GRAVITY　WALL
1.2.2.3 TYPE B, REPRESENTED BY L6+560

Table of Contents

1. Design Conditions 1
1.1 General 1
1.2 Applied Criteria 1
1.3 Format 1
1.4 Geometry 1
1.5 Ground Conditions 1
1.6 Materials Used 2
1.7 Sediment 3
1.8 Load 3
1.9 Other Loads 4
1.10 Uplift 4
1.11 Earth Pressure 4
1.12 Water Pressure 4
1.13 Load Combination Case 5
1.14 Conditions of Foundation 5
1.14.1allowable Shear Resistance Calculation Data 5
1.15 Allowable Values for Stability Calculations and Allowable Stresses of Members 5
1.15.1Tolerance For Stable Calculation 5
2. Stability Calculations 6
2.1 Block Data Not Considering Water Level 6
2.2 Body Weight, Earth and Sand Weight, Other Loads, Vertical Force and Horizontal Force Due to Uplift 6
2.3. Earth Pressure and Water Pressure 7
2.4 Aggregation of Acting Forces 10
2.5 Stability Calculation Results 12
2.5.1 Stability Against Overturning 12
2.5.2 Stability Against Sliding 13
2.5.3 Check of Bearing Capacity 13

1. Design Conditions

1.1 General

Title: Gravity Wall (TYPE C and TYPE II OF MAINTENANCE ROAD, REPRESENTED BY L 6 + 560)

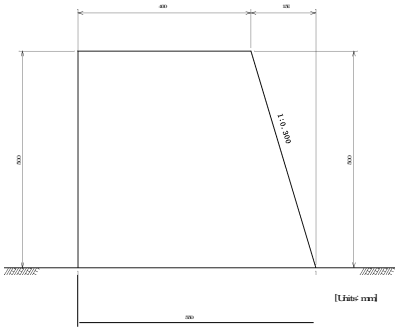
1.2 Applied Criteria

Japan Construction Technology Association, Civil Engineering Structure Standard Design Vol. 2, Manual (Retaining Wall) 2000

1.3 Format

'Gravity (direct foundation) '

1.4 Geometry



Width in the depth direction (block length) B=5000

1.5 Ground Conditions

Seismic scale: Medium scale

Region: A

Ground type: Type II

Judgment of Ground Classification

$$TG = 4\Sigma\frac{Hi}{Vsi} = 0.353 \ (0.2 \leqq TG < 0.6)$$

Here,

TG: Ground property value (s)

Hi: Thickness of the ith stratum (m)

Vsi: average shear elastic wave velocity of the i-th stratum (m/s)

case of cohesive soil

Vsi = 100 Ni 1/3 (1 ≦ Ni ≦ 25)

In the case of sandy soil

Vsi = 80 Ni 1/3 (1 ≦ Ni ≦ 50)

Ni: Average N value of the i-th stratum by the standard penetration test

Vsi = 50 m/s when N value is 0, and Vsi = 50 m/s when Vsi < 50 m/s

i: Number of the i-th stratum from the ground surface when the ground is divided into n layers from the ground surface to the seismic design foundation surface

Geological Number	Layer Type	Layer Thickness Hi (m)	Mean N-Value	Vsi (m/s)
1	sandy soil	5.500	12.0	183.154
2	sandy soil	2.370	5.0	136.798
3	cohesive soil	3.630	8.0	200.000
4	sandy soil	2.000	33.0	256.603
5	cohesive soil	4.000	19.0	266.840
6	cohesive soil	10.000	50.0	292.402

1.6 Materials Used

[concrete]　Vertical wall (plain concrete) : σck =　18 (N/mm2)

[soil]　Quality: Backfill soil:　sandy soil

Recessed soil:　sandy soil

Bearing Capacitying ground plane:　gravel

[internal friction angle]　Backside soil sand:　30.00 (degrees)

[unit volume weight]

(kN/m3)

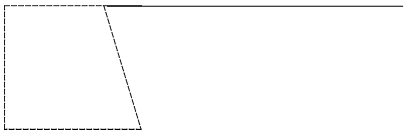
Body	Plain Concrete	23.000	
Water	For Calculation of	10.000	
Soil		Wet Weight	Saturated
Back surface		18.000	19.000
Front surface		18.000	19.000

[Design horizontal seismic coefficient]　Body: Kh = 0.20

Soil (Front) : Kh = 0.20 (Back) : Kh = 0.20

1.7 Soil

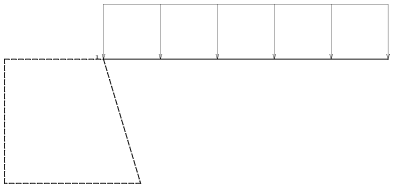
(1) Backside Soil Shape



Level difference between retaining wall crown and	0.000
Height without considering Earth Pressure Hr (m)	0.000

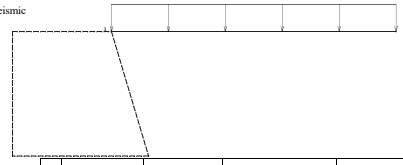
1.8 Load

[1] Normal



No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	vertical wall	Base Plate
1	0.000	4.000	10.000	10.000	○	-	-

[2] Seismic



No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	vertical wall	Base Plate
1	0.000	4.000	5.000	5.000	○	-	-

1.9 Other Loads

Not considered

1.10 Uplift

- Consider the Uplift equivalent as uplift pressure

1.11 Earth Pressure

- Earth Pressure formulas: trial wedges
- Angle of friction of Earth Pressure acting surface (degrees)

Load Condition	Active Earth Pressure		Passive Earth Pressure
	at the Stability Calculation	Cut	
Normal Earth Pressure	20.000		
Seismic Earth Pressure	15.000		

- The imaginary back surface of Earth Pressure for stability calculation is the back of the vertical wall.
- Angle between the surface at which earth pressure acts and the vertical plane at the time of stability calculation: 16.699(degrees)
- The design horizontal seismic intensity is applied to the inertia force at the time of earthquake when calculating the earth pressure below the water Level.
- Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal	1.000	0.000	
Seismic	1.000	0.000	

- Treatment of Earth Pressure different from the direction of Seismic motion

	Consider as	Availability Factor
Stability Calculation	Normal Earth Pressure	0.500
Vertical Wall Design		0.500

1.12 Water Pressure

- Concept of Hydrostatic Pressure Calculation

Load Condition	Back Surface	Front Surface
Normal	Consider	Consider
Seismic	Consider	Consider

- Hydrostatic pressure different from the direction of seismic motion

External Water Level	Stability Calculation	Consider
	Vertical Wall Design	Consider

1.13 Load Combination Case

No	Load Name	Comments
1	Normal	Normal
2	Seismic	Seismic

	Load Name	1	2
Soil	Soil 1	○	
	Soil 2		○
Water Level	Water Level 1	○	
	Water Level 2		○
Load	Load 1	○	
	Load 2		○
Active Earth Pressure	Not considered		
	Normal Earth Pressure	○	
	Seismic Earth Pressure		○
Passive Earth Pressure	Passive Earth Pressure 1		

1.14 Conditions of Foundation

1.14.1 Data for calculating allowable shear resistance

Bottom Plate width used for checking	Effective Loading Width
Cohesive force CB between base bottom surface and ground (kN/m2)	0.000
Friction coefficient between base and ground tan φB	0.600

1.15 Allowable Values for Stability Calculation and Allowable Stress of Members

1.15.1 Tolerance for Stability Calculation

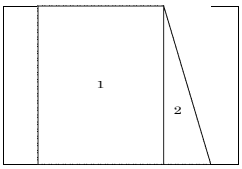
Load Condition	Allowable Eccentricity eB/B(m)	Safety Factor Against Overturning	Safety Factor Against Sliding	Allowable Bearing Capacity
Normal	1/6	1.500	1.500	200.000
Seismic	1/3	1.200	1.200	300.000

2. Stability Calculations

2.1 Block Data Not Considering Water Level

(1) Body weight

1) Block Division



2) Weight and Center of Gravity

Division	Equation Width x height x depth	Volume Vi (m3)	Center of Gravity (m)		Vi Xi	Vi Yi	Remarks
			Xi	Yi			
1	0.400 x 0.500 x 1.000	0.200	0.200	0.250	0.040	0.050	
2	1/2 x 0.150 x 0.500 x 1.000	0.038	0.450	0.167	0.017	0.006	
2		0.238			0.057	0.056	

Centroid position XG = 2 (Vi Xi) /2Vi = 0.057/0.238 = 0.239 (m)

YG = 2 (Vi Yi) /2Vi = 0.056/0.238 = 0.237 (m)

2.2 Body weight, earth and sand weight, other loads, Vertical Force and Horizontal Force due to Uplift

(1) Acting force due to Dead Weight

[1] Normal

Location	Vertical Force W = γ ·V (kN)			Acting Position X (m)
Body	23.000 x	0.238 =	5.463	0.239

[2] Seismic

Location	Vertical Force W = γ ·V (kN)			Acting Position X (m)
Body	23.000 x	0.238 =	5.463	0.239

Location	Horizontal Force H = W kh (kN)			Acting Position Y (m)
Body	5.463 x	0.20 =	1.093	0.237

(2) Dead-Weight

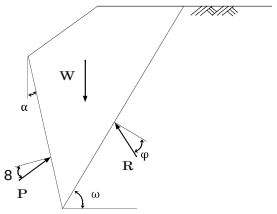
[1] Normal (Water Level 1)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position		Moment (kNm)	
			Xi	Yi	Ni Xi	Hi Yi
Body	5.463	0.000	0.239	0.000	1.308	0.000
Total	5.463	0.000			1.308	0.000

[2] Seismic (Water Level 2)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position		Moment (kNm)	
			Xi	Yi	Ni Xi	Hi Yi
Body	5.463	1.093	0.239	0.237	1.308	0.259
Total	5.463	1.093			1.308	0.259

2.3. Earth Pressure and Water Pressure



[1] Normal (Water Level 1)

The Earth Pressure is determined by the trial wedge method considering the cohesive force

Imaginary Backside Position (distance from toe) xp = 0.550 m

yp = 0.000 m

Imaginary Backside Height H = 0.500 m

Angle between the Surface at which the Earth Pressure Acts and the Vertical Surface α = 16.699 °

Unit Volume Weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle δ = 2/3 φ = 20.000 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil Weight (W) against Slip Angle (ω) , soil pressure (P) , Water Level hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Surcharge	Total	
62.00	1.871	0.000	4.159	6.030	2.714
63.00	1.821	0.000	4.048	5.869	2.716

Soil Weight (W) against Slip Angle (ω) , soil pressure (P) , Water Level hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Surcharge	Total	
64.00	1.772	0.000	3.939	5.711	2.715

The maximum soil pressure is

P = 2.716 kN when ω = 63.00 °

are used.

adhesive force of sliding surface

Co = c · L = 1.000 x 0.561 = 0.561 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega-\varphi) - Co \cdot \cos\varphi}{\cos(\omega-\varphi-\alpha-\delta)}$$

$$= \frac{5.869 \times \sin(63.00° - 30.00°) - 0.561 \times \cos 30.00°}{\cos(63.00° - 30.00° - 16.699 - 20.000°)} = 2.716 \text{ kN}$$

The horizontal component, vertical component and working position of the Earth Pressure at this time are as follows.

horizontal component

Ph = P·cos (α + δ) = 2.716 x cos (16.699° + 20.000°) =2.178 kN

Vertical component

Pv = P sin (α + δ) = 2.716 x sin (16.699° + 20.000°) =1.623 kN

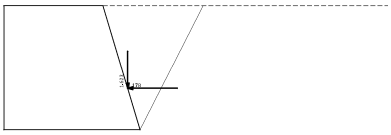
Acting position

$$Ho = \frac{H}{3} = \frac{0.500}{3} = 0.167 \text{ m}$$

x = xp-Ho · tan α = 0.550 -0.167 × tan 16.699 ° = 0.500 m

y = yp + Ho = 0.000 + 0.167 = 0.167 m

- Earth Pressure Diagram



[2] Seismic (Water Level 2)

The earth pressure is obtained by the trial wedge method considering inertia force and Cohesion force at the earthquake.

Imaginary Backside Position (distance from toe) xp = 0.550 m

yp = 0.000 m

Imaginary Backside Height H = 0.500 m

Angle between the Earth Pressure action surface and the vertical surface α = 16.699 °

Unit volume weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle 6 = 1/2 φ = 15.000 °

Seismic Composite Angle 0 = tan -1 kh = tan -10.20 = 11.310 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil weight (W) and soil pressure (P) Water Level with respect to Slip Angle (ω) hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Surcharge	Total	
52.00	2.433	0.000	2.703	5.136	2.360
53.00	2.370	0.000	2.634	5.004	2.361
54.00	2.310	0.000	2.566	4.876	2.360

The maximum soil pressure is determined by the following equation:

P = 2.361 kN when ω = 53.00 °

Cohesion of the sliding surface

Co = c · L = 1.000 x 0.626 = 0.626 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega-\varphi+\delta) - Co\cos\varphi}{\cos(\omega-\varphi-\alpha-\delta)}$$

$$= \frac{5.004/\cos 11.310° \times \sin(53.00° - 30.00° + 11.310°) - 0.626 \times \cos 30.00°}{\cos(53.00° - 30.00° - 16.699 - 15.000°)}$$

= 2.361 kN

The horizontal component, vertical component and working position of the Earth Pressure at this time are as follows.

horizontal component

Ph = P·cos (α + δ) = 2.361 x cos (16.699° + 15.000°) =2.009 kN

Vertical component

Pv = P sin (α + δ) = 2.361 x sin (16.699° + 15.000°) =1.241 kN

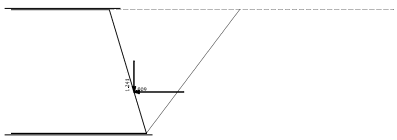
Acting position

$$Ho = \frac{H}{3} = \frac{0.500}{3} = 0.167 \text{ m}$$

x = xp-Ho · tan α = 0.550 -0.167 × tan 16.699 ° = 0.500 m

y = yp + Ho = 0.000 + 0.167 = 0.167 m

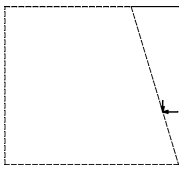
- Earth Pressure Diagram



2.4 Aggregation of Acting Forces

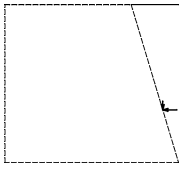
(1) Aggregate Force on front of Body

[1] Normal (Water Level 1)



Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length		Rotational Moment (kNm)	
			Xi (m)	Yi (m)	Mxi = Ni/Xi	Myi = Hi Yi
Dead Weight	5.463	0.000	0.240	0.000	1.308	0.000
Earth Pressure	1.623	2.178	0.500	0.167	0.812	0.364
Total	7.086	2.178			2.120	0.364

[2] Seismic (Water Level 2)



Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length		Rotational Moment (kNm)	
			Xi (m)	Yi (m)	Mxi = Ni/Xi	Myi = Hi Yi
Dead Weight	5.463	1.093	0.240	0.237	1.308	0.259
Earth Pressure	1.241	2.009	0.500	0.167	0.621	0.336
Total	6.704	3.102			1.929	0.594

Loading conditions (Water Level)	No (kN)	Ho (kN)	Mo (kNm)
Normal (Water Level 1)	7.086	2.178	1.756
Seismic (Water Level 2)	6.704	3.102	1.334

(2) Aggregate Force at Body center

Vertical Force : Nc = No (kN)
Horizontal Force : Hc = Ho (kN)
Rotational Moment: Mc = No Bj/2.0 - Mo (kNm) where:
Body Width in the Direction of Earth Pressure: Bj = 0.550 (m)

■ Per Unit Width

Loading conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kNm)
Normal (Water Level 1)	7.086	2.178	0.193
Seismic (Water Level 2)	6.704	3.102	0.509

■ Per Full Width (5.000 m)

Loading conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kNm)
Normal (Water Level 1)	35.428	10.890	0.963
Seismic (Water Level 2)	33.518	15.508	2.546

2.5 Stability Calculation Results

2.5.1 Stability against Overturning

(1) Calculation of Resultant Acting Point and Eccentricity

$$d = \frac{\Sigma M_r - \Sigma M_t}{\Sigma V}$$

Here,

d: Distance from toe of base plate to action point of resultant force (m)
ΣMr: Resistance moment around toe of base plate (kNm)
ΣMt: Fall moment around toe of base plate (kNm)
ΣV: Total vertical load at bottom of base plate (kN)

$$e = B/2 - d$$

Here,

e: Eccentric distance (m) from the center of the Base Plate of the point of action of the resultant force
B: Base Plate width (m): B = 0.550

$$ea = B/n$$

Here,

ea: Allowable eccentric distance (m)
n: Safety factor

Loading conditions (Water Level)	ΣMr (kNm)	ΣMt (kNm)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal (Water Level 1)	2.120	0.364	7.086	0.248	0.027	<<	0.092
Seismic (Water Level 2)	1.929	0.594	6.704	0.199	0.076	<<	0.183

(2) Calculation of the Safety Factor

$$F = \left| \frac{Mr}{Mo} \right|$$

Here,

Mr: Moment of resistance
Mo: Moment of rotation

Loading Conditions (Water Level)	Mr. (kNm)	Mo (kNm)	Safety Factor		
			F = Mr/Mo		Tolerance
Normal (Water Level 1)	2.120	0.364	5.827	≧	1.500
Seismic (Water Level 2)	1.929	0.594	3.245	≧	1.200

2.5.2 Stability Against Sliding

$$Fs = \frac{\Sigma V \mu + C_B B}{\Sigma H}$$

Here,

ΣV: Total vertical load at Base Plate (kN)
ΣH: Total horizontal load on Base Plate (kN)
μ: Friction coefficient between bottom slab and Bearing capacity of foundation ground,, μ = 0.600
C_B: Cohesion between slab and bearing capacity of foundation ground (kN/m2) , CB = 0.000
B: Bottom slab width (m), B = 0.550

Loading Conditions (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Safety Factor Fs		Required Safety Factor Fsa
Normal (Water Level 1)	7.086	2.178	1.952	≧	1.500
Seismic (Water Level 2)	6.704	3.102	1.297	≧	1.200

2.5.3 Check of Bearing Capacity

1) When the resultant action point lies within the base plate width of 1/3 (middle third) at the center of the bottom plate

$$q_1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6e}{B}\right)$$

$$q_2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6e}{B}\right)$$

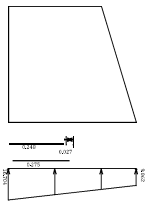
2) When the resultant point of action is within the bottom slab width of 2/3 in the center of the bottom plate.

$$q1 = \frac{2\Sigma V}{3(B/2 - e)}$$

Here,

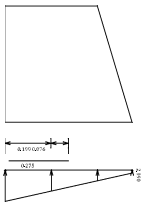
2V: Total vertical load acting on bottom face of slab (kN)
B: Bottom slab width (m) , B = 0.780
e: Eccentricity (m)

[1] Normal (Water Level 1)



Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction(kN/m2)		
		qmin	qmax	Tolerance
0.550	platformtype	9.062	16.704 ≦	200.000

[2] Seismic (Water Level 2)



Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction(kN/m2)		
		qmin	qmax	Tolerance
0.550	platform	2.090	22.287 ≦	300.000

1.2.2 GRAVITY WALL
1.2.2.4 TYPE C AND TYPE II, REPRESENTED BY L6+560

Table of Contents

1. Design Conditions 1
1.1 General Information 1
1.2 Applied Criteria 1
1.3 Format 1
1.4 Geometry 1
1.5 Ground conditions 1
1.6 Materials Used 2
1.7. Soil 3
1.8 Loads 3
1.9 Other loads 4
1.10 Uplift 4
1.11 Earth Pressure 4
1.12 Water Pressure 5
1.13 Load Combination Case 5
1.14 Foundation Conditions 6
1.14.1Data for calculating allowable shear resistance 6
1.15 Allowable Values for Stability Calculation and Allowable Stress of Members 6
1.15.1Tolerance for the stability calculation 6
2. Stability Calculation 7
2.1 Block Data Not Considering Water Level 7
2.2 Body Weight, Earth and Sand Weight, Other Loads, Vertical Force and Horizontal Force Due to Uplift 7
2.3 Earth Pressure and water pressure 8
2.4 Aggregation of Acting Forces 11
2.5 Stability Calculation Results 13
2.5.1 Stability Against Overturning 13
2.5.2 Stability Against Sliding 14
2.5.3 Check of Bearing Capacity 14

1. Design Conditions

1.1 General Information

Title: Gravity Wall (TYPE B REPRESENTED BY L6 + 560)

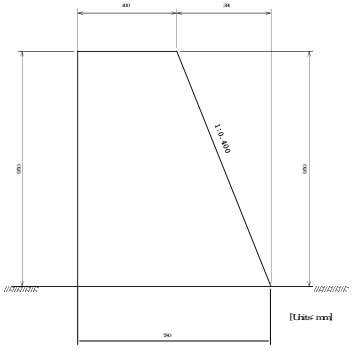
1.2 Applied Criteria

Japan Construction Technology Association, Civil Engineering Structure Standard Design Vol. 2, Manual (Retaining Wall) 2000

1.3 Format

'Gravity (direct foundation) '

1.4 Geometry



Width in the depth direction (block length) B=5000

1.5 Ground conditions

Seismic Scale: Medium

Geography: A

Ground type: Type II

Judgment of Ground Classification

$$TG = 4\Sigma \frac{Hi}{Vsi} = 0.353 \ (0.2 \leqq TG \leqq 0.6)$$

Here,

Here,

T_G: Ground property value (s)

Hi: Thickness of the ith stratum (m)

Vsi: Average shear elastic wave velocity of the i-th stratum (m/s)

Case of cohesive soil

Vsi = 100 Ni 1/3 (1 ≦ Ni ≦ 25)

In the case of sandy soil

Vsi = 80 Ni 1/3 (1 ≦ Ni ≦ 50)

Ni: Average N value of the i-th stratum by the standard penetration test

Vsi = 50 m/s when N value is 0, and Vsi = 50 m/s when Vsi < 50 m/s

i: Number of the i-th stratum from the ground surface when the ground is divided into n layers from the ground surface to the seismic design foundation surface

Geological Number	Layer Type	Layer Thickness Hi (m)	Mean N-Value	Vsi (m/s)
1	sandy soil	5.500	12.0	183.154
2	sandy soil	2.370	5.0	136.798
3	cohesive soil	3.630	8.0	200.000
4	sandy soil	2.000	33.0	256.603
5	cohesive soil	4.000	19.0	266.840
6	cohesive soil	10.000	50.0	292.402

1.6 Materials Used

[concrete] Vertical Wall (plain concrete) : σck = 18 (N/mm2)

【 Soil 】 Quality] Back Soily soil

Backfill: sandy soil

Zodiac:: gravel

[internal friction angle] Back Soil: 30.00 (degrees)

[unit weight]

(kN/m3)

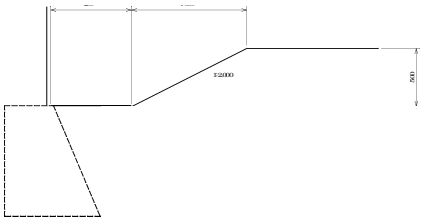
Body	Plain Concrete	23.000	
Water	For Calculation of	10.000	
Soil		Wet Weight	Saturated
Back surface		18.000	19.000
Front surface		18.000	19.000

[Design horizontal seismic coefficient] Body: Kh = 0.20

Soil (Front) : Kh = 0.20 (Back) : Kh = 0.20

1.7. Soil

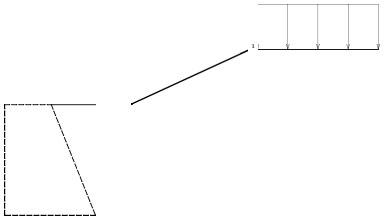
(1) Backside Soil Shape



Level difference between retaining wall crown and backside ground (m)		0.000
Slope		2.000
Embankment height	(m)	0.500
Horizontal length	(m)	0.700
Height without considering Earth Pressure Hr	(m)	0.000

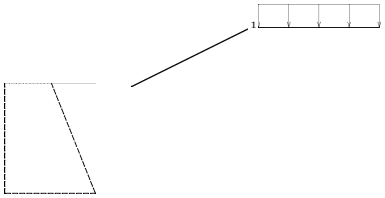
1.8 Load

[1] Normal



No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	Vertical Wall	Bottom Plate
1	1.800	4.000	10.000	10.000	○	-	-

[2] Seismic



No.	Loading Position (m)	Loading Width (m)	Load (kN/m2)		Items to Consider		
			Start Point	End Point	Stability	Vertical wall	Bottom Plate
1	1.800	4.000	5.000	5.000	○	-	-

1.9 Other loads

Not considered

1.10 Uplift

- Consider the Uplift equivalent as the uplift pressure

1.11 Earth Pressure

- Earth Pressure formulas: trial wedges
- Angle of wall friction of Earth Pressure acting surface (degrees)

Load Condition	Active Earth Pressure		Passive Earth Pressure
	at the Stability Calculation	Cut	
Normal Earth Pressure	20.000		Normal Earth Pressure
Seismic Earth Pressure	15.000		Seismic Earth Pressure

- The imaginary back surface of Earth Pressure for stability calculation is the back of the vertical wall.
- Angle between the surface at which earth pressure acts and the vertical plane at the time of stability calculation: 21.801 (degrees)
- The design horizontal seismic intensity is applied to the inertia force at the time of earthquake when calculating the earth pressure below the water Level.
- Raised embankment height ratio = 1.0 when the embankment height is 15.000 (m) .

- Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal	1.000	0.000	
Seismic	1.000	0.000	

- Treatment of Earth Pressure different from direction of Seismic motion

	Consider as	Availability Factor
Stability Calculation	Normal Earth Pressure	0.500
Vertical Wall Design		0.500

1.12 Water Pressure

- Concept of Hydrostatic Pressure Calculation

Load Condition	Back Surface	Front Surface
Normal	Consider	Consider
Seismic	Consider	Consider

- Hydrostatic pressure different from the direction of seismic motion

External Water Level	Stability Calculation	Consider
	Vertical Wall Design	Consider

1.13 Load Combination Case

No	Load Name	Comments
1	Normal	Normal
2	Seismic	Seismic

	Load Name	1	2
Soil	Soil 1	○	
	Soil 2		○
Water Level	Water Level 1	○	
	Water Level 2		○
Load	Load 1	○	
	Load 2		○
Active Earth Pressure	Not considered		
	Normal Earth Pressure	○	
	Seismic Earth Pressure		○
Passive Earth Pressure	Passive Earth Pressure 1		

1.14 Conditions of Foundation

1.14.1 Data for calculating allowable shear resistance

Bottom Plate width used for checking	Effective Loading Width
Cohesive force CB between base bottom surface and ground (kN/m2)	0.000
Friction coefficient between base and ground tan φB	0.600

1.15 Allowable Values for Stability Calculation and Allowable Stress of Members

1.15.1Tolerance for the stability calculation

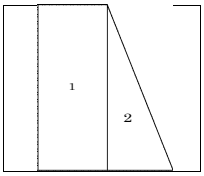
Load Condition	Allowable Eccentricity eB/B(m)	Safety Factor Against Overturning	Safety Factor Against Sliding	Allowable Bearing Capacity
Normal	1/6	1.500	1.500	200.000
Seismic	1/3	1.200	1.200	300.000

2. Stability Calculation

2.1 Block Data Not Considering Water Level

(1) Body weight

1) Block Division



2) Weight and Center of Gravity

Division	Width x Height x Depth Equation	Volume Vi (m3)	Center of Gravity (m) Xi	Yi	Vi Xi	Vi Yi	Remarks
1	0.400 x 0.950 x 1.000	0.380	0.200	0.475	0.076	0.180	
2	1/2 x 0.380 x 0.950 x 1.000	0.181	0.527	0.317	0.095	0.057	
2		0.561			0.171	0.238	

Centroid location XG = 2 (Vi Xi) /2Vi = 0.171/0.561 = 0.305 (m)

YG = 2 (Vi Yi) /2Vi = 0.238/0.561 = 0.424 (m)

2.2 Body weight, earth and sand weight, other loads, Vertical Force and Horizontal Force due to Uplift

(1) Acting force due to dead weight

[1] Normal

Location	W = γ	Vertical Force ·V (kN)		Acting Position X (m)
Body	23.000 x	0.561 =	12.892	0.305

[2] Seismic

Location	W = γ	Vertical Force ·V (kN)		Acting Position X (m)
Body	23.000 x	0.561 =	12.892	0.305

Location	W = γ	Vertical Force ·V (kN)		Acting Position X (m)
Body	12.892 x	0.20 =	2.578	0.424

(2) Dead-Weight

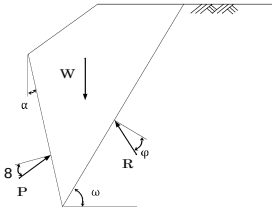
[1] Normal (Water Level 1)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position Xi	Yi	Moment (kNm) Ni Xi	Hi Yi
Body	12.892	0.000	0.305	0.000	3.935	0.000
Total	12.892	0.000			3.935	0.000

[2] Seismic (Water Level 2)

	Weight Ni (kN)	Horizontal Force Hi (kN)	Acting Position Xi	Yi	Moment (kNm) Ni Xi	Hi Yi
Body	12.892	2.578	0.305	0.424	3.935	1.093
Total	12.892	2.578			3.935	1.093

2.3. Earth Pressure and Water Pressure



[1] Normal (Water Level 1)

The Earth Pressure is determined by the trial wedge method considering the cohesive force.

Imaginary Backside Position (distance from toe) xp = 0.780 m

yp = 0.000 m

Imaginary Backside Height H = 0.950 m

Angle between the Surface at which the Earth Pressure Acts and the Vertical Surface α = 21.801 °

Unit Volume Weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle δ = 2/3 φ = 20.000 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil Weight (W) against Slip Angle (ω) , soil pressure (P) , Water Level hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN) Above Water Level	Below Water Level	Surcharge	Total	Earth Pressure P (kN)
65.00	7.125	0.000	0.000	7.125	3.124
66.00	6.927	0.000	0.000	6.927	3.125

Soil Weight (W) against Slip Angle (ω) , soil pressure (P) , Water Level hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN) Above Water Level	Below Water Level	Surcharge	Total	Earth Pressure P (kN)
67.00	6.736	0.000	0.000	6.736	3.122

The maximum soil pressure is determined by the following equation:

P = 3.125 kN at ω = 66.00 °

is true.

Cohesion of the sliding surface

Co = c · L = 1.000 x 1.112 = 1.112 kN

Earth Pressure

$$P = \frac{W \sin(\omega-\varphi) \cdot \text{Co} \cos\varphi}{\cos(\omega-\varphi-\alpha-\delta)}$$

$$= \frac{6.927 \times \sin(66.00° - 30.00°) \cdot 1.112 \times \cos 30.00°}{\cos(66.00° - 30.00° - 21.801° - 20.000°)} = 3.125 \text{ kN}$$

The horizontal component, vertical component, and working location of soil pressure at this time are as follows.

horizontal component

Ph = P · cos (α + δ) = 3.125 × cos (21.801° + 20.000°) =2.330 kN

Vertical component

Pv = P · sin (α + δ) = 3.125 × sin (21.801° + 20.000°) =2.083 kN

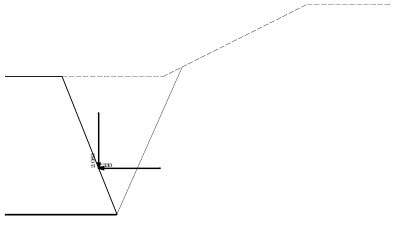
Acting position

$$Ho = \frac{H}{3} = \frac{0.950}{3} = 0.317 \text{ m}$$

x = xp-Ho · tan α = 0.780 -0.317 × tan 21.801 ° = 0.653 m

y = yp + Ho = 0.000 + 0.317 = 0.317 m

- Earth Pressure Diagram



[2] Seismic (Water Level 2)

The earth pressure is obtained by the trial wedge method considering inertia force and Cohesion force at the earthquake.

Imaginary Backside Position (distance from toe) xp = 0.780 m

yp = 0.000 m

Imaginary Backside Height H = 0.950 m

Angle between the Surface at which the Earth Pressure Acts and the Vertical Surface α = 21.801 °

Unit volume weight of Backside Soil γs = 18.000 kN/m3

Internal Friction Angle of Backside Soil φ = 30.000 °

Wall Friction Angle 6 = 1/2 φ = 15.000 °

Seismic Composite Angle θ = tan -1 kh = tan -10.20 = 11.310 °

Range of Slip Angle ωi = 10.00 ° to 80.00 °

Soil weight (W) and soil pressure (P) Water Level with respect to Slip Angle (ω) hw = 0.000 m

Slip Angle ω (°)	Soil Weight W (kN) Above Water Level	Below Water Level	Surcharge	Total	Earth Pressure P (kN)
36.00	21.913	0.000	2.879	24.792	6.271
37.00	20.980	0.000	2.521	23.501	6.272
38.00	20.089	0.000	2.180	22.269	6.242

The maximum soil pressure is determined by the following equation:

P = 6.272 kN at ω = 37.00 °

Cohesion of the sliding surface

Co = c · L = 1.000 x 2.409 = 2.409 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega-\varphi+\theta) - \text{Co} \cos\varphi}{\cos(\omega-\varphi-\alpha-\delta)}$$

$$= \frac{23.501/\cos 11.310° \times \sin(37.00° - 30.00° + 11.310°) - 2.409 \times \cos 30.00°}{\cos(37.00° - 30.00° - 21.801° - 15.000°)}$$

= 6.272 kN

The horizontal component, vertical component, and working location of soil pressure at this time are as follows.

horizontal component

Ph = P · cos (α + δ) = 6.272 × cos (21.801° + 15.000°) =5.022 kN

Vertical component

Pv = P · sin (α + δ) = 6.272 × sin (21.801° + 15.000°) =3.757 kN

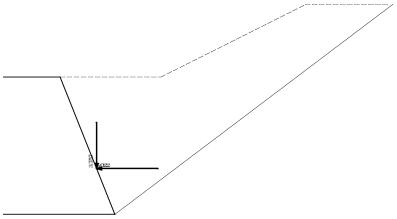
Acting position

$$Ho = \frac{H}{3} = \frac{0.950}{3} = 0.317 \text{ m}$$

x = xp-Ho · tan α = 0.780 -0.317 × tan 21.801 ° = 0.653 m

y = yp + Ho = 0.000 + 0.317 = 0.317 m

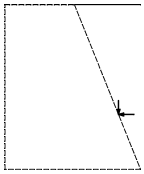
- Earth Pressure Diagram



2.4 Aggregation of Acting Forces

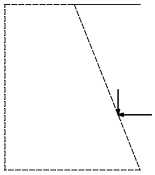
(1) Aggregate Force on front of Body

[1] Normal (Water Level 1)



Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length Xi (m)	Arm Length Yi (m)	Rotational Moment (kNm) Mxi = Ni,	Rotational Moment (kNm) Myi = Hi Yi
Dead Weight	12.892	0.000	0.305	0.000	3.935	0.000
Earth Pressure	2.083	2.330	0.653	0.317	1.360	0.739
Total	14.975	2.330			5.295	0.739

[2] Seismic (Water Level 2)



Item	Vertical Force Ni (kN)	Horizontal Force Hi (kN)	Arm Length Xi (m)	Arm Length Yi (m)	Rotational Moment (kNm) Mxi = Ni, Xi	Rotational Moment (kNm) Myi = Hi Yi
Dead Weight	12.892	2.578	0.305	0.424	3.935	1.093
Earth Pressure	3.757	5.022	0.653	0.317	2.453	1.592
Total	16.649	7.600			6.388	2.685

Loading Conditions (Water Level)	No (kN)	Ho (kN)	Mo(kN.m.)
Normal (Water Level 1)	14.975	2.330	4.556
Seismic (Water Level 2)	16.649	7.600	3.703

(2) Aggregate Force at Body center

Vertical Force : Nc = No (kN)

Horizontal Force : Hc = Ho (kN)

Rotational Moment: Mc = No · Bj/2.0 - Mo (kN.m.) where:

Body Width in the Direction of Earth Pressure: Bj = 0.780 (m)

■ Per Unit Width

Loading Conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal (Water Level 1)	14.975	2.330	1.284
Seismic (Water Level 2)	16.649	7.600	2.790

■ Per Full Width (5.000 m)

Loading Conditions (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal (Water Level 1)	74.873	11.650	6.419
Seismic (Water Level 2)	83.243	38.001	13.951

2.5 Stability Calculation Results

2.5.1 Stability against Overturning

(1) Calculation of Resultant Acting Point and Eccentricity

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,

d: Distance from toe of base plate to action point of resultant force (m)

ΣMr: Resistance moment around toe of base plate (kNm)

ΣMt: Fall moment around toe of base plate (kNm)

ΣV: Total vertical load at bottom of base plate (kN)

$$e = B/2 - d$$

Here,

e: Eccentric distance (m) from the center of the Base Plate of the point of action of the resultant force

B: Base Plate width (m) , B = 0.780

$$ea = B/n$$

Here,

ea: Allowable eccentric distance (m)

n: Safety factor

Loading conditions (Water Level)	ΣMr (kNm)	ΣMt (kNm)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal (Water Level 1)	5.295	0.739	14.975	0.304	0.086	≦	0.130
Seismic (Water Level 2)	6.388	2.685	16.649	0.222	0.168	≦	0.260

(2) Calculation of the Safety Factor

$$F = \left| \frac{Mr}{Mo} \right|$$

Here,

Mr: Moment of resistance

Mo: Moment of rotation

Loading Conditions (Water Level)	Mr. (kNm)	Mo (kNm)	Safety Factor F = Mr/Mo		Tolerance
Normal (Water Level 1)	5.295	0.739	7.169	≧	1.500
Seismic (Water Level 2)	6.388	2.685	2.379	≧	1.200

2.5.2 Stability Against Sliding

$$Fs = \frac{\Sigma V \cdot \mu + CB \cdot B}{\Sigma H}$$

Here,

ΣV: Total vertical load at Base Plate (kN)

ΣH: Total horizontal load on Base Plate (kN)

μ: Friction coefficient between bottom slab and Bearing capacity of foundation ground,, μ = 0.600

C_B: Cohesion between slab and bearing capacity of foundation ground (kN/m2) , CB = 0.000

B: Bottom slab width (m) , B = 0.780

Loading Conditions (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Safety Factor Fs		Required Safety Factor Fsa
Normal (Water Level 1)	14.975	2.330	3.856	≧	1.500
Seismic (Water Level 2)	16.649	7.600	1.314	≧	1.200

2.5.3 Check of Bearing Capacity

1) When the resultant action point lies within the base plate width of 1/3 (middle third) at the center of the bottom plate

$$q_1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6e}{B}\right)$$

$$q_2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6e}{B}\right)$$

2) When the resultant point of action is within the bottom slab width of 2/3 in the center of the bottom plate.

$$q1 = \frac{2\Sigma V}{3\,(B/2 - e)}$$

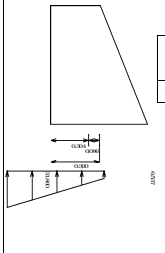
Here,

2V: Total vertical load acting on bottom face of slab (kN)

B: Bottom slab width (m) , B = 0.780

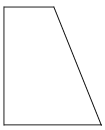
e: Eccentricity (m)

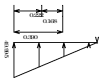
[1] Normal (Water Level 1)



Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction(kN/m2) qmin	qmax		Tolerance
0.780	Trapezoid	6.537	31.860	≦	200.000

[2] Seismic (Water Level 2)





Width of Subgrade Reaction (m) x and B	Shape of Subgrade Reaction	Subgrade Reaction(kN/m2)		
		qmin	qmax	Tolerance
0.666	Triangle	0.000	49.995 ≦	300.000

1.2.3 Inclined Wall

There are two types of shapes as inclined wall in this project. The wall whose heights, Hw is lower than 3.0 m is Type A, and the wall whose heights, Hw, is higher than 3.0 m is Type B.

