Ministry of Transport
Vietnam Expressway Corporation
Project Management Unit No. 85

THE WORLD BANK

IDA Credit No.: 3843-VN
Project ID No. : P106235

Consulting Services

for

Detailed Design for Da Nang - Quang Ngai Expressway

Development Project

SETTLEMENT CALCULATION & STABILITY ANALYSIS REPORT FOR PACKAGE 3A

The Joint Venture of

NIPPON KOEI CO.,LTD.
NIPPON ENGINEERING CONSULTANTS CO.,LTD.
CHODAI CO.,LTD.
THAI ENGINEERING CONSULTANTS CO., LTD.

November 2012

IDA Credit No.: 3843-VN
Project ID No. : P106235

Consulting Services

for

Detailed Design for Da Nang - Quang Ngai Expressway

Development Project

SETTLEMENT CALCULATION & STABILITY ANALYSIS REPORT FOR PACKAGE 3A

	Reported by	Checked by
NAME	**BUI XUAN HANH**	**YASUHIRO NOZUE**
SIGNATURE		
DATE	**10/ 11/ 2012**	**13/ 11/ 2012**

The Joint Venture of NK-NEC-Chodai-TEC
Project Manager

Ichizuru ISHIMOTO

November 2012

Contents

SETTLEMENT CALCULATION AND STABILITY ANALYSIS REPORT OF PACKAGE 3A

(Km 16+880 to Km 18+100)

1 DESIGN CRITERIA

The following standards shall be recommended to apply for soft soil treatment design:

- Standard for Investigation and Design of Embankment on Soft Ground 22TCN262-2000,
- Expressway – Requirement for Design TCVN5729-1997.

Pursuant to the above Standard, followings are criteria for soft soil treatment design:

1.1 Settlement and Consolidation

Soft ground on main road and interchange shall be treated to ensure both conditions as depicted below:

- Residual settlement (Sr) is less than: 10cm for approach sections, 20cm for culvert and under passing sections, and 30cm for other sections.
- Consolidation degree is not less than 90% or speed of residual settlement is less than 2cm per year.

1.2 Stability against sliding

Following conditions shall be confirmed for stability against sliding:

- Factor of safety is not less than 1.2 in period of filling and waiting for consolidation, and
- Factor of safety is not less than 1.4 at the end of final period of waiting for consolidation.

1.3 Traffic load.

Traffic load is evaluated in accordance with 22TCN262-2000 from following equations:

$$q = \frac{n \times G}{B \times l} \quad (1\text{-}1)$$

$$B = n \times b + (n-1) \times d + e \quad (1\text{-}2)$$

Whereas (see Figure 1-1)

n: Number of vehicle,

G: Weight of vehicle (=30 ton in case of H30),

B: Width of traffic load (Max. 14.3m as designated, 1 side),

l: distance between front wheel and rear wheel (=6.6m, in case of H30),

b = 1.8 m, e = 0.5m, d = 1.3m

Results: B=17.8m, n=6, and q=1.53 t/m^2 and will be distributed in the carriage ways as sketched for calculation as figure 1-2.

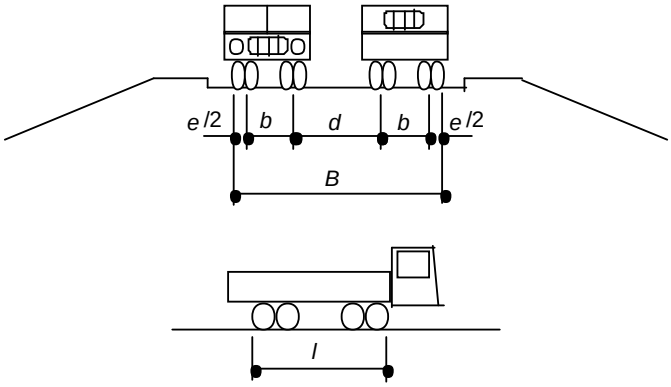


Figure 1-1 Traffic load calculation diagram

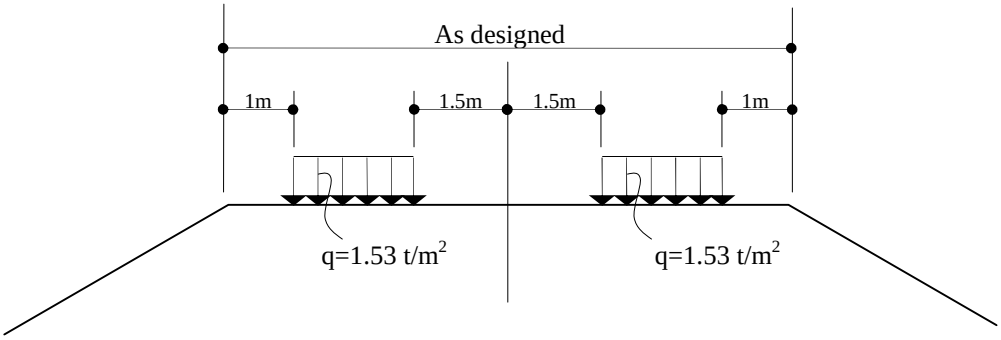


Figure 1-2 Traffic load value and distribution

2 CALCULATION METHODOLOGY

2.1 Theory and Calculation for Vertical Drain

a) Settlement

Due to variation of stress caused by embankment load by distribution depth of soil, a soil layer will be divided into sub-layers with 1~2m in thickness for settlement calculation and settlement of the soil layer will be summed up from the settlement of the sub-layers.

It is possible to calculate consolidation settlement by using original formula as depicted below (hereinafter referred to as Δe method):

$$S_c = \frac{e_o - e_1}{1 + e_0} H \qquad (2\text{-}1)$$

Or the following modified formulas (hereinafter referred to as Pc/Cc method):

$$S_c = \frac{C_c}{1 + e_0} H \log \frac{P_0 + \Delta P}{P_0}$$ For normal consolidation (2-2)

$$S_c = \frac{C_s}{1 + e_o} H \log \frac{P_o + \Delta P}{P_o}$$ For over consolidation and $P_c > P_0 + \Delta P$ (2-3)

$$S_c = \frac{C_s}{1 + e_o} H \log \frac{P_c}{P_0} + \frac{C_c}{1 + e_0} H \log \frac{P_0 + \Delta P}{P_c}$$ For over consolidation and $P_c < P_0 + \Delta P$ (2-4)

In the sand layer, the following formula can be used for immediately settlement (De Beer method)

$$S_i = 0.4 \frac{P_o}{N} H \log \frac{P_0 + \Delta P}{P_o} \qquad (2\text{-}5)$$

Whereas:

S_c: Consolidation settlement,

S_i: Immediately settlement of sandy soil layer,

e_o: Void ratio at pressure of P_0 (Initial void ratio),

e_1: Void ratio at pressure of $P_0+\Delta P$,

P_0: Overburden pressure,

ΔP: Pressure caused by embankment,

C_c: Compression index,

C_s: Swell index,

Pc: Pre-consolidation pressure,

H: Soil thickness.

N: Standard penetration test value

b) Consolidation

In case of no vertical drain, time factor (T_v) will be calculated from formulas (2-6) as follow:

$$T_v = \frac{t \times Cv}{H^2} \qquad (2\text{-}6)$$

Then consolidation degree will be computed by Terzaghi $U_v - T_v$ relationship as follow:

$$T_v = \frac{®}{4} \times \left(\frac{U}{100}\right)^2 \quad \text{in case } 0<U<53\% \quad (2\text{-}7)$$

$$T_v = 1.781 - 0.933 \times \log(100 - U) \quad \text{in case } U>53\% \quad (2\text{-}8)$$

Where as

t: Settlement time,

H: Drainage distance,

Tv: Time factor,

Uv: Consolidation degree,

Cv: Coefficient of Consolidation.

In case such vertical drain as PVD, sand drain, pack drain, etc. are installed for soft soil treatment, consolidation degree will be evaluated from Carrillo expression:

$$U = 1 - (1 - U_v) * (1 - U_h) \quad (2\text{-}9)$$

Whereas:

U: Consolidation degree,

U_v: Vertical component of consolidation being computed as mentioned above,

U_h: Horizontal component of consolidation being computed from Hansbo recommendations as follow:

$$U_h = 1 - \exp\left(\frac{-8 \times T_h}{F}\right) \quad (2\text{-}10)$$

$$T_h = \frac{C_h.t}{d_e^{\,2}} \quad (2\text{-}11)$$

$$F = F(n) + F_s + F_r \quad (2\text{-}12)$$

$$F(n) = \frac{n^2}{n^2 - 1} \ln n - \frac{3n^2 - 1}{4n^2} \quad (2\text{-}13)$$

$$n = \frac{d_e}{d_w} \quad (2\text{-}14)$$

$$F_s = \left(\frac{k_h}{k_s} - 1\right) \ln\left(\frac{d_s}{d_w}\right) \quad (2\text{-}15)$$

$$F_r = ®z(2L - z)\frac{k_h}{q_w} \quad (2\text{-}16)$$

Whereas:

T_h: Time factor,

C_h: Horizontal consolidation coefficient,

d_e: Effective drainage distance (=1.13d_s for square pattern, =1.05d_s for triangular pattern),

d_s: Center to center spacing between vertical drain units,

d_w: Diameter/equivalent diameter of vertical drain unit,

$k_{h:}$ Horizontal permeability,

$k_{s:}$ Permeability in smear zone,

d_s: Diameter of smear zone in cross section,

L: Drainage length,

q_w: Discharge capacity of vertical drain unit.

c) Shear strength due to consolidation

Undrain shear strength of soft soil is considered to increase for an amount of ΔC due to consolidation being evaluated as follow:

$$\Delta C = (P_0 - P_c + \Delta P) \times U \times m \quad (2\text{-}17)$$

Whereas:

ΔC: Increased amount of undrain shear strength due to consolidation,

m: Index of increase of undrains shear strength.

d) Sliding check

Bishop method as formulated below is recommended for sliding check.

$$Fs = \frac{\sum \frac{1}{m_a}[C \times b + (w - u \times b)\tan ¨]}{\sum w \sin \sim} \quad (2\text{-}18)$$

$$m_a = \cos \sim \left(1 + \tan \sim \frac{\tan ¨}{Fs}\right) \quad (2\text{-}19)$$

Whereas (see figure 2-2):

C: Cohesion,

φ: Internal friction angle,

b: Width of slice,

u: Pore water pressure acting at the slice base,

W: Weight of slice,

~ : Slice base angle to the horizontal direction.

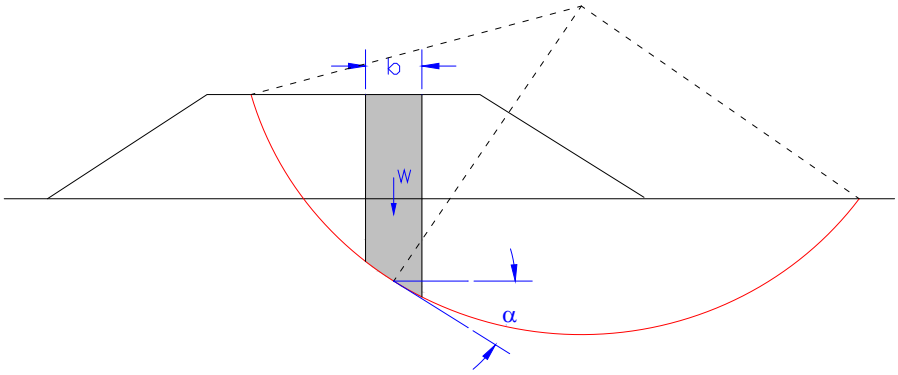


Figure 2-2 Sliding check model

2.2 Software

All calculation has been computed with assistance of software: K-Embankment for calculation of settlement and consolidation, and GeoStudio 2012 for stability analysis.

3 DESIGN SOIL VALUE

According to the supplementation work plan for Soil Investigation of Package 3A approved by PMU85, center-line boreholes (4 locations), cross-sectional boreholes (4 locations), should have been fulfilled for the design of package 3A. The following soil values for settlement calculation and stability analysis of package 3A are evaluated based on these limited data.

According to the soil investigation data, geological condition in each approach road section is quite different from each other. Therefore, soil values would be evaluated separately for each approach road section. Sandy soil was mainly detected in these areas. The soft soil, which will mostly affect to the stability of the embankment, was stratified into soils 1, tk2, tk2a and 3 in the Soil Investigation Report, it is detected as thin layers or lens sometime. The following contents will be the evaluation of soil values of these soils for Settlement Calculation and Stability Analysis.

(Please refer to Soil Investigation Report for PKG3A prepared by Thang Loi Jsc. for more detailed)

3.1 Filling material

Properties	**Unit**	**Value for abutment A1 (Phuc Dang borrow pit)**	**Value for abutment A2 (Duy Trung borrow pit)**
γ	t/m^3	1.71	1.91
C	t/m^2	1.50	2.02
ϕ	degree	12.87	21.4

3.2 Unit Weight

According to thickness of layers and number of testing samples are thin and little, unit weight (γ) of soils would be selected as average value.

- Approach road in A1 side

Layer/ Len	**¥=(t/m³)=**	**$¥_{sat}$ (t/m³)**
1	1.87	1.92
Tk2	1.92	1.92
2	1.62	1.63

- Approach road in A2 side

Soil	**¥=(t/m^3)=**	**¥$_{sat}$ (t/m^3)**
1	1.90	1.92
Tk2a	1.88	1.90
2	1.91	1.91
Tk2	1.68	1.70
3	1.71	1.73

3.3 Initial Undrain Shear Strength

Initial undrain shear strength of soft soil (Co) will be evaluated from the following basis:

For a reliable Co value for design, the analyzing Co value will also be referred to the following basis:

- Relationships between C and ϕ : Co = σ_v * tan(ϕ) + C (3-1)

Whereas:

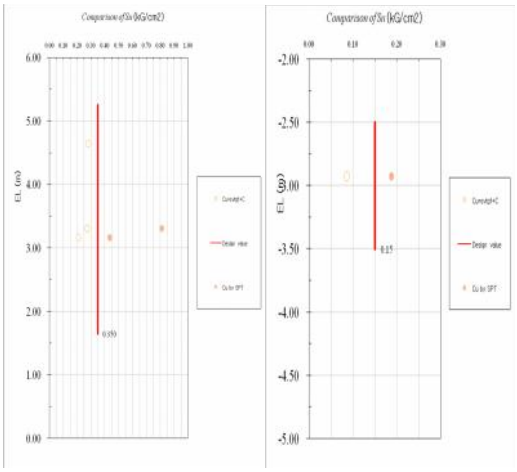
σ_v : overburden pressure

- Standard penetration test (SPT): following empirical relationships will be used to estimate Co value from SPT N

$$Co = \frac{N}{16} \times 100(KPa) \quad (3\text{-}2)$$

Data range and Co typical value of these testing is summary in following figures

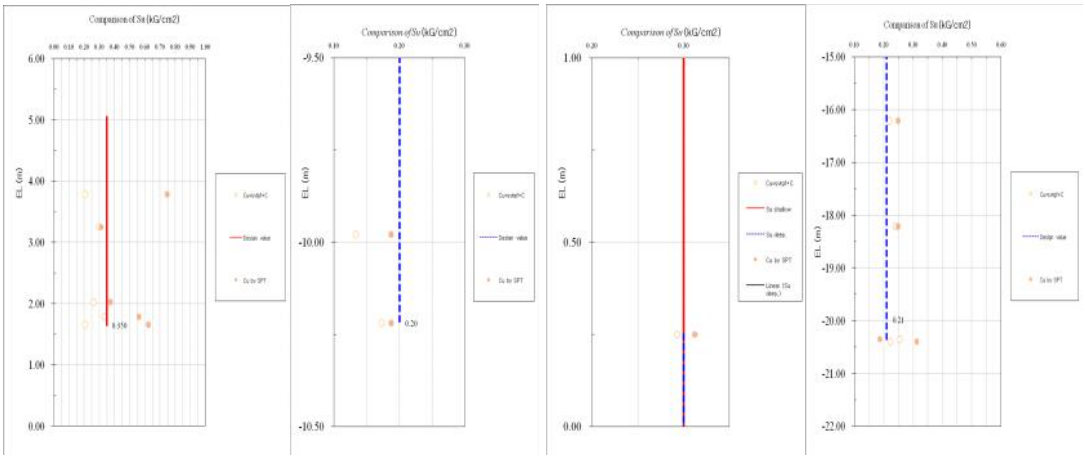
- Approach road in A1 side



Layer 1 Len Tk2

Figure 3-2 Summary of testing data of undrained shear strength for soil 1 and Tk2

- Approach road in A2 side



Soil 1 Soil tk2 Soil Tk2a Soil 3

Figure 3-3 Summary of testing data of undrained shear strength for soil 1, Tk2, Tk2a and 3

Typical values of Co from these tests are summarized in table 3-1 below.