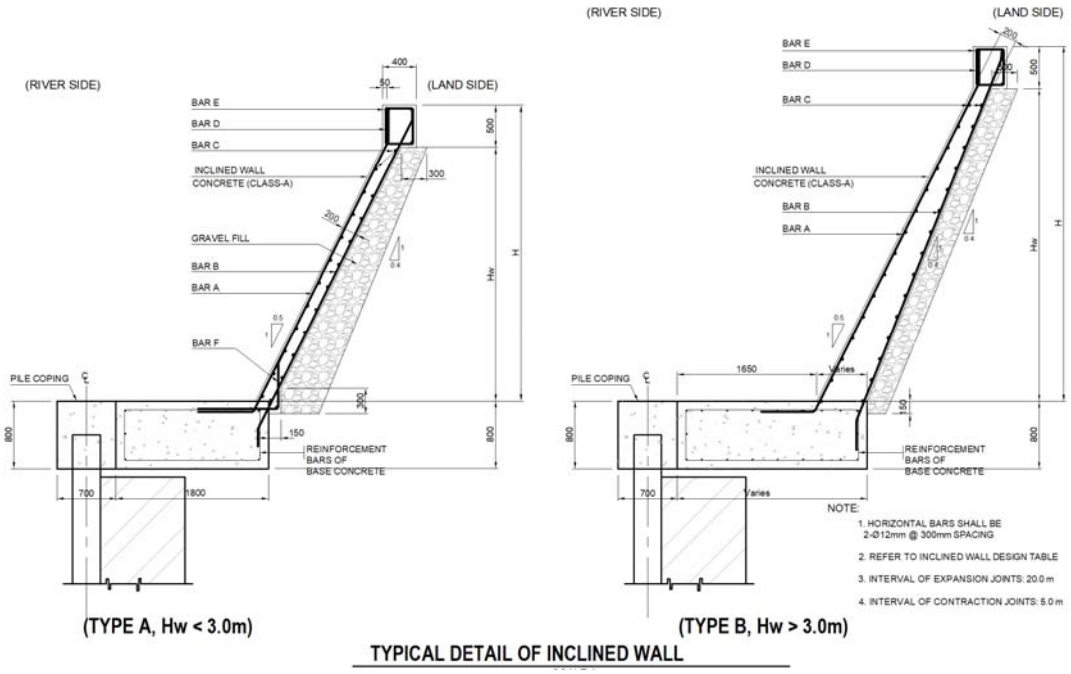


Figure Typical Detail of Inclined Wall

The structural calculation was conducted every 50cm from Hw=3.0 m to Hw=7.0 m.

In this design, inclined walls are installed in the revetment on the river channel side above SSP revetment. The toe portion of the inclined wall and the top coping of the revetment for low water channel are connected by dowel bars.

The stability of the inclined wall is usually evaluated by sliding, overturning, and bearing resistance. However, in this design, since the inclined wall is connected to the SSP revetment, and the vertical force is transmitted to SSP, bearing resistance isn't evaluated.

Also, when the inclined wall does not satisfy with the requirement of sliding and overturning, the shortage of horizontal force and moment is added to the structural calculation of the steel sheet pile.

The summary of the result is shown below.

Table　Summary of the Structure Calculation for Inclined Wall (Stability)

Wall Height (m)	Condition	Over-Turning									Slide					
		Base Length (m)	Resistaince Moment at ToeΣMr (kN・m)	Over-Turning Moment at ToeΣMt (kN・m)	Vertical LoadΣV (kN)	Distance from toe to the working point of resultant force d (m)	Eccentric Distance (m)	Acceptable Eccentric Distance (m)	Judge※	Moment of Acting to SSP (KN*m)	Vertical Load ΣV (kN)	Horozontal Load ΣH (kN)	Safety Factor	Required Safety Factor	Judge※	Forth of Acting to SSP (KN)
3.0m	Steady	1.8	83.383	44.730	52.632	0.734	0.166	0.3	OK	0	52.632	31.214	0.843	1.5	NG	13.7
	Earthquake	1.8	83.383	85.061	52.632	-0.032	0.932	0.6	NG	17.5	52.632	60.613	0.434	1.2	NG	38.7
3.5m	Steady	2.223	142.439	68.150	75.856	0.979	0.133	0.37	OK	0	75.856	42.594	0.890	1.5	NG	17.4
	Earthquake	2.223	142.439	128.329	75.856	0.186	0.926	0.741	NG	14.0	75.856	81.831	0.463	1.2	NG	50.3
4.0m	Steady	2.273	167.356	90.416	83.484	0.922	0.215	0.379	OK	0	83.484	51.169	0.816	1.5	NG	23.4
	Earthquake	2.273	167.356	169.597	83.484	-0.027	1.164	0.758	NG	33.9	83.484	97.546	0.428	1.2	NG	62.8
4.5m	Steady	2.323	195.363	116.991	91.674	0.855	0.307	0.387	OK	0	91.674	60.523	0.757	1.5	NG	30.0
	Earthquake	2.323	195.363	218.298	91.674	-0.250	1.412	0.774	NG	58.5	91.674	114.406	0.401	1.2	NG	76.3
5.0m	Steady	2.373	226.618	148.319	100.426	0.780	0.407	0.395	NG	1.2	100.426	70.628	0.711	1.5	NG	37.2
	Earthquake	2.373	226.618	274.713	100.426	-0.479	1.666	0.791	NG	87.9	100.426	132.189	0.380	1.2	NG	90.4
5.5m	Steady	2.423	261.259	184.470	109.742	0.700	0.512	0.404	NG	11.9	109.742	81.372	0.674	1.5	NG	44.8
	Earthquake	2.423	261.259	339.833	109.742	-0.716	1.928	0.808	NG	122.9	109.742	151.164	0.363	1.2	NG	105.5
6.0m	Steady	2.473	299.511	225.595	119.619	0.618	0.619	0.412	NG	24.8	119.619	92.723	0.645	1.5	NG	52.9
	Earthquake	2.473	299.511	413.655	119.619	-0.954	2.191	0.824	NG	163.5	119.619	171.145	0.349	1.2	NG	121.4
6.5m	Steady	2.523	341.517	271.326	130.059	0.540	0.722	0.421	NG	39.2	130.059	104.356	0.623	1.5	NG	61.1
	Earthquake	2.523	341.517	521.717	130.059	-1.386	2.648	0.841	NG	234.9	130.059	201.654	0.322	1.2	NG	147.5
7.0m	Steady	2.573	387.398	322.795	141.062	0.458	0.829	0.429	NG	56.4	141.062	116.659	0.605	1.5	NG	69.7
	Earthquake	2.573	387.398	625.821	141.062	-1.690	2.977	0.858	NG	298.9	141.062	227.027	0.311	1.2	NG	168.3
6.5m (Long Bottom Concrete)	Steady	4.323	589.905	268.291	158.803	2.025	0.137	0.72	OK	0	158.803	103.189	0.769	1.5	NG	50.3
	Earthquake	4.323	589.905	518.814	158.803	0.448	1.714	1.441	NG	43.4	158.803	206.124	0.385	1.2	NG	140.0
7.0m (Long Bottom Concrete)	Steady	4.423	669.223	322.795	172.235	2.011	0.201	0.737	OK	0	172.235	116.659	0.738	1.5	NG	59.3
	Earthquake	4.423	669.223	627.153	172.235	0.244	1.968	1.474	NG	85.0	172.235	233.262	0.369	1.2	NG	161.5
3.5m (Short Bottom Concrete, Aroud Sta.7+200)	Steady	0.7	37.223	40.470	33.278	-0.098	0.448	0.117	NG	11.1	33.278	28.866	0.576	1.5	NG	17.8
	Earthquake	0.7	37.223	77.646	33.278	-1.215	1.565	0.233	NG	44.4	33.278	53.509	0.311	1.2	NG	39.7

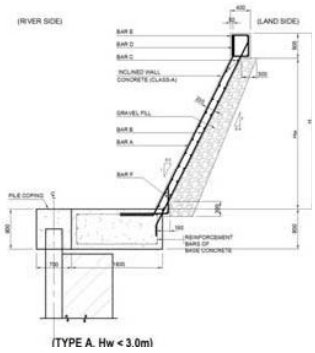
Table　Summary of the Structure Calculation for Inclined Wall (Stress Calculation)

Wall Height (m)	Condition	Stress Calculation																			
		Wall									Base Concrete										
		Compressive Stress			Tensile Stress				Shear Stress Intensity			Compressive Stress			Tensile Stress				Shear Stress Intensity		
		Compressive Stress (N/mm2)	Affordable Compressive Stress (N/mm2)	Judge	Diameter of Rabor	Tensile Stress (N/mm2)	Affordable Tensile Stress (N/mm2)	Judge	Shear Stress Intensity (N/mm2)	Affordable Shear Stress Intensity (N/mm2)	Judge	Compressive Stress (N/mm2)	Affordable Compressive Stress (N/mm2)	Judge	Diameter of Rabor	Tensile Stress (N/mm2)	Affordable Tensile Stress (N/mm2)	Judge	Shear Stress Intensity (N/mm2)	Affordable Shear Stress Intensity (N/mm2)	Judge
3.0m	Steady	0.447	8.200	OK	D20	22.606	140.000	OK	0.029	0.360	OK	0.447	8.200	OK	D16	22.606	140.000	OK	0.029	0.360	OK
	Earthquake	0.460	10.906	OK		23.229	186.200	OK	0.042	0.479	OK	0.460	10.906	OK		23.229	186.200	OK	0.042	0.479	OK
3.5m	Steady	0.327	8.200	OK	D20	10.207	140.000	OK	0.063	0.360	OK	0.569	8.200	OK	D16	28.743	140.000	OK	0.045	0.360	OK
	Earthquake	1.434	10.906	OK		44.747	186.200	OK	0.111	0.479	OK	1.624	10.906	OK		82.077	186.200	OK	0.065	0.479	OK
4.0m	Steady	0.457	8.200	OK	D20	15.117	140.000	OK	0.071	0.360	OK	0.753	8.200	OK	D16	38.044	140.000	OK	0.057	0.360	OK
	Earthquake	1.784	10.906	OK		59.030	186.200	OK	0.126	0.479	OK	0.460	10.906	OK		23.229	186.200	OK	0.042	0.479	OK
4.5m	Steady	0.591	8.200	OK	D20	20.613	140.000	OK	0.079	0.360	OK	0.968	8.200	OK	D16	48.932	140.000	OK	0.071	0.360	OK
	Earthquake	2.147	10.906	OK		74.893	186.200	OK	0.141	0.479	OK	0.460	10.906	OK		23.229	186.200	OK	0.042	0.479	OK
5.0m	Steady	0.731	8.200	OK	D20	26.784	140.000	OK	0.086	0.360	OK	1.224	8.200	OK	D16	62.255	140.000	OK	0.087	0.360	OK
	Earthquake	2.513	10.906	OK		92.039	186.200	OK	0.155	0.479	OK	0.462	10.906	OK		23.503	186.200	OK	0.042	0.479	OK
5.5m	Steady	0.753	8.200	OK	D25	22.140	140.000	OK	0.094	0.360	OK	1.511	8.200	OK	D16	76.355	140.000	OK	0.106	0.360	OK
	Earthquake	2.462	10.906	OK		72.346	186.200	OK	0.169	0.479	OK	0.460	10.906	OK		23.229	186.200	OK	0.042	0.479	OK
6.0m	Steady	0.884	8.200	OK	D25	27.110	140.000	OK	0.102	0.360	OK	1.859	8.200	OK	D16	93.932	140.000	OK	0.125	0.360	OK
	Earthquake	2.776	10.906	OK		85.148	186.200	OK	0.182	0.479	OK	0.460	10.906	OK		23.229	186.200	OK	0.042	0.479	OK
6.5m	Steady	1.014	8.200	OK	D25	32.331	140.000	OK	0.110	0.360	OK	2.249	8.200	OK	D16	113.675	140.000	OK	0.141	0.360	OK
	Earthquake	3.239	10.906	OK		103.333	186.200	OK	0.202	0.479	OK	0.460	10.906	OK		23.229	186.200	OK	0.042	0.479	OK
7.0m	Steady	1.144	8.200	OK	D25	37.864	140.000	OK	0.117	0.360	OK	2.266	8.200	OK	D20	88.725	140.000	OK	0.157	0.360	OK
	Earthquake	3.629	10.906	OK		120.072	186.200	OK	0.218	0.479	OK	0.386	10.906	OK		15.130	186.200	OK	0.042	0.479	OK
6.5m (Long Bottom Concrete)	Steady	1.144	8.200	OK	D25	35.082	140.000	OK	0.116	0.360	OK	1.802	8.200	OK	D25	54.179	140.000	OK	0.099	0.360	OK
	Earthquake	3.608	10.906	OK		110.679	186.200	OK	0.214	0.479	OK	5.024	10.906	OK		151.035	186.200	OK	0.135	0.479	OK
7.0m (Long Bottom Concrete)	Steady	1.242	8.200	OK	D25	40.286	140.000	OK	0.121	0.360	OK	2.161	8.200	OK	D25	64.956	140.000	OK	0.115	0.360	OK
	Earthquake	3.852	10.906	OK		124.952	186.200	OK	0.224	0.479	OK	6.085	10.906	OK		182.931	186.200	OK	0.153	0.479	OK
3.5m (Short Bottom Concrete, Aroud Sta.7+200)	Steady	1.095	8.200	OK	D20	13.495	140.000	OK	0.146	0.360	OK	0.026	8.200	OK	D16	0.026	140.000	OK	0.012	0.360	OK
	Earthquake	8.058	10.906	OK		99.332	186.200	OK	0.260	0.479	OK	0.026	10.906	OK		0.026	186.200	OK	0.012	0.479	OK
Canita H=2.4m	Steady	0.582	8.200	OK		29.167	140.000	OK	0.045	0.360	OK	0.659	8.200	OK		53.613	140.000	OK	0.030	0.360	OK
	Earthquake	1.662	10.906	OK		83.288	186.200	OK	0.066	0.479	OK	0.677	10.906	OK		55.090	186.200	OK	0.042	0.479	OK

The calculation sheets of Hw =3.0, the maximum height of Type A, and Hw =7.0, the maximum height of Type B, are shown in the following pages. The calculation of the other cases was conducted with the same procedures for those cases.

Type A

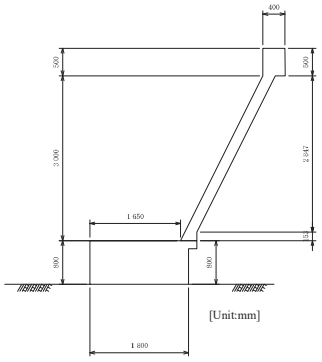
Hw :3.0m



(TYPE A. Hw < 3.0m)

1 Design Conditions

1.1 Geometry



Depth Width (Block Length) B = 5000 (mm)

1.2 Materials

[Concrete] Vertical wall (reinforced concrete) : σck = 20.7 (N/mm2)
Base concrete (reinforced concrete) : σck = 20.7 (N/mm2)

[Iron bar] Type: : Grade 275

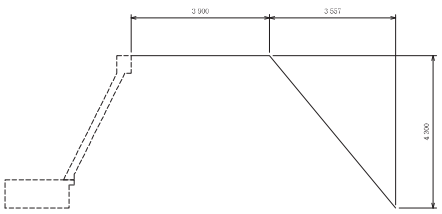
[Soil] Backfill : sand and gravel
Foudation : sandy gravel

[Internal Fdiction] Backfill : 30 degrees

[Unit weight]
(kN/m3)

Body	Base Concrete	22.500	
	Vertical wall	22.500	
Water		9.800	
Soil		Wet weight	Saturated weight
River side		19.000	19.000
Land side		20.000	20.800

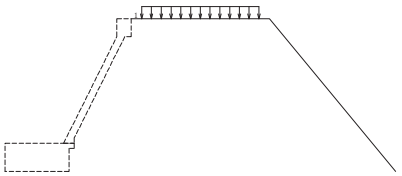
1.3 Backfill and Embankment



Level Difference Between Retaining Wall Crown And Ground Surface Start Point	(m)	0.000
Height Without Considering Earth Pressure Hr (in stability analysis) Hr	(m)	0.000

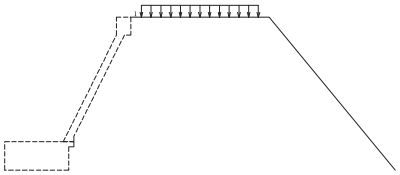
1.4 Loads

(1) Normal



Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			From	End Side	Stability Analysis	Vertical Wall	Bottom Slab
1	0.300	3.300	10.000	10.000	○	○	×

(2) Seismic



Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			From	End Side	Stability Analysis	Vertical Wall	Bottom Slab
1	0.300	3.300	5.000	5.000	○	○	×

1.5 Buoyancy

・Use the Water Level in Rear Side

1.6 Earth Pressure

・Earth Pressure Formulas: Trial Wedge

・Angle of Friction of Earth Pressure Acting Surface (Degrees)

Load Condition	Active Earth Pressure			Passive Earth Pressure
	In Case of Stability Analysis	In Case of Vertical Wall Design	Cut	
Normal Earth Pressure	23.333	23.33	——	——
Seismic Earth Pressure	17.500	17.500	——	——

・ The virtual rear surface of earth pressure in the stability analysis is at the heel end (a line extended vertically from the heel)

・ Angle between the earth pressure acting surface and the vertical plane in stability analysis
24.570 (degrees)

・ Angle between the earth pressure working surface and the vertical plane when designing the vertical wall
24.567 (degrees)

・The Design Horizontal Seismic Coefficient is applied to the inertia force during earthquakes when calculating the earth pressure below the water level.

・Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal Condition	0.000	0.000	——
Seismic Condition	0.000	0.000	——

・Consideration of Earth Pressure Different from Direction of Earthquake Motion

	Consideration I...	Effectivity
Stability Analysis	Seismic Earth Pressure	0.500
Vertical Wall Design		0.500

1.7 Load Combination Case

No	Load Name	Comments
1	Normal	Normal Condition
2	Seismic	Seismic Seismic condition

	Load Name	1	2
Soil	Front Soil 1	○	○
Load	Load 1	○	
	Load 2		○
Active Earth Pressure	Not Considered		
	Normal Earth Pressure	○	
	Seismic Earth Pressure		○

1.8 Foundation Conditions

Bottom Slab Width Used for Analysis	All	Width
Cohesion Between Foundation Bottom Surface And Ground C_B (kN/m2)	0.000	
Friction Coefficient Between Foundation Bottom Surface and Ground tan φ_B	0.500	

1.9 Allowable Values For Stability Analysis And Allowable Stresses of Members

1.9.1 Allowance in Stability Analysis

Load Condition	Allowable Eccentricity e_B/B (m)	Safety Factor for Overturning	Allowable Subgrade Reaction Intensity (kN/m2)
Normal	1/6	1.500	100.000
Seismic	1/3	1.200	100.000

Here,

B : Foundation Width (m)

e_B: load eccentricity (m), where $e_B = M_B/V$

M_B: moment acting on base (kNm)

V : vertical load acting on base (kN)

1.9.2 Allowable Stress of the Member

(1)Reinforced Concrete Member

1) Vertical Wall (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic	1.33	10.906	186.200	0.479	0.479

2) Bottom Slab (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic	1.33	10.906	186.200	0.479	0.479

Here,

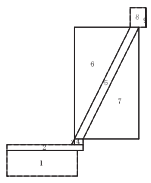
τa1: Shear Stress When Shear Force is Applied Only by Concrete

τa2: Shear Stress when Jointly Bearing with Oblique Tensile Reinforcement

2 Stability Analysis

2.1 Block Data

(1) Body Weight



2)Weight and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1							
2	x 0.652 x 1.000 x 22.500 x 1.800	26.406	0.900	0.326	23.765	8.608	bottom plate
3	x 0.148 x 1.000 x 22.500 x 1.950	6.494	0.975	0.726	6.331	4.714	bottom plate
4	1/2 x 0.076 x 0.153 x x 1.000 x 22.500	0.133	1.701	0.851	0.226	0.113	vertical wall
5	x 0.153 x 1.000 x 22.500 x 0.223	0.770	1.838	0.877	1.415	0.674	vertical wall
6	x 2.847 x 1.000 x 22.500 x 1.646	105.471	2.550	2.376	268.930	250.652	vertical wall
7	- 1/2 x 1.423 x 2.847 x 1.000 x 22.500	-45.594	2.201	2.851	-100.352	-129.989	vertical wall
8	- 1/2 x 1.423 x 2.847 x 1.000 x 22.500	-45.576	2.899	1.902	-132.111	-86.686	vertical wall
9	x 0.500 x 1.000 x 22.500 x 0.400	4.500	3.350	4.050	15.075	18.225	vertical wall
	1/2 x 0.005 x 0.500 x x 1.000 x 22.500	0.029	3.552	3.967	0.104	0.116	vertical wall
Σ		52.632	——	——	83.382	66.429	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 83.382/ 52.632 = 1.584 (m)

YG = Σ (Vi Yi)/ΣVi = 66.429/ 52.632 = 1.262 (m)

2.2 Body Weight, Weight of Soil, Arbitrary Load, Vertical Force by Buoyancy, Horizontal Force

(1) Working Force Due to Body Weight

1) Normal

2) Seismic

Position	Horizontal Load H = W kh (kN)			Acting Position Y (m)
Body(Reinforced)	52.632 ×	0.20	= 10.526	1.262

(2) Body Weight

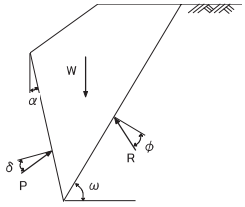
1) Normal

	Weight Ni (kN)	Horizontal force Hi (kN)	Position of action (m)		Moment (kNm)	
			Xi	Yi	Ni and Xi	Hi Yi
Body	52.632	0.000	1.584	0.000	83.383	0.000
Total	52.632	0.000	——	——	83.383	0.000

2) Seismic

	Weight Ni (kN)	Horizontal force Hi (kN)	Position of action (m)		Moment (kNm)	
			Xi	Yi	Ni and Xi	Hi Yi
Body	52.632	10.526	1.584	1.262	83.383	13.286
Total	52.632	10.526	——	——	83.383	13.286

2.3 Earth Pressure and Water Pressure



(1) Normal Condition

The earth pressure is obtained by the trial wedge method.

Position of Virtual Rear Surface (Distance from toe) xp = 1.584 m

yp = 0.000 m

Height of Virtual Rear Surface H = 4.3000 m

Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 24.570 °

Unit Weight of Soil γs = 19.000 kN/m3

Internal Friction Angle of Soil φ = 30.000 °

Angle between Ground Surface and Horizontal Plane β = 0.000 °

Wall Friction Angle δ = 23.333 °

Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °

Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)

Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
45.00	95.344	0.000	20.340	115.684	31.185

46.00	89.317	0.000	18.865	108.182	31.221

The maximum earth pressure is determined by the following equation:

when ω = 46.00 ° P = 31.221 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{108.182 \times \sin(46.00^\circ - 30.00^\circ)}{\cos(46.00^\circ - 30.00^\circ - -24.570^\circ - 23.333^\circ)}$$

= 31.221 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.

Horizontal Component

Ph = P · cos (α + δ) = 31.221 x cos (-24.570 ° + 23.333 °) = 31.214 kN

Vertical Component

Pv = P · sin (α + δ) = 31.221 x sin (-24.570 ° + 23.333 °) = -0.674 kN

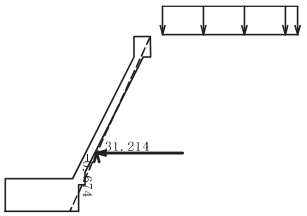
Acting Position

$$Ho = \frac{H}{3} = \frac{4.300}{3} = 1.433 \text{ m}$$

x = xp-Ho · tan α = 1.584 -1.433 × tan -24.570 ° = 2.239 m

y = yp + Ho = 0.000 + 1.433 = 1.433 m

・Earth Pressure Diagram



(2) Seismic Condition

The earth pressure is obtained by the trial wedge method considering the inertia force in the earthquake.

Position of Virtual Rear Surface (Distance from Toe) xp = 1.584 m

yp = 0.000 m

Height of Virtual Rear Surface H = 4.300 m

Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 24.570 °

Unit Weight of Soil γs = 19.000 kN/m3

Internal Friction Angle of Soil φ = 30.000 °

Wall Friction Angle δ = 17.5.000 °

Seismic Composite Angle

$$\theta = \tan^{-1}\frac{kh \cdot (WU + WL)}{WU + WL + Wq}$$

$$= \tan^{-1}\frac{0.20 \times (144.517 + 0.000)}{144.517 + 0.000 + 0.000}$$

= 11.310 °

Range of slip angle change ωi = 10.00 ° ~ 80.00 °

Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)

Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
37.00	152.791	0.000	0.000	152.791	50.465
38.00	144.517	0.000	0.000	144.517	50.471
39.00	136.605	0.000	0.000	136.605	50.321

The maximum earth pressure is determined by the following equation:

when ω = 38.00 ° P = 50.471 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega - \phi + \theta)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{144.517/\cos 11.310^\circ \times \sin(38.00^\circ - 30.00^\circ + 11.310^\circ)}{\cos(38.00^\circ - 30.00^\circ - -24.570^\circ - 17.500^\circ)}$$

= 50.471 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.

Horizontal Component

Ph = P, cos (α + δ) = 50.471 x cos (-24.570 ° + 17.500 °) = 50.087 kN

Vertical Component

Pv = P sin (α + δ) = 50.471 x sin (-24.570 ° + 17.500 °) = -6.212 kN

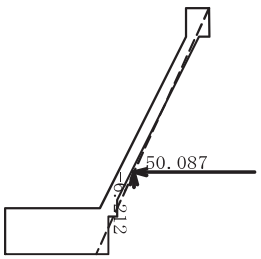
Acting Position

$$Ho = \frac{H}{3} = \frac{4.300}{3} = 1.433 \text{ m}$$

x = xp-Ho · tan α = 1.584 -1.433 × tan -24.570 ° = 2.239 m

y = yp + Ho = 0.000 + 1.433 = 1.433 m

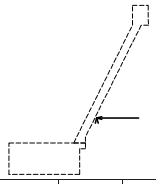
・Earth Pressure Diagram



2.4 Summary of Acting Forces

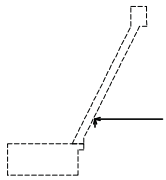
(1) Summary of forces acting on the footing front

1) Normal Condition



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	52.632	0.000	1.584	0.000	83.383	0.000
Earth Pressure	0.000	31.214	2.239	1.433	0.000	44.730
Total	52.632	31.214	——	——	83.383	44.730

2) Seismic Condition



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	52.632	10.526	1.584	1.262	83.383	13.286
Earth Pressure	0.000	50.087	2.239	1.433	0.000	71.775
Total	52.632	60.613	——	——	83.383	85.061

Load Condition (Water Level)	No (kN)	Ho (kN)	Mo (kN.m.)
Norma	52.632	31.214	38.653
Seismic	52.632	60.613	-1.678

(2)Summary of Forces Acting At the Footing Center

Vertical Force : Nc = No (kN)
Horizontal Force : Hc = Ho (kN)
Turning Moment : Mc = No Bj/2.0 - Mo (kN.m.)

Here,
Footing Width in Earth Pressure Direction : Bj = 1.800 (m)

■Per Unit Width

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Norma	52.632	31.214	8.716
Seismic	52.632	60.613	49.047

■Per full width (5.000 m)

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Norma	263.160	156.070	43.579
Seismic	263.160	303.067	245.234

2.5 Stability Analysis Results

2.5.1 Stability against Overturning

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,
d: Distance from the Toe of Bottom Slab to the Acting Point of Composited Force (m)
ΣMr: Resistive Moment of Toe of Bottom Slab (kN.m.)
ΣMt: Overturning Moment of Toe of Bottom Slab (kN.m.)
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)

$$e = \frac{B}{2} - d$$

Here,
e: Eccentricity from the Center of Bottom Slab to the Acting Point of Composited Force (m);
B: Bottom Slab Width (m), B = 1.800

ea = B/n

Here,
ea: Allowable Eccentricity (m)
n: Safety Factor

Load Condition	Σ Mr (kN.m.)	Σ Mt (kN.m.)	ΣV (kN)	d (m)	e (m)	Ea (m)
Normal	83.383	44.730	52.632	0.734	0.166<0.300	
Seismic	83.383	85.061	52.632	-0.032	0.932>0.600	

The inclined wall does not satisfy with the requirement. Therefore, it is assumed that the moment acts on the coping of SSP revetment, and the moment shortage (M_L) calculated from the following formula is added to the design of revetment for low water channel.

$e = \left|\frac{b}{2} - \frac{M+M_L}{N}\right| = \frac{b}{6}$, in Normal Condition

Above formula is converted to $M_L = \left|\frac{b}{6}\right| \times N - M$

$e = \left|\frac{b}{2} - \frac{M+M_L}{N}\right| = \frac{b}{3}$ in Seismic Condition

Above formula is converted to $M_L = \left|\frac{b}{6}\right| \times N - M$

Where,
M_L : Moment Shortage（=Moment acting on SSP revetment） (kN・m)

Load Condition	Base Length (m)	Resistaince Moment at Toe ΣMr (kN・m)	Over-Turning Moment at Toe ΣMt (kN・m)	Vertical Load ΣV (kN)	Acceptable Eccentric Distance (m)	Judge	Moment of Acting to SSP (KN*m)
Normal	1.8	83.383	44.730	52.632	0.3	OK	0
Seismic	1.8	83.383	85.061	52.632	0.6	NG	17.5

2.5.2 Stability Against Sliding

$$F_s = \frac{\Sigma V \cdot \mu + C_B \cdot B}{\Sigma H}$$

Here,
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
ΣH: Total Horizontal Load in Lower Side of Bottom Slab (kN)
μ: Cohesion Between Bottom Slab and Supporting Ground, μ = 0.500
C_B: Cohesion Between Bottom Slab And Supporting Ground (kN/m2), C_B = 0.000
B: Bottom Slab Width (m), B = 1.800

Load Condition (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Safety Factor Fs	Required Safety Factor Fsa
NormalCondition	52.632	31.214	0.843<1.500	
SeismicCondition	52.632	60.613	0.434<1.200	

The inclined wall does not satisfy the minimum safety factor. Therefore, the horizontal shortage is assumed to affect the coping (head) of revetment for low water channel, and the horizontal shortage calculated by the following formula is added to the design of SSP revetment.

$$SF = \frac{(\text{Total Vertical Forces of Inclined Wall}) \times f}{(\text{Total Horizontal Forces of Inclined Wall}) + (\text{Horizontal Shortage})}$$

Above formula is converted below,

$$(\text{Horizontal Shortage}) = \frac{(\text{Total Vertical Forces of Inclined Wall}) \times f}{(\text{Total Horizontal Forces of Inclined Wall}) \times SF}$$

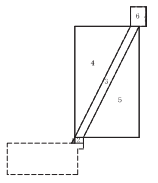
Where,
SF = 1.50 : in Normal Condition
SF = 1.20 : in Seismic and Wind Condition

3 Vertical Wall Design

3.1 Vertical Wall Base Design

3.1.1 Block data without considering water level

(1) Block Diversion



(2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	1/2× 0.076× 0.153× 1.000×22.500	0.133	0.051	0.051	0.007	0.007	Vertical Wall
2	0.223× 0.153× 1.000×22.500	0.770	0.188	0.077	0.145	0.059	Vertical Wall
3	1.646× 2.847× 1.000×22.500	105.471	0.900	1.577	94.924	166.328	Vertical Wall
4	-1/2× 1.423× 2.847× 1.000×22.500	-45.594	0.551	2.051	-25.122	-93.513	Vertical Wall
5	-1/2× 1.423× 2.847× 1.000×22.500	-45.576	1.249	1.102	-56.924	-50.225	Vertical Wall
6	0.400× 0.500× 1.000×22.500	4.500	1.700	3.250	7.650	14.625	Vertical Wall
7	1/2× 0.005× 0.500× 1.000×22.500	0.029	1.902	3.167	0.056	0.093	Vertical Wall
Σ		19.733	——	——	20.734	37.374	

Center of Gravity XG = Σ(Vi/Xi)/ΣVi = 20.734／19.733 = 1.051 (m)
YG = Σ(Vi Yi)/ΣVi = 37.374／19.733 = 1.894 (m)

3.1.2 Body Weight, Voluntary Load

(1) Body Weight

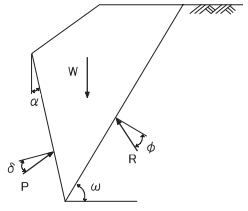
1) Seismic

Position	H = W kh (kN)	Acting Position Y (m)
Body(Reinforced)	19.733 × 0.200 = 3.947	1.894

Acting Position
X = Xc−XG = 0.150−1.051
= −0.901 m

Here,
Xc: Horizontal Distance from the Front of the Vertical Wall to the Center of the Design Section (m)

3.1.3 Earth Pressure and Water Pressure



(1) Normal

The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Section Center) xp = 0.150 m
yp = 0.000 m
Height of Virtual Rear Surface H = 3.500 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 24.567 °

Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Wall Friction Angle δ = 20.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
45.00	63.175	0.000	16.000	79.175	21.343
46.00	59.182	0.000	14.799	73.981	21.350
47.00	55.321	0.000	13.638	68.959	21.228

The maximum earth pressure is determined by the following equation:
when ω = 46.00° P = 21.350 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{73.981 \times \sin(46.00° - 30.00°)}{\cos(46.00° - 30.00° - -24.567° - 23.333°)}$$

= 21.350 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P・cos(α+δ) = 21.350×cos(-24.567°+23.333°) = 21.345 kN
Vertical Component
Pv = P・sin(α+δ) = 21.350×sin(-24.567°+23.333°) = -0.460 kN

Acting Position

$$Ho = \frac{H}{3} = \frac{3.500}{3} = 1.167 \text{ m}$$

x = Ho ・ tan α-xp = 1.167×tan-24.567°−0.150 = -0.683 m
y = yp + Ho = 0.000+1.167 = 1.167 m

(2) Seismic

The earth pressure is obtained by the trial wedge method considering the inertia force in the earthquake.
Position of Virtual Rear Surface (Distance from Section Center) xp = 0.150 m
yp = 0.000 m
Height of Virtual Rear Surface H = 3.500 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = -24.567 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Wall Friction Angle δ = 17.500 °
Seismic Composite Angle

$$\theta = \tan^{-1}\frac{kh \cdot (WU + WL)}{WU + WL + Wq}$$

$$= \tan^{-1}\frac{0.20 \times (95.753 + 0.000)}{95.753 + 0.000 + 0.000}$$

= 11.310°

Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
37.00	101.235	0.000	0.000	101.235	33.436
38.00	95.753	0.000	0.000	95.753	33.440
39.00	90.511	0.000	0.000	90.511	33.341

The maximum earth pressure is determined by the following equation:
when ω = 38.00 ° P = 33.440 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega - \phi + \theta)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{95.753/\cos 11.310° \times \sin(38.00° - 30.00° + 11.310°)}{\cos(38.00° - 30.00° - -24.567° - 17.500°)}$$

= 33.440 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P ・ cos (α + δ) = 33.440×cos(-24.567°+17.500°) = 33.186 kN
Vertical Component
Pv = P ・ sin (α + δ) = 33.440×sin(-24.567°+17.500°) = -4.114 kN
Acting Position

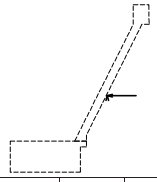
$$Ho = \frac{H}{3} = \frac{3.500}{3} = 1.167 \text{ m}$$

x = Ho ・ tan α-xp = 1.167×tan-24.567°−0.150 = -0.683 m
y = yp + Ho = 0.000+1.167 = 1.167 m

3.1.4 Calculation of Cross-Sectional Force

(Vertical forces are not summarized due to disregard of eccentric moments and axial forces)

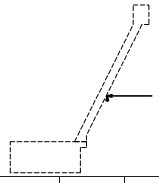
(1) Normal



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	19.733	0.000	-0.901	0.000	-17.775
Earth Pressure	-0.460	21.345	-0.683	1.167	25.224
Total	19.273	21.345	——	——	7.449

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

(2) Seismic

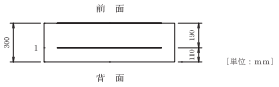


Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	19.733	3.947	-0.901	1.894	-10.300
Earth Pressure	-4.114	33.186	-0.683	1.167	41.538
Total	15.619	37.133	——	——	31.238

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

3.1.5 Section Calculations (Allowable Stress Method)

(1) Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	——	—	——	——	——
	2'	——	—	——	——	——
Back	1	11.0	φ20	3.142	8.00	25.133
	2	——	—	——	——	——

Required Reinforcement in Tension Side 9.901 (cm2)

(2) Verification of Bending Stress

(Reference)
Calculation of the neutral axis

$$x^2 + \frac{2 \cdot n}{b}\{As \cdot (x - d)\} = 0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot As \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

Here,
x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 300.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 15.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	N (kN)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
				Calculated	Allowance	Calculated	Allowance
Normal	7.449	0.000	8.782	1.056 ≦	8.200	18.433 ≦	140.000
Seismic	31.238	0.000	8.782	4.429 ≦	10.906	77.302 ≦	186.200

(3) Verification of Shear Stress

$$\tau_a = \frac{S_h}{b \cdot d} \leqq \tau_{a1}$$

Here,

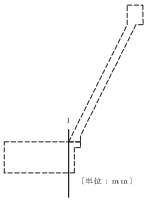
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)		
			Calculated	Allowable τa1	Allowable τa2
Normal	21.345	19.000	0.112 ≦	0.360	0.360
Seismic	37.133	19.000	0.195 ≦	0.479	0.479

4 Design of Base Concrete

4.1 Design of Checking Position

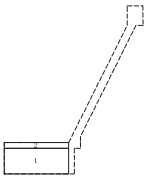
Distance from Wall = 0.000 m



4.2 Block Data Without Considering Water Level

(1) Body Weight

1) Block Diversion



2) Weight and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position Xi	Vi/Xi	Remarks
1	1.650× 0.652× 1.000×22.500	24.205	0.825	19.970	Base Concrete
2	1.650× 0.148× 1.000×22.500	5.495	0.825	4.533	Base Concrete
Σ		29.700	——	24.503	