Table 3-1 Summary of typical Co value from the testing data and recommendation

Layer	**Co proposed for design**	
	A1 abutment side	A2 abutment side
1	Co = 3.5	Co = 3.5
Tk2a	-	Co = 3.0
Tk2	Co = 1.5	Co = 2.0
3	-	Co = 2.1

3.4 Factor of Increase of Undrain Shear Strength

Undrain shear strength of soft soil will increase due to consolidation with a factor called "Factor of Increase of undrain shear strength" – m, which is basically evaluated from Triaxial test, CU scheme – CU test and, as instructed in the Standard 22TCN262-2000, m equals to tan(φ_{cu}).

As mentioned, there is no CU test conducted for soils. Therefore, in order to evaluate m value for soils, relationship between m value and some other soil properties are analyzed, the analyzing m value will also be referred to the following basis:

- Relationships between m-Ip:

$$m = 0.11 + 0.0037 * Ip \quad (3\text{-}4)$$

Which:

Ip : Plastic index

- Standard penetration test (SPT): following empirical relationships will be used to estimate m value from SPT N

$$m = \tan((\sqrt{12 * N} + 15) * 3.14/180) \quad (3\text{-}5)$$

- Approach road in A1 side

Table 3-2 Summary of typical m value from the testing data and recommendation

Layer	m = 0.11 + 0.0037 * Ip	m = $\tan((\sqrt{12*N}+15)*3.14/180)$	m proposed
1	0.21	0.45	0.25
Tk2	0.20	0.38	0.25

- Approach road in A2 side

Table 3-3 Summary of typical m value from the testing data and recommendation

Soil	m = 0.11 + 0.0037 * Ip	m = $\tan((\sqrt{12*N}+15)*3.14/180)$	m proposed
1	0.18	0.46	0.25
Tk2a	0.19	0.42	0.25
Tk2	0.18	0.38	0.25
3	0.20	0.42	0.25

3.5 Pre-Consolidation Condition and Consolidation Soil Parameters

- Approach road in A1 side

Figure 3-6 plots values of pre-consolidation pressure of the A1 abutment side in comparison with overburden pressure.

Relationship between compression pressure and e, Cv, mv, Kv of soils is shown in the table 4-1-A1, 4-2-A1.

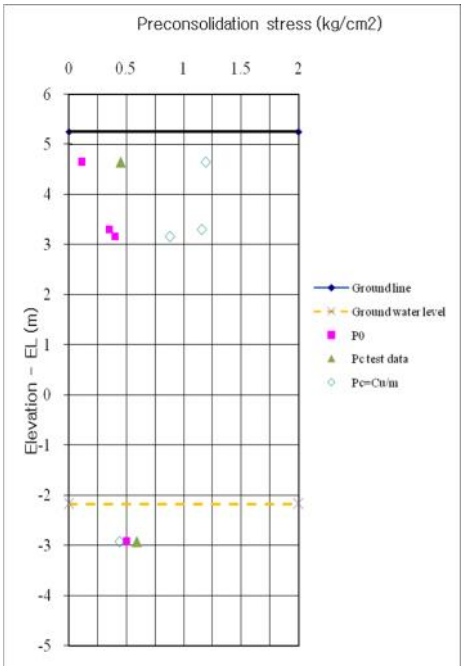


Figure 3-6 Variation of Pc with depth and in comparison with overburden pressure

Table 4-1-A1 Relationships between compression pressure and e, Cv, mv, Kv of soil 1

P	ε	C_v x10-3 cm2/s	m_v cm2/kG	K_v x10-7 cm/s
0.125	0.909	1.090	0.052	0.056
0.25	0.895	1.087	0.059	0.064
0.5	0.867	0.947	0.059	0.056
1	0.827	0.929	0.043	0.040
2	0.777	0.890	0.027	0.025
4	0.725	0.863	0.015	0.013
8	0.674	0.798	0.007	0.006

Table 4-2-A1 Relationships between compression pressure and e, Cv, mv, Kv of soil tk2

P	ε	C_v x10-3 cm2/s	m_v cm2/kG	K_v x10-7 cm/s
0.125	1.677	0.377	0.073	0.027
0.25	1.634	0.375	0.127	0.048
0.5	1.563	0.371	0.108	0.041
1	1.428	0.288	0.105	0.031
2	1.261	0.282	0.069	0.020
4	1.098	0.277	0.036	0.010
8	0.942	0.274	0.019	0.005

- Approach road in A2 side

Figure 3-7 plots values of pre-consolidation pressure of the A2 abutment side in comparison with overburden pressure.

Relationship between compression pressure and e, Cv, mv, Kv of soils is shown in the table 4-1-A2, 4-2-A2, 4-3-A2.

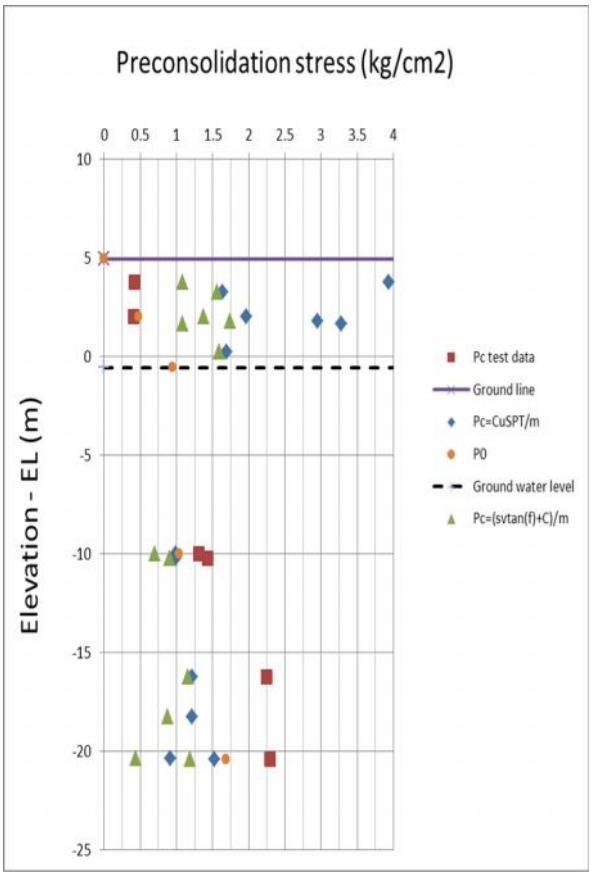


Figure 3-7 Variation of Pc with depth and in comparison with overburden pressure

Table 4-1-A2 Relationships between compression pressure and e, Cv, mv, Kv of soil 1

P	ε	C_v x10-3 cm2/s	m_v cm2/kG	K_v x10-7 cm/s
0.125	0.830	1.675	0.080	0.143
0.25	0.820	1.613	0.043	0.068
0.5	0.798	1.323	0.049	0.074
1	0.763	1.286	0.038	0.061
2	0.723	1.254	0.023	0.033
4	0.679	1.214	0.013	0.019
8	0.641	1.189	0.006	0.007

Table 4-2-A2 Relationships between compression pressure and e, Cv, mv, Kv of soil tk2

P	ε	C_v x10-3 cm2/s	m_v cm2/kG	K_v x10-7 cm/s
0.125	1.377	0.632	0.192	0.119
0.25	1.341	0.541	0.123	0.067
0.5	1.285	0.488	0.096	0.047
1	1.219	0.465	0.058	0.027
2	1.094	0.329	0.056	0.019
4	0.948	0.310	0.035	0.011
8	0.770	0.298	0.023	0.007

Table 4-3-A2 Relationships between compression pressure and e, Cv, mv, Kv of soil 3

P	ε	C_v x10-3 cm2/s	m_v cm2/kG	K_v x10-7 cm/s
0.125	1.210	0.600	0.265	0.152
0.25	1.176	0.539	0.123	0.066
0.5	1.118	0.509	0.107	0.055
1	1.051	0.506	0.063	0.033
2	0.961	0.464	0.044	0.021
4	0.833	0.310	0.033	0.011
8	0.689	0.305	0.020	0.006

3.6 Summary of Soil Value for Soft Soil Treatment Design

According to the analysis being presented above, values of the soil recommended for soft soil treatment design are summarized in the following table 3-3.