Center of Gravity Position XG = Σ(Vi/Xi)/ΣVi = 24.503／29.700 = 0.825 (m)

4.3 Subgrade Reaction

Vertical Force

$$N = \frac{1}{2}(q1+q2) \cdot L$$

Acting Position

$$X = \frac{2 \cdot q1+q2}{3 \cdot (q1+q2)} \cdot L$$

Here,

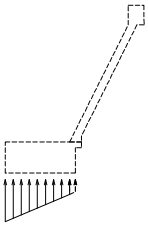
q1: Subgrade Reaction Force in the Front of Toe Slab(kN/m2)
q2: Subgrade Reaction Force at the Design Section of Toe Slab(kN/m2)
L : Subgrade Reaction Width (m)

(1) Normal

Subgrade Reaction Intensity (kN/m2)		Acting Width L (m)	Vertical Force N (kN)	Acting Position X (m)
q1	q2			
45.381	15.790	1.650	-50.466	0.958

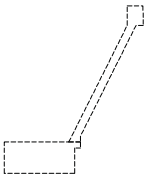
4.4 Calculation of Cross-Sectional Force

(1) Normal



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-29.700	0.825	-24.502
Subgrade Reaction	50.466	0.958	48.348
Total	20.766	——	23.846

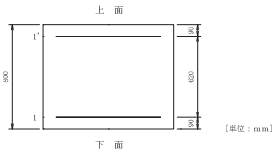
(2) Seismic



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-29.700	0.825	-24.502
Total	-29.700	——	-24.502

4.5 Section Calculations (Allowable Stress Method)

(1) Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Upper	1'	9.0	φ16	2.011	8.00	16.085
	2'	——	——	——	——	——
Bottom	1	9.0	φ16	2.011	8.00	16.085
	2	——	——	——	——	——

Required Reinforcement in Tension Side 2.480 (cm2)

(2) Verification of Bending Stress

(Reference)

Calculation of the neutral axis

$$x^2 + \frac{2 \cdot n}{b}\{As \cdot (x-d)\} = 0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot As \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
			Calculated	Allowance	Calculated	Allowance
Normal	23.846	16.250	0.447 ≦	8.200	22.606 ≦	140.000
Seismic	-24.502	16.250	0.460 ≦	10.906	23.229 ≦	186.200

(3) Verification of Shear Stress

$$\tau_a = \frac{S_h}{b \cdot d} \leqq \tau_{a1}$$

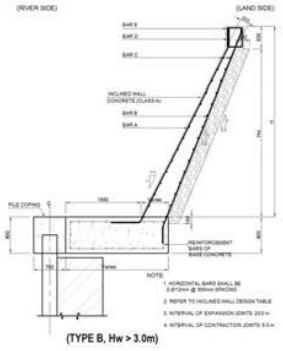
Here,

τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member (mm)
b : Member Section Width (mm)
τa1: Allowable Average Shear Stress of Concrete Alone (N/mm2)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (mm)	Shear Stress (N/mm2)	
			Calculated value τ	allowance τa1
Normal	20.766	710.000	0.029 ≦	0.360
Seismic	29.700	710.000	0.042 ≦	0.479

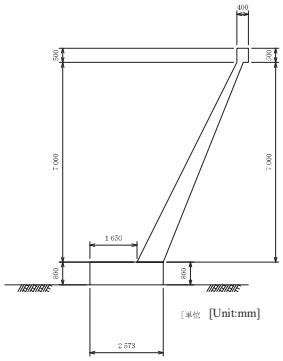
Type B

Hw :7.0m



1 Design Conditions

1.1 Geometry



Depth Width (Block Length) B = 5000 (mm)

1.2 Materials

[Concrete] Vertical wall (reinforced concrete) : σck = 20.7 (N/mm2)
Base concrete (reinforced concrete) : σck = 20.7 (N/mm2)

[Iron bar] Type: : Grade 275

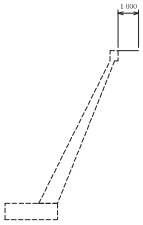
[Soil] Backfill : sand and gravel
Foudation : sandy gravel

[Internal Fdiction] Backfill : 30 degrees

[Unit weight]
(kN/m3)

Body	Base Concrete	22.500	
	Vertical wall	22.500	
Water		9.800	
Soil		Wet weight	Saturated weight
River side		19.000	19.000
Land side		20.000	20.800

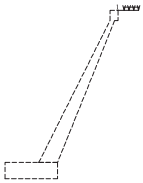
1.3 Backfill and Embankment



Level Difference Between Retaining Wall Crown And Ground Surface Start Point	(m)	0.000
Height Without Considering Earth Pressure Hr (in stability analysis) Hr	(m)	0.000

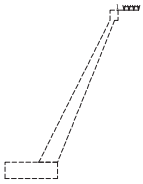
1.4 Loads

(1) Normal



Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			From	End Side	Stability Analysis	Vertical Wall	Bottom Slab
1	0.300	3.300	10.000	10.000	○	○	×

(2) Seismic



Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			From	End Side	Stability Analysis	Vertical Wall	Bottom Slab
1	0.300	3.300	5.000	5.000	○	○	×

1.5 Buoyancy

・Use the Water Level in Rear Side

1.6 Earth Pressure

・Earth Pressure Formulas: Trial Wedge

・Angle of Friction of Earth Pressure Acting Surface (Degrees)

Load Condition	Active Earth Pressure			Passive Earth Pressure
	In Case of Stability Analysis	In Case of Vertical Wall Design	Cut	
Normal Earth Pressure	23.333	23.33	——	——
Seismic Earth Pressure	17.500	17.500	——	——

・ The virtual rear surface of earth pressure in the stability analysis is at the heel end (a line extended vertically from the heel)

・ Angle between the earth pressure acting surface and the vertical plane in stability analysis
21.652 (degrees)

・ Angle between the earth pressure working surface and the vertical plane when designing the vertical wall
21.650 (degrees)

・The Design Horizontal Seismic Coefficient is applied to the inertia force during earthquakes when calculating the earth pressure below the water level.

・Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal Condition	0.000	0.000	——
Seismic Condition	0.000	0.000	——

・Consideration of Earth Pressure Different from Direction of Earthquake Motion

	Consideration I...	Effectivity
Stability Analysis	Seismic Earth Pressure	0.500
Vertical Wall Design		0.500

1.7 Load Combination Case

No	Load Name	Comments
1	Normal	Normal Condition
2	Seismic	Seismic Seismic condition

	Load Name	1	2
Soil	Front Soil 1	○	○
Load	Load 1	○	
	Load 2		○
Active Earth Pressure	Not Considered		
	Normal Earth Pressure	○	
	Seismic Earth Pressure		○

1.8 Foundation Conditions

Bottom Slab Width Used for Analysis	All Width
Cohesion Between Foundation Bottom Surface And Ground C_B (kN/m2)	0.000
Friction Coefficient Between Foundation Bottom Surface and Ground tan φ_B	0.500

1.9 Allowable Values For Stability Analysis And Allowable Stresses of Members

1.9.1 Allowance in Stability Analysis

Load Condition	Allowable Eccentricity e/B (m)	Safety Factor for Overturning	Allowable Subgrade Reaction Intensity (kN/m2)
Normal	1/6	1.500	100.000
Seismic	1/3	1.200	100.000

Here,

B : Foundation Width (m)

e_B: load eccentricity (m), where $e_B = M_B/V$

M_B: moment acting on base (kNm)

V : vertical load acting on base (kN)

1.9.2 Allowable Stress of the Member

(1)Reinforced Concrete Member

1) Vertical Wall (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic	1.33	10.906	186.200	0.479	0.479

2) Bottom Slab (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic	1.33	10.906	186.200	0.479	0.479

Here,

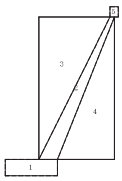
τa1: Shear Stress When Shear Force is Applied Only by Concrete

τa2: Shear Stress when Jointly Bearing with Oblique Tensile Reinforcement

2 Stability Analysis

2.1 Block Data

(1) Body Weight



2)Weight and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	2.573× 0.800× 1.000×22.500	46.314	1.286	0.400	59.583	18.526	bottom plate
2	3.723× 7.000× 1.000×22.500	586.372	3.511	4.300	2059.047	2521.402	vertical wall
3	-1/2× 3.500× 7.000× 1.000×22.500	-275.625	2.817	5.467	-776.353	-1506.759	vertical wall
4	-1/2× 2.800× 7.000× 1.000×22.500	-220.500	4.440	3.133	-978.954	-690.893	vertical wall
5	0.400× 0.500× 1.000×22.500	4.500	5.350	8.050	24.075	36.225	vertical wall
Σ		141.062	—	—	387.398	378.501	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 387.398／ 141.062 = 2.746 (m)

YG = Σ (Vi Yi)/ΣVi = 378.501／ 141.062 = 2.683 (m)

2.2 Body Weight, Weight of Soil, Arbitrary Load, Vertical Force by Buoyancy, Horizontal Force

(1) Working Force Due to Body Weight

1) Normal

2) Seismic

Position	Horizontal Load H = W kh (kN)	Acting Position Y (m)
Body(Reinforced)	141.062 × 0.20 = 28.212	2.633

(2) Body Weight

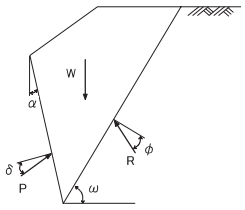
1) Normal

	Weight Ni (kN)	Horizontal force Hi (kN)	Position of action (m) Xi	Yi	Moment (kNm) Ni and Xi	Hi Yi
Body	141.062	0.000	2.746	0.000	387.398	0.000
Total	141.062	0.000	—	—	387.398	0.000

2) Seismic

	Weight Ni (kN)	Horizontal force Hi (kN)	Position of action (m) Xi	Yi	Moment (kNm) Ni and Xi	Hi Yi
Body	141.062	28.212	2.746	2.683	387.398	75.700
Total	141.062	28.212	—	—	387.398	75.700

2.3 Earth Pressure and Water Pressure



(1) Normal Condition

The earth pressure is obtained by the trial wedge method.

Position of Virtual Rear Surface (Distance from toe) xp = 2.255 m

yp = 0.000 m

Height of Virtual Rear Surface H = 8.300 m

Angle between the Earth Pressure Acting Surface and the Vertical Plane A = -21.652 °

Unit Weight of Soil γs = 19.000 kN/m3

Internal Friction Angle of Soil φ = 30.000 °

Angle between Ground Surface and Horizontal Plane β = 0.000 °

Wall Friction Angle δ = 23.333 °

Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °

Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)

Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
47.00	350.478	0.000	33.000	383.478	116.249
48.00	329.463	0.000	33.000	362.463	116.709
49.00	309.098	0.000	33.000	342.098	116.666

The maximum earth pressure is determined by the following equation:

when ω = 48.00 ° P = 116.709 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{362.463 \times \sin(48.00^\circ - 30.00^\circ)}{\cos(48.00^\circ - 30.00^\circ - -21.652^\circ - 23.333^\circ)}$$

= 116.709 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.

Horizontal Component

Ph = P · cos (α + δ) = 116.709×cos(-21.652°＋23.333°) ＝ 116.659 kN

Vertical Component

Pv = P · sin (α + δ) = 116.709×sin(-21.652°＋23.333°) ＝ 3.423 kN

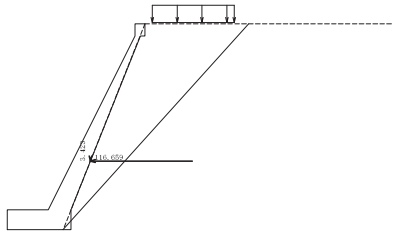
Acting Position

$$Ho = \frac{H}{3} = \frac{8.300}{3} = 2.767 \text{ m}$$

x = xp-Ho · tan α = 2.255－2.767×tan-21.652°＝ 3.353 m

y = yp + Ho = 0.000＋2.767 ＝ 2.767 m

・Earth Pressure Diagram



(2) Seismic Condition

The earth pressure is obtained by the trial wedge method considering the inertia force in the earthquake.

Position of Virtual Rear Surface (Distance from Toe) xp = 2.255 m

yp = 0.000 m

Height of Virtual Rear Surface H = 8.3000 m

Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 21.652 °

Unit Weight of Soil γs = 19.000 kN/m3

Internal Friction Angle of Soil φ = 30.000 °

Wall Friction Angle δ = 17.5.000 °

Seismic Composite Angle

$$\theta = \tan^{-1}\frac{kh \cdot (WU + WL)}{WU + WL + Wq}$$

$$= \tan^{-1}\frac{0.20 \times (548.374 + 0.000)}{548.374 + 0.000 + 0.000}$$

= 11.310 °

Range of slip angle change ωi = 10.00 ° ~ 80.00 °

Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)

Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
38.00	577.854	0.000	0.000	577.854	199.335
39.00	548.374	0.000	0.000	548.374	199.338
40.00	520.138	0.000	0.000	520.138	198.802

The maximum earth pressure is determined by the following equation:

when ω = 39.00 ° P = 19900338 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega - \phi + \theta)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{548.374/\cos 11.310^\circ \times \sin(39.00^\circ - 30.00^\circ + 11.310^\circ)}{\cos(39.00^\circ - 30.00^\circ - -21.652^\circ - 17.500^\circ)}$$

= 199.338 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.

Horizontal Component

Ph = P, cos (α + δ) = 199.338 × cos(-21.652°＋17.500°) ＝ 198.815 kN

Vertical Component

Pv = P sin (α + δ) = 199.338 × sin(-21.652°＋17.500°) ＝ -14.434 kN

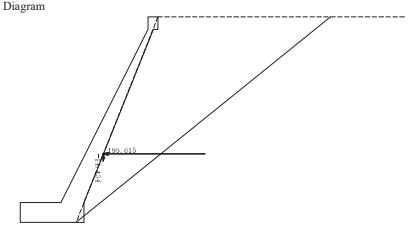
Acting Position

$$Ho = \frac{H}{3} = \frac{8.300}{3} = 2.767 \text{ m}$$

x = xp-Ho · tan α = 2.255－2.767×tan-21.652°＝ 3.353 m

y = yp + Ho = 0.000＋2.767 ＝ 2.767 m

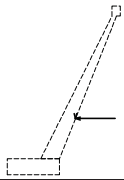
・Earth Pressure Diagram



2.4 Summary of Acting Forces

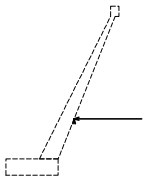
(1) Summary of forces acting on the footing front

1) Normal Condition



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	141.062	0.000	2.746	0.000	387.398	0.000
Earth Pressure	0.000	116.659	3.353	2.767	0.000	322.795
Total	141.062	116.659	——	——	387.398	322.795

2) Seismic Condition



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	141.062	28.212	2.746	2.683	387.398	75.700
Earth Pressure	0.000	198.815	3.353	2.767	0.000	550.121
Total	141.062	227.027	——	——	387.398	625.821

Load Condition (Water Level)	No (kN)	Ho (kN)	Mo (kN.m.)
Norma	141.062	116.659	64.603
Seismic	141.062	227.027	-238.423

(2)Summary of Forces Acting At the Footing Center

Vertical Force : Nc = No (kN)

Horizontal Force : Hc = Ho (kN)

Turning Moment : Mc = No Bj/2.0 - Mo (kN.m.)

Here,

Footing Width in Earth Pressure Direction : Bj = 2.573 (m)

■Per Unit Width

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Norma	141.062	116.659	116.873
Seismic	141.062	227.027	419.899

■Per full width (5.000 m)

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Norma	705.308	583.295	584.365
Seismic	705.308	1135.137	2099.494

2.5 Stability Analysis Results

2.5.1 Stability against Overturning

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,

d: Distance from the Toe of Bottom Slab to the Acting Point of Composited Force (m)
ΣMr: Resistive Moment of Toe of Bottom Slab (kN.m.)
ΣMt: Overturning Moment of Toe of Bottom Slab (kN.m.)
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)

$$e = \frac{B}{2} - d$$

Here,

e: Eccentricity from the Center of Bottom Slab to the Acting Point of Composited Force (m);
B: Bottom Slab Width (m), B = 1.800

ea = B/n

Here,

ea: Allowable Eccentricity (m)
n: Safety Factor

Load Condition (Water Level)	Σ Mr (kN.m.)	Σ Mt (kN.m.)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal	387.398	322.795	141.062	0.458	0.829	>	0.429
Seismic	387.398	625.821	141.062	-1.690	2.977	>	0.858

The inclined wall does not satisfy with the requirement. Therefore, it is assumed that the moment acts on the coping of SSP revetment, and the moment shortage (M_L) calculated from the following formula is added to the design of revetment for low water channel.

$e = \left|\frac{b}{2} - \frac{M+M_L}{N}\right| = \frac{b}{6}$, in Normal Condition

Above formula is converted to $M_L = \left|\frac{b}{6}\right| \times N - M$

$e = \left|\frac{b}{2} - \frac{M+M_L}{N}\right| = \frac{b}{3}$ in Seismic Condition

Above formula is converted to $M_L = \left|\frac{b}{6}\right| \times N - M$

Where,

M_L : Moment Shortage（=Moment acting on SSP revetment） (kN・m)

Load Condition	Base Length (m)	Resistaince Moment at Toe ΣMr (kN・m)	Over-Turning Moment at Toe ΣMt (kN・m)	Vertical Load ΣV (kN)	Acceptable Eccentric Distance (m)	Judge	Moment of Acting to SSP (KN*m)
Normal	2.573	387.398	322.795	141.062	0.429	NG	56.4
Seismic	2.573	387.398	625.821	141.062	0.858	NG	298.9

2.5.2 Stability Against Sliding

$$F_s = \frac{\Sigma V \cdot \mu + C_B \cdot B}{\Sigma H}$$

Here,

ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
ΣH: Total Horizontal Load in Lower Side of Bottom Slab (kN)
μ: Cohesion Between Bottom Slab and Supporting Ground, μ = 0.500
C_B: Cohesion Between Bottom Slab And Supporting Ground (kN/m2), C_B = 0.000
B: Bottom Slab Width (m), B = 1.800

Load Condition (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Safety Factor Fs		Required Safety Factor Fsa
NormalCondition	141.062	116.659	0.605	<	1.500
SeismicCondition	141.062	227.027	0.311	<	1.200

The inclined wall does not satisfy the minimum safety factor. Therefore, the horizontal shortage is assumed to affect the coping (head) of revetment for low water channel, and the horizontal shortage calculated by the following formula is added to the design of SSP revetment.

$$SF = \frac{(\text{Total Vertical Forces of Inclined Wall}) \times f}{(\text{Total Horizontal Forces of Inclined Wall}) + (\text{Horizontal Shortage})}$$

Above formula is converted below,

$$(\text{Horizontal Shortage}) = \frac{(\text{Total Vertical Forces of Inclined Wall}) \times f}{(\text{Total Horizontal Forces of Inclined Wall}) \times SF}$$

Where,

SF = 1.50 : in Normal Condition
SF = 1.20 : in Seismic and Wind Condition

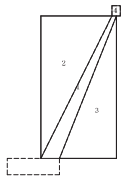
Load Condition	Vertical Load ΣV (kN)	Horozontal Load ΣH (kN)	Required Safety Factor	Judge	Forth of Acting to SSP (KN)
Normal	141.062	116.659	1.5	NG	69.7
Seismic	141.062	227.027	1.2	NG	168.3

3 Vertical Wall Design（ここから）

3.1 Vertical Wall Base Design

3.1.1 Block data without considering water level

(1) Block Diversion



(2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	3.723× 7.000× 1.000×22.500	586.372	1.862	3.500	1091.826	2052.304	Vertical Wall
2	-1/2× 3.500× 7.000× 1.000×22.500	-275.625	1.167	4.667	-321.654	-1286.342	Vertical Wall
3	-1/2× 2.800× 7.000× 1.000×22.500	-220.500	2.790	2.333	-615.195	-514.426	Vertical Wall
4	0.400× 0.500× 1.000×22.500	4.500	3.700	7.250	16.650	32.625	Vertical Wall
Σ		94.747	—	—	171.626	284.160	

Center of Gravity XG = Σ(Vi/Xi)/ΣVi = 171.626／ 94.747 = 1.811 (m)
YG = Σ(Vi Yi)/ΣVi = 284.160／ 94.747 = 2.999 (m)

3.1.2 Body Weight, Voluntary Load

(1) Body Weight

1) Seismic

Position	W = γ ・ V (kN)	Acting Position X (m)
Body(Reinforced)	94.747 × 0.200 = 18.949	2.999

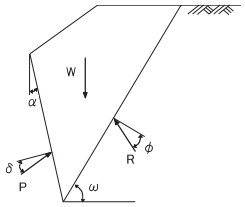
Acting Position

$$X = Xc - XG = 0.462 - 1.811 = -1.350 \text{ m}$$

Here,

Xc: Horizontal Distance from the Front of the Vertical Wall to the Center of the Design Section (m)

3.1.3 Earth Pressure and Water Pressure



1) Normal

The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Section Center) xp = 0.461 m
yp = 0.000 m
Height of Virtual Rear Surface H = 7.500 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = -21.650 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Wall Friction Angle δ = 23.333 °
Range of Slip Angle Change ωi = 10.00 °～ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN) Above Water Level	Below Water Level	Vertical Load	Total	Earth Pressure P (kN)
47.00	286.201	0.000	33.000	319.201	96.762
48.00	269.042	0.000	33.000	302.042	97.253
49.00	252.414	0.000	32.427	284.841	97.138

The maximum earth pressure is determined by the following equation:
when ω = 48.00° P = 97.253 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{302.042 \times \sin(48.00^\circ - 30.00^\circ)}{\cos(48.00^\circ - 30.00^\circ - -21.650^\circ - 23.333^\circ)}$$

= 97.253 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.

Horizontal Component

Ph = P・cos(α+δ) = 97.253×cos(-21.650°+23.333°) = 97.211 kN

Vertical Component

Pv = P・sin(α+δ) = 97.253×sin(-21.650°+23.333°) = 2.857 kN

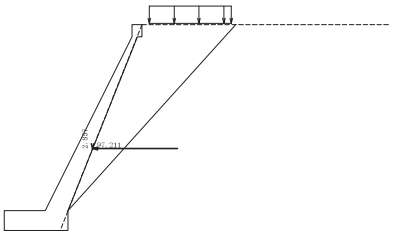
Acting Position

$Ho = \frac{H}{3} = \frac{7.500}{3} = 2.500$ m

x = Ho ・ tan α-xp = 2.500×tan-21.650°−0.461 = -1.453 m

y = yp + Ho = 0.000+2.500 = 2.500 m

・Earth Pressure Diagram



2) Seismic

The earth pressure is obtained by the trial wedge method considering the inertia force in the earthquake.

Position of Virtual Rear Surface (Distance from Section Center) xp = 0.491 m

yp = 0.000 m

Height of Virtual Rear Surface H = 7.5000 m

Angle between the Earth Pressure Acting Surface and the Vertical Plane A = -21.650 °

Unit Weight of Soil γs = 19.000 kN/m3

Internal Friction Angle of Soil φ = 30.000 °

Wall Friction Angle δ = 17.500 °

Range of Slip Angle Change ωi = 10.00 °～ 80.00 °

Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)

Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
38.00	471.858	0.000	0.000	471.858	162.769
39.00	447.787	0.000	0.000	447.787	162.772
40.00	424.732	0.000	0.000	424.732	162.335

The maximum earth pressure is determined by the following equation:

when ω = 39.00 ° P = 162.772 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega - \phi + \theta)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{447.787/\cos 11.310^\circ \times \sin(39.00^\circ - 30.00^\circ + 11.310^\circ)}{\cos(39.00^\circ - 30.00^\circ - -21.650^\circ - 17.500^\circ)}$$

= 162.772 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.

Horizontal Component

Ph = P ・ cos (α + δ) = 162.772×cos(-21.650°+17.500°) = 162.345 kN

Vertical Component

Pv = P・sin (α + δ) = 162.772×sin(-21.650°+17.500°) = -11.779 kN

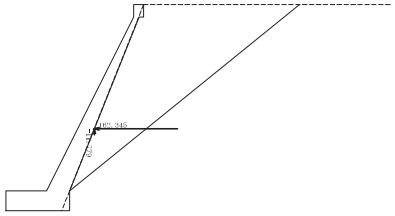
Acting Position

$Ho = \frac{H}{3} = \frac{7.500}{3} = 2.500$ m

x = Ho ・ tan α-xp = 2.500×tan-21.650°−0.461 = -1.453 m

y = yp + Ho = 0.000+2.500 = 2.500 m

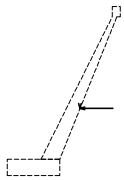
・Earth Pressure Diagram



3.1.4 Calculation of Cross-Sectional Force

(Vertical forces are not summarized due to disregard of eccentric moments and axial forces)

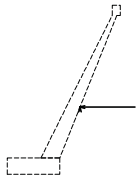
1) Normal



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	94.747	0.000	-1.350	0.000	-127.900
Earth Pressure	2.857	97.211	-1.453	2.500	238.875
Total	97.604	97.211	——	——	110.975

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

2) Seismic

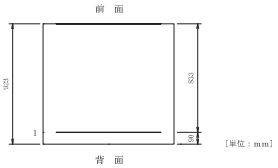


Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	94.747	18.949	-1.350	2.999	-71.068
Earth Pressure	-11.779	162.345	-1.453	2.500	422.983
Total	82.968	181.294	——	——	351.916

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

3.1.5 Section Calculations (Allowable Stress Method)

1) Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	——	—	——	——	——
	2'	——	—	——	——	——
Back	1	9.0	φ25	4.909	8.00	39.270
	2	——	—	——	——	——

Required Reinforcement in Tension Side 8.651 (cm2)

(2)Verification of Bending Stress

(Reference)

Calculation of the neutral axis

$$x^2 + \frac{2 \cdot n}{b}\{As \cdot (x - d)\} = 0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot As \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)

h : Member Section Height (mm), h = 923.000

b : Member Section Width (mm), b = 1000.000

d : Effective Height of Member (mm)

As: Total Cross-Sectional Area of Rebar in Tension (mm2)

n : Young's Modulus Ratio of Rebar to Concrete, n = 15.00

e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)

σc: Bending Compressive Stress of Concrete (N/mm2)

σs: Tensile Stress of Rebar (N/mm2)

M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	N (kN)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
				Calculated	Allowance	Calculated	Allowance
Normal	110.975	0.000	25.982	1.144 ≦	8.200	37.864 ≦	140.000
Seismic	351.916	0.000	25.982	3.629 ≦	10.906	120.072 ≦	186.200

(3)Verification of Shear Stress

$$\tau_a = \frac{S_h}{b \cdot d} \leqq \tau_{a1}$$

Here,

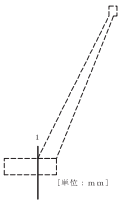
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)		
			Calculated	Allowable τa1	Allowable τa2
Normal	97.211	83.300	0.117 ≦	0.360	0.360
Seismic	181.294	83.300	0.218 ≦	0.479	0.479

4 Design of Base Concrete

4.1 Design of Checking Position

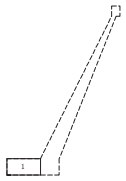
Distance from wall = 0.000 m



4.2 Block Data Without Considering Water Level

(1) Body Weight

1) Block Diversion



2) Weight and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position Xi	Vi/Xi	Remarks
1	1.650× 0.800× 1.000×22.500	29.700	0.825	24.503	Base Concrete
Σ		29.700	——	24.503	

Center of Gravity Position XG = Σ(Vi/Xi)/ΣVi = 24.503／29.700 ＝ 0.825 (m)

4.3 Subgrade Reaction

Vertical Force

$$N = \frac{1}{2}(q1+q2) \cdot L$$

Acting Position

$$X = \frac{2 \cdot q1+q2}{3 \cdot (q1+q2)} \cdot L$$

Here,

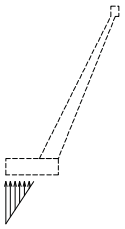
q1: Subgrade Reaction Force in the Front of Toe Slab(kN/m2)
q2: Subgrade Reaction Force at the Design Section of Toe Slab(kN/m2)
L : Subgrade Reaction Width (m)

(1) Normal

Subgrade Reaction Intensity (kN/m2)		Acting Width L (m)	Vertical Force N (kN)	Acting Position X (m)
q1	q2			
205.479	0.000	1.373	-141.061	1.192

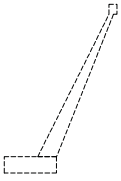
4.4 Calculation of Cross-Sectional Force

(1) Normal



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-29.700	0.825	-24.503
Subgrade Reaction	141.061	1.192	168.192
Total	111.361	——	143.690

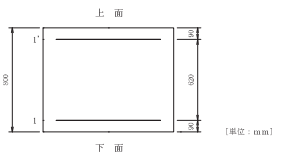
(2) Seismic



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-29.700	0.825	-24.503
Total	-29.700	——	-24.503

4.5 Section Calculations (Allowable Stress Method)

(1) Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Upper	1'	9.0	φ20	3.142	8.00	25.133
	2'	——	——	——	——	——
Bottom	1	9.0	φ20	3.142	8.00	25.133
	2	——	——	——	——	——

Required Reinforcement in Tension Side 15.634 (cm2)

(2) Verification of Bending Stress

(Reference)

Calculation of the neutral axis

$$x^2 + \frac{2 \cdot n}{b}\left\{As \cdot (x-d)\right\} = 0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot As \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 800.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 15.00

e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
			Calculated	Allowance	Calculated	Allowance
Normal	143.690	19.668	2.266 ≦	8.200	88.725 ≦	140.000
Seismic	-24.503	19.668	0.386 ≦	10.906	15.130 ≦	186.200

(3) Verification of Shear Stress

$$\tau_a = \frac{S_h}{b \cdot d} \leqq \tau_{a1}$$

Here,

τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member (mm)
b : Member Section Width (mm)
τa1: Allowable Average Shear Stress of Concrete Alone (N/mm2)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (mm)	Shear Stress (N/mm2)	
			Calculated value τ	allowance τa1
Normal	111.361	710.000	0.157 ≦	0.360
Seismic	29.700	710.000	0.042 ≦	0.479

1.2.4 Inverted T-shaped Retarding Wall

(1) Cross-section for Structural Calculation

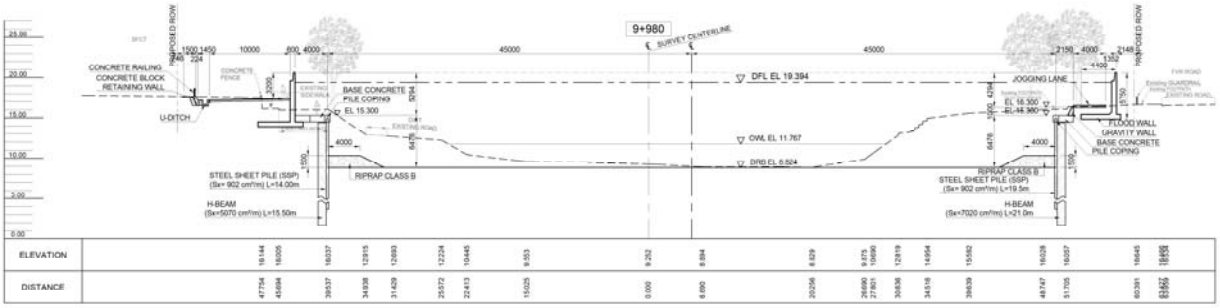
Cross-sections for the structural calculation are selected considering the following points.

- The wall height is high. (≒ acting force is large)
- Embedded depth is small.

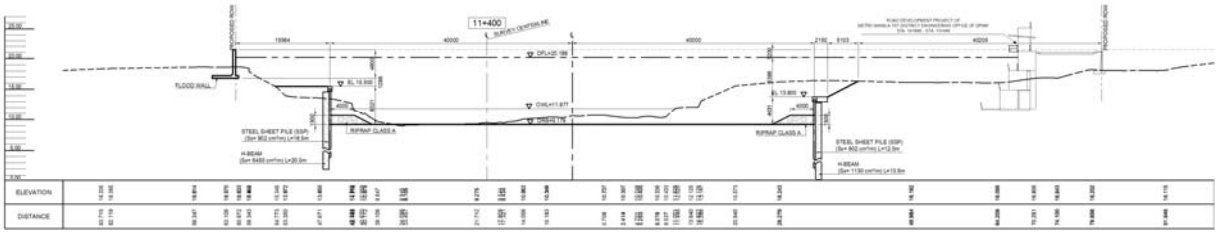
The selected cross-sections are shown below:

Left Side

[Sta 9+980] (Wall height is the highest class)

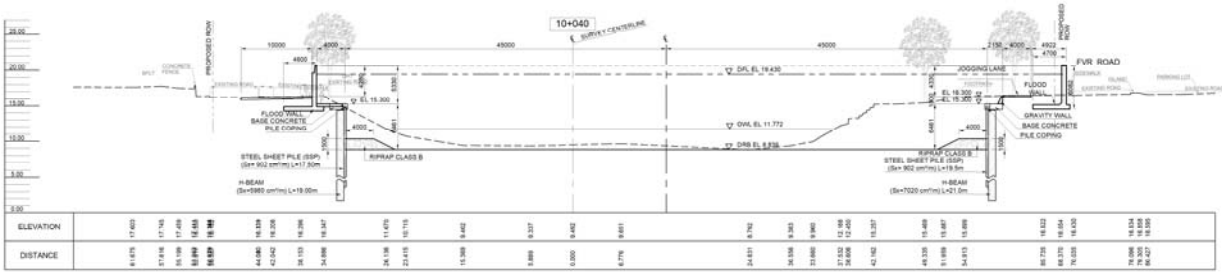


[Sta 11+400] (Embedded depth at the land side is small)



Right Side

[Sta 10+040] (Wall height is the highest class, and Embedded depth is small)



(2) Calculation Case

The calculation case are shown below:

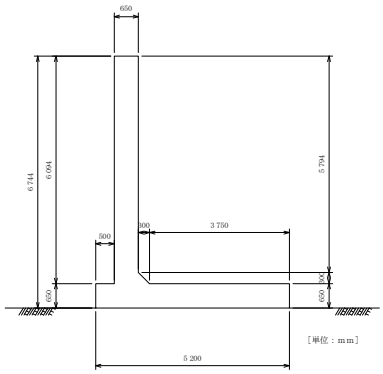
- Normal Condition
- Seismic Condition
- Flood Condition

The calculation sheets are shown in the following pages.

1 Invert T-shaped Wall, Left Bank Sta.9+980

1.1 Design Conditions

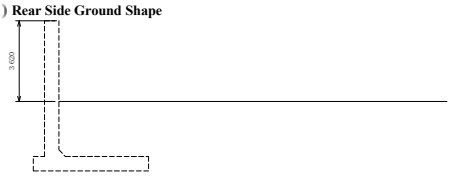
1.1.1 Geometry



Depth Width (Block Length) B = 5000 (mm)

1.1.2 Backfill and Embankment

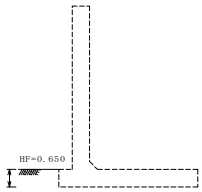
(1) Rear Side Ground Shape



Level Difference Between Retaining Wall Crown And Ground Surface Start Point	(m)	3.600
Height Without Considering Earth Pressure Hr (in stability analysis) Hr	(m)	0.000

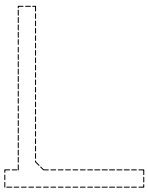
(2) Front Side Ground Shape

1) Normal and Flood Condition



Height	Stability Analysis		Design of Toe Slab
	Vertical	Horizontal	
0.650	Considered	Considered	Considered

2) Seismic Condition



Height	Stability Analysis		Design of Toe Slab
	Vertical	Horizontal	
0.00	Not Considered	Not Considered	Not Considered

1.1.3 Material

[Concrete] Vertical wall (reinforced concrete) : σck = 20.0 (N/mm2)
Base concrete (reinforced concrete) : σck = 20.0 (N/mm2)

[Iron bar] Type: : Grade 275

[Soil] Backfill : sand and gravel
Foudation : sandy gravel

[Internal Fdiction] Backfill : 30 degrees

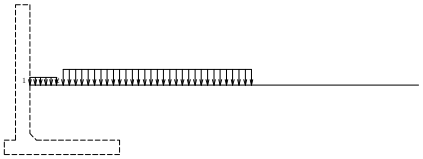
[Unit weight]
(kN/m3)

Body	24.500	
Water	9.800	
Soil	Wet weight	Saturated weight
River side	20.000	20.800
Land side	20.000	20.800

[Seismic Intensity] Body : 0.200
Foundation Riverside : 0.200
Foundation Landside : 0.200

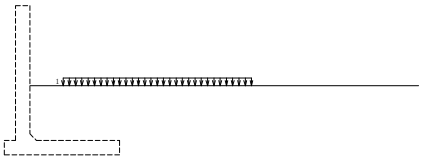
1.1.4 Loads

[1]Normal, Seismic



Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			Beginning	End	Stability Analysis	Vertical Wall	Bottom Slab
1	0.000	1.200	5.000	5.000	○	○	○
2	1.500	8.500	10.000	10.000	○	○	○

[2]Seismic



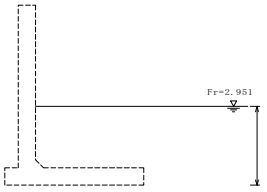
Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			Beginning	End	Stability Analysis	Vertical Wall	Bottom Slab
1	1.500	8.500	5.000	5.000	○	○	○

[2]Flood
Not Concidered

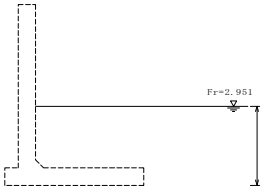
1.1.5 Water Level

[1]Normal

■With Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 2.951 m

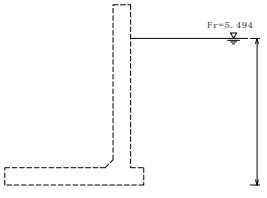


■Without Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 2.951 m

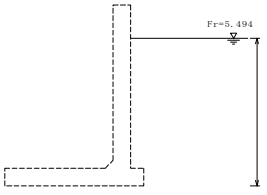


[2]Seidmic
Not Considered

[3]Flood
■With Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 5.494 m



■Without Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 5.494 m



1.1.6 Buoyancy

・Use the Water Level in Rear Side

1.1.7 Earth Pressure

・Earth Pressure Formulas: Trial Wedge

・Angle of Friction of Earth Pressure Acting Surface (Degrees)

Load Condition	Active Earth Pressure			Passive Earth Pressure
	In Case of Stability Analysis	In Case of Vertical Wall Design	Cut	
Normal Earth Pressure	0.000	23.333	———	———
Seismic Earth Pressure	30.303	17.500	———	———
Flood Earth Pressure	0.000	0.000	———	0.000

・ The virtual rear surface of earth pressure in the stability analysis is at the heel end (a line extended vertically from the heel)

・ Angle between the earth pressure acting surface and the vertical plane in stability analysis
0.000 (degrees)

・ Angle between the earth pressure working surface and the vertical plane when designing the vertical wall
Normal, Seismic 0.000 (degrees)
Flood 0.000 (degrees)

・The Design Horizontal Seismic Coefficient is applied to the inertia force during earthquakes when calculating the earth pressure below the water level.

・Passive Earth Pressure

Load Condition	Height of Acting	Effectivity
Flood	3.024	0.500

・Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal Condition	0.000	0.000	———
Seismic Condition	0.000	0.000	0.000
Flood Condtion	0.000	0.000	0.000

・Consideration of Earth Pressure Different from Direction of Earthquake Motion

	Consideration I...	Effectivity
Stability Analysis	Normal Earth Pressure	0.500
Vertical Wall Design		0.500

1.1.8 Water Pressure

・Concept of Calculation of Hydrostatic Pressure

Load Condition	Rear Side	Front Side
Normal Condition	Considered	Considered
Seismic Condition	Considered	Considered
Flood Condition	Considered	Considered

・Consideration of Hydrostatic Pressure Different from the Direction of Earthquake Motion

Outside Water Level	Stability analysis	Considered
	Vertical Wall Design	Considered

・Consideration of Dynamic Water Pressure Calculation

Outside Water Level	Considered

1.1.9 Load Combination Case

No	Load Name	Comments
1	Normal	
2	Seismic	Seismic
3	Flood	Flood

	Load Name	1	2	3
Soil	Front Soil 1	○		
	Front Soil 2		○	
	Front Soil 3			○
Water Level	Buoyancy 1	○		
	Buoyancy 2		○	
	Buoyancy 3			○
Load	Load 1	○		
	Load 2		○	
Active Earth Pressure	Not Considered			
	Normal Earth Pressure	○		○
	Seismic Earth Pressure		○	
Passive Earth Pressure	Passive Earth Pressure 1			○

1.1.10 Foundation Conditions

1.1.10.1 Data for calculating allowable shear resistance

Bottom Slab Width Used for Analysis	All Width
Cohesion Between Foundation Bottom Surface And Ground C_B (kN/m2)	0.000

Friction Coefficient Between Foundation Bottom Surface and Ground tan φ_B	0.500

1.1.11 Allowable Values For Stability Analysis and Allowable Stresses of Members

1.1.11.1 Allowance in Stability Analysis

Load Condition	Allowable Eccentricity eB/B (m)	Safety Factor for Overturning	Allowable Subgrade Reaction Intensity (kN/m2)
Normal	1/6	1.500	200.000
Seismic, Flood	1/3	1.200	300.000

1.1.11.2 Allowable Stress of the Member

(1)Reinforced Concrete Member

1) Vertical Wall (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic, Flood	1.33	10.906	186.200	0.479	0.479

2) Bottom Slab (General Member)

(N/mm2)

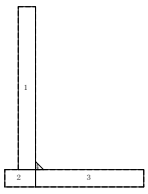
Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic, Flood	1.33	10.906	186.200	0.479	0.479

Here,
τa1: Shear Stress When Shear Force is Applied Only by Concrete
τa2: Shear Stress When Jointly Bearing With Oblique Tensile Reinforcement

1.2 Stability Analysis

1.2.1 Block Data Not Considering Water Level

(1)Body Weight
1)Block Diversion

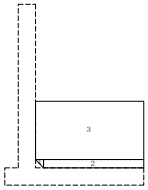


2)Weight and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.650× 6.094× 1.000	3.961	0.825	3.697	3.268	14.644	
2	1.150× 0.650× 1.000	0.748	0.575	0.325	0.430	0.243	
3	4.050× 0.650× 1.000	2.632	3.175	0.325	8.358	0.856	
4	1/2× 0.300× 0.300× 1.000	0.045	1.250	0.750	0.056	0.034	
Σ		7.386	——	——	12.112	15.776	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 12.112／ 7.386 ＝ 1.640 (m)
YG = Σ (Vi Yi)/ΣVi = 15.776／ 7.386 ＝ 2.136 (m)

(2)Soil in Rear Side
1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	1/2× 0.300× 0.300× 1.000	0.045	1.350	0.850	0.061	0.038	
2	3.750× 0.300× 1.000	1.125	3.325	0.800	3.741	0.900	
3	4.050× 2.174× 1.000	8.805	3.175	2.037	27.955	17.935	
Σ		9.975	——	——	31.756	18.873	

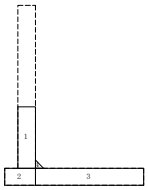
Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 31.756／ 9.975 ＝ 3.184 (m)
YG = Σ (Vi Yi)/ΣVi = 18.873／ 9.975 ＝ 1.892 (m)

1.2.2 Block Data Considering Water Level

(1)Body Weight

[1]Normal (With Buoyancy)

1)Block Diversion



2)Volume and Center of Gravity

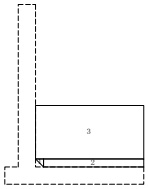
Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.650× 2.301× 1.000	1.496	0.825	1.801	1.234	2.693	
2	1.150× 0.650× 1.000	0.748	0.575	0.325	0.430	0.243	
3	4.050× 0.650× 1.000	2.632	3.175	0.325	8.358	0.856	
4	1/2× 0.300× 0.300× 1.000	0.045	1.250	0.750	0.056	0.034	
Σ		4.921	——	——	10.078	3.825	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 10.078／ 4.921 ＝ 2.048 (m)
YG = Σ (Vi Yi)/ΣVi = 3.825／ 4.921 ＝ 0.777 (m)

(2)Soil in Rear Side

[1]Normal (With Buoyancy 2)

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	1/2× 0.300× 0.300× 1.000	0.045	1.350	0.850	0.061	0.038	
2	3.750× 0.300× 1.000	1.125	3.325	0.800	3.741	0.900	
3	4.050× 2.001× 1.000	8.104	3.175	1.951	25.730	15.807	
Σ		9.274	——	——	29.532	16.745	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 29.532／ 9.274 ＝ 3.184 (m)
YG = Σ (Vi Yi)/ΣVi = 16.745／ 9.274 ＝ 1.806 (m)

1.2.3 Body Weight, Weight of Soil, Arbitrary Load, Vertical Force by Buoyancy, Horizontal Force

(1)Working Force Due to Body Weight

[1]Normal

Position	Vertical Force W = γ ・ V (kN)	Acting Position X (m)
Body(Reinforced)	24.500 × 7.386 ＝ 180.959	1.640
Soil (Rear Side)	20.000 × 9.975 ＝ 199.494	3.184
Total	380.453	2.449

[2]Seismic

Position	Vertical Force W = γ ・ V (kN)	Acting Position X (m)
Body(Reinforced)	24.500 × 7.386 ＝ 180.959	1.640
Soil (Rear Side)	20.000 × 9.975 ＝ 199.494	3.184
Total	380.453	2.449

Position	Horizontal Load H = W kh (kN)	Acting Position Y (m)
Body(Reinforced)	180.959 × 0.20 ＝ 36.192	2.136
Soil (Rear Side)	199.494 × 0.20 ＝ 39.899	1.892
Total	76.091	2.008

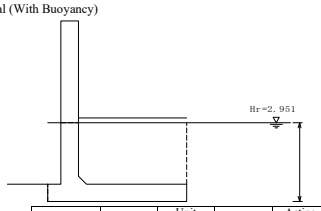
[3]Flood

Position	Vertical Force W = γ ・ V (kN)	Acting Position X (m)

Body(Reinforced)	24.500 × 7.386 ＝ 180.959	3.560
Soil (Rear Side)	19.000 × 9.975 ＝ 189.519	2.016
Total	370.479	2.770

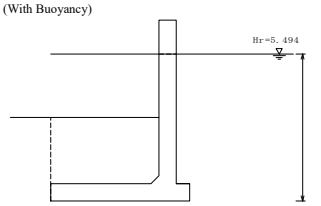
(2)Acting Force by Weight of Soil And Buoyancy

[1]Normal (With Buoyancy)



Position	Volume V (m3)	Unit Weight γ (kN/m3)	Buoyancy Fi (kN)	Acting Position Xi (m)	Fi/Xi
Body	4.921	9.800	48.223	2.048	98.767
Soil (Rear Side)	9.274	9.800	90.885	3.184	289.409
Total	——	——	139.108	——	388.176

[3]Flood (With Buoyancy)



Position	Volume V (m3)	Unit Weight γ (kN/m3)	Buoyancy Fi (kN)	Acting Position Xi (m)	Fi/Xi
Body	6.574	9.800	64.421	3.459	222.861
Soil (Front Side)	9.975	9.800	97.752	2.016	197.099
Soil (Rear Side)	——	——	162.173	——	419.960
Total	6.574	9.800	64.421	3.459	222.861

1.2.4 Load on the Surface

Vertical Force

$$N = \frac{1}{2} \cdot (q1+q2) \cdot L$$

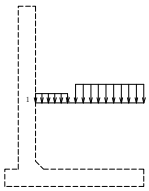
Horizontal Load

$$H = N \cdot kh$$

Here,

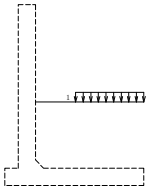
q : Load Intensity
L : Loading Length
kh: Design Horizontal Seismic Coefficient, kh = 0.200 (Medium)
X : Distance from the Toe to the Acting Position of Composited Force
Y : Distance from the Lower Surface of the Bottom Slab to the Acting Position of Composited Force

[1]Normal



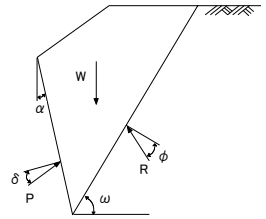
Item	q1 (kN/m2)	q2 (kN/m2)	L (m)	Vertical Force N (kN)	Horizontal Load H (kN)	Acting Position X (m)	Acting Position Y (m)
1	5.000	5.000	1.200	6.000	———	1.750	———
2	10.000	10.000	2.550	25.500	———	3.925	———

[2]Seismic



Item	q1 (kN/m2)	q2 (kN/m2)	L (m)	Vertical Force N (kN)	Horizontal Load H (kN)	Acting Position X (m)	Acting Position Y (m)
1	5.000	5.000	2.550	12.750	2.550	3.925	3.124

1.2.5 Earth Pressure and Water Pressure



[1]Normal (With Buoyancy 1)
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 3.124 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 2.95 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
61.00	5.826	24.618	17.317	47.761	23.295
62.00	5.588	23.615	16.611	45.814	23.343
63.00	5.355	22.629	15.918	43.902	23.343

The maximum earth pressure is determined by the following equation:
when ω = 62.00 ° P = 123.343 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{45.814 \times \sin(62.00^\circ - 35.00^\circ)}{\cos(62.00^\circ - 35.00^\circ - 0.000^\circ - 0.000^\circ)}$$

= 23.343 kN

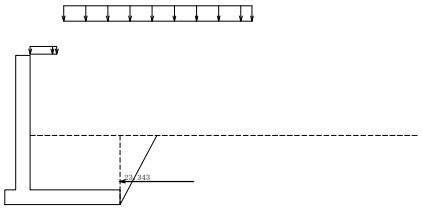
The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 23.343×cos(0.000°+ 0.000°) = 23.343 kN

Vertical Component
Pv = P · sin (α + δ) = 23.343×sin(0.000°+ 0.000°) = 0.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{3.124}{3} = 1.041 \text{ m}$$

x = xp-Ho · tan α = 5.200－1.041×tan0.000°= 5.200 mm
y = yp + Ho = 0.000＋1.041 = 1.041 m

・Earth Pressure Diagram



[2]Normal (Without Buoyancy)
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 3.124 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 2.951 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
61.00	54.097	0.000	17.317	71.414	34.831
62.00	51.892	0.000	16.611	68.503	34.904
63.00	49.727	0.000	15.918	65.645	34.904

The maximum earth pressure is determined by the following equation:
when ω = 62.00 ° P = 34.904 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{68.503 \times \sin(62.00^\circ - 35.00^\circ)}{\cos(62.00^\circ - 35.00^\circ - 0.000^\circ - 0.000^\circ)}$$

= 34.904 kN

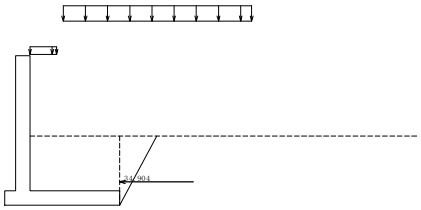
The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 34.904×cos(0.000°+ 0.000°) = 34.904 kN
Vertical Component
Pv = P · sin (α + δ) = 34.904×sin(0.000°+ 0.000°) = 0.000 kN

Acting Position

$$Ho = \frac{H}{3} = \frac{3.124}{3} = 1.041 \text{ m}$$

x = xp-Ho · tan α =5.200－1.041×tan0.000°= 5.200 m
y = yp + Ho =0.000＋1.041 = 1.041 m

・Earth Pressure Diagram



[3]Seismic
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 3.124 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Combined angle during earthquake θ = $\tan^{-1}$kh = $\tan^{-1}$0.20 = 11.310°
Wall Friction Angle

$$\delta = \tan^{-1}\frac{\sin\phi \cdot \sin(\theta + \Delta - \beta)}{1 - \sin\phi \cdot \cos(\theta + \Delta - \beta)}$$

$$= \tan^{-1}\frac{\sin 35.00^\circ \times \sin(11.310^\circ + 19.994^\circ - 0.000^\circ)}{1 - \sin 35.00^\circ \times \cos(11.310^\circ + 19.994^\circ - 0.000^\circ)}$$

= 30.303°

$$\Delta = \sin^{-1}\frac{\sin(\beta + \theta)}{\sin\phi} = \sin^{-1}\frac{\sin(0.000^\circ + 11.310^\circ)}{\sin 35.00^\circ} = 19.994^\circ$$

Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
46.00	94.245	0.000	15.084	109.329	44.846
47.00	91.008	0.000	14.566	105.574	44.874
48.00	87.874	0.000	14.064	101.938	44.825

The maximum earth pressure is determined by the following equation:
when ω = 47.00 ° P = 44.874 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{105.574 / \cos 11.310^\circ \times \sin(47.00^\circ - 35.00^\circ + 11.310^\circ)}{\cos(47.00^\circ - 35.00^\circ - 0.000^\circ - 30.303^\circ)}$$

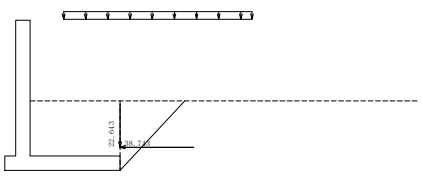
= 44.874 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 44.874×cos(0.000°+30.303°) = 38.743 kN
Vertical Component
Pv = P · sin (α + δ) = 44.874×sin(0.000°+30.303°) = 22.643 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{3.124}{3} = 1.041 \text{ m}$$

x = xp-Ho · tan α = 5.200－1.041×tan0.000°= 5.200 m
y = yp + Ho =0.000＋1.041 = 1.041 m

・Earth Pressure Diagram



[4] Flood (With Buoyancy)
The earth pressure is obtained by the trial wedge method.

Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 0.650 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 5.494 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
59.00	0.000	1.168	0.000	1.168	0.647
60.00	0.000	1.122	0.000	1.122	0.648
61.00	0.000	1.077	0.000	1.077	0.647

The maximum earth pressure is determined by the following equation:
when ω = 60.00 ° 0.648 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{1.122 \times \sin(60.00^\circ - 30.00^\circ)}{\cos(60.00^\circ - 30.00^\circ - 0.000^\circ - 0.000^\circ)}$$

$$= 0.648 \text{ kN}$$

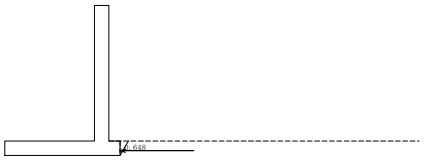
The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 0.648×cos(0.000°+ 0.000°) = 0.648 kN
Vertical Component
Pv = P · sin (α + δ) = 0.648×sin(0.000°+ 0.000°) = 0.000 kN

Acting Position

$$Ho = \frac{H}{3} = \frac{0.650}{3} = 0.217 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.217×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.217 = 0.217 m

・Earth Pressure Diagram



[5]Flood Without Buoyancy
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 0.650 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 5494 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
59.00	2.412	0.000	0.000	2.412	1.337
60.00	2.317	0.000	0.000	2.317	1.338
61.00	2.225	0.000	0.000	2.225	1.337

The maximum earth pressure is determined by the following equation:
when ω = 60.00 ° P = 1.338 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{2.317 \times \sin(60.00^\circ - 30.00^\circ)}{\cos(60.00^\circ - 30.00^\circ - 0.000^\circ - 0.000^\circ)}$$

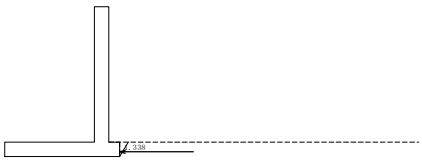
$$= 1.338 \text{ kN}$$

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 1.338×cos(0.000°+ 0.000°) = 1.338 kN
Vertical Component
Pv = P · sin (α + δ) = 1.338×sin(0.000°+ 0.000°) = 0.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{0.650}{3} = 0.217 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.217×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.217 = 0.217 m

・Earth Pressure Diagram



Passive earth Pressure
(This pressure is considered for the stability against Sliding)

[1]Flood
The earth pressure is obtained by the Mononobe ad Okabe method.
Height of the ground surface H = 3.024 m
Height above water surface H1 = 3.024 m
Height below water surface H2 = 0.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °

Coefficient of passive earth pressure

$$K = \frac{\cos^2(\phi + \alpha)}{\cos^2\alpha \cdot \cos(\alpha - \delta) \cdot \left[1 - \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi + \beta)}{\cos(\alpha - \delta) \cdot \cos(\alpha - \beta)}}\right]^2}$$

$$= \frac{\cos^2(35.00^\circ + 0.000^\circ)}{\cos^2 0.000^\circ \cdot \cos(0.000^\circ - 0.000^\circ)} \times \frac{1}{\left[1 - \sqrt{\frac{\sin(35.00^\circ + 0.000^\circ) \cdot \sin(35.00^\circ + 0.000^\circ)}{\cos(0.000^\circ - 0.000^\circ) \cdot \cos(0.000^\circ - 0.000^\circ)}}\right]^2}$$

$$= 3.6902$$

Earth pressure at the upper edge
p1= q・K = 9.500×3.6902 = 35.057 kN/m²

Earth pressure at the water surface
p2= K・γs・H1+p1
= 3.6902×19.000×3.024+35.057
= 247.081 kN/m²

Earth pressure at the bottom
p3= p2 = 247.081 kN/m²

Earth pressure above water surface

$$P1 = \frac{1}{2} \cdot (p1 + p2) \cdot H1 = \frac{1}{2} \times (35.057 + 247.081) \times 3.024 = 426.592 \text{ kN}$$

Earth pressure below water surface

$$P2 = \frac{1}{2} \cdot (p2 + p3) \cdot H2 = \frac{1}{2} \times (247.081 + 247.081) \times 0.000 = 0.000 \text{ kN}$$

Total Earth pressure
P = P1+P2 = 426.592+0.000 = 426.592 kN

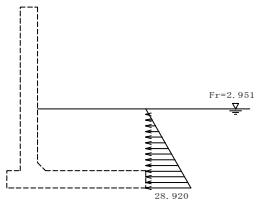
Total Earth pressure at horizontal direction
Ph = P・cos(α−δ) = 426.592×cos(0.000°− 0.000°) = 426.592 kN

Hydrostatic Pressure

$$P = \frac{1}{2} \cdot \gamma w \cdot h^2$$

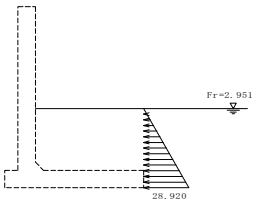
$$Y = \frac{h}{3}$$

Where、
γw : unit weiht of water (kN/m³), γw=9.800
h : water head (m)
Y : acting point (m)
[1]Normal with Buoyancy



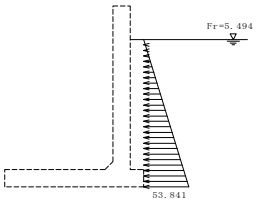
	h (m)	P (kN)	Acting Point Y (m)
Rear	2.951	42.671	0.984

[2]Normal without Buoyancy



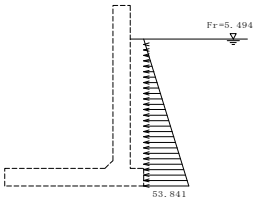
	h (m)	P (kN)	Acting Point Y (m)
Rear	2.951	42.671	0.984

[3]Flood with Buoyancy



	h (m)	P (kN)	Acting Point Y (m)
Front	5.494	147.902	1.831

[4]Flood without Buoyancy

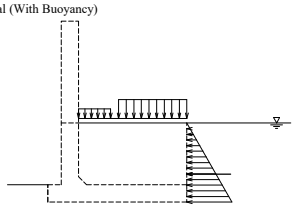


	h (m)	P (kN)	Acting Point Y (m)
Front	5.494	147.902	1.831

1.2.6 Summary of Acting Forces

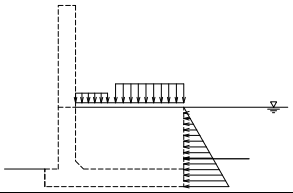
(1)Summary of Forces Acting On the Footing Front

[1]Normal (With Buoyancy)



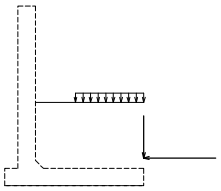
Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length Xi (m)	Arm length Yi (m)	Angular Moment (kN.m.) Mxi = Ni, Xi	Angular Moment (kN.m.) Myi = Hi Yi
Body Weight	380.453	0.000	2.449	0.000	931.874	0.000
Buoyancy	-139.108	0.000	2.790	0.000	-388.176	0.000
Load on Surface	31.500	0.000	3.511	0.000	110.588	0.000
Rear Side Water Pressure	0.000	42.671	0.000	0.984	0.000	41.974
Earth Pressure	0.000	23.343	5.200	1.041	0.000	24.300
Total	272.845	66.014	———	———	654.286	66.274

[2]Normal (Without Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length Xi (m)	Arm length Yi (m)	Angular Moment (kN.m.) Mxi = Ni, Xi	Angular Moment (kN.m.) Myi = Hi Yi
Body Weight	380.453	0.000	2.449	0.000	931.874	0.000
Load on Surface	31.500	0.000	3.511	0.000	110.588	0.000
Rear Side Water Pressure	0.000	42.671	0.000	0.984	0.000	41.974
Earth Pressure	0.000	34.904	5.200	1.041	0.000	36.335
Total	411.953	77.575	———	———	1042.462	78.309

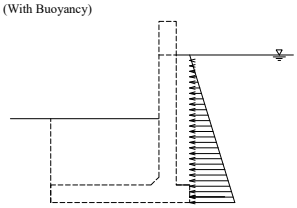
[3]Seismic (With Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length Xi (m)	Arm length Yi (m)	Angular Moment (kN.m.) Mxi = Ni, Xi	Angular Moment (kN.m.) Myi = Hi Yi
Body Weight	380.453	76.091	2.449	2.008	931.874	152.798
Load on Surface	12.750	2.550	3.925	3.124	50.044	7.966
Earth Pressure	22.643	38.743	5.200	1.041	117.744	40.331
Total	415.846	117.384	———	———	1099.661	201.096

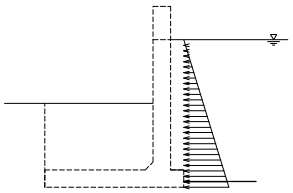
Load Condition (Water Level)	No (kN)	Ho (kN)	Mo (kN.m.)
Normal (With Buoyancy)	272.845	66.014	588.011
Normal (Without Buoyancy)	411.953	77.575	964.152
Seismic (With Buoyancy)	415.846	117.384	898.565
Seismic (Without Buoyancy)	415.846	117.384	898.565

[4]Flood (With Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length Xi (m)	Arm length Yi (m)	Angular Moment (kN.m.) Mxi = Ni, Xi	Angular Moment (kN.m.) Myi = Hi Yi
Body Weight	370.479	0.000	2.770	0.000	1026.372	0.000
Buoyancy	-162.173	0.000	2.590	0.000	-419.960	0.000
Load on Surface	0.000	147.902	0.000	1.831	0.000	270.857
Rear Side Water Pressure	0.000	0.648	5.200	0.217	0.000	0.141
Earth Pressure	208.305	148.550	———	———	606.412	270.998
Total	370.479	0.000	2.770	0.000	1026.372	0.000

[5] Flood (Without Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length Xi (m)	Arm length Yi (m)	Angular Moment (kN.m.) Mxi = Ni, Xi	Angular Moment (kN.m.) Myi = Hi Yi
Body Weight	370.479	0.000	2.770	0.000	1026.372	0.000
Rear Side Water Pressure	0.000	147.902	0.000	1.831	0.000	270.857
Earth Pressure	0.000	1.338	5.200	0.217	0.000	0.290
Total	370.479	149.240	———	———	1026.372	271.148

Load Condition (Water Level)	No (kN)	Ho (kN)	Mo (kN.m.)
Flood (With Buoyancy)	208.305	148.550	335.414
Flood (Without Buoyancy)	370.479	149.240	755.224

(2)Summary of Forces Acting At the Footing Center

Vertical Force : Nc = No (kN)
Horizontal Force : Hc = Ho (kN)
Turning Moment : Mc = No Bj/2.0 - Mo (kN.m.)

Here,

Footing Width in Earth Pressure Direction : Bj = 7.500 (m)

■Per Unit Width

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal (With Buoyancy)	272.845	66.014	121.386
Normal (Without Buoyancy)	411.953	77.575	106.927
Seismic (With Buoyancy)	415.846	117.384	182.635
Seismic (Without Buoyancy)	415.846	117.384	182.635
Flood (With Buoyancy)	208.305	148.550	206.180
Flood (Without Buoyancy)	370.479	149.240	208.020

■Per full width (9.000 m)

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal (With Buoyancy)	1364.226	330.071	606.932
Normal (Without Buoyancy)	2059.767	387.876	534.633
Seismic (With Buoyancy)	2079.232	586.918	913.177

Seismic (Without Buoyancy)	2079.232	586.918	913.177
Flood (With Buoyancy)	1041.527	742.749	1030.898
Flood (Without Buoyancy)	1852.394	746.199	1040.102

1.2.7 Stability Analysis Results

1.2.7.1 Stability against Overturning

(1)Calculation of Acting Point of Composited Force and Eccentricity

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,

d: Distance from the Toe of Bottom Slab to the Acting Point of Composited Force (m)
ΣMr: Resistive Moment of Toe of Bottom Slab (kN.m.)
ΣMt: Overturning Moment of Toe of Bottom Slab (kN.m.)
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)

$$e = \frac{B}{2} - d$$

Here,

e: Eccentricity from the Center of Bottom Slab to the Acting Point of Composited Force (m);
B: Bottom Slab Width (m), B = 7.500

ea = B/n

Here,

ea: Allowable Eccentricity (m)
n: Safety Factor

Load Condition (Water Level)	Σ Mr (kN.m.)	Σ Mt (kN.m.)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal (With Buoyancy)	654.286	66.274	272.845	2.155	0.445	≦	0.867
Seismic (With Buoyancy)	1099.661	201.096	415.846	2.161	0.439	≦	1.733
Flood (With Buoyancy)	606.412	270.998	208.305	1.610	0.990	≦	1.733

1.2.7.2 Stability Against Sliding

$$F_s = \frac{\Sigma V \cdot \mu + C_B \cdot B + \alpha \cdot Pp}{\Sigma H}$$

Here,

ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
ΣH: Total Horizontal Load in Lower Side of Bottom Slab (kN)
m.: Cohesion Between Bottom Slab and Supporting Ground, m = 0.577
C_B: Cohesion Between Bottom Slab And Supporting Ground (kN/m2), C_B = 0.000
B: Bottom Slab Width (m), B = 7.500
α: Effeective Rate of Passive Earth Pressure
Pp: Passive Earth Pressure

Load Condition (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Passive Earth Pressure Pp(kN)	Effectiive Rate	Safety Factor Fs		Required Safety Factor Fsa
Normal (With Buoyancy)	272.845	66.014	—	—	2.067	≧	1.500
Seismic (With Buoyancy)	415.846	117.384	—	—	1.771	≧	1.200
Flood (With Buoyancy)	208.305	148.550	426.592	0.500	2.137	≧	1.200

1.2.7.3 Verification of Bearing

1)When the Acting Point of Composited Force is within the 1/3 of Bottom Slab Width (middle third) in the Center of the Bottom Slab.

$$q_1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6e}{B}\right)$$

$$q_2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6e}{B}\right)$$

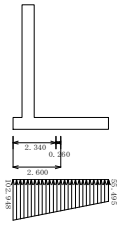
2)When the Acting Point of Composited Force is within the 2/3 of Bottom Slab Width in the Center of the Bottom Slab.

$$q_1 = \frac{2\Sigma V}{3 \cdot (B/2 - e)}$$

Here,

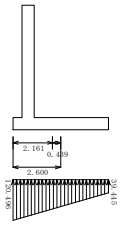
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
B: Bottom Slab Width (m), B = 7.500
e: Eccentricity (m)

[1]Normal (Without Buoyancy)



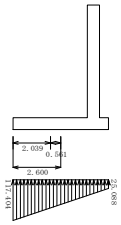
Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2) qmin	qmax		Allowance
5.200	Trapezoid	55.495	102.948	≦	200.000

[2]Seismic (With Buoyancy)



Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2) qmin	qmax		Allowance
5.200	Trapezoid	39.445	120.496	≦	300.000

[3]Flood (With Buoyancy)



Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2) qmin	qmax		Allowance
5.200	Trapezoid	25.088	117.404	≦	300.000

1.3 Vertical Wall Design

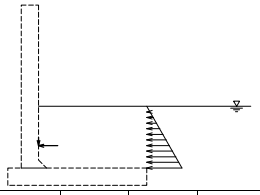
1.3.1 Checking Position

Distance from Base = 0.000 m

1.3.2 Calculation of Cross-Sectional Force

(Vertical forces are not summarized due to disregard of eccentric moments and axial forces)

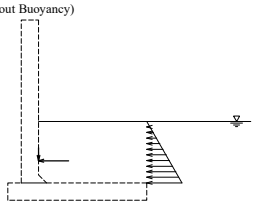
[1]Normal (With Buoyancy)



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	98.149	0.000	-0.005	0.000	0.000
Hydrostatic on Rear Side	0.000	25.944	0.000	0.767	19.899
Earth Pressure	4.480	10.386	-0.325	0.825	8.568
Total	0.000	36.330	———	———	28.467

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

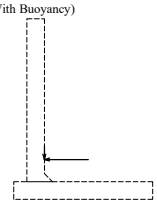
[2]Normal (Without Buoyancy)



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	98.149	0.000	-0.005	0.000	0.000
Hydrostatic on Rear Side	0.000	25.944	0.000	0.767	19.899
Earth Pressure	6.957	16.128	-0.325	0.825	13.306
Total	0.000	42.072	———	———	33.204

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

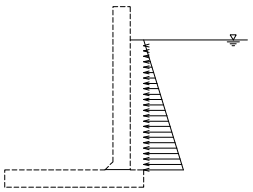
[3]Seismic (With Buoyancy)



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	98.149	19.630	-0.005	3.014	59.162
Earth Pressure	7.450	23.628	-0.325	0.825	19.493
Total	0.000	43.258	———	———	78.656

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

[5]Flood

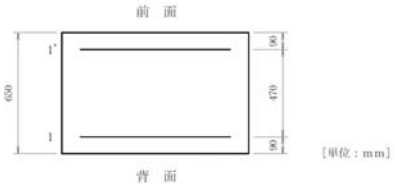


Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	98.149	0.000	0.005	0.000	0.000
Hydrostatic on Rear Side	0.000	114.975	0.000	1.615	185.647
Hydrostatic on Front Side	0.000	114.975	———	———	185.647
Earth Pressure	98.149	0.000	0.005	0.000	0.000
Total	0.000	114.975	0.000	1.615	185.647

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

1.3.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D25	5.067	8.00	40.536
	2'	—	–	——	—	——
Back	1	9.0	D25	5.067	8.00	40.536
	2	—	–	——	—	——

Required Reinforcement in Tension Side 7.923 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2+\frac{2\cdot n}{b}\{As\cdot(x-d)\}=0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c=\frac{M}{\frac{b\cdot x}{2}\cdot\left(\frac{h}{2}-\frac{x}{3}\right)+n\cdot As\cdot\frac{(x-d)\cdot(h/2-d)}{x}}$$

$$\sigma_s=n\cdot\sigma_c\cdot\frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	N (kN)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
				Calculated	Allowance	Calculated	Allowance
Normal (Without Buoyancy)	33.204	0.000	15.671	0.705 ≦	8.200	16.333 ≦	140.000
Seismic (With Buoyancy)	78.656	0.000	15.671	1.670 ≦	10.906	38.691 ≦	186.200

Flood (Without Buoyancy)	185.647	0.000	11.846	5.312 ≦ 10.906	178.199 ≦ 186.200

(3)Verification of Shear Stress

$$\tau_m=\frac{S_h}{b\cdot d}\leqq\tau_{a1}$$

Here,

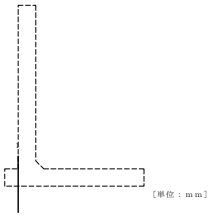
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)		
			Calculated	Allowable τa1	Allowable τa2
Normal (With Buoyancy)	36.330	56.000	0.065 ≦	0.360	0.360
Seismic (With Buoyancy)	43.258	56.000	0.077 ≦	0.479	0.479
Flood (With Buoyancy)	114.975	56.000	0.205 ≦	0.479	0.479

1.4 Design of Toe Slab

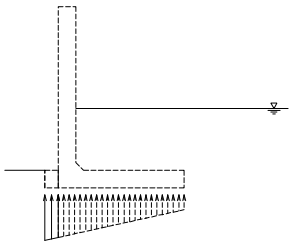
1.4.1 Checking Position

Distance from Base = 0.000 m



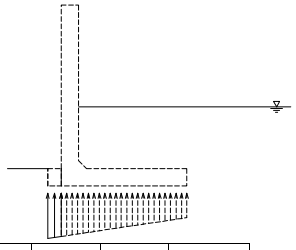
1.4.2 Calculation of Cross-Sectional Force

[1]Normal (With Buoyancy)



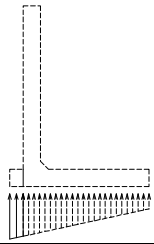
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-7.963	0.250	-1.991
Buoyancy	3.185	0.250	0.796
Subgrade Reaction	38.408	0.253	9.710
Total	33.630	———	8.516

[2]Normal (Without Buoyancy)



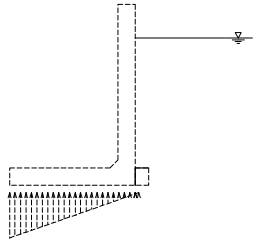
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-7.963	0.250	-1.991
Subgrade Reaction	50.333	0.252	12.678
Total	42.371	———	10.688

[3]Seismic 1 (With Buoyancy)



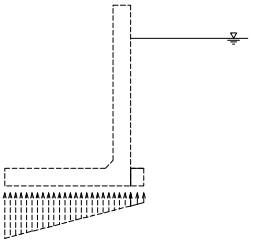
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-7.963	0.250	-1.991
Subgrade Reaction	58.300	0.253	14.737
Total	50.337	———	12.747

[5]Flood (With Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	7.963	0.250	1.991
Buoyancy	-3.185	0.250	-0.796
Subgrade Reaction	-0.151	0.043	-0.007
Total	4.627	———	1.188

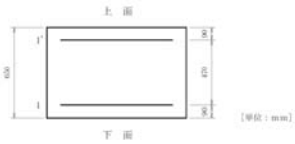
[6]Flood (Without Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	7.963	0.250	1.991
Subgrade Reaction	-14.763	0.237	-3.506
Total	-6.801	———	-1.515

1.4.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D25	5.067	8.00	40.536
	2'	—	–	——	—	——
Back	1	9.0	D25	5.067	8.00	40.536
	2	—	–	——	—	——

Required Reinforcement in Tension Side 0.144 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2+\frac{2\cdot n}{b}\{As\cdot(x-d)\}=0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c=\frac{M}{\frac{b\cdot x}{2}\cdot\left(\frac{h}{2}-\frac{x}{3}\right)+n\cdot As\cdot\frac{(x-d)\cdot(h/2-d)}{x}}$$

$$\sigma_s=n\cdot\sigma_c\cdot\frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
			Calculated	Allowance	Calculated	Allowance
Normal (Without Buoyancy)	10.688	16.893	0.227 ≦	8.200	5.257 ≦	140.000
Seismic (With Buoyancy)	12.747	16.893	0.271 ≦	10.906	6.270 ≦	186.200
Flood (Without Buoyancy)	-1.515	15.671	0.032 ≦	10.906	0.745 ≦	186.200

(3)Verification of Shear Stress

$$\tau_m=\frac{S_h}{b\cdot d}\leqq\tau_{a1}$$

Here,

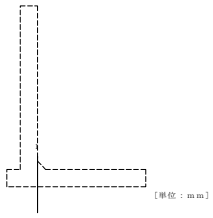
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)	
			Calculated	Allowable τa
Normal (With Buoyancy)	15.088	560.000	0.027 ≦	0.360
Seismic 1 (With Buoyancy)	18.060	560.000	0.032 ≦	0.479
Flood (With Buoyancy)	6.801	560.000	0.012 ≦	0.479

1.5 Design of the Heel Slab

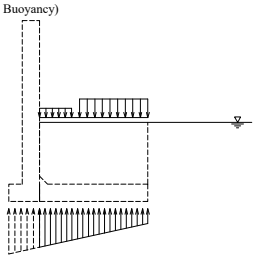
1.5.1 Checking Position

Distance from Base = 0.000 m



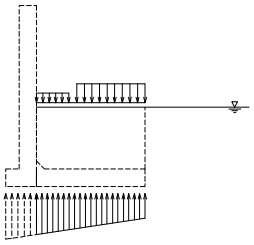
1.5.2 Calculation of Cross-Sectional Force

[1]Normal (With Buoyancy)



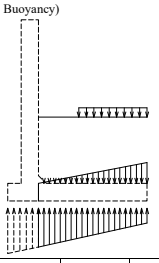
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	265.093	2.023	536.423
Buoyancy	-117.125	2.025	-237.178
Load on Surface	31.500	2.361	74.363
Subgrade Reaction	-188.379	1.721	-324.117
Total	-8.911	———	49.491

[2]Normal (Without Buoyancy)



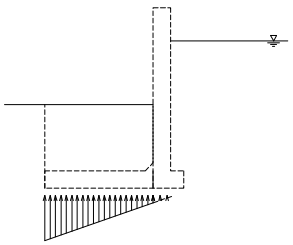
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	265.093	2.023	536.423
Load on Surface	31.500	2.361	74.363
Subgrade Reaction	-299.596	1.856	-556.164
Total	-3.003	———	54.622

[3]Seismic (With Buoyancy)