Table 3-3 Summary of Soil Parameters for A1 abutment side Recommended for Design

Symbol	**Unit**	**Soil**		
		1	**tk2**	**2**
γ	T/m^3	1.87	1.62	1.92
C	T/m^2	1.64	1.85	-
ϕ	Degree	18.08	11.18	30.04
Su	T/m^2	3.50	1.85	-
m	-	0.25	0.25	-
e_0	-	0.844	1.701	0.791
C_v	cm^2/sec	Table 4-1-A1	Table 4-2-A1	-

K_v	cm/s	Table 4-1-A1	Table 4-2-A1	-
Cc		0.169	0.54	-
Cr		0.022	0.09	-
Pc	T/m^2	10.30	7.70	-
N	Blows	7 - 13	3	8

Table 3-4 Summary of Soil Parameters for A2 abutment side Recommended for Design

Symbol	Unit	Soil				
		1	**tk2a**	**2**	**tk2**	**3**
γ	T/m^3	1.90	1.88	1.91	1.68	1.71
C	T/m^2	1.20	1.62	-	0.57	0.63
Φ	Degree	16.4	16.22	30.59	5.32	5.8
Su	T/m^2	3.50	3.00	-	2.00	2.10
m	-	0.25	0.25	-	0.25	0.25
e_0	-	0.834	0.873	0.828	1.43	1.325
C_v	cm^2/sec	Table 4-1-A2	-	-	Table 4-2-A2	Table 4-3-A2
Kv	cm/s	Table 4-1-A2	-	-	Table 4-2-A2	Table 4-3-A2
Cc		0.136	0.30	-	0.61	0.48
Cr		0.03	0.05	-	0.10	0.15
Pc	T/m^2	11.9	16.30	-	10.50	20.60
N	Blows	5 - 12	5	9	3	3 - 5

4 SOFT SOIL TREATMENT ANALYSIS

4.1 Outline of the study

- High embankment (the embankment height is over 12m) always is the object to be studied carefully in highway design (22 TCN 263 – 2000 - Instructions for highway survey, item 14.11) that concentrate on following matters:

+ Evaluation for stability of the embankment and slope;

+ Selection of suitable backfilling material;

+ Strengthen for slope protection.

- Package 3A includes the main bridge part and two approach road at two side of each abutment. Although, the soft soil thickness is small but the height of abutment A1 and A2 is quite high (abutment A1 height is 7.6m and abutment A2 height is 11.4m). Therefore, stability of the embankment and settlement of foundation under the embankment would be considered to study.

4.2 Time for soft soil treatment

This package is planned to be completed within 42 months. And a period of less than 14 months approximately is recommended for soft soil treatment in consideration of the following issues:

- Time for preparation works,

- Time for construction of culverts and underpass structures,

- Time for construction of piles and abutments,

- Time for construction of pavement and completion, and

- Reasonable reuse of surcharge and preloading material section by section to minimize expense for material.

4.3 Result of soft soil treatment design

Detail of settlement calculation and stability analysis results as well as detail calculation sheets are combined in the appendix of this report. It is summarized in the following tables:

a) Treatment method

Section Station	Length (m)	Emb. Height (m)	Soft soil Thickness (m)	Treatment method				
				Surcharge (m)	Method-Spacing(m)	Depth (m)	Rein. Geo-textile/ Temporary Geo.(No).	
							Cross Sec.	Longitude Sec.
16+880-16+980.4	100.4	7.64	5.5	0	None	0	0	0
18+025.2-18+100	74.8	11.41	6.5	0	None	0	0	0

b) Stage banking

Section	First stage		Second stage		Third stage		Total time (month)
	Filling Height (m)	Waiting Time (month)	Filling Height (m)	Waiting Time (month)	Filling Height (m)	Waiting Time (month)	
16+880-16+980.4	FG+0.2	1.0	-	-	-	-	4.0
18+025.2-18+100	FG+0.6	10.0	-	-	-	-	14.0

c) Calculation result

Section		Total. Settlement (cm)	CSB Thickness (cm)	Residual settlement (cm)	Cons. Degree (%)	Factor of safety, Fs		
						First Stage	Second Stage	Opening Stage
16+880-16+980.4	Left	19.69	0	0.01	99.95	1.437		1.458
	Right					1.411		1.531
16+880-16+980.4	Left	59.44	0	5.52	90.71	1.338		1.836
	Right					1.309		1.743

5 OBSERVATION SYSTEM DURING FILLED AND SURCHARGE LOADING

- Observation data of vertical settlement at center line and horizontal movement at both sides of embankment is not over regulated value below:

  + Settlement rate is not more than 10mm per day, and/or

  + Horizontal movement is not more than 5mm per day

- Postponing and unloading shall be requested in case the monitoring data have a tendency to increase gradually and then over the above requirement

- After postponing, reloading shall only be allowable at least one week after all the monitoring data are within the above limitations.

6 CONCLUSION

- Stability of embankment at both two sides can be kept by selected filling material;

- The residual settlement satisfies regular requirement (<10cm);

- No need any improvement solution for the foundation under the embankment;

- Monitoring is required for safety construction as shown above.

7 APPENDICES

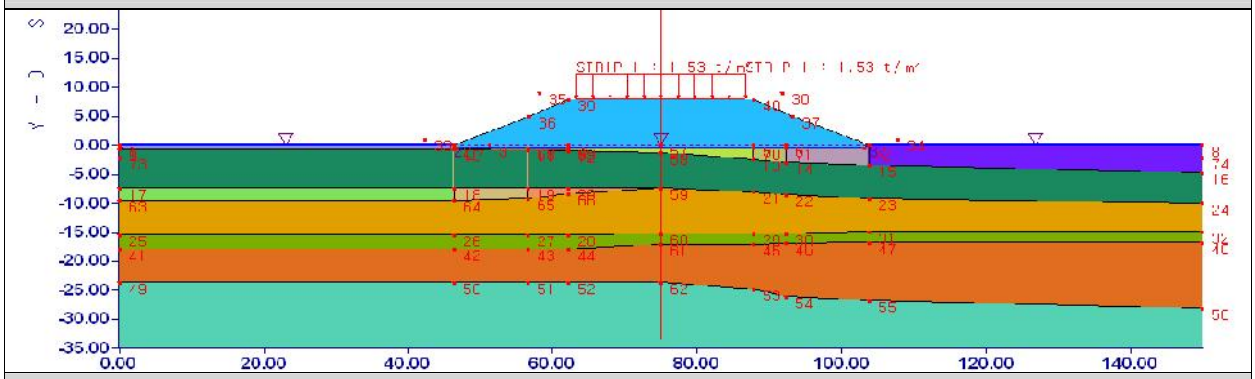
7.1 Detailed settlement calculation & stability analysis of approach road at A1 side

7.1.1 Analysis output (AP01)

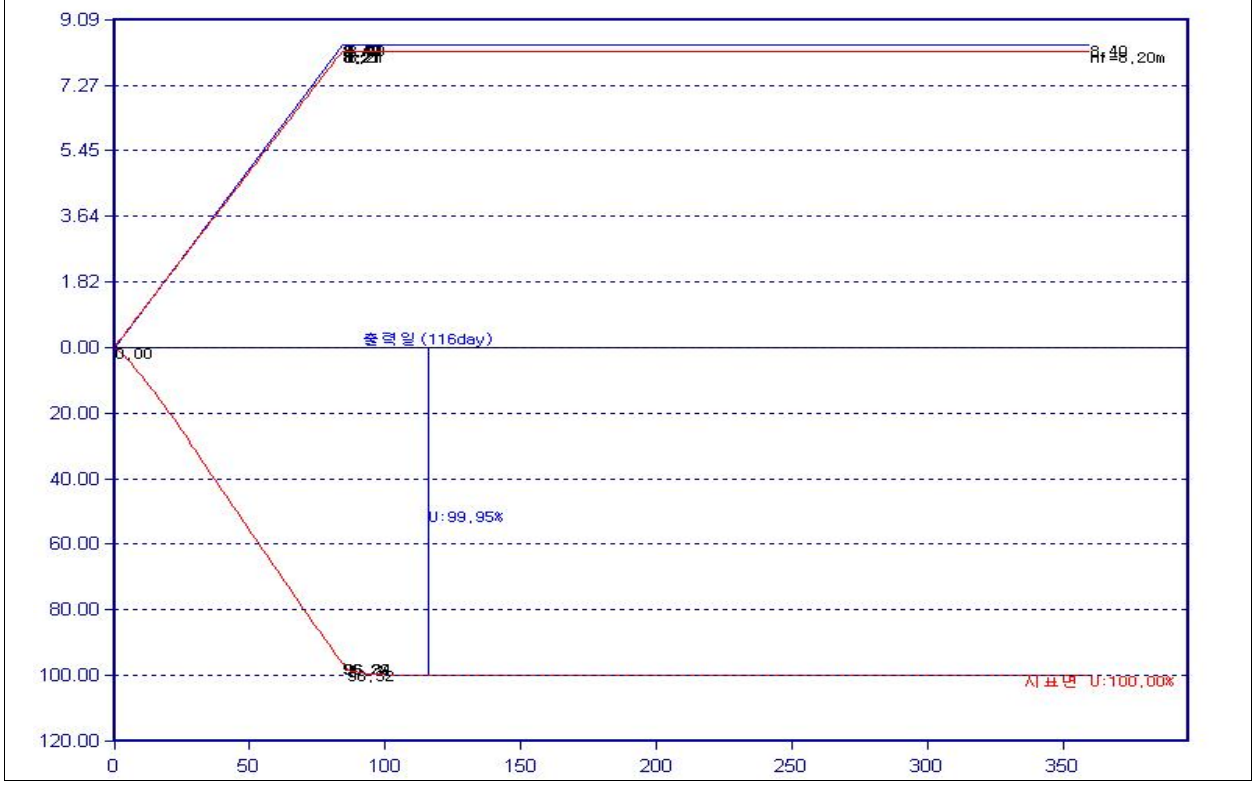
■ NONE

1) Settlement analysis

Representative section



Analysis output



	Section (STA.)	extention (m)	standard section	Height of embankment F.G(m)	allowable residual settlement (cm)	Total Soft soil thickness (m)
1.	AP01	100.4	16+980.4	7.64	10	

Treatment method	spacing (m)	Height of surcharge (m)	Geotextile layer (200KN/m)	embank step	Treatment Depth(m)	degree of consolidation (%)	Total settlement (cm)		Residual settlement (cm3)
							Without traffic load	Include traffic load	
NONE	-		-	1	-	90.64		19.88	1.86

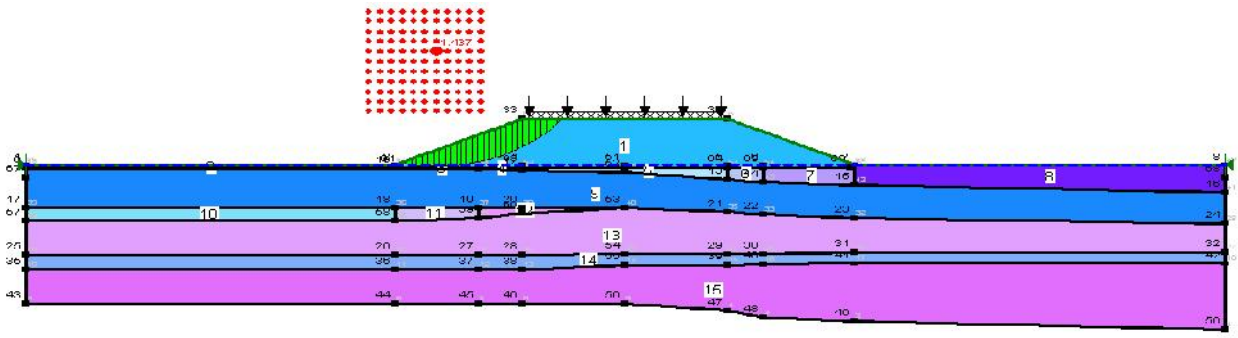
code			
section		AP01	
Treatment method	Surcharge height(m)	-	
	Stage	Filling height (m)	Waiting time (month)
	#3	-	-
	#2	-	-
	#1	FG+0.2	1
	Total(month)	4	
	CSB Thickness	-	
	Reinforced Geo-textile		
	Type of vertical drain	NONE	
	Pattern and Spacing(m)	-	
	Treatment Depth(m)	-	

2) Slope Stability Analysis

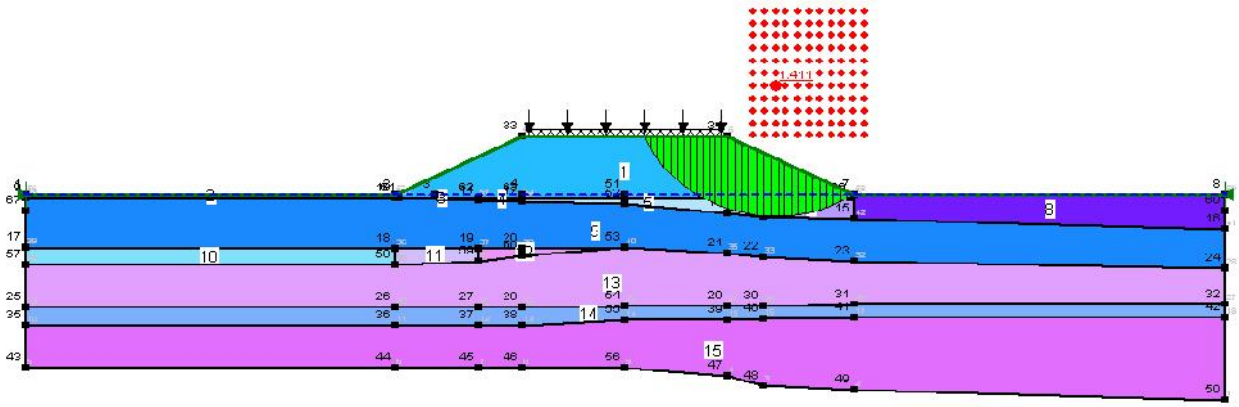
Content	Analysis Step				Remark
	Step 1	Step 2	Step 3	Final	
H(m)	FG+0.2			7.64	
FS	1.437	-	-	1.458	Left side
	1.411	-	-	1.531	Right side

1. Step 1

Left side

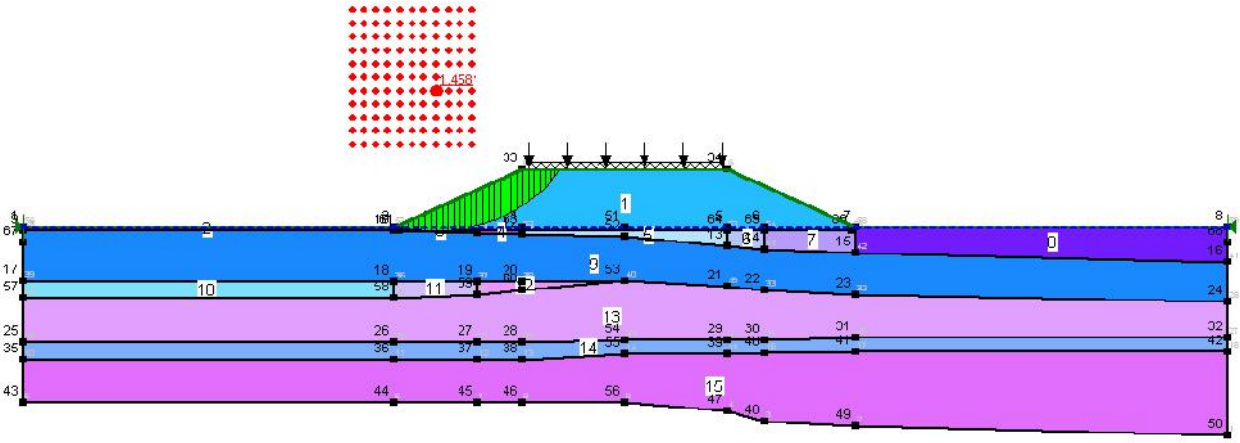


Right side

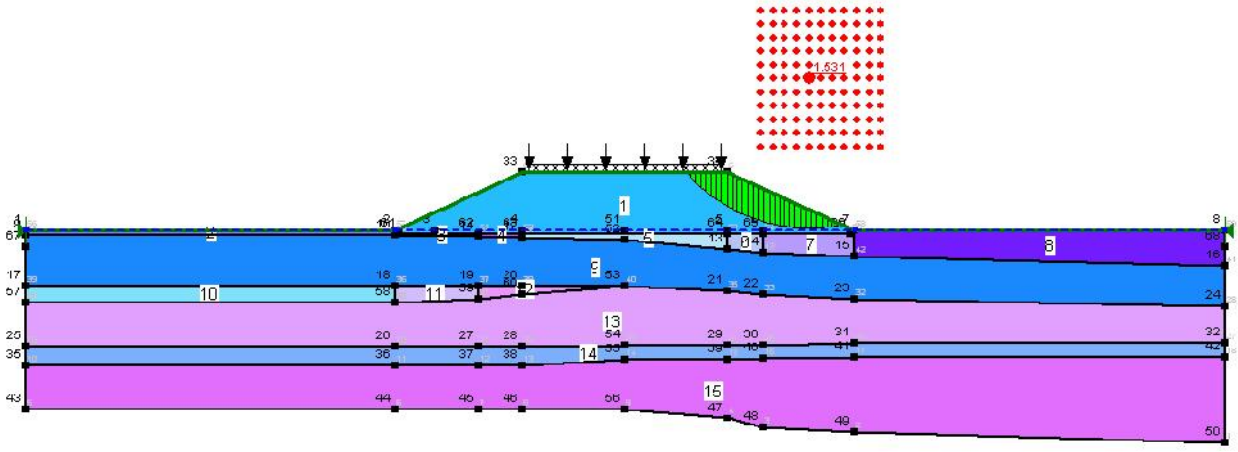


2. Final Step

Left side



Right side



3) Settlement analysis calculate output data

1.Input Data For Calculation Settlement

~~~~~~

▦ Analysis Control

~~~~~~~~~~~~~~~~~~~~

- Total Load Stage : 2
- Calculation Method :Total Load Method
- Calculation Max. Time : 360 day