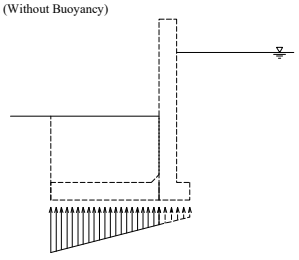
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	265.093	2.023	536.423
Load on Surface	12.750	2.775	35.381
Earth Pressure	22.643	2.700	61.136
Subgrade Reaction	-287.583	1.725	-496.070
Total	12.903	———	136.870

[4]Flood (With Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-255.118	2.023	-516.138
Buoyancy	123.992	2.025	251.083
Subgrade Reaction	202.873	2.512	509.679
Total	71.747	———	244.624

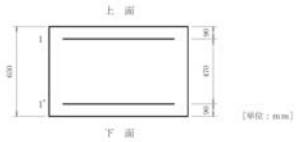
[6]Flood (Without Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-255.118	2.023	-516.138
Subgrade Reaction	329.889	2.323	766.303
Total	74.771	———	250.166

1.5.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D25	5.067	8.00	40.536
	2'	—	–	——	—	——
Back	1	9.0	D25	5.067	8.00	40.536
	2	—	–	——	—	——

Required Reinforcement in Tension Side 26.183 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2 + \frac{2 \cdot n}{b}\left\{As \cdot (x-d)\right\} = 0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot As \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2) Calculated	Allowance	Tensile Stress (N/mm2) Calculated	Allowance
Normal (Without Buoyancy)	33.204	15.671	0.705 ≦	8.200	16.333 ≦	140.000
Seismic (With Buoyancy)	78.656	15.671	1.670 ≦	10.906	38.691 ≦	186.200
Flood (Without Buoyancy)	250.166	15.671	5.313 ≦	10.906	123.057 ≦	186.200

(3)Verification of Shear Stress

$$\tau_m = \frac{S_h}{b \cdot d} \leqq \tau_{a1}$$

Here,

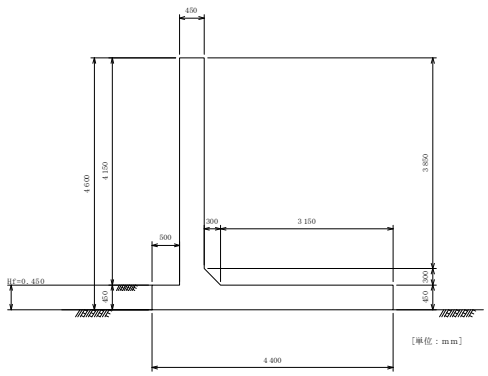
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2) Calculated	Allowable τa2
Normal (With Buoyancy)	8.911	560.000	0.016 ≦	0.360
Seismic (With Buoyancy)	12.903	560.000	0.023 ≦	0.479
Flood (With Buoyancy)	79.745	560.000	0.142 ≦	0.479

2 Invert T-shaped Wall, Left Bank Sta.11+400

2.1 Design Conditions

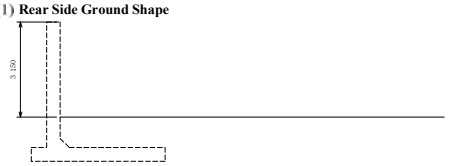
2.1.1 Geometry



Depth Width (Block Length) B = 5000 (mm)

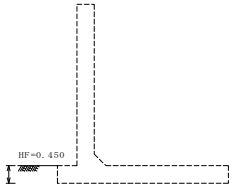
2.1.2 Backfill and Embankment

(1) Rear Side Ground Shape



Level Difference Between Retaining Wall Crown And Ground Surface Start Point	(m)	3.150
Height Without Considering Earth Pressure Hr (in stability analysis) Hr	(m)	0.000

(2) Front Side Ground Shape



Height	Stability Analysis		Design of Toe Slab
	Vertical	Horizontal	
0.00	Not Considered	Not Considered	Not Considered

2.1.3 Material

[Concrete] Vertical wall (reinforced concrete) : σck = 20.0 (N/mm2)
Base concrete (reinforced concrete) : σck = 20.0 (N/mm2)

[Iron bar] Type: : Grade 275

[Soil] Backfill : sand and gravel
Foudation : sandy gravel

[Internal Fdiction] Backfill : 30 degrees

[Unit weight]
(kN/m3)

Body	24.500	
Water	9.800	
Soil	Wet weight	Saturated weight

River side	20.000	20.800
Land side	20.000	20.800

[Seismic Intensity] Body : 0.200
Foundation Riverside : 0.200
Foundation Landside : 0.200

2.1.4 Loads

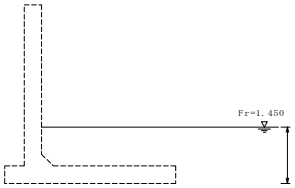
[1]Normal
Not Concidered

[2]Seismic
Not Concidered

[3]Flood
Not Concidered

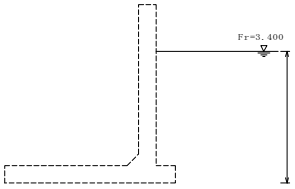
2.1.5 Water Level

[1]Normal
■With Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 1.450 m



[2]Seidmic
Not Considered

[3]Flood
■With Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 3.400 m



2.1.6 Buoyancy

・Use the Water Level in Rear Side

2.1.7 Earth Pressure

・Earth Pressure Formulas: Trial Wedge

・Angle of Friction of Earth Pressure Acting Surface (Degrees)

Load Condition	Active Earth Pressure			Passive Earth Pressure
	In Case of Stability Analysis	In Case of Vertical Wall Design	Cut	
Normal Earth Pressure	0.000	20.000	———	———
Seismic Earth Pressure	25.683	15.000	———	———
Flood Earth Pressure	0.000	0.000	———	0.000

・ The virtual rear surface of earth pressure in the stability analysis is at the heel end (a line extended vertically from the heel)

・ Angle between the earth pressure acting surface and the vertical plane in stability analysis
0.000 (degrees)

・ Angle between the earth pressure working surface and the vertical plane when designing the vertical wall
Normal, Seismic 0.000 (degrees)
Flood 0.000 (degrees)

・The Design Horizontal Seismic Coefficient is applied to the inertia force during earthquakes when calculating the earth pressure below the water level.

・Passive Earth Pressure

Load Condition	Height of Acting	Effectivity
Flood	0.950	0.500

・Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal Condition	0.000	0.000	———
Seismic Condition	0.000	0.000	0.000
Flood Condtion	0.000	0.000	0.000

・Consideration of Earth Pressure Different from Direction of Earthquake Motion

	Consideration I...	Effectivity
Stability Analysis	Seismic Earth Pressure	0.500
Vertical Wall Design		0.500

2.1.8 Water Pressure

・Concept of Calculation of Hydrostatic Pressure

Load Condition	Rear Side	Front Side
Normal Condition	Considered	Considered
Seismic Condition	Considered	Considered
Flood Condition	Considered	Considered

・Consideration of Hydrostatic Pressure Different from the Direction of Earthquake Motion

Outside Water Level	Stability analysis	Considered
	Vertical Wall Design	Considered

・Consideration of Dynamic Water Pressure Calculation

Outside Water Level	Considered

2.1.9 Load Combination Case

No	Load Name	Comments
1	Normal	
2	Seismic	Seismic
3	Flood	Flood

	Load Name	1	2	3
Soil	Front Soil 1	○	○	
	Front Soil 2			○
Water Level	Buoyancy 1	○		
	Buoyancy 2		○	
	Buoyancy 3			○
Load	Load 1			○
Active Earth Pressure	Not Considered			
	Normal Earth Pressure	○		○
	Seismic Earth Pressure		○	
Passive Earth Pressure	Passive Earth Pressure 1			○

2.1.10 Foundation Conditions

2.1.10.1 Data For Calculating Allowable Shear Resistance

Bottom Slab Width Used for Analysis		All Width
Cohesion Between Foundation Bottom Surface And Ground	C_B (kN/m2)	0.000
Friction Coefficient Between Foundation Bottom Surface and Ground	tan φ_B	0.500

2.1.11 Allowable Values For Stability Analysis And Allowable Stresses of Members

2.1.11.1 Allowance in Stability Analysis

Load Condition	Allowable Eccentricity eB/B (m)	Safety Factor for Overturning	Allowable Subgrade Reaction Intensity (kN/m2)
Normal	1/6	1.500	200.000
Seismic, Flood	1/3	1.200	300.000

2.1.11.2 Allowable Stress of the Member

(1)Reinforced Concrete Member

1) Vertical Wall (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic, Flood	1.33	10.906	186.200	0.479	0.479

2) Bottom Slab (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic, Flood	1.33	10.906	186.200	0.479	0.479

Here,

τa1: Shear Stress When Shear Force is Applied Only by Concrete

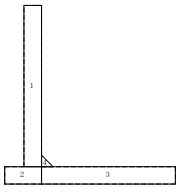
τa2: Shear Stress when Jointly Bearing with Oblique Tensile Reinforcement

2.2 Stability Analysis

2.2.1 Block Data Not Considering Water Level

(1)Body Weight

1)Block Diversion



2)Weight and Center of Gravity

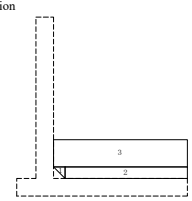
Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.450× 4.150× 1.000	1.867	0.725	2.525	1.354	4.715	
2	0.950× 0.450× 1.000	0.428	0.475	0.225	0.203	0.096	
3	3.450× 0.450× 1.000	1.553	2.675	0.225	4.153	0.349	
4	1/2× 0.300× 0.300× 1.000	0.045	1.050	0.550	0.047	0.025	
Σ		3.893	——	——	5.757	5.186	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 5.757／ 3.893 ＝ 1.479 (m)

YG = Σ (Vi Yi)/ΣVi = 5.186／ 3.893 ＝ 1.332 (m)

(2)Soil in Rear Side

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	1/2× 0.300× 0.300× 1.000	0.045	1.150	0.650	0.052	0.029	
2	3.150× 0.300× 1.000	0.945	2.825	0.600	2.670	0.567	
3	3.450× 0.700× 1.000	2.415	2.675	1.100	6.460	2.657	
Σ		3.405	——	——	9.181	3.253	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 9.181／ 3.405 ＝ 2.696 (m)

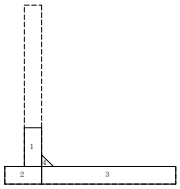
YG = Σ (Vi Yi)/ΣVi = 3.253／ 3.405 ＝ 0.955 (m)

2.2.2 Block Data Considering Water Level

(1)Body Weight

[1]Normal (With Buoyancy 2)

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.450× 1.000× 1.000	0.450	0.725	0.950	0.326	0.427	
2	0.950× 0.450× 1.000	0.428	0.475	0.225	0.203	0.096	
3	3.450× 0.450× 1.000	1.553	2.675	0.225	4.153	0.349	
4	1/2× 0.300× 0.300× 1.000	0.045	1.050	0.550	0.047	0.025	
Σ		2.475	——	——	4.729	0.898	

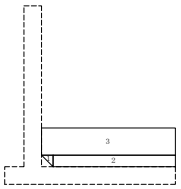
Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 4.729／ 2.475 ＝ 1.911 (m)

YG = Σ (Vi Yi)/ΣVi = 0.898／ 2.475 ＝ 0.363 (m)

(2)Soil in Rear Side

[1]Normal (With Buoyancy 2)

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m)		Vi/Xi	Vi Yi	Remarks
			Xi	Yi			
1	1/2× 0.300× 0.300× 1.000	0.045	1.150	0.650	0.052	0.029	
2	3.150× 0.300× 1.000	0.945	2.825	0.600	2.670	0.567	
3	3.450× 0.700× 1.000	2.415	2.675	1.100	6.460	2.657	
Σ		3.405	——	——	9.181	3.253	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 9.181／ 3.405 ＝ 2.696 (m)
YG = Σ (Vi Yi)/ΣVi = 3.253／ 3.405 ＝ 0.955 (m)

2.2.3 Body Weight, Weight of Soil, Arbitrary Load, Vertical Force by Buoyancy, Horizontal Force

(1)Working Force Due to Body Weight
[1]Normal

Position	Vertical Force W = γ ・ V (kN)			Acting Position X (m)
Body(Reinforced)	24.500 ×	3.893 ＝	95.366	1.479
Soil (Rear Side)	19.000 ×	3.405 ＝	64.695	2.696
Total			160.061	1.971

[2]Seismic

Position	Vertical Force W = γ ・ V (kN)			Acting Position X (m)
Body(Reinforced)	24.500 ×	3.893 ＝	95.366	1.479
Soil (Rear Side)	19.000 ×	3.405 ＝	64.695	2.696
Total			160.061	1.971

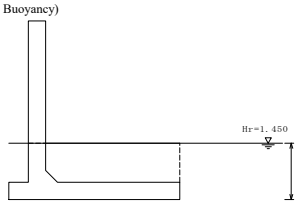
Position	Horizontal Load H = W kh (kN)			Acting Position Y (m)
Body(Reinforced)	95.366 ×	0.20 ＝	19.073	1.332
Soil (Rear Side)	64.695 ×	0.20 ＝	12.939	0.955
Total			32.012	1.180

[3]Flood

Position	Vertical Force W = γ ・ V (kN)			Acting Position X (m)
Body(Reinforced)	24.500 ×	3.892 ＝	95.366	2.921

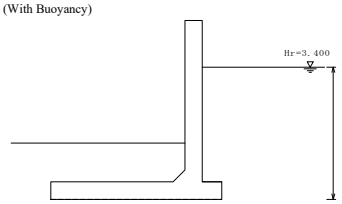
Soil (Rear Side)	19.000 ×	3.405 ＝	64.695	1.704
Total			160.061	2.429

(2)Acting Force by Weight of Soil And Buoyancy
[1]Normal (With Buoyancy)



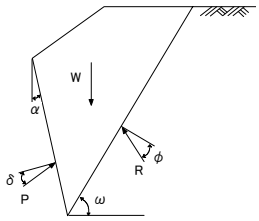
Position	Volume V (m3)	Unit Weight γ (kN/m3)	Buoyancy Fi (kN)	Acting Position Xi (m)	Fi/Xi
Body	2.475	9.800	24.255	1.911	46.349
Soil (Rear Side)	3.405	9.800	33.369	2.696	89.979
Total	——	——	57.624	——	136.328

[3]Flood (With Buoyancy)



Position	Volume V (m3)	Unit Weight γ (kN/m3)	Buoyancy Fi (kN)	Acting Position Xi (m)	Fi/Xi
Body	0.225	9.800	2.205	4.150	9.151
Total	——	——	2.205	——	9.151

2.2.4 Earth Pressure and Water Pressure



[1]Normal (With Buoyancy)
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 4.400 m
yp = 0.000 m
Height of Virtual Rear Surface H = 1.450 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 1.450 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
59.00	0.000	5.811	0.000	5.811	3.221
60.00	0.000	5.584	0.000	5.584	3.224
61.00	0.000	5.361	0.000	5.361	3.221

The maximum earth pressure is determined by the following equation:
when ω = 60.00 ° P = 3.224 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{5.584 \times \sin(60.00^\circ - 30.00^\circ)}{\cos(60.00^\circ - 30.00^\circ - 0.000^\circ - 0.000^\circ)}$$

$$= 3.224 \text{ kN}$$

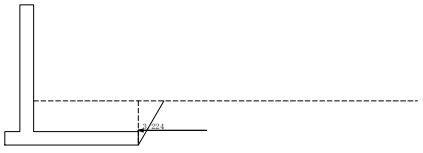
The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P ・ cos (α + δ) = 3.224×cos(0.000°＋ 0.000°) ＝ 3.224 kN
Vertical Component

Pv = P ・ sin (α + δ) = 3.224×sin(0.000°＋ 0.000°) ＝ 0.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{1.450}{3} = 0.483 \text{ m}$$

x = xp-Ho ・ tan α = 4.400－0.483×tan0.000°＝ 4.400 m
y = yp + Ho =0.000＋0.483 ＝ 0.483 m

・Earth Pressure Diagram



[2]Seismic
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 4.400 m
yp = 0.000 m
Height of Virtual Rear Surface H = 1.450 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Combined angle during earthquake θ ＝ $\tan^{-1}$kh ＝ $\tan^{-1}$0.20 ＝ 11.310°
Wall Friction Angle

$$\delta = \tan^{-1}\frac{\sin\phi \cdot \sin(\theta + \Delta - \beta)}{1 - \sin\phi \cdot \cos(\theta + \Delta - \beta)}$$

$$= \tan^{-1}\frac{\sin 30.00^\circ \times \sin(11.310^\circ + 23.094^\circ - 0.000^\circ)}{1 - \sin 30.00^\circ \times \cos(11.310^\circ + 23.094^\circ - 0.000^\circ)}$$

$$= 25.683^\circ$$

$$\Delta = \sin^{-1}\frac{\sin(\beta + \theta)}{\sin\phi} = \sin^{-1}\frac{\sin(0.000^\circ + 11.310^\circ)}{\sin 30.00^\circ} = 23.094^\circ$$

Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
42.00	22.183	0.000	0.000	22.183	9.213
43.00	21.419	0.000	0.000	21.419	9.217
44.00	20.683	0.000	0.000	20.683	9.208

The maximum earth pressure is determined by the following equation:

when ω = 43.00 °　P = 9.217 kN

Earth Pressure

$$P = \frac{W/\cos\theta \cdot \sin(\omega-\phi+\theta)}{\cos(\omega-\phi-\alpha-\delta)}$$

$$= \frac{21.419/\cos 11.310^\circ \times \sin(43.00^\circ - 30.00^\circ + 11.310^\circ)}{\cos(43.00^\circ - 30.00^\circ - 0.000^\circ - 25.683^\circ)}$$

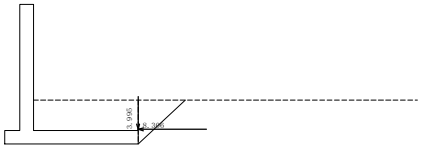
$$= 9.217 \text{ kN}$$

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P ・ cos (α + δ) = 9.217×cos(0.000°+25.683°) = 8.306 kN
Vertical Component
Pv = P · sin (α + δ) = 9.217×sin(0.000°+25.683°) = 3.995 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{1.450}{3} = 0.483 \text{ m}$$

x = xp-Ho ・ tan α = 4.400－0.483×tan0.000°= 4.400 m
y = yp + Ho =0.000＋0.483 = 0.483 m

・Earth Pressure Diagram



[3]Flood (With Buoyancy)
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 4.400 m
yp = 0.000 m
Height of Virtual Rear Surface H = 0.450 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 27.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 °～ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 2.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
57.00	0.000	0.605	0.000	0.605	0.349
58.00	0.000	0.582	0.000	0.582	0.350
59.00	0.000	0.560	0.000	0.560	0.350

The maximum earth pressure is determined by the following equation:
when ω = 58.00 °　P = 0.350 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega-\phi)}{\cos(\omega-\phi-\alpha-\delta)}$$

$$= \frac{0.582 \times \sin(58.00^\circ - 27.00^\circ)}{\cos(58.00^\circ - 27.00^\circ - 0.000^\circ - 0.000^\circ)}$$

$$= 0.350 \text{ kN}$$

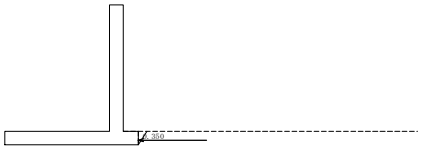
The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P ・ cos (α + δ) = 0.350×cos(0.000°+ 0.000°) = 0.350 kN
Vertical Component
Pv = P · sin (α + δ) = 0.350×sin(0.000°+ 0.000°) = 0.000 kN

Acting Position

$$Ho = \frac{H}{3} = \frac{0.450}{3} = 0.150 \text{ m}$$

x = xp-Ho ・ tan α = 4.400－0.150×tan0.000°= 4.400 m
y = yp + Ho =0.000＋0.150 = 0.150 m

・Earth Pressure Diagram



Passive earth Pressure
(This pressure is considered for the stability against Sliding)

[1]Flood
The earth pressure is obtained by the Mononobe ad Okabe method.
Height of the ground surface H = 0.950 m
Height above water surface H1 = 0.950 m
Height below water surface H2 = 0.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 19.000 kN/m3
Internal Friction Angle of Soil φ = 30.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °

Coefficient of passive earth pressure

$$K = \frac{\cos^2(\phi+\alpha)}{\cos^2\alpha \cdot \cos(\alpha-\delta) \cdot \left[1-\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi+\beta)}{\cos(\alpha-\delta)\cdot\cos(\alpha-\beta)}}\right]^2}$$

$$= \frac{\cos^2(30.00^\circ + 0.000^\circ)}{\cos^2 0.000^\circ \cdot \cos(0.000^\circ - 0.000^\circ)} \times \frac{1}{\left[1-\sqrt{\frac{\sin(30.00^\circ + 0.000^\circ)\cdot\sin(30.00^\circ + 0.000^\circ)}{\cos(0.000^\circ - 0.000^\circ)\cdot\cos(0.000^\circ - 0.000^\circ)}}\right]^2}$$

$$= 3.0000$$

Earth pressure at the upper edge
p1= q・K = 10.000×3.0000 = 30.000 kN/m²

Earth pressure at the water surface
p2= K・γs・H1＋p1
= 3.0000×19.000×0.950＋30.000
= 84.150 kN/m²

Earth pressure at the bottom
p3= p2 = 84.150 kN/m²

Earth pressure above water surface

$$P1 = \frac{1}{2} \cdot (p1+p2) \cdot H1 = \frac{1}{2} \times (30.000 + 84.150) \times 0.950 = 54.221 \text{ kN}$$

Earth pressure below water surface

$$P2 = \frac{1}{2} \cdot (p2+p3) \cdot H2 = \frac{1}{2} \times (84.150 + 84.150) \times 0.000 = 0.000 \text{ kN}$$

Total Earth pressure
P = P1＋P2 = 54.221＋0.000 = 54.221 kN

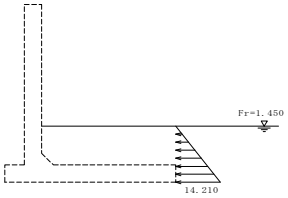
Total Earth pressure at horizontal direction
Ph = P・cos(α－δ) = 54.221×cos(0.000°－ 0.000°) = 54.221 kN

Hydrostatic Pressure

$$P = \frac{1}{2} \cdot \gamma w \cdot h^2$$

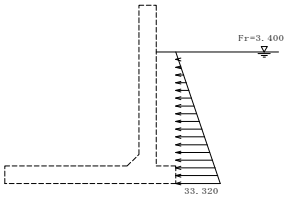
$$Y = \frac{h}{3}$$

Where、
γw : unit weiht of water (kN/m³), γw=9.800
h : water head (m)
Y : acting point (m)
[1]Normal with Buoyancy



	h (m)	P (kN)	Acting Point Y (m)
Rear	1.450	10.302	0.483

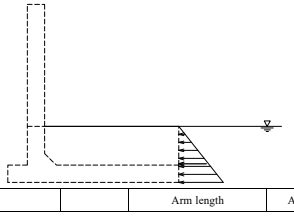
[3]Flood



	h (m)	P (kN)	Acting Point Y (m)
Front	3.400	56.644	1.133

2.2.5 Summary of Acting Forces

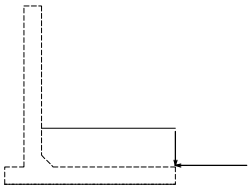
(1)Summary of Forces Acting On the Footing Front
[1]Normal



Item			Arm length	Angular Moment (kN.m.)

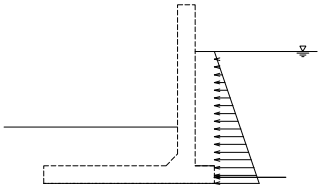
	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	160.061	0.000	1.971	0.000	315.500	0.000
Buoyancy	-57.624	0.000	2.366	0.000	-136.328	0.000
Rear Side Water Pressure	0.000	10.302	0.000	0.483	0.000	4.979
Earth Pressure	0.000	3.224	4.400	0.483	0.000	1.557
Total	102.437	13.526	———	———	179.172	6.537

[3]Seismic



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	160.061	32.012	1.971	1.180	315.500	37.770
Earth Pressure	3.995	8.306	4.400	0.483	17.578	4.012
Total	164.056	40.318	———	———	333.078	41.782

[3]Flood (With Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	160.061	0.000	2.429	0.000	388.770	0.000
Buoyancy	-2.205	0.000	4.150	0.000	-9.151	0.000
Rear Side Water Pressure	0.000	56.644	0.000	1.133	0.000	64.197
Earth Pressure	0.000	0.350	4.400	0.150	0.000	0.053
Total	157.856	56.994	———	———	379.619	64.249

Load Condition (Water Level)	No (kN)	Ho (kN)	Mo (kN.m.)
Normal	102.437	13.526	172.635
Seismic	164.056	40.318	291.296
Flood	157.856	56.994	315.370

(2)Summary of Forces Acting At the Footing Center

Vertical Force : Nc = No (kN)
Horizontal Force : Hc = Ho (kN)
Turning Moment : Mc = No Bj/2.0 - Mo (kN.m.)

Here,

Footing Width in Earth Pressure Direction : Bj = 7.500 (m)

■Per Unit Width

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal	102.437	13.526	52.727
Seismic	164.056	40.318	69.628
Flood	157.856	56.994	31.914

■Per full width (5.000 m)

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal	512.187	67.631	263.633
Seismic	820.282	201.591	348.141
Flood	789.281	284.970	159.569

2.2.6 Stability Analysis Results

2.2.6.1 Stability against Overturning

(1)Calculation of Acting Point of Composited Force and Eccentricity

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,

d: Distance from the Toe of Bottom Slab to the Acting Point of Composited Force (m)
ΣMr: Resistive Moment of Toe of Bottom Slab (kN.m.)
ΣMt: Overturning Moment of Toe of Bottom Slab (kN.m.)
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)

$$e = \frac{B}{2} - d$$

Here,

e: Eccentricity from the Center of Bottom Slab to the Acting Point of Composited Force (m);
B: Bottom Slab Width (m), B = 7.500

ea = B/n

Here,

ea: Allowable Eccentricity (m)
n: Safety Factor

Load Condition (Water Level)	Σ Mr (kN.m.)	Σ Mt (kN.m.)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal	179.172	6.537	102.437	1.685	0.515	≦	0.733
Seismic	333.078	41.782	164.056	1.776	0.424	≦	1.467
Flood	379.619	64.249	157.856	1.998	0.202	≦	1.467

2.2.6.2 Stability Against Sliding

$$F_s = \frac{\Sigma V \cdot \mu + C_B \cdot B + \alpha \cdot Pp}{\Sigma H}$$

Here,

ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
ΣH: Total Horizontal Load in Lower Side of Bottom Slab (kN)
m.: Cohesion Between Bottom Slab and Supporting Ground, m = 0.577
C_B: Cohesion Between Bottom Slab And Supporting Ground (kN/m2), C_B = 0.000
B: Bottom Slab Width (m), B = 7.500
α: Effeective Rate of Passive Earth Pressure
Pp: Passive Earth Pressure

Load Condition (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Passive Earth Pressure Pp(kN)	Effective Rate	Safety Factor Fs		Required Safety Factor Fsa
Normal	102.437	13.526	—	—	3.787	≧	1.500

Seismic	164.056	40.318	—	—	2.035	≧	1.200
Flood	157.856	56.994	54.221	0.500	1.861	≧	1.200

2.2.6.3 Verification of Bearing

1)When the Acting Point of Composited Force is within the 1/3 of Bottom Slab Width (middle third) in the Center of the Bottom Slab.

$$q_1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6e}{B}\right)$$

$$q_2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6e}{B}\right)$$

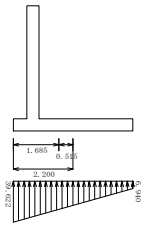
2)When the Acting Point of Composited Force is within the 2/3 of Bottom Slab Width in the Center of the Bottom Slab.

$$q_1 = \frac{2\Sigma V}{3 \cdot (B/2 - e)}$$

Here,

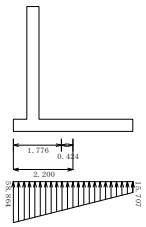
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
B: Bottom Slab Width (m), B = 7.500
e: Eccentricity (m)

[1]Normal (Without Buoyancy)



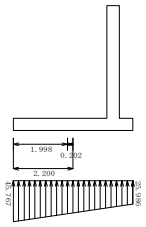
Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2)		
		qmin	qmax	Allowance
4.400	Trapezoid	6.940	39.622 ≦	200.000

[2]Seismic (With Buoyancy)



Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2)		
		qmin	qmax	Allowance
4.400	Trapezoid	15.707	58.864 ≦	300.000

[3]Flood (With Buoyancy)



Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2)		
		qmin	qmax	Allowance
4.400	Trapezoid	25.986	45.979 ≦	300.000

2.3 Vertical Wall Design

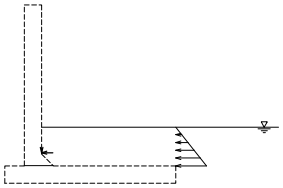
2.3.1 Checking Position

Distance from Base = 0.000 m

2.3.2 Calculation of Cross-Sectional Force

(Vertical forces are not summarized due to disregard of eccentric moments and axial forces)

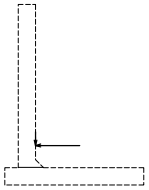
[1]Normal



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	46.856	0.000	-0.008	0.000	0.000
Hydrostatic on Rear Side	0.000	4.900	0.000	0.333	1.633
Earth Pressure	0.468	1.286	-0.225	0.333	0.428
Total	0.000	6.186	———	———	2.062

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

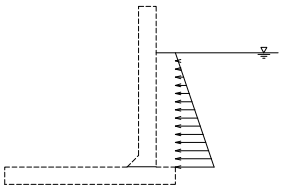
[2]Seismic



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	46.856	9.371	-0.008	2.029	19.010
Earth Pressure	1.111	4.148	-0.225	0.333	1.381
Total	0.000	13.519	———	———	20.391

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

[3]Flood



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	46.856	0.000	0.008	0.000	0.000
Hydrostatic on Rear Side	0.000	42.642	0.000	0.983	41.932
Total	0.000	42.642	———	———	41.932

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

2.3.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D19	2.865	8.00	22.920
	2'	——	—	——	——	——
Back	1	9.0	D19	2.865	8.00	22.920
	2	——	—	——	——	——

Required Reinforcement in Tension Side 6.510 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2 + \frac{2 \cdot n}{b}\left\{As \cdot (x-d)\right\} = 0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot As \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	N (kN)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
				Calculated	Allowance	Calculated	Allowance
Normal	2.062	0.000	10.107	0.120 ≦	8.200	2.777 ≦	140.000
Seismic	20.391	0.000	10.107	1.192 ≦	10.906	27.472 ≦	186.200
Flood	41.932	0.000	10.107	2.450 ≦	11.010	56.493 ≦	186.200

(3)Verification of Shear Stress

$$\tau_m = \frac{S_h}{b \cdot d} \leqq \tau_{a1}$$

Here,

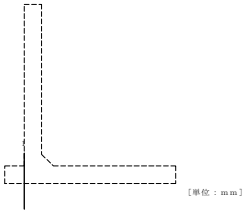
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)		
			Calculated	Allowable τa1	Allowable τa2
Normal	6.186	36.000	0.017 ≦	0.360	0.360
Seismic	13.519	36.000	0.038 ≦	0.479	0.479
Flood	42.642	36.000	0.118 ≦	0.470	0.470

2.4 Design of Toe Slab

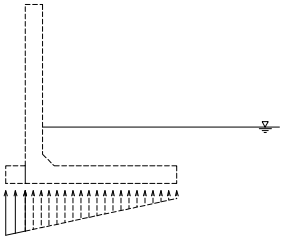
2.4.1 Checking Position

Distance from Base = 0.000 m



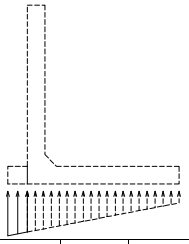
2.4.2 Calculation of Cross-Sectional Force

[1]Normal



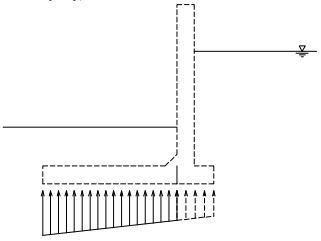
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-5.512	0.250	-1.378
Buoyancy	2.205	0.250	0.551
Subgrade Reaction	18.883	0.254	4.798
Total	15.575	———	3.971

[2]Seismic



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-5.512	0.250	-1.378
Subgrade Reaction	28.206	0.254	7.154
Total	22.693	———	5.776

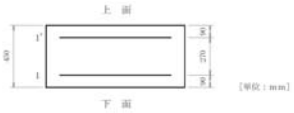
[3]Flood (With Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-103.834	1.721	-178.711
Subgrade Reaction	131.141	1.842	241.603
Total	27.307	———	62.892

2.4.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D19	2.865	8.00	22.920
	2'	——	–	——	——	——
Back	1	9.0	D19	2.865	8.00	22.920
	2	——	–	——	——	——

Required Reinforcement in Tension Side 10.054 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2+\frac{2\cdot n}{b}\left\{As\cdot(x-d)\right\}=0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c=\frac{M}{\frac{b\cdot x}{2}\cdot\left(\frac{h}{2}-\frac{x}{3}\right)+n\cdot As\cdot\frac{(x-d)\cdot(h/2-d)}{x}}$$

$$\sigma_s=n\cdot\sigma_c\cdot\frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
			Calculated	Allowance	Calculated	Allowance
Normal	3.971	10.107	0.232 ≦	8.200	5.350 ≦	140.000
Seismic	5.776	10.107	0.337 ≦	10.906	7.781 ≦	186.200
Flood	-2.515	10.107	0.147 ≦	11.010	3.389 ≦	186.200

(3)Verification of Shear Stress

$$\tau_m=\frac{S_h}{b\cdot d}\leqq\tau_{sa}$$

Here,

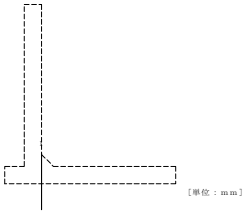
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)	
			Calculated	Allowable τa
Normal	8.795	360.000	0.024 ≦	0.360
Seismic	12.784	360.000	0.036 ≦	0.479
Flood	10.247	360.000	0.028 ≦	0.470

2.5 Design of the Heel Slab

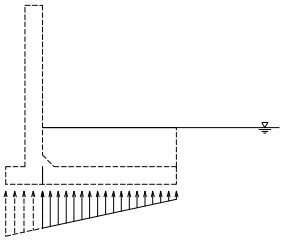
2.5.1 Checking Position

Distance from Base = 0.000 m



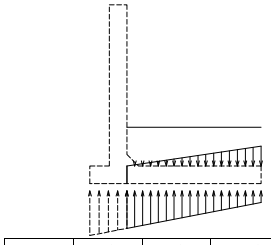
2.5.2 Calculation of Cross-Sectional Force

[1]Normal



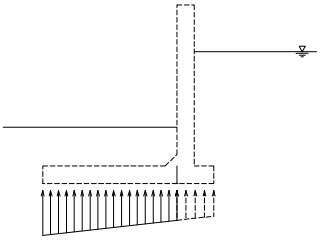
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	103.834	1.721	178.711
Buoyancy	-49.024	1.725	-84.567
Subgrade Reaction	-68.147	1.352	-92.137
Total	-13.338	———	2.007

[2]Seismic



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	103.834	1.721	178.711
Earth Pressure	3.995	2.300	9.189
Subgrade Reaction	-112.561	1.427	-160.604
Total	-4.733	———	27.295

[3]Flood



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-103.834	1.721	-178.711
Subgrade Reaction	131.141	1.842	241.603
Total	27.307	———	62.892

2.5.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D19	2.865	8.00	22.920
	2'	—	–	——	—	——
Back	1	9.0	D19	2.865	8.00	22.920
	2	—	–	——	—	——

Required Reinforcement in Tension Side 10.054 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2+\frac{2\cdot n}{b}\left\{As\cdot(x-d)\right\}=0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c=\frac{M}{\frac{b\cdot x}{2}\cdot\left(\frac{h}{2}-\frac{x}{3}\right)+n\cdot As\cdot\frac{(x-d)\cdot(h/2-d)}{x}}$$

$$\sigma_s=n\cdot\sigma_c\cdot\frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
			Calculated	Allowance	Calculated	Allowance
Normal	2.007	10.107	0.117 ≦	8.200	2.704 ≦	140.000
Seismic	20.391	10.107	1.192 ≦	10.906	27.472 ≦	186.200
Flood	62.892	10.107	3.675 ≦	11.010	84.732 ≦	186.200

(3)Verification of Shear Stress

$$\tau_m=\frac{S_h}{b\cdot d}\leqq\tau_{a1}$$

Here,

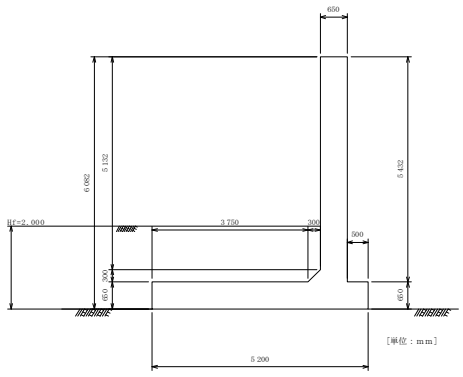
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)	
			Calculated	Allowable τa2
Normal	13.338	360.000	0.037 ≦	0.360
Seismic	4.733	360.000	0.013 ≦	0.479
Flood	27.372	360.000	0.076 ≦	0.470

3 Invert T-shaped Wall, Right Bank Sta.10+040.00

3.1 Design Conditions

3.1.1 Geometry



Depth Width (Block Length) B = 5000 (mm)

3.1.2 Backfill and Embankment

(1)Rear Side Ground Shape



Level Difference Between Retaining Wall Crown And Ground Surface Start Point	(m)	0.000
Height Without Considering Earth Pressure Hr (in stability analysis) Hr	(m)	0.000

3.1.3 Material

[Concrete] Vertical wall (reinforced concrete) : σck = 20.0 (N/mm2)
Base concrete (reinforced concrete) : σck = 20.0 (N/mm2)

[Iron bar] Type: : Grade 275

[Soil] Backfill : sand and gravel
Foudation : sandy gravel

[Internal Fdiction] Backfill : 30 degrees

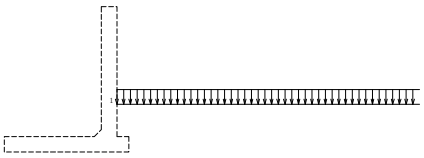
[Unit weight]
(kN/m3)

Body	24.500	
Water	9.800	
Soil	Wet weight	Saturated weight
River side	20.000	20.800
Land side	20.000	20.800

[Seismic Intensity] Body : 0.200
Foundation Riverside : 0.200
Foundation Landside : 0.200

3.1.4 Loads

[1]Normal



Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			From	End Side	Stability Analysis	Vertical Wall	Bottom Slab
1	0.000	infinity	10.000	10.000	○	○	×

[2]Seismic

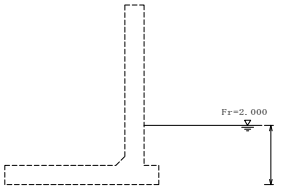


Item	Loading Position (m)	Loading Width (m)	Load Strength (kN/m2)		Study to Be Considered		
			From	End Side	Stability Analysis	Vertical Wall	Bottom Slab
1	0.000	infinity	5.000	5.000	○	○	×

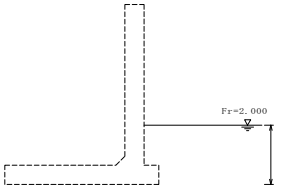
[2]Flood
Not concidered

3.1.5 Water Level

[1]Normal
■With Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 2.000 m

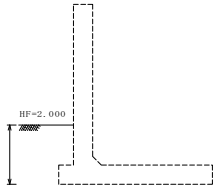


■Without Buoyancy : Water Leve in Front Side level Ff = 0.000 m, Water Level in Rear Side Fr = 2.000 m

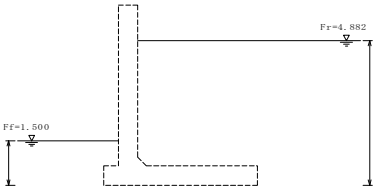


[2]Seidmic
Not Considered

[3]Flood
■With Buoyancy : Water Leve in Front Side level Ff = 1.500 m, Water Level in Rear Side Fr = 4.882 m



■Without Buoyancy : Water Leve in Front Side level Ff = 1.500 m, Water Level in Rear Side Fr = 4.882 m



3.1.6 Buoyancy

・Use the Water Level in Rear Side

3.1.7 Earth Pressure

・Earth Pressure Formulas: Trial Wedge

・Angle of Friction of Earth Pressure Acting Surface (Degrees)

Load Condition	Active Earth Pressure			Passive Earth Pressure
	In Case of Stability Analysis	In Case of Vertical Wall Design	Cut	
Normal Earth Pressure	0.000	23.333	———	———
Seismic Earth Pressure (Rear→Front)	30.303	17.500	———	0.000
Seismic Earth Pressure (Front→Rear)	0.000	23.333	———	0.000
Flood Earth Pressure	0.000	23.333	———	0.000

・ The virtual rear surface of earth pressure in the stability analysis is at the heel end (a line extended vertically from the heel)

・ Angle between the earth pressure acting surface and the vertical plane in stability analysis

0.000 (degrees)

・ Angle between the earth pressure working surface and the vertical plane when designing the vertical wall
Normal, Seismic 0.000 (degrees)
Flood 0.000 (degrees)

・The Design Horizontal Seismic Coefficient is applied to the inertia force during earthquakes when calculating the earth pressure below the water level.