▦ Node Coordinate Data

~~~~~~~~~~~~~~~~~~~~~~~~

- Total Node No. : 74

Node No.	X (m)	Y (m)	Node No.	X (m)	Y (m)	Node No.	X (m)	Y (m)
1	0.00	0.00	16	150.00	-4.70	31	103.75	-14.90
2	46.25	0.00	17	0.00	-7.30	32	150.00	-14.90
3	51.25	0.00	18	46.25	-7.40	33	42.25	1.00
4	62.25	0.00	19	56.65	-7.40	34	107.75	1.00
5	87.75	0.00	20	62.25	-7.40	35	58.24	9.00
6	92.35	0.00	21	87.75	-8.00	36	56.80	5.00
7	103.75	0.00	22	92.35	-8.50	37	93.25	5.00
8	150.00	0.00	23	103.75	-9.10	38	91.76	9.00
9	0.00	-0.60	24	150.00	-10.00	39	62.25	7.90
10	46.25	-0.60	25	0.00	-15.40	40	87.75	7.90
11	56.65	-0.80	26	46.25	-15.40	41	0.00	-17.80
12	62.25	-1.00	27	56.65	-15.40	42	46.25	-17.80
13	87.75	-2.50	28	62.25	-15.40	43	56.65	-17.80
14	92.35	-3.00	29	87.75	-15.20	44	62.25	-17.80
15	103.75	-3.40	30	92.35	-15.20	45	87.75	-17.00

Node No.	X (m)	Y (m)	Node No.	X (m)	Y (m)
46	92.35	-16.90	61	75.00	-17.10
47	103.75	-16.80	62	75.00	-23.60
48	150.00	-16.80	63	0.00	-9.50
49	0.00	-23.60	64	46.25	-9.50
50	46.25	-23.60	65	56.65	-9.10
51	56.65	-23.60	66	62.25	-8.40
52	62.25	-23.60	67	46.75	-0.50
53	87.75	-24.70	68	56.65	-0.50
~~~~~~~~~~~~~~~~~~~~~~~~

54	92.35	-26.00	69	62.25	-0.50
55	103.75	-26.70	70	87.75	-0.50
56	150.00	-28.00	71	92.35	-0.50
57	75.00	0.00	72	103.25	-0.50
58	75.00	-1.30	73	0.00	-2.18
59	75.00	-7.30	74	150.00	-2.18
60	75.00	-15.20			

▦ Line Information

~~~~~~~~~~~~~~~~~~~

- Total Line No. : 16

Line No.	Layer No.	Nodes On Line	rt (tf/㎥)	rsat (tf/㎥)	c (tf/㎡)	Friction Angle(deg)	Soil Type	Soil Mat.No
1		1 2 36 39 40 37 7 8	1.710	1.710	1.50	12.9	EMBANK	0
2	1	1 2 67-72 7 8	1.870	1.920	3.50	0.0	CLAY	1
3	2	9 10 2 67-72 7 8	1.870	1.920	3.50	0.0	CLAY	2
4	3	9-11 68-72 7 8	1.870	1.920	3.50	0.0	CLAY	3
5	4	9-12 69-72 7 8	1.870	1.920	3.50	0.0	CLAY	4
6	5	9-12 58 13 70-72 7 8	1.870	1.920	3.50	0.0	CLAY	5
7	6	9-12 58 13 14 71 72 7 8	1.870	1.920	3.50	0.0	CLAY	6
8	7	9-12 58 13-15 7 8	1.870	1.920	3.50	0.0	CLAY	7
9	8	9-12 58 13-16	1.920	1.920	0.00	30.4	SAND	8
10	9	17-20 59 21-24	1.620	1.630	1.85	0.0	CLAY	9
11	10	63 64 18-20 59 21-24	1.620	1.630	1.85	0.0	CLAY	9
12	11	63-65 19 20 59 21-24	1.620	1.630	1.85	0.0	CLAY	11
13	12	63-66 59 21-24	1.920	1.920	0.00	30.4	SAND	12
14	13	25-28 60 29-32	1.920	1.920	0.00	30.4	SAND	13
15	14	41-44 61 45-48	1.920	1.920	0.00	30.4	SAND	14
16	15	49-52 62 53-56	0.000	0.000	0.00	0.0	BEDROCK	15

▦ Embankment Step Information

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Total Step No. : 1

Step No.	Line No.	Type
1	1	EMBANK

▦ Soil Properties

~~~~~~~~~~~~~~~~~~~

- Total Soil No. : 15
~~~~~~~~~~~~~~~~~~~

Soil No.	Soil Type	Cal.Method	Drainage Condition	Rebound Coefficient	Cu'/P	Ca	(ts/tp)
1	CLAY	Cc	Single	0.000	0.210	0.000	0.00
2	CLAY	Cc	Single	0.000	0.210	0.000	0.00
3	CLAY	Cc	Single	0.000	0.210	0.000	0.00
4	CLAY	Cc	Single	0.000	0.210	0.000	0.00
5	CLAY	Cc	Single	0.000	0.210	0.000	0.00
6	CLAY	Cc	Single	0.000	0.210	0.000	0.00
7	CLAY	Cc	Single	0.000	0.210	0.000	0.00
8	SAND	Debeer		0.000	0.000	0.000	0.00
9	CLAY	Cc	Both	0.000	0.200	0.000	0.00
10	CLAY	Cc	Both	0.000	0.200	0.000	0.00
11	CLAY	Cc	Both	0.000	0.200	0.000	0.00
12	SAND	Debeer		0.000	0.000	0.000	0.00
13	SAND	Debeer		0.000	0.000	0.000	0.00
14	SAND	Debeer		0.000	0.000	0.000	0.00
15	BEDROCK	NONE		0.000	0.000	0.000	0.00

Soil No.	Soil Type	N-Value	Cc	Cs	Pc (tf/㎡)	OCR	e-logP No.	logMv -logP	logCv -logP
1	CLAY	0.0	0.169	0.022	0.45	2.90	2	0	1
2	CLAY	0.0	0.169	0.022	0.45	2.90	2	0	1
3	CLAY	0.0	0.169	0.022	0.45	2.90	2	0	1
4	CLAY	0.0	0.169	0.022	0.45	2.90	2	0	1
5	CLAY	0.0	0.169	0.022	0.45	2.90	2	0	1
6	CLAY	0.0	0.169	0.022	0.45	2.90	2	0	1
7	CLAY	0.0	0.169	0.022	0.45	2.90	2	0	1
8	SAND	7.0	0.000	0.000	0.00	1.00	0	0	0
9	CLAY	0.0	0.539	0.090	0.59	1.00	1	0	2
10	CLAY	0.0	0.539	0.090	0.59	1.00	1	0	2
11	CLAY	0.0	0.539	0.090	0.59	1.00	1	0	2
12	SAND	13.0	0.000	0.000	0.00	1.00	0	0	0
13	SAND	13.0	0.000	0.000	0.00	1.00	0	0	0
14	SAND	13.0	0.000	0.000	0.00	1.00	0	0	0
15	BEDROCK	0.0	0.000	0.000	0.00	0.00	0	0	0

▦ Water Table Information

~~~~~~~~~~~~~~~~~~~~~~~~~~

- Consideration Of Buoyancy : No
- Unit Weight Of Water :1.000 (tf/㎥)
~~~~~~~~~~~~~~~~~~~~~~~~~~

- Nodes On Water Surface :1 2 7 8

Node No.	X (m)	Y (m)
1	0.00	0.00
2	46.25	0.00
7	103.75	0.00
8	150.00	0.00

▦ External Load