・Passive Earth Pressure

Load Condition	Height of Acting	Effectivity
Seismic Condition (Rear → Front)	1.500	0.500
Seismic Condition (Front → Rear)	1.500	0.500
Flood	2.000	0.500

・Cohesion (kN/m2)

Load Condition	For Sliding Surfaces	For Cohesive Height	For Passive Earth Pressure
Normal Condition	0.000	0.000	———
Seismic Condition	0.000	0.000	0.000
Flood Condtion	0.000	0.000	0.000

・Consideration of Earth Pressure Different from Direction of Earthquake Motion

	Consideration I...	Effectivity
Stability Analysis	Normal Earth Pressure	0.500
Vertical Wall Design		0.500

3.1.8 Water Pressure

・Concept of Calculation of Hydrostatic Pressure

Load Condition	Rear Side	Front Side
Normal Condition	Considered	Considered
Seismic Condition	Considered	Considered
Flood Condition	Considered	Considered

・Consideration of Hydrostatic Pressure Different from the Direction of Earthquake Motion

Outside Water Level	Stability analysis	Considered
	Vertical Wall Design	Considered

・Consideration of Dynamic Water Pressure Calculation

Outside Water Level	Considered

3.1.9 Load Combination Case

No	Load Name	Comments
1	Normal	
2	Seismic	Seismic (Rear → Front)
3	Seismic	Seismic (Front → Rear)
4	Flood	Flood

	Load Name	1	2	3	4
Soil	Front Soil 1	○	○	○	
	Front Soil 2				○
Water Level	Buoyancy 1	○			
	Buoyancy 2		○	○	
	Buoyancy 3				○
Load	Load 1	○			○
	Load 2		○	○	
Active Earth Pressure	Not Considered				
	Normal Earth Pressure	○			○
	Seismic Earth Pressure		○	○	
Passive Earth Pressure	Passive Earth Pressure 1		○	○	
	Passive Earth Pressure 2				○

3.1.10 Foundation Conditions

3.1.10.1 Data For Calculating Allowable Shear Resistance

Bottom Slab Width Used for Analysis	All	Width
Cohesion Between Foundation Bottom Surface And Ground C_B (kN/m2)		0.000
Friction Coefficient Between Foundation Bottom Surface and Ground tan φ_B		0.500

3.1.11 Allowable Values For Stability Analysis And Allowable Stresses of Members

3.1.11.1 Allowance in Stability Analysis

Load Condition	Allowable Eccentricity eB/B (m)	Safety Factor for Overturning	Safety Factor for Sliding	Allowable Subgrade Reaction Intensity (kN/m2)
Normal	1/6	1.500	1.500	200.000
Seismic, Flood	1/3	1.200	1.200	300.000

3.1.11.2 Allowable Stress of the Member

(1)Reinforced Concrete Member

1) Vertical Wall (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic, Flood	1.33	10.906	186.200	0.479	0.479

2) Bottom Slab (General Member)

(N/mm2)

Load Condition	Premium Coefficient	Compressive Stress of Concrete σca	Tensile Stress of Rebar σsa	Shear Stress Intensity τa1	τa2
Normal	1.00	8.200	140.000	0.360	0.360
Seismic, Flood	1.33	10.906	186.200	0.479	0.479

Here,

τa1: Shear Stress When Shear Force is Applied Only by Concrete

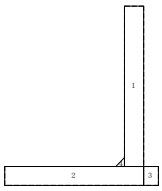
τa2: Shear Stress when Jointly Bearing with Oblique Tensile Reinforcement

3.2 Stability Analysis

3.2.1 Block Data Not Considering Water Level

(1)Body Weight

1)Block Diversion



2)Weight and Center of Gravity

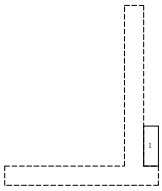
Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.650× 5.432× 1.000	3.531	4.375	3.366	15.447	11.885	
2	4.700× 0.650× 1.000	3.055	2.350	0.325	7.179	0.993	
3	0.500× 0.650× 1.000	0.325	4.950	0.325	1.609	0.106	
4	1/2× 0.300× 0.300× 1.000	0.045	3.950	0.750	0.178	0.034	
Σ		6.956	——	——	24.413	13.017	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 24.413／ 6.956 ＝ 3.510 (m)

YG = Σ (Vi Yi)/ΣVi = 13.017／ 6.956 ＝ 1.871 (m)

(2)Soil in Rear Side

1)Block Diversion



2)Volume and Center of Gravity

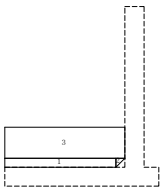
Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.500× 1.350× 1.000	0.675	4.950	1.325	3.341	0.894	
Σ		0.675	——	——	3.341	0.894	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 3.341／ 0.675 ＝ 4.950 (m)

YG = Σ (Vi Yi)/ΣVi = 0.894／ 0.675 ＝ 1.325 (m)

(3)Soil in Front Side

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	3.750× 0.300× 1.000	1.125	1.875	0.800	2.109	0.900	
2	1/2× 0.300× 0.300× 1.000	0.045	3.850	0.850	0.173	0.038	
3	4.050× 1.050× 1.000	4.253	2.025	1.475	8.611	6.272	
Σ		5.423	——	——	10.894	7.211	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 10.894／ 5.423 ＝ 2.009 (m)

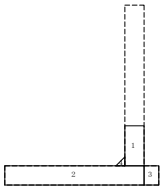
YG = Σ (Vi Yi)/ΣVi = 7.211／ 5.423 ＝ 1.330 (m)

3.2.2 Block Data Considering Water Level

(1)Body Weight

[1]Normal (With Buoyancy 2)

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.650× 1.350× 1.000	0.877	4.375	1.325	3.839	1.163	
2	4.700× 0.650× 1.000	3.055	2.350	0.325	7.179	0.993	
3	0.500× 0.650× 1.000	0.325	4.950	0.325	1.609	0.106	
4	1/2× 0.300× 0.300× 1.000	0.045	3.950	0.750	0.178	0.034	
Σ		4.303	——	——	12.805	2.295	

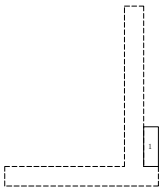
Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 12.805／ 4.303 ＝ 2.976 (m)

YG = Σ (Vi Yi)/ΣVi = 2.295／ 4.303 ＝ 0.533 (m)

(2)Soil in Rear Side

[1]Normal (With Buoyancy 2)

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	0.500× 1.350× 1.000	0.675	4.950	1.325	3.341	0.894	
Σ		0.675	——	——	3.341	0.894	

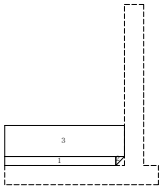
Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 3.341／ 0.675 ＝ 4.950 (m)

YG = Σ (Vi Yi)/ΣVi = 0.894／ 0.675 ＝ 1.325 (m)

(3)Soil in Front Side

[1]Normal (With Buoyancy 2)

1)Block Diversion



2)Volume and Center of Gravity

Number	Equation Width x Height x Depth	Volume Vi (m3)	Center of Gravity Position (m) Xi	Yi	Vi/Xi	Vi Yi	Remarks
1	3.750× 0.300× 1.000	1.125	1.875	0.800	2.109	0.900	
2	1/2× 0.300× 0.300× 1.000	0.045	3.850	0.850	0.173	0.038	
3	4.050× 1.050× 1.000	4.253	2.025	1.475	8.611	6.272	
Σ		5.423	——	——	10.894	7.211	

Center of Gravity Position XG = Σ (Vi/Xi)/ΣVi = 10.894／ 5.423 ＝ 2.009 (m)

YG = Σ (Vi Yi)/ΣVi = 7.211／ 5.423 ＝ 1.330 (m)

3.2.3 Body Weight, Weight of Soil, Arbitrary Load, Vertical Force by Buoyancy, Horizontal Force

(1)Working Force Due to Body Weight

[1]Normal

Position	Vertical Force W = γ ・ V (kN)	Acting Position X (m)
Body(Reinforced)	24.500 × 6.956 ＝ 170.417	3.510
Soil (Rear Side)	20.000 × 0.675 ＝ 13.500	4.950
Soil (Front Side)	20.000 × 5.423 ＝ 108.450	2.009
Total	292.367	3.020

[2]Seismic 1

Position	Vertical Force W = γ ・ V (kN)	Acting Position X (m)
Body(Reinforced)	24.500 × 6.956 ＝ 170.417	3.510
Soil (Rear Side)	20.000 × 0.675 ＝ 13.500	4.950
Soil (Front Side)	20.000 × 5.423 ＝ 108.450	2.009
Total	292.367	3.020

Position	Horizontal Load H = W kh (kN)	Acting Position Y (m)
Body(Reinforced)	170.417 × 0.20 ＝ 34.083	1.871
Soil (Rear Side)	13.500 × 0.20 ＝ 2.700	1.325
Total	36.783	1.831

[2]Seismic 2

Position	Vertical Force W = γ ・ V (kN)	Acting Position X (m)
Body(Reinforced)	24.500 × 6.956 ＝ 170.417	3.510
Soil (Rear Side)	20.000 × 0.675 ＝ 13.500	4.950
Total	183.917	3.615

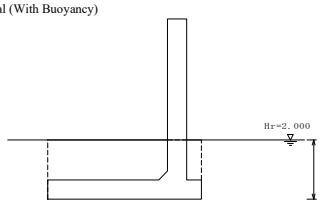
Position	Horizontal Load H = W kh (kN)	Acting Position Y (m)
Body(Reinforced)	170.417 × 0.20 ＝ 34.083	1.871
Total	-34.083	1.871

[3]Flood

Position	Vertical Force W = γ ・ V (kN)	Acting Position X (m)
Body(Reinforced)	24.500 × 6.956 ＝ 170.417	1.690
Soil (Rear Side)	20.000 × 5.423 ＝ 108.450	3.191
Soil (Front Side)	20.000 × 0.675 ＝ 13.500	0.250
Total	292.367	2.180

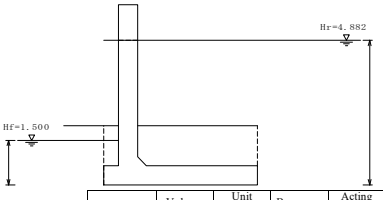
(2)Acting Force by Weight of Soil And Buoyancy

[1]Normal (With Buoyancy)



Position	Volume V (m3)	Unit Weight γ (kN/m3)	Buoyancy Fi (kN)	Acting Position Xi (m)	Fi/Xi
Body	4.303	9.800	42.165	2.976	125.487
Soil (Rear Side)	0.675	9.800	6.615	4.950	32.744
Soil (Front Side)	5.423	9.800	53.140	2.009	106.761
Total	——	——	101.920	——	264.992

[3]Flood (With Buoyancy)



Position	Volume V (m3)	Unit Weight γ (kN/m3)	Buoyancy Fi (kN)	Acting Position Xi (m)	Fi/Xi
Body	6.176	9.800	60.523	1.800	108.914
Soil (Front Side)	5.423	9.800	53.140	3.191	169.570
Soil (Rear Side)	0.675	9.800	6.615	0.250	1.654
Total	——	——	120.278	——	280.138

3.2.4 Load on the Surface

Vertical Force

$$N = \frac{1}{2} \cdot (q1+q2) \cdot L$$

Horizontal Load

$$H = N \cdot kh$$

Here,

q : Load Intensity

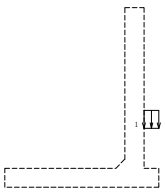
L : Loading Length

kh : Design Horizontal Seismic Coefficient, kh = 0.200 (Medium)

X : Distance from the Toe to the Acting Position of Composited Force

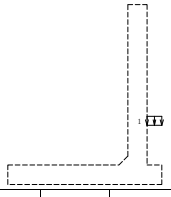
Y : Distance from the Lower Surface of the Bottom Slab to the Acting Position of Composited Force

[1]Normal



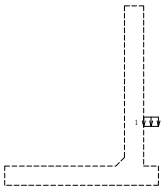
Item	q1 (kN/m2)	q2 (kN/m2)	L (m)	Vertical Force N (kN)	Horizontal Load H (kN)	Acting Position X (m)	Acting Position Y (m)
1	10.000	10.000	0.500	5.000	———	4.950	———

[2]Seismic 1



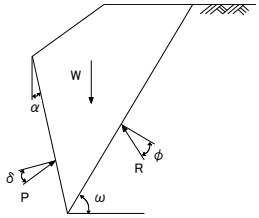
Item	q1 (kN/m2)	q2 (kN/m2)	L (m)	Vertical Force N (kN)	Horizontal Load H (kN)	Acting Position X (m)	Acting Position Y (m)
1	5.000	5.000	0.500	2.500	0.500	4.950	———

[3]Seismic 2



Item	q1 (kN/m2)	q2 (kN/m2)	L (m)	Vertical Force N (kN)	Horizontal Load H (kN)	Acting Position X (m)	Acting Position Y (m)
1	5.000	5.000	0.500	2.500	———	4.950	———

3.2.5 Earth Pressure and Water Pressure



[1]Normal (With Buoyancy 1), Normal Without Buoyancy 1
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 2.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 2.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
61.00	0.000	11.308	11.086	22.394	10.922
62.00	0.000	10.847	10.634	21.481	10.945

63.00	0.000	10.394	10.191	20.585	10.945

The maximum earth pressure is determined by the following equation:
when ω = 62.00 ° P = 10.945 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{21.481 \times \sin(62.00^\circ - 35.00^\circ)}{\cos(62.00^\circ - 35.00^\circ - 0.000^\circ - 0.000^\circ)}$$

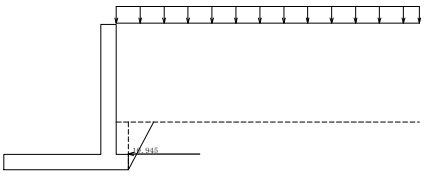
= 10.945 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 10.945×cos(0.000°+ 0.000°) = 10.945 kN
Vertical Component
Pv = P · sin (α + δ) = 10.945×sin(0.000°+ 0.000°) = 0.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{2.000}{3} = 0.667 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.667×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.667 = 0.667 m

・Earth Pressure Diagram



[2]Normal (Without Buoyancy)
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 2.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 2.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
61.00	22.172	0.000	11.086	33.258	16.221
62.00	21.268	0.000	10.634	31.902	16.255
63.00	20.381	0.000	10.191	30.572	16.255

The maximum earth pressure is determined by the following equation:
when ω = 62.00 ° P = 16.255 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{31.902 \times \sin(62.00^\circ - 35.00^\circ)}{\cos(62.00^\circ - 35.00^\circ - 0.000^\circ - 0.000^\circ)}$$

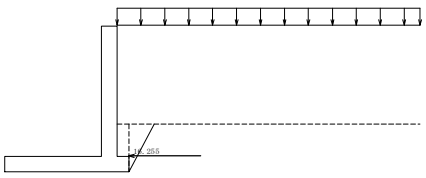
= 16.255 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 16.255×cos(0.000°+ 0.000°) = 16.255 kN
Vertical Component
Pv = P · sin (α + δ) = 16.255×sin(0.000°+ 0.000°) = 0.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{2.000}{3} = 0.667 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.667×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.667 = 0.667 m

・Earth Pressure Diagram



[3]Seismic 1
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 2.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °

Angle between Ground Surface and Horizontal Plane β = 0.000 °
Combined angle during earthquake θ = $\tan^{-1}$kh = $\tan^{-1}$0.20 = 11.310°
Wall Friction Angle

$$\delta = \tan^{-1}\frac{\sin\phi \cdot \sin(\theta + \Delta - \beta)}{1 - \sin\phi \cdot \cos(\theta + \Delta - \beta)}$$

$$= \tan^{-1}\frac{\sin 35.00^\circ \times \sin(11.310^\circ + 19.994^\circ - 0.000^\circ)}{1 - \sin 35.00^\circ \times \cos(11.310^\circ + 19.994^\circ - 0.000^\circ)}$$

= 30.303°

sinϕ sin35.00

Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
46.00	38.628	0.000	9.657	48.285	19.806
47.00	37.301	0.000	9.325	46.626	19.818
48.00	36.016	0.000	9.004	45.020	19.796

The maximum earth pressure is determined by the following equation:
when ω = 47.00 ° P = 19.818 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$

$$= \frac{46.626 / \cos 11.310^\circ \times \sin(47.00^\circ - 35.00^\circ + 11.310^\circ)}{\cos(47.00^\circ - 35.00^\circ - 0.000^\circ - 30.303^\circ)}$$

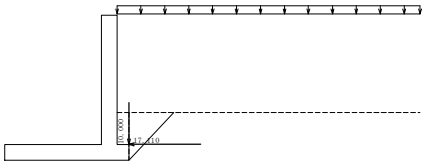
= 19.818 kN

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 19.818×cos(0.000°+30.303°) = 17.110 kN
Vertical Component
Pv = P · sin (α + δ) = 19.818×sin(0.000°+30.303°) = 10.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{2.000}{3} = 0.667 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.667×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.667 = 0.667 m

・Earth Pressure Diagram



[4]Seismic 2
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 2.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = β = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °

Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 0.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
61.00	22.172	0.000	5.543	27.715	6.759
62.00	21.268	0.000	5.317	26.585	6.773
63.00	20.381	0.000	5.095	25.476	6.773

The maximum earth pressure is determined by the following equation:
when ω = 62.00 ° P = 6.773 kN

Earth Pressure

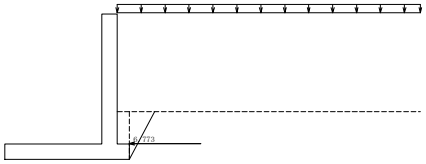
$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$
$$= \frac{26.585 \times \sin(62.00^\circ - 35.00^\circ)}{\cos(62.00^\circ - 35.00^\circ - 0.000^\circ - 0.000^\circ)} \times 0.500$$
$$= 6.773 \text{ kN}$$

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 6.773×cos(0.000°+ 0.000°) = 6.773 kN
Vertical Component
Pv = P · sin (α + δ) = 6.773×sin(0.000°+ 0.000°) = 0.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{2.000}{3} = 0.667 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.667×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.667 = 0.667 m

・Earth Pressure Diagram



[4]Normal (With Buoyancy)
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 2.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 2.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
61.00	0.000	11.308	0.000	11.308	5.515
62.00	0.000	10.847	0.000	10.847	5.527
63.00	0.000	10.394	0.000	10.394	5.527

The maximum earth pressure is determined by the following equation:
when ω = 62.00 ° P = 5.527 kN

Earth Pressure

$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$
$$= \frac{10.847 \times \sin(62.00^\circ - 35.00^\circ)}{\cos(62.00^\circ - 35.00^\circ - 0.000^\circ - 0.000^\circ)}$$
$$= 5.527 \text{ kN}$$

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.

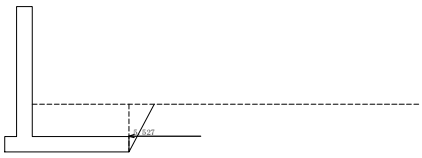
Horizontal Component
Ph = P · cos (α + δ) = 5.527×cos(0.000°+ 0.000°) = 5.527 kN
Vertical Component
Pv = P · sin (α + δ) = 5.527×sin(0.000°+ 0.000°) = 0.000 kN

Acting Position

$$Ho = \frac{H}{3} = \frac{2.000}{3} = 0.667 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.667×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.667 = 0.667 m

・Earth Pressure Diagram



[5]Flood Without Buoyancy
The earth pressure is obtained by the trial wedge method.
Position of Virtual Rear Surface (Distance from Toe) xp = 5.200 m
yp = 0.000 m
Height of Virtual Rear Surface H = 2.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °
Wall Friction Angle δ = 0.000 °
Range of Slip Angle Change ωi = 10.00 ° ~ 80.00 °
Soil Weight (W) against Slip Angle (ω), Earth Pressure (P)
Water Level hw = 2.000 m

Slip Angle ω (°)	Weight of Soil W (kN)				Earth Pressure P (kN)
	Above Water Level	Below Water Level	Vertical Load	Total	
61.00	22.172	0.000	0.000	22.172	10.814
62.00	21.268	0.000	0.000	21.268	10.837
63.00	20.381	0.000	0.000	20.381	10.837

The maximum earth pressure is determined by the following equation:
when ω = 62.00 ° P = 10.837 kN

Earth Pressure

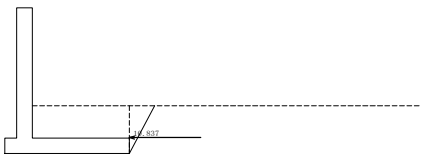
$$P = \frac{W \cdot \sin(\omega - \phi)}{\cos(\omega - \phi - \alpha - \delta)}$$
$$= \frac{21.268 \times \sin(62.00^\circ - 35.00^\circ)}{\cos(62.00^\circ - 35.00^\circ - 0.000^\circ - 0.000^\circ)}$$
$$= 10.837 \text{ kN}$$

The horizontal component, vertical component, and acting position of earth pressure at this time are as follows.
Horizontal Component
Ph = P · cos (α + δ) = 10.837×cos(0.000°+ 0.000°) = 10.837 kN
Vertical Component
Pv = P · sin (α + δ) = 10.837×sin(0.000°+ 0.000°) = 0.000 kN
Acting Position

$$Ho = \frac{H}{3} = \frac{2.000}{3} = 0.667 \text{ m}$$

x = xp-Ho · tan α = 5.200−0.667×tan0.000°= 5.200 m
y = yp + Ho =0.000+0.667 = 0.667 m

・Earth Pressure Diagram



Passive earth Pressure
(This pressure is considered for the stability against Sliding)

[2]Seismic 1
The earth pressure is obtained by the Mononobe ad Okabe method.
Height of the ground surface H = 1.500 m
Height above water surface H1 = 1.500 m
Height below water surface H2 = 0.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane A = 0.000 °
Unit Weight of Soil γs = 20.000 kN/m3
Internal Friction Angle of Soil φ = 35.000 °
Angle between Ground Surface and Horizontal Plane β = 0.000 °

Combined angle during earthquake below water surface
θ = $\tan^{-1}$kh = $\tan^{-1}$0.20 = 11.310 °

Coefficient of passive earth pressure

$$K = \frac{\cos^2(\phi+\alpha-\theta)}{\cos\theta\cdot\cos^2\alpha\cdot\cos(\alpha-\delta-\theta)\cdot\left[1-\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi+\beta-\theta)}{\cos(\alpha-\delta-\theta)\cdot\cos(\alpha-\beta)}}\right]^2}$$

$$= \frac{\cos^2(35.00^\circ+0.000^\circ-11.310^\circ)}{\cos 11.310^\circ\cdot\cos^2 0.000^\circ\cdot\cos(0.000^\circ-0.000^\circ-11.310^\circ)} \times \frac{1}{\left[1-\sqrt{\frac{\sin(35.00^\circ+0.000^\circ)\cdot\sin(35.00^\circ+0.000^\circ-11.310^\circ)}{\cos(0.000^\circ-0.000^\circ-11.310^\circ)\cdot\cos(0.000^\circ-0.000^\circ)}}\right]^2}$$

$$= 3.2855$$

Notod that when φ+β−θ<0,it is assumed sin(φ+β−θ) = 0

Earth pressure at the upper edge

$p1 = q \cdot K = 0.000 \times 3.2855 = 0.000\ kN/m^2$

Earth pressure at the water surface

$p2 = K \cdot \gamma s \cdot H1 + p1$

$= 3.2855 \times 20.000 \times 1.500 + 0.000$

$= 98.565\ kN/m^2$

Earth pressure at the bottom

$p3 = p2 = 98.565\ kN/m^2$

Earth pressure above water surface

$P1 = \frac{1}{2} \cdot (p1+p2) \cdot H1 = \frac{1}{2} \times (0.000 + 98.565) \times 1.500 = 73.924\ kN$

Earth pressure below water surface

$P2 = \frac{1}{2} \cdot (p2+p3) \cdot H2 = \frac{1}{2} \times (98.565 + 98.565) \times 0.000 = 0.000\ kN$

Total Earth pressure

$P = P1 + P2 = 73.924 + 0.000 = 73.924\ kN$

Total Earth pressure at horizontal direction

$Ph = P \cdot \cos(\alpha-\delta) = 73.924 \times \cos(0.000^\circ - 0.000^\circ) = 73.924\ kN$

[3]Seismic 1

The earth pressure is obtained by the Mononobe ad Okabe method.

Height of the ground surface	H =	1.500 m
Height above water surface	H1 =	1.500 m
Height below water surface	H2 =	0.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane	A =	0.000 °
Unit Weight of Soil	γs =	20.000 kN/m3
Internal Friction Angle of Soil	φ =	35.000 °
Angle between Ground Surface and Horizontal Plane	β =	0.000 °

Combined angle during earthquake below water surface

$\theta = \tan^{-1}kh = \tan^{-1}0.20 = 11.310^\circ$

Coefficient of passive earth pressure

$$K = \frac{\cos^2(\phi+\alpha-\theta)}{\cos\theta\cdot\cos^2\alpha\cdot\cos(\alpha-\delta-\theta)\cdot\left[1-\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi+\beta-\theta)}{\cos(\alpha-\delta-\theta)\cdot\cos(\alpha-\beta)}}\right]^2}$$

$$= \frac{\cos^2(35.00^\circ+0.000^\circ-11.310^\circ)}{\cos 11.310^\circ\cdot\cos^2 0.000^\circ\cdot\cos(0.000^\circ-0.000^\circ-11.310^\circ)} \times \frac{1}{\left[1-\sqrt{\frac{\sin(35.00^\circ+0.000^\circ)\cdot\sin(35.00^\circ+0.000^\circ-11.310^\circ)}{\cos(0.000^\circ-0.000^\circ-11.310^\circ)\cdot\cos(0.000^\circ-0.000^\circ)}}\right]^2}$$

$$= 3.2855$$

Notod that when φ+β−θ<0,it is assumed sin(φ+β−θ) = 0

Earth pressure at the upper edge

$p1 = q \cdot K = 0.000 \times 3.2855 = 0.000\ kN/m^2$

Earth pressure at the water surface

$p2 = K \cdot \gamma s \cdot H1 + p1$

$= 3.2855 \times 20.000 \times 1.500 + 0.000$

$= 98.565\ kN/m^2$

Earth pressure at the bottom

$p3 = p2 = 98.565\ kN/m^2$

Earth pressure above water surface

$P1 = \frac{1}{2} \cdot (p1+p2) \cdot H1 = \frac{1}{2} \times (0.000 + 98.565) \times 1.500 = 73.924\ kN$

Earth pressure below water surface

$P2 = \frac{1}{2} \cdot (p2+p3) \cdot H2 = \frac{1}{2} \times (98.565 + 98.565) \times 0.000 = 0.000\ kN$

Total Earth pressure

$P = P1 + P2 = 73.924 + 0.000 = 73.924\ kN$

Total Earth pressure at horizontal direction

$Ph = P \cdot \cos(\alpha-\delta) = 73.924 \times \cos(0.000^\circ - 0.000^\circ) = 73.924\ kN$

[3]Flood with bouyancy

The earth pressure is obtained by the Mononobe ad Okabe method.

Height of the ground surface	H =	2.000 m
Height above water surface	H1 =	0.500 m
Height below water surface	H2 =	0.000 m
Angle between the Earth Pressure Acting Surface and the Vertical Plane	A =	0.000 °
Unit Weight of Soil	γs =	20.000 kN/m3
Internal Friction Angle of Soil	φ =	35.000 °
Angle between Ground Surface and Horizontal Plane	β =	0.000 °

Coefficient of passive earth pressure

$$K = \frac{\cos^2(\phi+\alpha)}{\cos^2\alpha\cdot\cos(\alpha-\delta)\cdot\left[1-\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi+\beta)}{\cos(\alpha-\delta)\cdot\cos(\alpha-\beta)}}\right]^2}$$

$$= \frac{\cos^2(35.00^\circ+0.000^\circ)}{\cos^2 0.000^\circ\cdot\cos(0.000^\circ-0.000^\circ)} \times \frac{1}{\left[1-\sqrt{\frac{\sin(35.00^\circ+0.000^\circ)\cdot\sin(35.00^\circ+0.000^\circ)}{\cos(0.000^\circ-0.000^\circ)\cdot\cos(0.000^\circ-0.000^\circ)}}\right]^2}$$

$$= 3.6902$$

Earth pressure at the upper edge

$p1 = q \cdot K = 5.000 \times 3.6902 = 18.451\ kN/m^2$

Earth pressure at the water surface

$p2 = K \cdot \gamma s \cdot H1 + p1$

$= 3.6902 \times 20.000 \times 0.500 + 18.451$

$= 55.353\ kN/m^2$

Earth pressure at the bottom

$p3 = K \cdot (\gamma s - \gamma w') \cdot H2 + p2$

$= 3.6902 \times (20.000 - 9.800) \times 1.500 + 55.353$

$= 111.813\ kN/m^2$

Earth pressure above water surface

$P1 = \frac{1}{2} \cdot (p1+p2) \cdot H1 = \frac{1}{2} \times (18.451 + 55.353) \times 0.500 = 18.451\ kN$

Earth pressure below water surface

$P2 = \frac{1}{2} \cdot (p2+p3) \cdot H2 = \frac{1}{2} \times (55.353 + 111.813) \times 1.500 = 125.375\ kN$

Total Earth pressure

$P = P1 + P2 = 18.451 + 125.375 = 143.826\ kN$

Total Earth pressure at horizontal direction

$Ph = P \cdot \cos(\alpha-\delta) = 143.826 \times \cos(0.000^\circ - 0.000^\circ) = 143.826\ kN$

Hydrostatic Pressure

$P = \frac{1}{2} \cdot \gamma w \cdot h^2$

$Y = \frac{h}{3}$

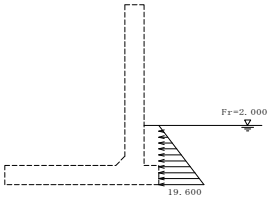
Where、

γw : unit weiht of water (kN/m³), γw=9.800

h : water head (m)

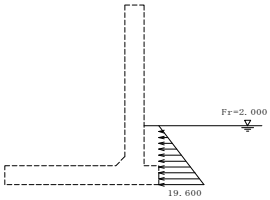
Y : acting point (m)

[1]Normal with Buoyancy



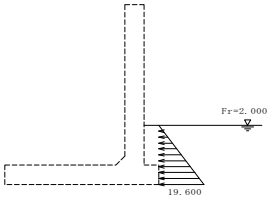
	h (m)	P (kN)	Acting Point Y (m)
Rear	2.000	19.600	0.667

[2]Normal without Buoyancy



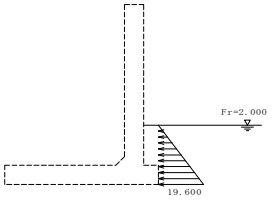
	h (m)	P (kN)	Acting Point Y (m)
Rear	2.000	19.600	0.667

[3]Flood with Buoyancy



	h (m)	P (kN)	Acting Point Y (m)
Front	1.500	-11.025	0.500
Rear	4.882	116.786	1.627

[4]Flood without Buoyancy

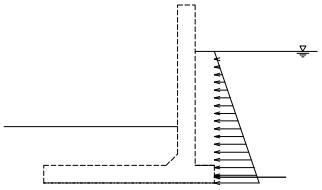


	h (m)	P (kN)	Acting Point Y (m)
Front	1.500	-11.025	0.500
Rear	4.882	116.786	1.627

3.2.6 Summary of Acting Forces

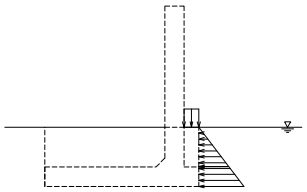
(1)Summary of Forces Acting On the Footing Front

[1]Normal (With Buoyancy)



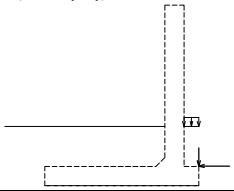
Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	292.367	0.000	3.020	0.000	882.822	0.000
Buoyancy	-101.920	0.000	2.600	0.000	-264.992	0.000
Load on Surface	5.000	0.000	4.950	0.000	24.750	0.000
Rear Side Water Pressure	0.000	19.600	0.000	0.667	0.000	13.067
Earth Pressure	0.000	10.945	5.200	0.667	0.000	7.300
Total	195.447	30.545	———	———	642.580	20.367

[2]Normal (Without Buoyancy)



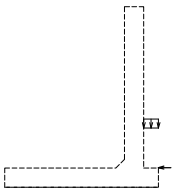
Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	292.367	0.000	3.020	0.000	882.822	0.000
Load on Surface	5.000	0.000	4.950	0.000	24.750	0.000
Rear Side Water Pressure	0.000	19.600	0.000	0.667	0.000	13.067
Earth Pressure	0.000	16.255	5.200	0.667	0.000	10.842
Total	297.367	35.855	———	———	907.572	23.909

[3]Seismic 1 (With Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	292.367	36.783	3.020	1.831	882.822	67.360
Load on Surface	2.500	0.500	4.950	2.000	12.375	1.000
Earth Pressure	10.000	17.110	5.200	0.667	52.000	11.412
Total	304.867	54.393	———	———	947.197	79.773

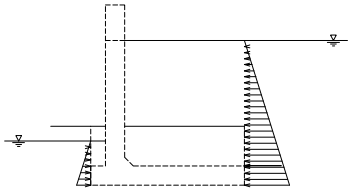
[4]Seismic 2 (With Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	183.917	-34.083	3.615	1.871	664.944	-63.783
Load on Surface	2.500	0.000	4.950	0.000	12.375	0.000
Earth Pressure	0.000	6.773	5.200	0.667	0.000	4.518
Total	186.417	-27.310	———	———	677.319	-59.265

Load Condition (Water Level)	No (kN)	Ho (kN)	Mo (kN.m.)
Normal (With Buoyancy)	195.447	30.545	622.213
Normal (Without Buoyancy)	297.367	35.855	883.664
Seismic 1 (With Buoyancy)	304.867	54.393	867.425
Seismic 1 (Without Buoyancy)	304.867	54.393	867.425
Seismic 2 (With Buoyancy)	186.417	-27.310	736.584
Seismic 2 (Without Buoyancy)	186.417	-27.310	736.584

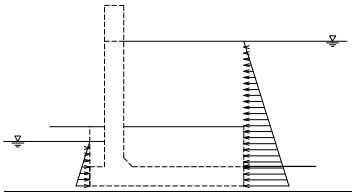
[5]Flood (With Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	292.367	0.000	2.180	0.000	637.487	0.000
Buoyancy	-120.278	0.000	2.329	0.000	-280.138	0.000
Load on Surface	0.000	116.786	0.000	1.627	0.000	190.050
Rear Side Water Pressure	0.000	-11.025	0.000	0.500	0.000	-5.513
Earth Pressure	0.000	5.527	5.200	0.667	0.000	3.687

Total	172.089	111.288	———	———	357.349	188.224

[5] Flood (Without Buoyancy)



Item	Vertical Force Ni (kN)	Horizontal Load Hi (kN)	Arm length		Angular Moment (kN.m.)	
			Xi (m)	Yi (m)	Mxi = Ni, Xi	Myi = Hi Yi
Body Weight	292.367	0.000	2.180	0.000	637.487	0.000
Front Side Water Pressure	0.000	116.786	0.000	1.627	0.000	190.050
Rear Side Water Pressure	0.000	-11.025	0.000	0.500	0.000	-5.513
Earth Pressure	0.000	10.837	5.200	0.667	0.000	7.228
Total	292.367	116.598	———	———	637.487	191.766

Load Condition (Water Level)	No (kN)	Ho (kN)	Mo (kN.m.)
Flood (With Buoyancy)	172.089	111.288	169.125
Flood (Without Buoyancy)	292.367	116.598	445.721

(2)Summary of Forces Acting At the Footing Center

Vertical Force : Nc = No (kN)
Horizontal Force : Hc = Ho (kN)
Turning Moment : Mc = No Bj/2.0 - Mo (kN.m.)

Here,

Footing Width in Earth Pressure Direction : Bj = 7.500 (m)

■Per Unit Width

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal (With Buoyancy)	297.367	35.855	-110.509
Seismic 1 (With Buoyancy)	304.867	54.393	-74.770
Seismic 1 (Without Buoyancy)	304.867	54.393	-74.770
Seismic 2 (With Buoyancy)	186.417	-27.310	-251.899
Seismic 2 (Without Buoyancy)	186.417	-27.310	-251.899
Flood (With Buoyancy)	172.089	111.288	278.306
Flood (Without Buoyancy)	292.367	116.598	314.434

■Per full width (9.000 m)

Load Condition (Water Level)	Nc (kN)	Hc (kN)	Mc (kN.m.)
Normal (With Buoyancy)	977.235	152.725	-570.254
Normal (Without Buoyancy)	1486.835	179.275	-552.546
Seismic 1 (With Buoyancy)	1524.335	271.967	-373.850
Seismic 1 (Without Buoyancy)	1524.335	271.967	-373.850
Seismic 2 (With Buoyancy)	932.085	-136.552	-1259.497
Seismic 2 (Without Buoyancy)	932.085	-136.552	-1259.497
Flood (With Buoyancy)	860.444	556.441	1391.529
Flood (Without Buoyancy)	1461.835	582.991	1572.168

3.2.7 Stability Analysis Results

3.2.7.1 Stability against Overturning

(1)Calculation of Acting Point of Composited Force and Eccentricity

$$d = \frac{\Sigma Mr - \Sigma Mt}{\Sigma V}$$

Here,

d: Distance from the Toe of Bottom Slab to the Acting Point of Composited Force (m)
ΣMr: Resistive Moment of Toe of Bottom Slab (kN.m.)
ΣMt: Overturning Moment of Toe of Bottom Slab (kN.m.)
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)

$$e = \frac{B}{2} - d$$

Here,

e: Eccentricity from the Center of Bottom Slab to the Acting Point of Composited Force (m);
B: Bottom Slab Width (m), B = 7.500

ea = B/n

Here,

ea: Allowable Eccentricity (m)
n: Safety Factor

Load Condition (Water Level)	Σ Mr (kN.m.)	Σ Mt (kN.m.)	ΣV (kN)	d (m)	e (m)		Ea (m)
Normal (With Buoyancy)	642.580	20.367	195.447	3.184	0.584	≦	0.867
Seismic 1 (With Buoyancy)	947.197	79.773	304.867	2.845	0.245	≦	1.733
Seismic 2 (With Buoyancy)	677.319	-59.265	186.417	3.951	1.351	≦	1.733
Flood (With Buoyancy)	357.349	188.224	172.089	0.983	1.617	≦	1.733

3.2.7.2 Stability Against Sliding

$$F_s = \frac{\Sigma V \cdot \mu + C_B \cdot B + \alpha \cdot Pp}{\Sigma H}$$

Here,

ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
ΣH: Total Horizontal Load in Lower Side of Bottom Slab (kN)
m.: Cohesion Between Bottom Slab and Supporting Ground, m = 0.577
C_B: Cohesion Between Bottom Slab And Supporting Ground (kN/m2), C_B = 0.000
B: Bottom Slab Width (m), B = 7.500
α: Effeective Rate of Passive Earth Pressure
Pp: Passive Earth Pressure

Load Condition (Water Level)	Vertical Load ΣV (kN)	Horizontal Load ΣH (kN)	Passive Earth Pressure Pp(kN)	Effective Rate	Safety Factor Fs		Required Safety Factor Fsa
Normal (With Buoyancy)	195.447	30.545	0.000	0.000	3.199	≧	1.500
Seismic 1 (With Buoyancy)	304.867	54.393	73.924	0.500	3.482	≧	1.200

Seismic 2 (With Buoyancy)	186.417	-27.310	73.924	0.500	4.766	≧	1.200
Flood (With Buoyancy)	172.089	111.288	143.826	0.500	1.419	≧	1.200

3.2.7.3 Verification of Bearing

1)When the Acting Point of Composited Force is within the 1/3 of Bottom Slab Width (middle third) in the Center of the Bottom Slab.

$$q_1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6e}{B}\right)$$

$$q_2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6e}{B}\right)$$

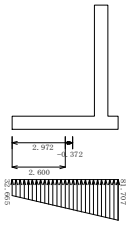
2)When the Acting Point of Composited Force is within the 2/3 of Bottom Slab Width in the Center of the Bottom Slab.

$$q_1 = \frac{2\Sigma V}{3 \cdot (B/2 - e)}$$

Here,

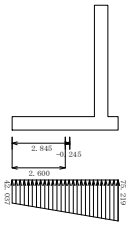
ΣV: Total Vertical Load in Lower Side of Bottom Slab (kN)
B: Bottom Slab Width (m), B = 7.500
e: Eccentricity (m)

[1]Normal (Without Buoyancy)



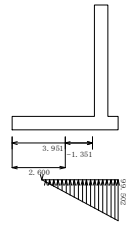
Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2)			
		qmin	qmax		Allowance
5.200	Trapezoid	32.665	81.707	≦	200.000

[2]Seismic 1 (With Buoyancy)



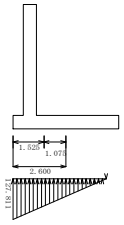
Subgrade Reaction Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2)			
		qmin	qmax		Allowance
5.200	Trapezoid	42.037	75.219	≦	300.000

[3]Seismic 2 (With Buoyancy)



Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2)			
		qmin	qmax		Allowance
3.747	Triangle	0.0000	99.502	≦	300.000

[4]Flood (With Buoyancy)



Acting Width (m)	Subgrade Reaction Shape	Subgrade Reaction Intensity (kN/m2)		
		qmin	qmax	Allowance
5.200	Triangle	0.000	127.811 ≦	300.000

3.3 Vertical Wall Design

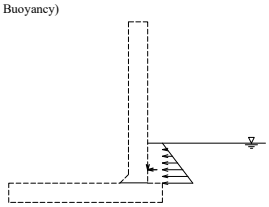
3.3.1 Checking Position

Distance from Base = 0.000 m

3.3.2 Calculation of Cross-Sectional Force

(Vertical forces are not summarized due to disregard of eccentric moments and axial forces)

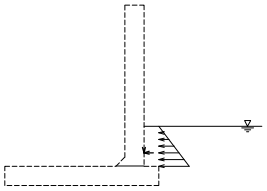
[1]Normal (With Buoyancy)



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	87.607	0.000	0.005	0.000	0.000
Hydrostatic on Rear Side	0.000	8.930	0.000	0.450	4.019
Earth Pressure	2.207	5.115	-0.325	0.450	2.302
Total	0.000	14.045	———	———	6.320

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

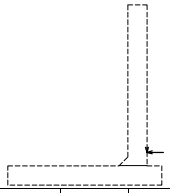
[2]Normal (Without Buoyancy)



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	87.607	0.000	0.005	0.000	0.000
Hydrostatic on Rear Side	0.000	8.930	0.000	0.450	4.019
Earth Pressure	3.071	7.120	-0.325	0.450	3.204
Total	0.000	16.050	———	———	7.223

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

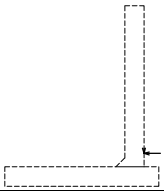
[3]Seismic 1 (With Buoyancy)



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	87.607	17.521	0.005	2.683	47.011
Earth Pressure	2.852	9.044	-0.325	0.450	4.070
Total	0.000	26.565	———	———	51.081

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

[4]Seismic 2 (With Buoyancy)

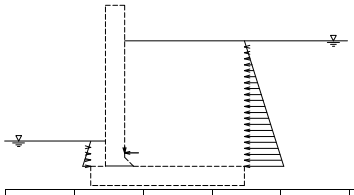


Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	87.607	-17.521	0.005	2.683	-47.011

Earth Pressure	1.209	2.802	-0.325	0.450	1.261
Total	0.000	-14.719	———	———	-45.750

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

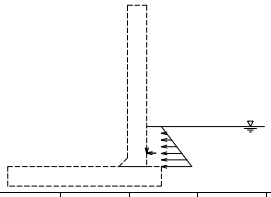
[5]Flood (With Buoyancy)



Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	87.607	0.000	-0.005	0.000	0.000
Hydrostatic on Rear Side	0.000	87.758	0.000	1.411	123.797
Hydrostatic on Front Side	0.000	-3.540	0.000	0.283	-1.003
Earth Pressure	0.900	2.086	-0.325	0.450	0.939
Total	0.000	86.304	———	———	123.733

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

[6]Flood (Without Buoyancy)

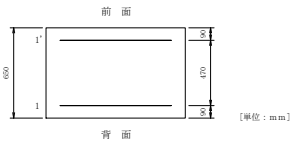


Item	Ni (kN)	Hi (kN)	Xi (m)	Yi (m)	M = Mxi + Myi (kN.m.)
Body Weight	87.607	0.000	-0.005	0.000	0.000
Hydrostatic on Rear Side	0.000	87.758	0.000	1.411	123.797
Hydrostatic on Front Side	0.000	-3.540	0.000	0.283	-1.003
Earth Pressure	1.764	4.090	-0.325	0.450	1.840
Total	0.000	88.308	———	———	124.635

*Xi is the distance from the design section center (+ toward front) and Yi is the height from the design section

3.3.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D25	5.067	8.00	40.536
	2'	—	–	—	—	—
Back	1	9.0	D25	5.067	8.00	40.536
	2	—	–	—	—	—

Required Reinforcement in Tension Side 12.755 (cm2)

(2)Verification of Bending Stress

(Reference)

Calculation of the neutral axis

$$x^2 + \frac{2 \cdot n}{b}\{As \cdot (x-d)\} = 0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot As \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	N (kN)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
				Calculated	Allowance	Calculated	Allowance
Normal (Without Buoyancy)	7.223	0.000	15.671	0.153 ≦	8.200	3.553 ≦	140.000
Seismic 1 (With Buoyancy)	51.081	0.000	15.671	1.085 ≦	10.906	25.127 ≦	247.380
Seismic 2 (With Buoyancy)	-45.750	0.000	15.671	0.972 ≦	10.906	22.505 ≦	247.380

Flood (Without Buoyancy)	124.635	0.000	15.671	2.647	≦	10.906	61.308	≦ 186.200

(3)Verification of Shear Stress

$$\tau_m = \frac{S_h}{b \cdot d} \leqq \tau_{a1}$$

Here,

τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

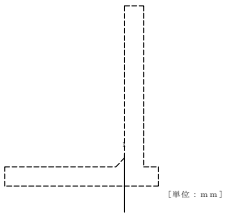
Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)		
			Calculated	Allowable τa1	Allowable τa2
Normal (With Buoyancy)	14.045	56.000	0.025 ≦	0.360	0.360
Seismic 1 (With Buoyancy)	26.565	56.000	0.047 ≦	0.479	0.479
Seismic 2 (With Buoyancy)	-14.719	56.000	0.026 ≦	0.479	0.479
Flood (With Buoyancy)	86.304	56.000	0.154 ≦	0.479	0.479

3.4 Design of Toe Slab

3.4.1 Checking Position

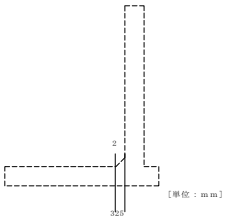
[1]Verification of Bending Stress

Distance from Base = 0.000 m



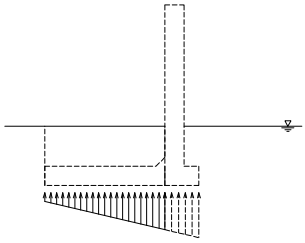
[2]Verification of Shear Stress

Distance from Base = 0.000 m



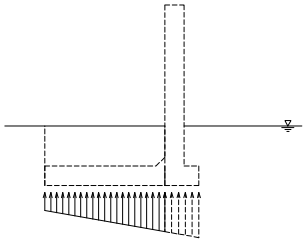
3.4.2 Calculation of Cross-Sectional Force

[1]Normal (With Buoyancy)



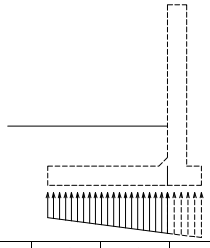
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-174.049	2.023	-352.059
Buoyancy	79.380	2.025	160.745
Subgrade Reaction	129.557	1.609	208.469
Total	34.888	———	17.155

[2]Normal (Without Buoyancy)



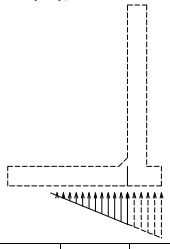
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-174.049	2.023	-352.059
Subgrade Reaction	209.641	1.776	372.313
Total	35.592	———	20.254

[3]Seismic 1 (With Buoyancy)



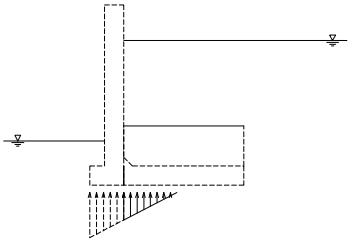
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-174.049	2.023	-352.059
Subgrade Reaction	222.583	1.866	415.406
Total	48.535	———	63.347

[4]Seismic 2 (With Buoyancy)



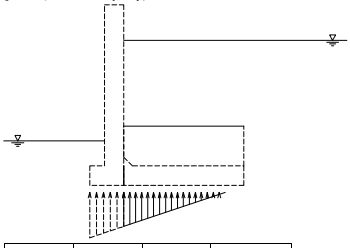
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-65.599	1.993	-130.715
Subgrade Reaction	89.549	0.866	77.520
Total	23.951	———	-53.195

[5]Flood (With Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	174.049	2.023	352.059
Buoyancy	-79.380	2.025	-160.745
Subgrade Reaction	-64.042	0.600	-38.404
Total	30.627	———	152.910

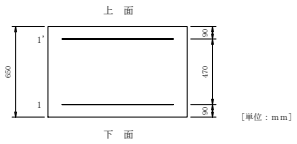
[6]Flood (Without Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	174.049	2.023	352.059
Subgrade Reaction	-163.858	1.142	-187.071
Total	10.190	———	164.987

3.4.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D25	5.067	8.00	40.536
	2'	——	—	——	——	——
Back	1	9.0	D25	5.067	8.00	40.536
	2	——	—	——	——	——

Required Reinforcement in Tension Side 12.755 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2+\frac{2\cdot n}{b}\left\{As\cdot(x-d)\right\}=0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c=\frac{M}{\frac{b\cdot x}{2}\cdot\left(\frac{h}{2}-\frac{x}{3}\right)+n\cdot As\cdot\frac{(x-d)\cdot(h/2-d)}{x}}$$

$$\sigma_s=n\cdot\sigma_c\cdot\frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
			Calculated	Allowance	Calculated	Allowance
Normal (Without Buoyancy)	20.254	15.671	0.430 ≦	8.200	9.963 ≦	140.000
Seismic 1 (With Buoyancy)	63.347	15.671	1.345 ≦	10.906	31.161 ≦	186.200
Seismic 2 (With Buoyancy)	-53.195	15.671	1.130 ≦	10.906	26.167 ≦	186.200
Flood (Without Buoyancy)	124.635	15.671	2.647 ≦	10.906	61.308 ≦	186.200

(3)Verification of Shear Stress

$$\tau_m=\frac{S_h}{b\cdot d}\leqq\tau_{a1}$$

Here,

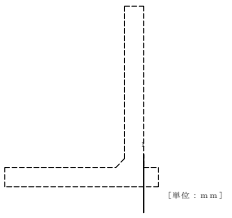
τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)	
			Calculated	Allowable τa2
Normal (With Buoyancy)	27.215	560.000	0.049 ≦	0.360
Seismic 1 (With Buoyancy)	40.966	560.000	0.073 ≦	0.479
Seismic 2 (With Buoyancy)	9.219	560.000	0.016 ≦	0.479
Flood (With Buoyancy)	30.627	560.000	0.055 ≦	0.479

3.5 Design of the Heel Slab

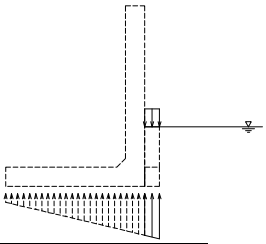
3.5.1 Checking Position

Distance from Base = 0.000 m



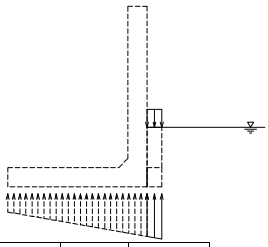
3.5.2 Calculation of Cross-Sectional Force

[1]Normal (With Buoyancy)



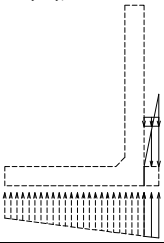
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	21.462	0.250	5.366
Buoyancy	-9.800	0.250	-2.450
Load on Surface	5.000	0.250	1.250
Subgrade Reaction	-30.230	0.253	-7.659
Total	-13.567	———	-3.493

[2]Normal (Without Buoyancy)



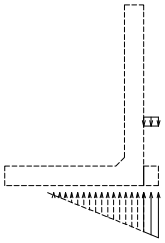
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	21.462	0.250	5.366
Load on Surface	5.000	0.250	1.250
Subgrade Reaction	-39.675	0.252	-10.017
Total	-13.212	———	-3.401

[3]Seismic 1 (With Buoyancy)



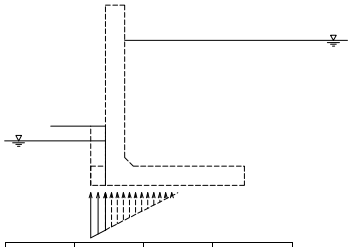
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	21.462	0.250	5.366
Load on Surface	2.500	0.250	0.625
Earth Pressure	10.000	0.333	3.333
Subgrade Reaction	-36.812	0.252	-9.269
Total	-2.849	———	0.054

[4]Seismic 2 (With Buoyancy)



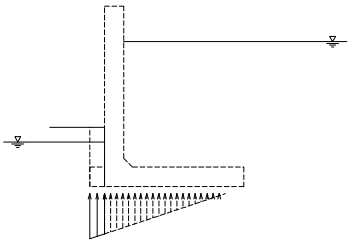
Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	21.462	0.250	5.366
Load on Surface	2.500	0.250	0.625
Subgrade Reaction	-40.408	0.269	-10.881
Total	-16.446	———	-4.890

[5]Flood (With Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-21.462	0.250	-5.366
Buoyancy	9.800	0.250	2.450
Subgrade Reaction	53.408	0.258	13.764
Total	41.745	———	10.849

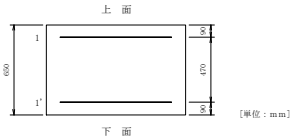
[6]Flood (Without Buoyancy)



Item	Ni (kN)	Xi (m)	M = Ni, Xi (kN.m.)
Body Weight	-21.462	0.250	-5.366
Subgrade Reaction	60.413	0.255	15.394
Total	38.951	———	10.029

3.5.3 Section Calculations (Allowable Stress Method)

(1)Rebar Placement



Single Reinforcement

Position		Cover (cm)	Rebar Diameter	Rebar Area (cm2/pc)	Number	Amount of Reinforcement (cm2)
Front	1'	9.0	D25	5.067	8.00	40.536
	2'	—	–	——	—	——
Back	1	9.0	D25	5.067	8.00	40.536
	2	—	–	——	—	——

Required Reinforcement in Tension Side 0.452 (cm2)

(2)Verification of Bending Stress

Calculation of the neutral axis

$$x^2+\frac{2\cdot n}{b}\left\{As\cdot(x-d)\right\}=0.0$$

From the above, x shall be obtained.

Calculation of Stress Intensity

$$\sigma_c=\frac{M}{\frac{b\cdot x}{2}\cdot\left(\frac{h}{2}-\frac{x}{3}\right)+n\cdot As\cdot\frac{(x-d)\cdot(h/2-d)}{x}}$$

$$\sigma_s=n\cdot\sigma_c\cdot\frac{d-x}{x}$$

Here,

x : Distance from the Concrete Compression Edge to the Neutral Axis (mm)
h : Member Section Height (mm), h = 400.000
b : Member Section Width (mm), b = 1000.000
d : Effective Height of Member (mm)
As: Total Cross-Sectional Area of Rebar in Tension (mm2)
n : Young's Modulus Ratio of Rebar to Concrete, n = 9.00
e : Distance from the Centroid Axis of the Member Section to the Acting Point of Axial Force (mm)
σc: Bending Compressive Stress of Concrete (N/mm2)
σs: Tensile Stress of Rebar (N/mm2)
M : Bending Moment (N.mm)

Load Condition (Water Level)	M (kN.m.)	x (cm)	Compressive Stress (N/mm2)		Tensile Stress (N/mm2)	
			Calculated	Allowance	Calculated	Allowance
Normal (Without Buoyancy)	-3.493	15.671	0.074 ≦	8.200	1.718 ≦	140.000
Seismic 1 (With Buoyancy)	0.054	15.671	0.001 ≦	10.906	0.027 ≦	186.200
Seismic 2 (With Buoyancy)	-4.890	15.671	0.104 ≦	10.906	2.405 ≦	186.200
Flood (Without Buoyancy)	10.849	15.671	0.230 ≦	10.906	5.336 ≦	186.200

(3)Verification of Shear Stress

$$\tau_m=\frac{S_h}{b\cdot d}\leqq\tau_{a1}$$

Here,

τm: Average Shear Stress of Concrete (N/mm2)
Sh : Shear Force (N)
d : Effective Height of Member Section (mm)
b : Member Section Width (mm)

Load Condition (Water Level)	Shear Force Sh (kN)	Effective Height d (cm)	Shear Stress (N/mm2)	
			Calculated	Allowable τa2
Normal (With Buoyancy)	13.567	560.000	0.024 ≦	0.360
Seismic 1 (With Buoyancy)	2.849	560.000	0.005 ≦	0.479
Seismic 2 (With Buoyancy)	16.446	560.000	0.029 ≦	0.479
Flood (With Buoyancy)	15.735	560.000	0.028 ≦	0.479

1.2.5 Consolidation Analysis

The calculation sheets are shown in the following pages.

Left Bank
Station 5+560

Contents

Page

1. Initial Condition 1

2. Results 7

1. Initial Condition

Title :L_7+560

1.1 Initial Condition

1.1.1 Nodal Points Data

Node No	X (m)	Y (m)	Node No	X (m)	Y (m)	Node No	X (m)	Y (m)
1	-64.54	9.87	7	-45.00	-7.38	13	-45.20	14.70
2	-64.54	9.11	8	-45.00	7.44	14	-46.96	18.13
3	-64.54	7.44	9	-45.00	9.11	15	-50.56	18.06
4	-64.54	-7.38	10	-45.00	9.87	16	-52.85	13.48
5	-64.54	-14.47	11	-45.00	13.48	17	-64.54	13.48
6	-45.00	-14.47	12	-45.00	14.70			

1.1.2 Layer Shape Data

Shape Number	Constitution Setting Points						Layer Type	Floor digging / Backfill
1	11	12	13	14	15	16	Embankment	don't
2	11	16	17	1	10		Sand	don't
3	10	1	2	9			Cray	don't
4	9	2	3	8			Sand	don't
5	8	3	4	7			Cray	don't
6	7	4	5	6			Sand	don't

1.1.3 Embankment Condition

Execution Stage	Shape No.	Soil Type	Saturated Unit Weight (kN/m³)	Unit Weight (kN/m³)	Construction Period start	Construction Period Finish	Embankment Removal Date	Construction Period for a second time Start day for a second time	Construction Period for a second time Finish day for a second time	Removal day for a second time
1	1	Embankment	19.5	19.0	0	60	---	---	---	---

1.1.4 Soil Condition

Layer (Shape) No	Layer Name	Calculation Method	Saturated UnitWeight (kN/m³)	Unit Weight (kN/m³)	Layer Type
2	As	B.K.Hough	17.5	17.5	Sand
3	Dc	Delta e method	18.0	18.0	Clay
4	Ds	B.K.Hough	19.0	19.0	Sand
5	Dc	Delta e method	18.0	18.0	Clay
6	Ds	B.K.Hough	19.0	19.0	Sand

Layer (Shape) No	e -logP Curve	logMv -logP Curve	logCv -logP Curve	Water Content (%)	N Value	Compression Index Cc Normal	Compression Index Cc Over	Consolidation Yield Stress Pc (kN/m²)	increase in Preconsolidation qo(kN/m²)	t=(sqr)Tv Replaceable Coefficient (sqr)
2	20	0	0	0	0	0.00	0.00	0.00	0.00	0.00
3	15	0	2	0	0	0.00	0.00	0.00	0.00	0.00
4	22	0	0	0	0	0.00	0.00	0.00	0.00	0.00
5	15	0	2	0	0	0.00	0.00	0.00	0.00	0.00
6	22	0	0	0	0	0.00	0.00	0.00	0.00	0.00

1.1.5 Ground Water Level

Water Unit Weight : 10.0 kN/m³

Ground water influence : There is it. (convergence condition = 1.00cm)

Node No	X (m)	Y (m)
1	-64.54	13.48
2	-45.00	13.48

1.2 Common Item about Calculation

1.2.1 Calculation Condition(Common Item)

Calculation Method : Boussinesq method

Lay No.	Reduction Coefficient of Settlement
2	1.00
3	1.00
4	1.00
5	1.00
6	0.00

1.2.2 Shear Deformation

Calculation Method: Japan Ins of Constraction Eng.
"Flexible Sluiceways"(1998)
Calculation Shape Number: 6433908
Division pitch of Calculation Shape Number: 0.0

Depth which has the influence of shear deformation

Node No	X (m)	Y (m)

layer (Form)	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00
5	0.00	0.00

Execution	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00

Poisson's ratio :0.00

1.2.3 Residual Condition

Calculation of Settlement Period length 60 day

1.3 Calculation of Computation Time Condition

1.3.1 Calculation Condition(Settlement Time)

History Condition :Lasped days

Calculation Period :36000 day

Output condition of Cross Section Diagram

Degree of Consolidation :100% Calculation point(X Coodinate) :-55.00m

Creation method of Time-Settlemnt Curve :Parallel Translation Method

1.3.2 Consolidation Condition

Coefficient-of-consolidation calculation method of some layers
Layer Thickness Converting Method : Parallel Translation Method

Drainage Condition

Layer (Form)	Drainage Condition
2	Sand Layer
3	Both Side
4	Sand Layer
5	Both Side
6	Sand Layer

Bedrock Condition :Drained

1.4.1 Curves Record

(1)e-logP Curve
Curve 20 :Loose Sand
Interpolation Method between Data :Curve Line
Layer No. in use : 2

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	0.20	0.30	0.50	1.00	2.00	3.00	5.00	10.00
Void Ratio e	0.780	0.760	0.742	0.714	0.688	0.678	0.662	0.640

Number	9	10	11	12
Consolidation Stress (kN/m²)	20.00	30.00	50.00	100.00
Void Ratio e	0.621	0.611	0.600	0.590

Curve 15 :DD-BH-L01
Interpolation Method between Data :Curve Line
Layer No. in use : 3 5

Number	1	2	3	4	5	6
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	800.00
Void Ratio e	1.960	1.920	1.800	1.650	1.450	1.000

Curve 22 :Compacted Sand
Interpolation Method between Data :Curve Line
Layer No. in use : 4 6

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	0.20	0.30	0.50	1.00	2.00	3.00	5.00	10.00
Void Ratio e	0.490	0.484	0.477	0.467	0.457	0.451	0.443	0.433

Number	9	10	11	12	13	14
Consolidation Stress (kN/m²)	20.00	30.00	50.00	100.00	200.00	1000.00
Void Ratio e	0.423	0.417	0.410	0.400	0.390	0.380

(2)logCv-logP Curve
Curve 2 :DD-BH-L01 (Dc1)
Interpolation Method between Data :Curve Line
Consolidation Stress Calculation Method :Geometrica
Layer No. in use : 3 5

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00	1600.00
Coefficient of Consolidation Cv(cm²/day)	62.00	87.00	148.00	158.00	55.00	35.00	28.00	23.00

2. Results

2.1 Results of each Points

Calculation Point 1 : Left_Crest
Calculation Depth : -50.563 m
Ground Water Level : 13.477 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	3.610	13.57	64.05	0.00	8.423
3	delta e method	0.760	30.14	49.31	0.00	4.996
4	B.K.Hough	1.670	40.70	43.21	0.00	1.201
5	delta e method	14.820	107.49	21.60	0.00	28.107
6	B.K.Hough	7.090	198.68	12.46	0.00	0.000

Sub Total: 42.726(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.631	0.593	——	——	——	——	——	——
3	1.894	1.704	——	——	——	48.94	——	145.738
4	0.413	0.403	——	——	——	——	——	——
5	1.632	1.582	——	——	——	117.80	——	129.660
6	0.390	0.389	——	——	——	——	——	——

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	8.423	100.000	——	8.423
3	100.000	4.996	99.954	——	4.993
4	100.000	1.201	100.000	——	1.201
5	99.999	28.107	9.497	——	2.669
6	100.000	0.000	100.000	——	0.000

Sub Total: 42.726(cm) Sub Total: 17.286(cm)

Residual Settlement: 25.440(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	3.610	0.000
3	0.760	145.738
4	1.670	0.000
5	14.820	129.660
6	7.090	0.000

Sa = 100.00

ΔS= 25.44

Sa ≧ΔS ・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)

ΔS : Designing residual settlement(Total settlement) (cm)

Calculation Point 2 : Center_of_Embankment
Calculation Depth : -48.764 m
Ground Water Level : 13.477 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	3.610	13.57	76.88	0.00	8.859
3	delta e method	0.760	30.14	57.85	0.00	5.605
4	B.K.Hough	1.670	40.70	49.11	0.00	1.320
5	delta e method	14.820	107.49	22.31	0.00	28.990
6	B.K.Hough	7.090	198.68	12.59	0.00	0.000

Sub Total: 44.774(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.631	0.591	——	——	——	——	——	——
3	1.894	1.681	——	——	——	51.50	——	151.103
4	0.413	0.402	——	——	——	——	——	——
5	1.632	1.580	——	——	——	118.12	——	129.141
6	0.390	0.389	——	——	——	——	——	——

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	8.859	100.000	——	8.859
3	100.000	5.605	99.965	——	5.603
4	100.000	1.320	100.000	——	1.320
5	99.999	28.989	9.478	——	2.748
6	100.000	0.000	100.000	——	0.000

Sub Total: 44.774(cm) Sub Total: 18.530(cm)

Residual Settlement: 26.244(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	3.610	0.000
3	0.760	151.103
4	1.670	0.000
5	14.820	129.141
6	7.090	0.000

Sa = 100.00

ΔS= 26.24

Sa ≧ΔS ・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)

ΔS : Designing residual settlement(Total settlement) (cm)

Calculation Point 3 : Right_Side_of_Embank
Calculation Depth : ment -46 m
Ground Water Level : 13.477 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	3.610	13.57	65.27	0.00	8.468
3	delta e method	0.760	30.14	49.91	0.00	5.039
4	B.K.Hough	1.670	40.70	43.60	0.00	1.209
5	delta e method	14.820	107.49	21.64	0.00	28.162
6	B.K.Hough	7.090	198.68	12.47	0.00	0.000

Sub Total: 42.878(cm)

Lay No.	eo	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.631	0.593	——	——	——	——	——	——
3	1.894	1.702	——	——	——	49.12	——	146.130
4	0.413	0.403	——	——	——	——	——	——
5	1.632	1.582	——	——	——	117.82	——	129.628
6	0.390	0.389	——	——	——	——	——	——

[Immediate Sinkage] "Flexible Sluiceways"(1998)
Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00
Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]
Degree of Consolidation: 100%
(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	8.468	100.000	——	8.468
3	100.000	5.039	99.955	——	5.037
4	100.000	1.209	100.000	——	1.209
5	99.999	28.162	9.496	——	2.674
6	100.000	0.000	100.000	——	0.000

Sub Total: 42.878(cm) Sub Total: 17.388(cm)
Residual Settlement: 25.490(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	3.610	0.000
3	0.760	146.130
4	1.670	0.000
5	14.820	129.628
6	7.090	0.000

Sa = 100.00
ΔS= 25.49
Sa ≧ΔS ・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Designing residual settlement(Total settlement) (cm)

Calculation Point 4 : Toe_of_Embankment
Calculation Depth : -45.200 m
Ground Water Level : 13.477 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	3.610	13.57	27.25	0.00	6.034
3	delta e method	0.760	30.14	31.18	0.00	3.556
4	B.K.Hough	1.670	40.70	30.57	0.00	0.919
5	delta e method	14.820	107.49	19.80	0.00	25.876
6	B.K.Hough	7.090	198.68	12.10	0.00	0.000

Sub Total: 36.385(cm)

Lay No.	eo	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.631	0.604	——	——	——	——	——	——
3	1.894	1.759	——	——	——	42.99	——	132.121
4	0.413	0.405	——	——	——	——	——	——
5	1.632	1.586	——	——	——	116.97	——	130.977
6	0.390	0.389	——	——	——	——	——	——

[Immediate Sinkage] "Flexible Sluiceways"(1998)
Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00
Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]
Degree of Consolidation: 100%
(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	6.034	100.000	——	6.034
3	100.000	3.556	99.907	——	3.553
4	100.000	0.919	100.000	——	0.919
5	99.999	25.876	9.545	——	2.470
6	100.000	0.000	100.000	——	0.000

Sub Total: 36.385(cm) Sub Total: 12.976(cm)
Residual Settlement: 23.409(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	3.610	0.000
3	0.760	132.121
4	1.670	0.000
5	14.820	130.977
6	7.090	0.000

Sa = 100.00
ΔS= 23.41
Sa ≧ΔS ・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Designing residual settlement(Total settlement) (cm)

2.2 Degree of Consolidation - Duration in days

Calculation Point 1 : Left_Crest
Calculation Depth : -50.563 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	17	32	46	60	222	541	1020	1714	2903	---
Settlement	4.273	8.545	12.818	17.091	21.363	25.636	29.908	34.181	38.454	42.726

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.842	1.685	2.527	3.369	4.211	5.054	5.896	6.738	7.580	8.423

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	9	14	20	25	31	37	43	49	55	---
Settlement	0.500	0.999	1.499	1.998	2.498	2.997	3.497	3.997	4.496	4.996

Layer No. : 4 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.120	0.240	0.360	0.480	0.600	0.720	0.841	0.961	1.081	1.201

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	64	164	330	563	864	1243	1736	2432	3622	---
Settlement	2.811	5.621	8.432	11.243	14.054	16.864	19.675	22.486	25.296	28.107

Layer No. : 6 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	1	1	1	1	1	1	1	1	1	---
Settlement	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Calculation Point 2 : Center_of_Embankment
Calculation Depth : -48.764 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	17	31	45	59	204	518	996	1693	2887	---
Settlement	4.477	8.955	13.432	17.910	22.387	26.864	31.342	35.819	40.297	44.774

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.886	1.772	2.658	3.544	4.430	5.315	6.201	7.087	7.973	8.859

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	9	14	20	25	31	37	43	49	55	---
Settlement	0.560	1.121	1.681	2.242	2.802	3.363	3.923	4.484	5.044	5.605

Layer No. : 4 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.132	0.264	0.396	0.528	0.660	0.792	0.924	1.056	1.188	1.320

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	64	164	331	565	867	1248	1743	2442	3636	---
Settlement	2.899	5.798	8.697	11.596	14.495	17.394	20.293	23.192	26.091	28.990

Layer No. : 6 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	1	1	1	1	1	1	1	1	1	---
Settlement	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Calculation Point 3 : Right_Side_of_Embank
Calculation Depth : ment -46 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	17	32	46	60	220	539	1017	1711	2901	---
Settlement	4.288	8.576	12.864	17.151	21.439	25.727	30.015	34.303	38.591	42.878

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.847	1.694	2.540	3.387	4.234	5.081	5.928	6.775	7.621	8.468

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	9	14	20	25	31	37	43	49	55	---
Settlement	0.504	1.008	1.512	2.016	2.520	3.023	3.527	4.031	4.535	5.039

Layer No. : 4 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.121	0.242	0.363	0.484	0.604	0.725	0.846	0.967	1.088	1.209

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	64	164	330	563	864	1244	1737	2433	3623	---
Settlement	2.816	5.632	8.449	11.265	14.081	16.897	19.714	22.530	25.346	28.162

Layer No. : 6 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	1	1	1	1	1	1	1	1	1	---
Settlement	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Calculation Point 4 : Toe_of_Embankment
Calculation Depth : -45.200 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	19	36	52	111	321	661	1141	1829	3007	---
Settlement	3.638	7.277	10.915	14.554	18.192	21.831	25.469	29.108	32.746	36.385

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.603	1.207	1.810	2.414	3.017	3.620	4.224	4.827	5.431	6.034

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	9	15	20	26	31	37	43	49	55	---
Settlement	0.356	0.711	1.067	1.422	1.778	2.134	2.489	2.845	3.200	3.556

Layer No. : 4 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.092	0.184	0.276	0.367	0.459	0.551	0.643	0.735	0.827	0.919

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	63	162	327	557	855	1231	1719	2408	3586	---
Settlement	2.588	5.175	7.763	10.350	12.938	15.526	18.113	20.701	23.289	25.876

Layer No. : 6 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : Ds

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	1	1	1	1	1	1	1	1	1	---
Settlement	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

2.3 Calculation result on the way in each construction stage

Calculation Point 1 : Left_Crest
Calculation Depth : -50.563 m
Ground Water Level : 13.477 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5	6		
1	0.000	145.738	0.000	129.660	0.000		

Calculation Point 2 : Center_of_Embankment
Calculation Depth : -48.764 m
Ground Water Level : 13.477 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5	6		
1	0.000	151.103	0.000	129.141	0.000		

Calculation Point 3 : Right_Side_of_Embank
Calculation Depth : ment -46 m
Ground Water Level : 13.477 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5	6		
1	0.000	146.130	0.000	129.628	0.000		

Calculation Point 4 : Toe_of_Embankment
Calculation Depth : -45.200 m
Ground Water Level : 13.477 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5	6		
1	0.000	132.121	0.000	130.977	0.000		

Left Bank
Station. 9+360

Contents

Page

1. Initial Condition 1

2. Results 7

1. Initial Condition

Title :

1.1 Initial Condition

1.1.1 Nodal Points Data

Node No	X (m)	Y (m)
1	-67.75	-11.41
2	-45.00	-11.41
3	-45.00	1.93
4	-45.00	4.95
5	-45.00	10.96
6	-45.00	11.96
7	-45.00	14.73
8	-45.00	15.10
9	-47.00	15.10

Node No	X (m)	Y (m)
10	-49.11	19.22
11	-59.71	19.01
12	-60.73	16.97
13	-61.74	17.12
14	-67.75	17.12
15	-67.75	16.73
16	-67.75	11.96
17	-67.75	10.96
18	-67.75	4.95

Node No	X (m)	Y (m)
19	-67.75	1.93
20	-59.08	16.74
21	-58.94	16.73
22	-58.90	15.75
23	-58.79	15.71
24	-52.33	14.73
25	-45.71	14.82

1.1.2 Layer Shape Data

Shape Number	Constitution Setting Points										Layer Type	Floor digging / Backfill
1	12	11	10	9	8	7	25	24	23	20	Embankment	don't
2	7	25	24	23	20	12	13	14	15	16	Cray	don't
	6											
3	16	17	5	6							Sand	don't
4	17	18	4	5							Cray	don't
5	18	19	3	4							Cray	don't

1.1.3 Embankment Condition

Execution Stage	Shape No.	Soil Type	Saturated Unit Weight (kN/m³)	Unit Weight (kN/m³)	Construction Period start	Construction Period Finish	Embankment Removal Date	Construction Period for a second time Start day for a second time	Construction Period for a second time Finish day for a second time	Removal day for a second time
1	1	Embankment	19.5	19.0	0	60	---	---	---	---