~~~~~~~~~~~~~~~~~

▶ Strip Load

- Total Strip Load No. : 1

Load No.	Left			Right			Used State
	X (m)	Y (m)	Load (tf/㎡)	X (m)	Y (m)	Load (tf/㎡)	
1	63.25	7.90	1.53	86.75	7.90	1.53	Used

▦ Loading Stage Information

~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Total Loading Stage No. : 2

Stage No.	Load			Construction Time	
	Loading Type	Load Type	Embankment Step No. or External Load No.	Start (day)	End (day)
1	재하	EMBANK	1	0	84
2	재하	STRIP	1	85	86

▦ Information Of Vertical Drain

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Calculation Method Of the Consolidation :

⇒ Only the degree Uh Of Horizontal Consolidation

Soil Mat. No.	Drain Type	Cal. Method	Well /Smear	Drain			Well Resistance		Soil		Smear Zone	
				Pattern	Dis. (m)	Dia. (cm)	Vertical Drainage	Kw (cm/sec)	α (Cv/Ch)	Kh (cm/sec)	Dia. (cm)	Ks (cm/sec)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

1	NONE										
2	NONE										
3	NONE										
4	NONE										
5	NONE										
6	NONE										
7	NONE										
8	NONE										
9	NONE										
10	NONE										
11	NONE										
12	NONE										
13	NONE										
14	NONE										

Drain Type --> SD:SAND DRAIN, PD:PAPER BOARD DRAIN, SCP:SAND COMPACTION PILE, PACK:PACK DRAIN
GCP:GRAVEL COMPACTION PILE, CD:CYLINDRICAL DRAIN,FIBER:FIBER DRAIN,NONE:None Drain

Well/Smear --> NONE:None Consideration both Smear and Well Resistance.
W/S:Both Consideration Well Resistance and Smear Effect
SMEAR:Only Consideration Smear Effect. WELL:Only Consideration Well Resistance

▦ Testing Result Curve

~~~~~~~~~~~~~~~~~~~~~~

▶ e-logP Curve

- Curve No. : 1 => 3L
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
e	1.677	1.634	1.563	1.428	1.247	1.084	0.942		

- Curve No. : 2 => 1R
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
e	0.909	0.895	0.867	0.827	0.777	0.725	0.674		

▶ logMv-logP Curve
~~~~~~~~~~~~~~~~~~~~~~

- Curve No. : 1 => 1R
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
Mv(㎠/kgf)	0.0520	0.0590	0.0590	0.0430	0.0270	0.0150	0.0070		

- Curve No. : 2 => 1L
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
Mv(㎠/kgf)	0.0730	0.1270	0.1080	0.1050	0.0750	0.0360	0.0190		

▶ logCv-logP Curve

- Curve No. : 1 => 1R
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
Cv(㎠/day)	94.180	93.920	81.820	802.660	76.900	74.560	68.950		

- Curve No. : 2 => TK2
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
Cv(㎠/day)	32.570	32.400	32.050	24.880	24.360	23.930	23.670		

2. Settlement Result

▶ Settlement each Calculation Point

⊙ Calculation Point 1 : x = 75 m

- Total Layer No. : 5

Layer No.	Soil Mat.No	Soil Type	Cal.Method	Height (m)	ρt (tf/㎥)	ρsat (tf/㎥)	Po (tf/㎡)	△P (tf/㎡)	Settlement (Sf,cm)
4	4	CLAY	Cc	0.80	1.870	1.920	0.37	15.24	10.99
8	8	SAND	Debeer	6.00	1.920	1.920	3.50	15.03	8.68
12	12	SAND	Debeer	7.90	1.920	1.920	9.89	14.05	0.00
13	13	SAND	Debeer	1.90	1.920	1.920	14.40	13.01	0.00
14	14	SAND	Debeer	6.50	1.920	1.920	18.26	12.03	0.00

∑= 19.67 cm

Layer No.	Soil Mat.No	eo	e1	Mv (㎠/kgf)	Cc	Cs	Drain Type	Drainage Condition	Cv (㎠/day)
4	4	0.909	0.000	0.000	0.169	0.022	NONE	Single	382.550
8	8	0.000	0.000	0.000	0.000	0.000	NONE		0.000
12	12	0.000	0.000	0.000	0.000	0.000	NONE		0.000
13	13	0.000	0.000	0.000	0.000	0.000	NONE		0.000
14	14	0.000	0.000	0.000	0.000	0.000	NONE		0.000

- Settlement and Ratio of Consolidation at Calculation Time : 116 day

Layer No.	Soil Mat.No	Soil Type	Cal. Time(day)	U (%)	Settlement (St,cm)	Residual Settlement (Sr,cm)
4	4	CLAY	116	99.91	10.98	0.01
8	8	SAND	116	100.00	8.68	0.00
12	12	SAND	116	0.00	0.00	0.00
13	13	SAND	116	0.00	0.00	0.00
14	14	SAND	116	0.00	0.00	0.00

[U = 99.95 % ∑St = 19.66 cm ∑Sr = 0.01 cm]

3. Time and Settlement for Ratio Of Consolidation at each calculation Point

⊙ Calculation Point 1 : x = 75 m

~~~~~~

▶ Degree Of Consolidation and Settlement with time at converted 1 layer

[Calculation Method]

*** Terzaghi's Solution ***

∴$Cv \times t = Tv \times H^2$

- $Tv <= 0.224$

∴ $Ur = 100 * \sqrt{(4 * Tv / \pi)}$

~~~~~~

- Tv > 0.224

∴ Ur = 100 - 10 ^ ((1.781 - Tv) / 0.933)

- Drain Type : None
- Vertical drainage condition of clay : Single
- Conversion Coefficient Of Consolidation of clay(Cv') : 382.55 ㎠/day
- Converted Lengh Of Clay(H') : 0.8 m
- Vertical drainage path length of clay(H=H') : 0.8 m

▤ Summation of the time and settlement at each layer

☞ at 4 Layer : CLAY(Soil Material No. --> 4)

U(%)	5	10	15	20	25	30	35	40	45	50
Time	8.67	13.91	18.38	22.57	26.57	30.50	34.43	38.33	42.21	46.14
Sett.	0.55	1.10	1.65	2.20	2.75	3.30	3.85	4.40	4.95	5.50

U(%)	55	60	65	70	75	80	85	90	95	100
Time	50.00	54.00	58.00	62.00	66.08	70.21	74.31	78.46	82.62	120.00
Sett.	6.04	6.59	7.14	7.69	8.24	8.79	9.34	9.89	10.44	10.99

▤ U & Time & Settlement Of Conversion 1 layer at each Calculation Point

U(%)	5	10	15	20	25	30	35	40	45	50
Time	8.67	13.91	18.38	22.57	26.57	30.50	34.43	38.33	42.21	46.14
Sett.	0.55	1.10	1.65	2.20	2.75	3.30	3.85	4.40	4.95	5.50

U(%)	55	60	65	70	75	80	85	90	95	100
Time	50.00	54.00	58.00	62.00	66.08	70.21	74.31	78.46	82.62	120.00
Sett.	6.04	6.59	7.14	7.69	8.24	8.79	9.34	9.89	10.44	10.99

▶ Time/Settlement of Sandy layers

☞ at 8 Layer : SAND(Soil Material No. --> 8)

U(%)	5	10	15	20	25	30	35	40	45	50
Time	4.30	8.80	13.10	17.60	21.90	26.22	30.70	35.00	39.50	43.80
Sett.	0.43	0.87	1.30	1.74	2.17	2.60	3.04	3.47	3.91	4.34

U(%)	55	60	65	70	75	80	85	90	95	100
Time	48.20	52.60	56.90	61.40	65.70	70.10	74.50	78.80	83.30	86.00
Sett.	4.77	5.21	5.64	6.08	6.51	6.94	7.38	7.81	8.25	8.68

◈ Total time & settlement & U at each Calculation Points ◈

☞ Total degree of consolidation at each calculation points(ratio of settlement) :

==>[consideration both consolidation settlement and immeadiately settlement of sandy soil]

U(%)	5	10	15	20	25	30	35	40	45	50
Time	6.39	11.48	16.09	20.39	24.63	28.75	32.83	36.96	41.04	45.17
Sett.	0.98	1.97	2.95	3.93	4.92	5.90	6.88	7.87	8.85	9.84

U(%)	55	60	65	70	75	80	85	90	95	100
Time	49.29	53.39	57.57	61.75	65.92	70.21	74.39	78.61	82.91	120.00
Sett.	10.82	11.80	12.79	13.77	14.75	15.74	16.72	17.70	18.69	19.67

4). Calculation increase of undrain shear strength.