1.1.4 Soil Condition

Layer (Shape) No	Layer Name	Calculation Method	Saturated Unit Weight (kN/m³)	Unit Weight (kN/m³)	Layer Type
2	Ac	Delta e method	15.5	15.5	Clay
3	As	B.K.Hough	17.5	17.5	Sand
4	Ac	Delta e method	15.5	15.0	Clay
5	Dc	Delta e method	18.0	18.0	Clay

Layer (Shape) No	e -logP Curve	logMv -logP Curve	logCv -logP Curve	Water Content (%)	N Value	Compression Index Cc Normal	Compression Index Cc Over	Consolidation Yield Stress Pc (kN/m²)	Increase in Preconsolidation q0(kN/m²)	t=(sqr)Tv Replaceable Coefficient (sqr)
2	14	0	1	0	0	0.00	0.00	0.00	0.00	0.00
3	20	0	0	0	0	0.00	0.00	0.00	0.00	0.00
4	14	0	1	0	0	0.00	0.00	0.00	0.00	0.00
5	16	0	2	0	0	0.00	0.00	0.00	0.00	0.00

1.1.5 Ground Water Level

Water Unit Weight : 10.0 kN/m³

Ground water influence : There is it. (convergence condition = 1.00cm)

Node No	X (m)	Y (m)
1	-60.70	16.97
2	-45.00	14.80

1.2 Common Item about Calculation

1.2.1 Calculation Condition(Common Item)

Calculation Method : Boussinesq method

Lay No.	Reduction Coefficient of Settlement
2	1.00
3	1.00
4	1.00
5	1.00

1.2.2 Shear Deformation

Calculation Method: Japan Ins of Constraction Eng.
"Flexible Sluiceways"(1998)
Calculation Shape Number: 6433908
Division pitch of Calculation Shape Number: 0.0

Depth which has the influence of shear deformation

Node No	X (m)	Y (m)

layer (Form)	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00

Execution	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00

Poisson's ratio :0.00

1.2.3 Residual Condition

Calculation of Settlement Period length 60 day

1.3 Calculation of Computation Time Condition

1.3.1 Calculation Condition(Settlement Time)

History Condition :Lasped days

Calculation Period :36000 day

Output condition of Cross Section Diagram

Degree of Consolidation :100% Calculation point(X Coodinate) :-55.00m

Creation method of Time-Settlemnt Curve :Parallel Translation Method

1.3.2 Consolidation Condition

Coefficient-of-consolidation calculation method of some layers
Layer Thickness Converting Method : Parallel Translation Method

Drainage Condition

Layer (Form)	Drainage Condition
2	Both Side
3	Sand Layer
4	Both Side
5	Both Side

Bedrock Condition :Drained

1.4.1 Curves Record

(1)e-logP Curve
Curve 14 :DD-BH-L10
Interpolation Method between Data :Curve Line
Layer No. in use : 2 4

Number	1	2	3	4	5	6	7
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00
Void Ratio e	1.360	1.350	1.320	1.240	1.120	1.000	0.880

Curve 20 :Loose Sand
Interpolation Method between Data :Curve Line
Layer No. in use : 3

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	0.20	0.30	0.50	1.00	2.00	3.00	5.00	10.00
Void Ratio e	0.780	0.760	0.742	0.714	0.688	0.678	0.662	0.640

Number	9	10	11	12
Consolidation Stress (kN/m²)	20.00	30.00	50.00	100.00
Void Ratio e	0.621	0.611	0.600	0.590

Curve 16 :DD-BH-L13
Interpolation Method between Data :Curve Line
Layer No. in use : 5

Number	1	2	3	4	5	6	7
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00
Void Ratio e	1.370	1.350	1.320	1.240	1.120	1.000	0.880

(2)logCv-logP Curve
Curve 1 :DD-BH-L10 (Ac)
Interpolation Method between Data :Curve Line
Consolidation Stress Calculation Method :Geometrica
Layer No. in use : 2 4

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00	1600.00
Coefficient of Consolidation Cv(cm²/day)	29.00	98.00	69.00	66.00	24.00	20.00	18.00	16.00

Curve 2 :DD-BH-L01 (Dc1)
Interpolation Method between Data :Curve Line
Consolidation Stress Calculation Method :Geometrica
Layer No. in use : 5

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00	1600.00
Coefficient of Consolidation Cv(cm²/day)	62.00	87.00	148.00	158.00	55.00	35.00	28.00	23.00

2. Results

2.1 Results of each Points

Calculation Point 1 : Left_Crest
Calculation Depth : -59.709 m
Ground Water Level : 16.833 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	delta e method	4.868	13.39	21.12	0.00	3.778
3	B.K.Hough	1.000	30.52	25.62	0.00	0.783
4	delta e method	6.010	50.80	26.67	0.00	11.179
5	delta e method	3.020	79.41	24.97	0.00	5.222

Sub Total: 20.962(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	1.359	1.341	——	——	——	21.49	——	87.945
3	0.611	0.598	——	——	——	——	——	——
4	1.319	1.276	——	——	——	62.73	——	68.726
5	1.273	1.233	——	——	——	91.04	——	169.290

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	3.778	23.814	——	0.900
3	100.000	0.783	100.000	——	0.783
4	100.000	11.179	12.915	↓	1.444
5	100.000	5.222	12.915	12.915	0.674

Sub Total: 20.962(cm) Sub Total: 3.801(cm)

Residual Settlement: 17.162(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	4.868	87.945
3	1.000	0.000
5	12.453	169.290

Calculation Point 2 : Center_of_Embankment
Calculation Depth : -55.000 m
Ground Water Level : 16.182 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	delta e method	3.175	8.73	61.11	0.00	10.098
3	B.K.Hough	1.000	21.21	57.23	0.00	1.631
4	delta e method	6.010	41.49	46.65	0.00	18.961
5	delta e method	3.020	70.10	35.07	0.00	7.360

Sub Total: 38.050(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	1.363	1.288	——	——	——	24.69	——	97.557
3	0.620	0.593	——	——	——	——	——	——
4	1.332	1.258	——	——	——	60.47	——	68.329
5	1.288	1.232	——	——	——	85.86	——	173.874

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	10.098	38.452	——	3.883
3	100.000	1.631	100.000	——	1.631
4	100.000	18.961	12.928	↓	2.451
5	100.000	7.360	12.928	12.928	0.952

Sub Total: 38.050(cm) Sub Total: 8.917(cm)

Residual Settlement: 29.134(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	3.175	97.557
3	1.000	0.000
5	12.607	173.874

Sa = 50.00
ΔS= 29.13
Sa ≧ΔS ・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

Calculation Point 3 : Right_Side_of_Embank
Calculation Depth : ment -49 m
Ground Water Level : 15.368 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	delta e method	2.814	7.74	61.24	0.00	8.959
3	B.K.Hough	1.000	19.23	50.62	0.00	1.686
4	delta e method	6.010	39.50	40.22	0.00	16.125
5	delta e method	3.020	68.11	31.45	0.00	6.656

Sub Total: 33.426(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	1.365	1.290	——	——	——	23.10	——	93.903
3	0.622	0.595	——	——	——	——	——	——
4	1.335	1.272	——	——	——	56.12	——	67.916
5	1.291	1.241	——	——	——	82.35	——	175.985

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	8.959	42.565	——	3.813
3	100.000	1.686	100.000	——	1.686
4	100.000	16.125	12.917	↓	2.083
5	100.000	6.656	12.917	12.917	0.860

Sub Total: 33.426(cm) Sub Total: 8.442(cm)

Residual Settlement: 24.984(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	2.814	93.903
3	1.000	0.000
5	12.694	175.985

Sa = 50.00
ΔS= 24.98
Sa ≧ΔS ・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Designing residual settlement(Total settlement) (cm)

Calculation Point 4 : Toe_of_Embankment
Calculation Depth : -47.000 m
Ground Water Level : 15.076 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	delta e method	2.842	7.82	15.80	0.00	1.628
3	B.K.Hough	1.000	19.38	24.89	0.00	1.200
4	delta e method	6.010	39.66	28.19	0.00	11.076
5	delta e method	3.020	68.27	25.87	0.00	5.515

Sub Total: 19.419(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	1.365	1.351	——	——	——	13.59	——	38.604
3	0.622	0.602	——	——	——	——	——	——
4	1.334	1.291	——	——	——	51.87	——	68.364
5	1.291	1.249	——	——	——	80.17	——	176.843

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point=-55.000m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	1.628	27.019	——	0.440
3	100.000	1.200	100.000	——	1.200
4	100.000	11.076	12.957	↓	1.435
5	100.000	5.515	12.957	12.957	0.715

Sub Total: 19.419(cm) Sub Total: 3.790(cm)

Residual Settlement: 15.629(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	2.842	38.604
3	1.000	0.000
5	12.686	176.843

Sa = 10.00
ΔS= 15.63
Sa ≧ΔS ・・・・・・・・・・・・・・・・・・ NG

Sa : Allowance residual settlement(cm)
ΔS : Designing residual settlement(Total settlement) (cm)

2.2 Degree of Consolidation - Duration in days

Calculation Point 1 : Left_Crest
Calculation Depth : -59.709 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	40	69	130	222	347	518	757	1114	1747	---
Settlement	2.096	4.192	6.289	8.385	10.481	12.577	14.674	16.770	18.866	20.962

Layer No. : 2 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	34	54	78	115	163	223	302	412	602	---
Settlement	0.378	0.756	1.133	1.511	1.889	2.267	2.645	3.023	3.400	3.778

Layer No. : 3 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.078	0.157	0.235	0.313	0.391	0.470	0.548	0.626	0.704	0.783

Layer No. : 4 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	192	318	481	686	953	1329	1972	---
Settlement	1.118	2.236	3.354	4.472	5.590	6.707	7.825	8.943	10.061	11.179

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	192	318	481	686	953	1329	1972	---
Settlement	0.522	1.044	1.567	2.089	2.611	3.133	3.656	4.178	4.700	5.222

Calculation Point 2 : Center_of_Embankment
Calculation Depth : -55.000 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	33	54	85	138	222	369	613	985	1627	---
Settlement	3.805	7.610	11.415	15.220	19.025	22.830	26.635	30.440	34.245	38.050

Layer No. : 2 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	25	39	51	63	81	104	135	177	250	---
Settlement	1.010	2.020	3.029	4.039	5.049	6.059	7.068	8.078	9.088	10.098

Layer No. : 3 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.163	0.326	0.489	0.652	0.815	0.978	1.142	1.305	1.468	1.631

Layer No. : 4 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	192	318	480	685	951	1327	1969	---
Settlement	1.896	3.792	5.688	7.585	9.481	11.377	13.273	15.169	17.065	18.961

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	192	318	480	685	951	1327	1968	---
Settlement	0.736	1.472	2.208	2.944	3.680	4.416	5.152	5.888	6.624	7.360

Calculation Point 3 : Right_Side_of_Embank
Calculation Depth : ment -49 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	31	51	76	123	202	349	599	973	1616	---
Settlement	3.343	6.685	10.028	13.370	16.713	20.056	23.398	26.741	30.083	33.426

Layer No. : 2 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	23	37	48	58	72	91	115	150	209	---
Settlement	0.896	1.792	2.688	3.584	4.480	5.375	6.271	7.167	8.063	8.959

Layer No. : 3 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.169	0.337	0.506	0.674	0.843	1.011	1.180	1.349	1.517	1.686

Layer No. : 4 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	192	318	481	686	953	1329	1972	---
Settlement	1.612	3.225	4.837	6.450	8.062	9.675	11.287	12.900	14.512	16.125

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	192	318	481	686	953	1329	1972	---
Settlement	0.666	1.331	1.997	2.663	3.328	3.994	4.659	5.325	5.991	6.656

Calculation Point 4 : Toe_of_Embankment
Calculation Depth : -47.000 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	37	63	126	225	363	551	807	1177	1815	---
Settlement	1.942	3.884	5.826	7.768	9.709	11.651	13.593	15.535	17.477	19.419

Layer No. : 2 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	31	50	67	96	133	180	241	327	474	---
Settlement	0.163	0.326	0.488	0.651	0.814	0.977	1.139	1.302	1.465	1.628

Layer No. : 3 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.120	0.240	0.360	0.480	0.600	0.720	0.840	0.960	1.080	1.200

Layer No. : 4 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	191	316	478	682	947	1321	1960	---
Settlement	1.108	2.215	3.323	4.431	5.538	6.646	7.753	8.861	9.969	11.076

Layer No. : 5 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	51	102	191	316	478	682	947	1321	1960	---
Settlement	0.551	1.103	1.654	2.206	2.757	3.309	3.860	4.412	4.963	5.515

2.3 Calculation result on the way in each construction stage

Calculation Point 1 : Left_Crest
Calculation Depth : -59.709 m
Ground Water Level : 16.833 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5			
1	87.945	0.000	68.726	169.290			

Calculation Point 2 : Center_of_Embankment
Calculation Depth : -55.000 m
Ground Water Level : 16.182 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5			
1	97.557	0.000	68.329	173.874			

Calculation Point 3 : Right_Side_of_Embank
Calculation Depth : ment -49 m
Ground Water Level : 15.368 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5			
1	93.903	0.000	67.916	175.985			

Calculation Point 4 : Toe_of_Embankment
Calculation Depth : -47.000 m
Ground Water Level : 15.076 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4	5			
1	38.604	0.000	68.364	176.843			

Right Bank
Station. 7+240

Contents

Page

1. Initial Condition 1

2. Results 7

1. Initial Condition

Title : R_7+240

1.1 Initial Condition

1.1.1 Nodal Points Data

Node No	X (m)	Y (m)	Node No	X (m)	Y (m)	Node No	X (m)	Y (m)
1	64.64	15.78	8	45.00	11.14	15	52.46	15.48
2	64.64	9.11	9	45.00	14.60	16	53.61	15.48
3	64.64	-1.78	10	45.20	14.60	17	54.22	15.78
4	64.64	-12.03	11	46.62	17.43	18	50.35	14.81
5	45.00	-12.03	12	46.92	17.93	19	47.07	12.97
6	45.00	-1.78	13	50.52	17.86			
7	45.00	9.11	14	51.71	15.48			

1.1.2 Layer Shape Data

Shape Number	Constitution Setting Points									Layer Type	Floor digging / Backfill
1	8	9	10	11	12	13	14	18	19	Embankment	don't
2	8	19	18	14	15	16	17	1	2	7	Sand	don't
3	7	2	3	6							Clay	don't

1.1.3 Embankment Condition

Execution Stage	Shape No.	Soil Type	Saturated Unit Weight (kN/m³)	Unit Weight (kN/m³)	Construction Period start	Construction Period Finish	Embankment Removal Date	Construction Period for a second time Start day for a second time	Construction Period for a second time Finish day for a second time	Removal day for a second time
1	1	Embankment	19.5	19.0	0	60	---	---	---	---

1.1.4 Soil Condition

Layer (Shape) No	Layer Name	Calculation Method	Saturated Unit Weight (kN/m³)	Unit Weight (kN/m³)	Layer Type
2	As	B.K.Hough	17.5	17.5	Sand
3	Dc	Delta e method	18.0	18.0	Clay

Layer (Shape) No	e -logP Curve	logMv -logP Curve	logCv -logP Curve	Water Content (%)	N Value	Compression Index Cc Normal	Compression Index Cc Over	Consolidation Yield in Stress Py (kN/m²)	Increase in Preconsolidation q0(kN/m²)	t=(sqr)Tv Replaceable Coefficient (sqr)
2	20	0	0	0	0	0.00	0.00	0.00	0.00	0.00
3	17	0	4	0	0	0.00	0.00	0.00	0.00	0.00

1.1.5 Ground Water Level

Water Unit Weight : 10.0 kN/m³

Ground water influence : There is it. (convergence condition = 1.00cm)

Node No	X (m)	Y (m)
1	45.00	14.60
2	45.20	14.60
3	51.71	15.48
4	52.46	15.48
5	53.61	15.48
5	54.22	15.78
5	64.64	15.78

1.2 Common Item about Calculation

1.2.1 Calculation Condition(Common Item)

Calculation Method : Boussinesq method

Lay No.	Reduction Coefficient of Settlement
2	1.00
3	1.00

1.2.2 Shear Deformation

Calculation Method: Japan Ins of Construction Eng.
"Flexible Sluiceways"(1998)
Calculation Shape Number: 6433908
Division pitch of Calculation Shape Number: 0.0

Depth which has the influence of shear deformation

Node No	X (m)	Y (m)

layer (Form)	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00
2	0.00	0.00

Execution	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00

Poisson's ratio :0.00

1.2.3 Residual Condition

Calculation of Settlement Period length 60 day

1.3 Calculation of Computation Time Condition

1.3.1 Calculation Condition(Settlement Time)

History Condition :Lasped days

Calculation Period :36000 day

Output condition of Cross Section Diagram

Degree of Consolidation :100% Calculation point(X Coodinate) : 48.71m

Creation method of Time-Settlemnt Curve :Parallel Translation Method

1.3.2 Consolidation Condition

Coefficient-of-consolidation calculation method of some layers
Layer Thickness Converting Method : Parallel Translation Method

Drainage Condition

Layer (Form)	Drainage Condition
2	Sand Layer
3	Both Side

Bedrock Condition :Drained

1.4.1 Curves Record

(1)e-logP Curve
Curve 20 :Loose Sand
Interpolation Method between Data :Curve Line
Layer No. in use : 2

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	0.20	0.30	0.50	1.00	2.00	3.00	5.00	10.00
Void Ratio e	0.780	0.760	0.742	0.714	0.688	0.678	0.662	0.640

Number	9	10	11	12
Consolidation Stress (kN/m²)	20.00	30.00	50.00	100.00
Void Ratio e	0.621	0.611	0.600	0.590

Curve 17 :DD-BH-R03
Interpolation Method between Data :Curve Line
Layer No. in use : 3

Number	1	2	3	4	5	6	7
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00
Void Ratio e	1.860	1.800	1.660	1.520	1.360	1.000	0.960

(2)logCv-logP Curve
Curve 4 :DD-BH-R03 (Dc3)
Interpolation Method between Data :Curve Line
Consolidation Stress Calculation Method :Geometrica
Layer No. in use : 3

Number	1	2	3	4	5	6	7
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00
Coefficient of Consolidation Cv(cm²/day)	123.00	97.00	103.00	47.00	61.00	71.00	40.00

2. Results

2.1 Results of each Points

Calculation Point 1 : Toe_of_Embankment
Calculation Depth : 45.200 m
Ground Water Level : 14.600 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	2.207	8.28	36.58	0.00	5.853
3	delta e method	10.890	60.11	19.60	0.00	24.391

Sub Total: 30.245(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.646	0.602	——	——	——	——	——	——
3	1.619	1.560	——	——	——	69.22	——	70.982

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	5.853	100.000	——	5.853
3	100.000	24.391	9.563	——	2.333

Sub Total: 30.245(cm) Sub Total: 8.186(cm)

Residual Settlement: 22.059(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement, it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	2.207	0.000
3	10.890	70.982

Sa = 100.00
ΔS= 22.06
Sa ≧ΔS ・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

Calculation Point 2 : Left_Crest
Calculation Depth : 46.916 m
Ground Water Level : 14.832 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	3.724	13.97	58.13	0.00	8.283
3	delta e method	10.890	71.49	21.64	0.00	21.127

Sub Total: 29.410(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.630	0.594	——	——	——	——	——	——
3	1.582	1.532	——	——	——	81.60	——	56.948

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	8.283	100.000	——	8.283
3	100.000	21.127	8.566	——	1.810

Sub Total: 29.410(cm) Sub Total: 10.093(cm)

Residual Settlement: 19.317(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement, it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	3.724	0.000
3	10.890	56.948

Sa = 100.00
ΔS= 19.32
Sa ≧ΔS ・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

Calculation Point 3 : Center_of_Embankment
Calculation Depth : 48.717 m
Ground Water Level : 15.076 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	4.784	17.94	48.47	0.00	8.371
3	delta e method	10.890	79.44	21.34	0.00	17.856

Sub Total: 26.227(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.624	0.595	――	――	――	――	――	――
3	1.561	1.519	――	――	――	89.47	――	51.345

[Immediate Sinkage] "Flexible Sluiceways"(1998)
Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00
Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]
Degree of Consolidation: 100%
(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	8.371	100.000	――	8.371
3	99.999	17.856	8.133	――	1.452

Sub Total: 26.227(cm) Sub Total: 9.824(cm)
Residual Settlement: 16.404(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	4.784	0.000
3	10.890	51.345

Sa = 100.00
ΔS= 16.40
Sa ≧ΔS ・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

Calculation Point 4 : Right_Crest
Calculation Depth : 50.517 m
Ground Water Level : 15.319 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	B.K.Hough	5.782	21.68	28.36	0.00	6.773
3	delta e method	10.890	86.93	18.90	0.00	13.964

Sub Total: 20.737(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	0.619	0.600	――	――	――	――	――	――
3	1.544	1.511	――	――	――	95.91	――	48.311

[Immediate Sinkage] "Flexible Sluiceways"(1998)
Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00
Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]
Degree of Consolidation: 100%
(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	6.773	100.000	――	6.773
3	99.999	13.964	7.889	――	1.102

Sub Total: 20.737(cm) Sub Total: 7.875(cm)
Residual Settlement: 12.862(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	5.782	0.000
3	10.890	48.311

Sa = 100.00
ΔS= 12.86
Sa ≧ΔS ・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

2.2 Degree of Consolidation - Duration in days

Calculation Point 1 : Toe_of_Embankment
Calculation Depth : 45.200 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	25	46	88	246	504	866	1349	2035	3209	---
Settlement	3.024	6.049	9.073	12.098	15.122	18.147	21.171	24.196	27.220	30.245

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.585	1.171	1.756	2.341	2.927	3.512	4.097	4.683	5.268	5.853

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	63	162	326	555	852	1227	1713	2399	3573	---
Settlement	2.439	4.878	7.317	9.757	12.196	14.635	17.074	19.513	21.952	24.391

Calculation Point 2 : Left_Crest
Calculation Depth : 46.916 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	19	37	54	142	408	834	1431	2285	3748	---
Settlement	2.941	5.882	8.823	11.764	14.705	17.646	20.587	23.528	26.469	29.410

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.828	1.657	2.485	3.313	4.141	4.970	5.798	6.626	7.455	8.283

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	71	194	398	685	1055	1522	2128	2983	4446	---
Settlement	2.113	4.225	6.338	8.451	10.564	12.676	14.789	16.902	19.014	21.127

Calculation Point 3 : Center_of_Embankment
Calculation Depth : 48.717 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	18	34	49	94	350	802	1459	2406	4028	---
Settlement	2.623	5.245	7.868	10.491	13.114	15.736	18.359	20.982	23.605	26.227

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.837	1.674	2.511	3.348	4.186	5.023	5.860	6.697	7.534	8.371

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	76	212	439	756	1166	1684	2357	3305	4927	---
Settlement	1.786	3.571	5.357	7.143	8.928	10.714	12.499	14.285	16.071	17.856

Calculation Point 4 : Right_Crest
Calculation Depth : 50.517 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	17	33	49	88	350	825	1521	2528	4251	---
Settlement	2.074	4.147	6.221	8.295	10.368	12.442	14.516	16.589	18.663	20.737

Layer No. : 2 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.677	1.355	2.032	2.709	3.386	4.064	4.741	5.418	6.096	6.773

Layer No. : 3 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	79	223	464	802	1238	1788	2503	3511	5235	---
Settlement	1.396	2.793	4.189	5.586	6.982	8.378	9.775	11.171	12.567	13.964

2.3 Calculation result on the way in each construction stage

Calculation Point 1 : Toe_of_Embankment
Calculation Depth : 45.200 m
Ground Water Level : 14.600 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3					
1	0.000	70.982					

Calculation Point 2 : Left_Crest
Calculation Depth : 46.916 m
Ground Water Level : 14.832 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3					
1	0.000	56.948					

Calculation Point 3 : Center_of_Embankment
Calculation Depth : 48.717 m
Ground Water Level : 15.076 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3					
1	0.000	51.345					

Calculation Point 4 : Right_Crest
Calculation Depth : 50.517 m
Ground Water Level : 15.319 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3					
1	0.000	48.311					

Right Bank
Station. 8+600

Contents

Page

1. Initial Condition 1

2. Results 7

1. Initial Condition

Title : R_8+600

1.1 Initial Condition

1.1.1 Nodal Points Data

Node No	X (m)	Y (m)	Node No	X (m)	Y (m)	Node No	X (m)	Y (m)
1	65.30	19.87	10	45.00	14.90	19	65.30	11.77
2	58.34	19.87	11	45.00	11.77	20	47.83	9.30
3	54.38	17.89	12	45.00	9.98	21	48.54	9.98
4	53.61	17.89	13	45.00	8.97	22	50.42	11.77
5	52.98	17.89	14	45.00	4.75	23	50.45	11.80
6	52.58	18.69	15	45.00	0.00	24	51.22	12.36
7	49.08	18.76	16	65.30	0.00	25	51.76	12.68
8	48.68	18.26	17	65.30	4.75	26	52.61	13.03
9	47.00	14.90	18	65.30	9.98			

1.1.2 Layer Shape Data

Shape Number	Constitution Setting Points										Layer Type	Floor digging / Backfill
1	4	5	6	7	8	9	10	11	12	13	Embankment	don't
	20	21	22	23	24	25	26					
2	22	23	24	25	26	4	3	2	1	19	Cray	don't
3	21	22	19	18							Sand	don't
4	14	13	20	21	18	17					Cray	don't

1.1.3 Embankment Condition

Execution Stage	Shape No.	Soil Type	Saturated Unit Weight (kN/m³)	Unit Weight (kN/m³)	Construction Period start	Construction Period Finish	Embankment Removal Date	Construction Period for a second time Start day for a second time	Construction Period for a second time Finish day for a second time	Removal day for a second time
1	1	Embankment	19.5	19.0	0	60	---	---	---	---

1.1.4 Soil Condition

Layer (Shape) No	Layer Name	Calculation Method	Saturated Unit Weight (kN/m³)	Unit Weight (kN/m³)	Layer Type
2	Ac	Delta e method	15.5	15.5	Clay
3	As	B.K.Hough	17.5	17.5	Sand
4	Dc	Delta e method	18.0	18.0	Clay

Layer (Shape) No	e -logP Curve	logMv -logP Curve	logCv -logP Curve	Water Content (%)	N Value	Compression Index Cc Normal	Compression Index Cc Over	Consolidation Yield Stress Pc (kN/m²)	Increase in Preconsolidation qo(kN/m²)	t=(sqr)Tv Replaceable Coefficient (sqr)
2	14	0	1	0	0	0.00	0.00	0.00	0.00	0.00
3	20	0	0	0	0	0.00	0.00	0.00	0.00	0.00
4	18	0	5	0	0	0.00	0.00	0.00	0.00	0.00

1.1.5 Ground Water Level

Water Unit Weight : 10.0 kN/m³

Ground water influence : There is it. (convergence condition = 1.00cm)

Node No	X (m)	Y (m)
1	45.00	14.90
2	47.00	14.90
3	53.61	17.89
4	54.38	17.89
5	58.34	19.87
5	65.30	19.87

1.2 Common Item about Calculation

1.2.1 Calculation Condition(Common Item)

Calculation Method : Boussinesq method

Lay No.	Reduction Coefficient of Settlement
2	1.00
3	1.00
4	1.00

1.2.2 Shear Deformation

Calculation Method: Japan Ins of Construction Eng. "Flexible Sluiceways"(1998)
Calculation Shape Number: 6433908
Division pitch of Calculation Shape Number: 0.0

Depth which has the influence of shear deformation

Node No	X (m)	Y (m)

layer (Form)	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00

Execution	Modulus of deformation (kN/m²)	Load Length (m)
1	0.00	0.00

Poisson's ratio :0.00

1.2.3 Residual Condition

Calculation of Settlement Period length 60 day

1.3 Calculation of Computation Time Condition

1.3.1 Calculation Condition(Settlement Time)

History Condition :Lasped days

Calculation Period :36000 day

Output condition of Cross Section Diagram

Degree of Consolidation :100% Calculation point(X Coodinate) : 48.71m

Creation method of Time-Settlemnt Curve :Parallel Translation Method

1.3.2 Consolidation Condition

Coefficient-of-consolidation calculation method of some layers
Layer Thickness Converting Method : Parallel Translation Method

Drainage Condition

Layer (Form)	Drainage Condition
2	Both Side
3	Sand Layer
4	Both Side

Bedrock Condition :Drained

1.4.1 Curves Record

(1)e-logP Curve
Curve 14 :DD-BH-L10
Interpolation Method between Data :Curve Line
Layer No. in use : 2

Number	1	2	3	4	5	6	7
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00
Void Ratio e	1.360	1.350	1.320	1.240	1.120	1.000	0.880

Curve 20 :Loose Sand
Interpolation Method between Data :Curve Line
Layer No. in use : 3

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	0.20	0.30	0.50	1.00	2.00	3.00	5.00	10.00
Void Ratio e	0.780	0.760	0.742	0.714	0.688	0.678	0.662	0.640

Number	9	10	11	12	13
Consolidation Stress (kN/m²)	20.00	30.00	50.00	100.00	1000.00
Void Ratio e	0.621	0.611	0.600	0.590	0.580

Curve 18 :DD-BH-R13
Interpolation Method between Data :Curve Line
Layer No. in use : 4

Number	1	2	3	4	5	6	7
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00
Void Ratio e	1.860	1.800	1.660	1.520	1.360	1.000	0.960

(2)logCv-logP Curve
Curve 1 :DD-BH-L10 (Ac)
Interpolation Method between Data :Curve Line
Consolidation Stress Calculation Method :Geometrica
Layer No. in use : 2

Number	1	2	3	4	5	6	7	8
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00	800.00	1600.00
Coefficient of Consolidation Cv(cm²/day)	29.00	98.00	69.00	66.00	24.00	20.00	18.00	16.00

Curve 5 :DD-BH-R13 (Dc4)
Interpolation Method between Data :Curve Line
Consolidation Stress Calculation Method :Geometrica
Layer No. in use : 4

Number	1	2	3	4	5	6
Consolidation Stress (kN/m²)	12.00	25.00	50.00	100.00	200.00	400.00
Coefficient of Consolidation Cv(cm²/day)	580.00	110.00	55.00	120.00	80.00	60.00

2. Results

2.1 Results of each Points

Calculation Point 1 : Toe_of_Embankment
Calculation Depth : 47.000 m
Ground Water Level : 14.900 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
4	delta e method	4.453	17.81	68.32	0.00	45.687

Sub Total: 45.687(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
4	1.837	1.546	——	——	——	39.17	——	57.347

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
4	100.000	45.687	21.020	——	9.603

Sub Total: 45.687(cm) Sub Total: 9.603(cm)

Residual Settlement: 36.083(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
4	4.453	57.347

Sa = 100.00
ΔS= 36.08
Sa ≧ΔS ・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

Calculation Point 2 : Left_Crest
Calculation Depth : 49.079 m
Ground Water Level : 15.840 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
3	B.K.Hough	0.513	1.93	106.54	0.00	3.038
4	delta e method	5.230	24.77	67.47	0.00	50.027

Sub Total: 53.065(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
3	0.689	0.589	——	——	——	——	——	——
4	1.801	1.533	——	——	——	47.80	——	54.184

[Immediate Sinkage] "Flexible Sluiceways"(1998)

Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00

Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]

Degree of Consolidation: 100%

(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
3	100.000	3.038	100.000	——	3.038
4	100.000	50.027	17.397	——	8.703

Sub Total: 53.065(cm) Sub Total: 11.742(cm)

Residual Settlement: 41.324(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
3	0.513	0.000
4	5.230	54.184

Sa = 100.00
ΔS= 41.32
Sa ≧ΔS ・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

Calculation Point 3 : Center_of_Embankment
Calculation Depth : 50.829 m
Ground Water Level : 16.630 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	delta e method	0.306	0.84	90.59	0.00	3.284
3	B.K.Hough	1.790	8.39	56.97	0.00	5.419
4	delta e method	5.230	36.03	48.50	0.00	35.242

Sub Total: 43.945(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	1.524	1.253	——	——	——	8.77	——	14.546
3	0.645	0.595	——	——	——	——	——	——
4	1.733	1.549	——	——	——	55.19	——	58.999

[Immediate Sinkage] "Flexible Sluiceways"(1998)
Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00
Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]
Degree of Consolidation: 100%
(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	3.284	99.188	——	3.258
3	100.000	5.419	100.000	——	5.419
4	100.000	35.242	18.154	——	6.398

Sub Total: 43.945(cm) Sub Total: 15.075(cm)
Residual Settlement: 28.871(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	0.306	14.546
3	1.790	0.000
4	5.230	58.999

Sa = 100.00
ΔS= 28.87
Sa ≧ΔS・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

Calculation Point 4 : Right_Crest
Calculation Depth : 52.579 m
Ground Water Level : 17.421 m

Lay No.	Calculation Method	Thickness of the Layer (m)	Effective Pressure po (kN/m²)	Stress Increment Dp (kN/m²)	Increase in Preconsolidation Loading qo(kN/m²)	Total Settlement (cm)
2	delta e method	1.247	3.43	40.68	0.00	3.035
3	B.K.Hough	1.790	13.57	31.74	0.00	3.224
4	delta e method	5.230	41.21	31.02	0.00	24.006

Sub Total: 30.264(cm)

Lay No.	e0	e1	Mv (cm²/kN)	Cc1	Cc2	SQRT(po(po+Dp)) (kN/m²)	po+Dp/2 (kN/m²)	Cv (cm²/day)
2	1.387	1.329	——	——	——	12.30	——	30.715
3	0.631	0.602	——	——	——	——	——	——
4	1.704	1.580	——	——	——	54.55	——	58.380

[Immediate Sinkage] "Flexible Sluiceways"(1998)
Sub Total(Immediate Sinkage) : 0.000(cm)

[Side Sinkage] "Flexible Sluiceways"(1998) Poisson's ratio : 0.00
Sub Total(Side Sinkage) : 0.000(cm)

[Cross Section Diagram] [Residual Settlement]
Degree of Consolidation: 100%
(Calculation Point= 48.710m) Duration of a period: 60days

Lay No.	Degree of Consolidation (%)	Settlement (cm)	Degree of Consolidation of the period(%) Settlement	Unit Layer	Settlement of the period (cm)
2	100.000	3.035	54.774	——	1.662
3	100.000	3.224	100.000	——	3.224
4	100.000	24.006	18.058	——	4.335

Sub Total: 30.264(cm) Sub Total: 9.221(cm)
Residual Settlement: 21.043(cm)

※When the amount of the immediate sinkage is included in the amount of the total settlement,it doesn't become output (consolidation × total settlement = settlement).

Thinkness of the combined clay layers

Lay No.	Thinkness of the combined clay layers	Cv of the combined layer
2	1.247	30.715
3	1.790	0.000
4	5.230	58.380

Sa = 100.00
ΔS= 21.04
Sa ≧ΔS・・・・・・・・・・・・・・・・・・ OK

Sa : Allowance residual settlement(cm)
ΔS : Desigining residual settlement(Total settlement) (cm)

2.2 Degree of Consolidation - Duration in days

Calculation Point 1 : Toe_of_Embankment
Calculation Depth : 47.000 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	37	59	92	139	201	278	379	521	764	---
Settlement	4.569	9.137	13.706	18.275	22.843	27.412	31.981	36.549	41.118	45.687

Layer No. : 4 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	37	59	92	139	201	278	379	521	764	---
Settlement	4.569	9.137	13.706	18.275	22.843	27.412	31.981	36.549	41.118	45.687

Calculation Point 2 : Left_Crest
Calculation Depth : 49.079 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	34	56	96	162	249	362	509	716	1071	---
Settlement	5.307	10.613	15.920	21.226	26.533	31.839	37.146	42.452	47.759	53.065

Layer No. : 3 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.304	0.608	0.911	1.215	1.519	1.823	2.127	2.431	2.734	3.038

Layer No. : 4 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	42	70	120	189	279	392	539	746	1101	---
Settlement	5.003	10.005	15.008	20.011	25.014	30.016	35.019	40.022	45.024	50.027

Calculation Point 3 : Center_of_Embankment
Calculation Depth : 50.829 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	22	39	54	88	160	280	394	584	910	---
Settlement	4.395	8.789	13.184	17.578	21.973	26.367	30.762	35.156	39.551	43.945

Layer No. : 2 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	10	16	22	27	33	38	44	49	55	---
Settlement	0.328	0.657	0.985	1.314	1.642	1.971	2.299	2.628	2.956	3.284

Layer No. : 3 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.542	1.084	1.626	2.168	2.710	3.252	3.793	4.335	4.877	5.419

Layer No. : 4 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	41	67	112	176	259	362	497	688	1013	---
Settlement	3.524	7.048	10.573	14.097	17.621	21.145	24.669	28.193	31.718	35.242

Calculation Point 4 : Right_Crest
Calculation Depth : 52.579 m
Overall Degree of Consolidation

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	26	44	60	98	162	258	393	585	914	---
Settlement	3.026	6.053	9.079	12.105	15.132	18.158	21.185	24.211	27.237	30.264

Layer No. : 2 soil name : Ac

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	20	31	41	49	57	67	82	102	138	---
Settlement	0.303	0.607	0.910	1.214	1.517	1.821	2.124	2.428	2.731	3.035

Layer No. : 3 Immediate Sinkage(calculated by B.K.Hough or DeBeer), soil name : As

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	6	12	18	24	30	36	42	48	54	---
Settlement	0.322	0.645	0.967	1.289	1.612	1.934	2.256	2.579	2.901	3.224

Layer No. : 4 soil name : Dc

Deg. of Consolidation	10	20	30	40	50	60	70	80	90	100
Duration	41	67	113	178	261	366	502	695	1024	---
Settlement	2.401	4.801	7.202	9.602	12.003	14.403	16.804	19.205	21.605	24.006

2.3 Calculation result on the way in each construction stage

Calculation Point 1 : Toe_of_Embankment
Calculation Depth : 47.000 m
Ground Water Level : 14.900 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	4						
1	57.347						

Calculation Point 2 : Left_Crest
Calculation Depth : 49.079 m
Ground Water Level : 15.840 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	3	4					
1	0.000	54.184					

Calculation Point 3 : Center_of_Embankment
Calculation Depth : 50.829 m
Ground Water Level : 16.630 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4				
1	14.546	0.000	58.999				

Calculation Point 4 : Right_Crest
Calculation Depth : 52.579 m
Ground Water Level : 17.421 m

Cv value of each construction stage in each layer (cm2/day)

	Layer No.						
Loading	2	3	4				
1	30.715	0.000	58.380				

REPUBLIC OF THE PHILIPPINES

DEPARTMENT OF
PUBLIC WORKS AND HIGHWAYS

THE DETAILED DESIGN STUDY FOR THE PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE IV)

FINAL REPORT

VOLUME-4C
STRUCTURAL CALCULATION FOR CONTRACT PACKAGE-3 (2/2)

AUGUST 2020

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.
JAPAN WATER AGENCY
NIPPON KOEI CO., LTD.
CTI ENGINEERING CO., LTD.

IE
CR(1)
20-002