1. Step1

Zone No.	Layer No.	Drain Mat.No	Soil Type	Treat method	dP (t/㎡)	cons (%)	m	friction (Ø,°)	Co (Co,t/㎡)	Co+ C (t/㎡)
1	1	1	CLAY	NONE	-	-	0.210	0.00	3.50	3.50
2	2	2	CLAY	NONE	4.57	100.00	0.210	0.00	3.50	4.38
3	3	3	CLAY	NONE	11.32	100.00	0.210	0.00	3.50	5.82
4	4	4	CLAY	NONE	13.86	100.00	0.210	0.00	3.50	6.39
5	5	5	CLAY	NONE	11.76	97.97	0.210	0.00	3.50	6.04
6	6	6	CLAY	NONE	5.00	68.14	0.210	0.00	3.50	4.33
7	0	7	CLAY	NONE	-	-	0.210	0.00	3.50	3.50
8	8	8	SAND	NONE	-	-	0.000	30.40	0.00	0.00
9	9	9	CLAY	NONE	-	-	0.200	0.00	1.85	1.85
10	10	9	CLAY	NONE	4.97	91.16	0.200	0.00	1.85	3.91
11	11	11	CLAY	NONE	12.99	100.00	0.200	0.00	1.85	5.64
12	12	12	SAND	NONE	-	-	0.000	30.40	0.00	0.00
13	13	13	SAND	NONE	-	-	0.000	30.40	0.00	0.00
14	14	14	SAND	NONE	-	-	0.000	30.40	0.00	0.00

2. Final Step

Zone No.	Layer No.	Drain Mat.No	Soil Type	Treat method	dP (t/㎡)	cons (%)	m	friction (Ø,°)	Co (Co,t/㎡)	Co+ C (t/㎡)
1	1	1	CLAY	NONE	-	-	0.210	0.00	3.50	3.50
2	2	2	CLAY	NONE	4.64	100.00	0.210	0.00	3.50	4.40
3	3	3	CLAY	NONE	11.69	100.00	0.210	0.00	3.50	5.90
4	4	4	CLAY	NONE	15.24	100.00	0.210	0.00	3.50	6.68
5	5	5	CLAY	NONE	12.21	98.55	0.210	0.00	3.50	6.15
6	6	6	CLAY	NONE	5.10	67.91	0.210	0.00	3.50	4.34
7	0	7	CLAY	NONE	-	-	0.210	0.00	3.50	3.50
8	8	8	SAND	NONE	-	-	0.000	30.40	0.00	0.00
9	9	9	CLAY	NONE	-	-	0.200	0.00	1.85	1.85
10	10	9	CLAY	NONE	5.17	90.92	0.200	0.00	1.85	3.95
11	11	11	CLAY	NONE	13.83	100.00	0.200	0.00	1.85	5.81
12	12	12	SAND	NONE	-	-	0.000	30.40	0.00	0.00
13	13	13	SAND	NONE	-	-	0.000	30.40	0.00	0.00
14	14	14	SAND	NONE	-	-	0.000	30.40	0.00	0.00

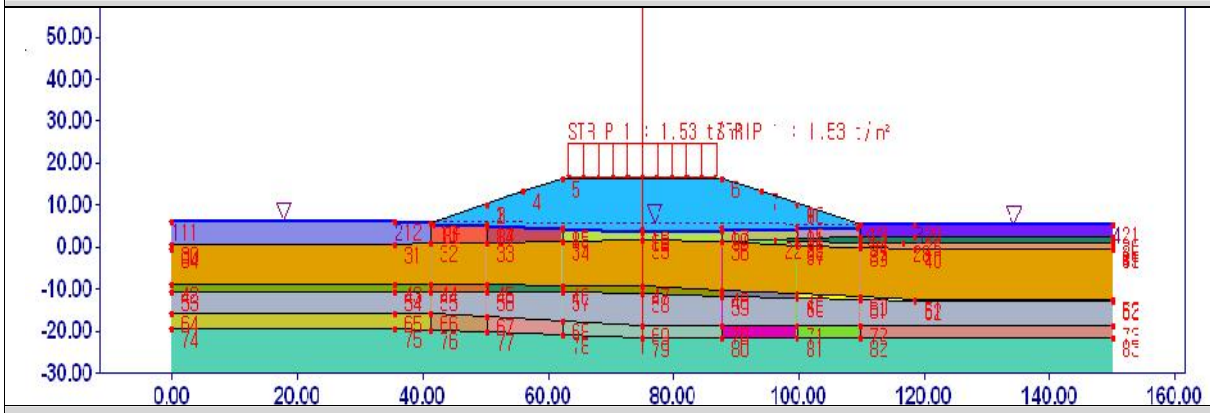
7.2 Detailed settlement calculation & stability analysis of approach road at A2 side

7.2.1 Analysis output (AP02)

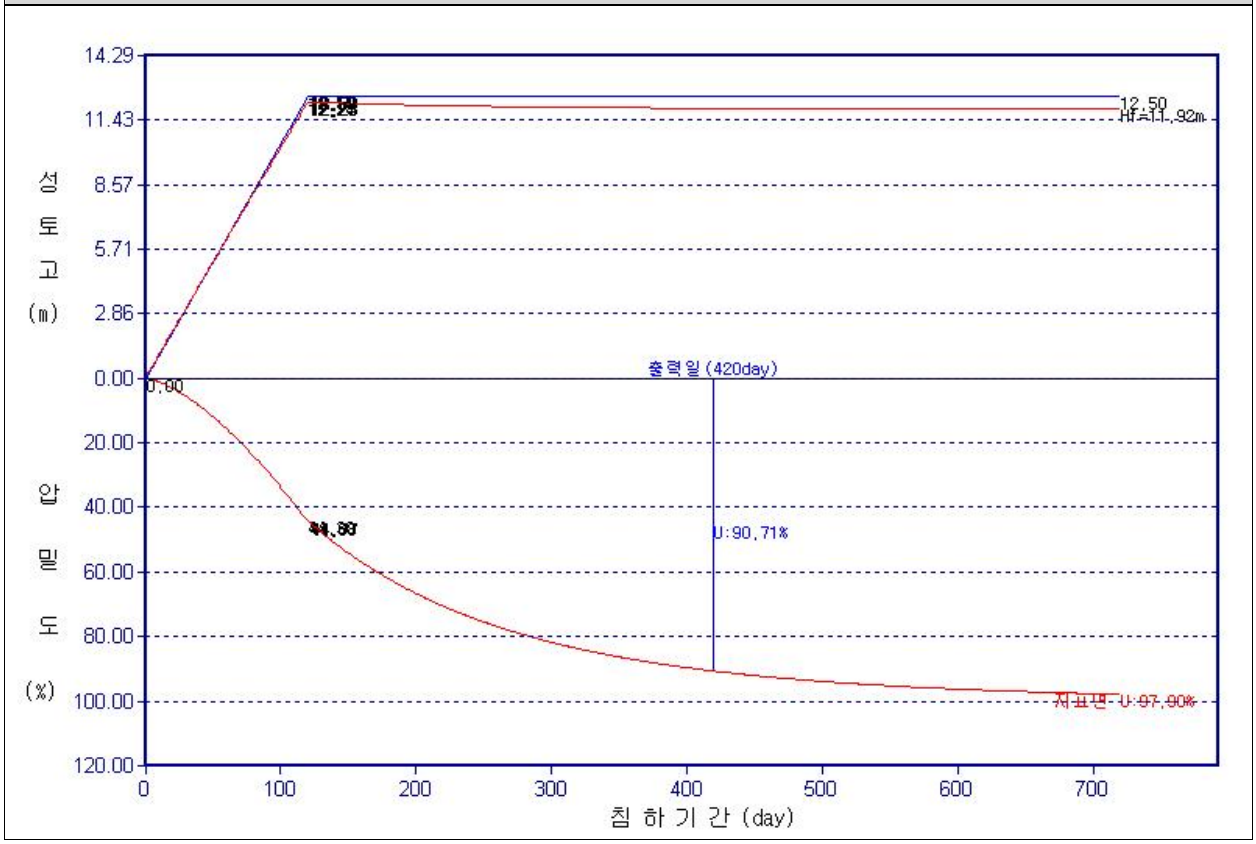
■ **NONE**

1)Settlement analysis

Representative section



Analysis output



Section (STA.)		extention (m)	standard section	Height of embankment F.G(m)	allowable residual settlement (cm)	Total Soft soil thickness (m)
1.	AP02	74.8		11.41	10	6.5

Treatment method	spacing (m)	Height of surcharge (m)	Geotextile layer (200KN/m)	embank step	Treatment Depth(m)	degree of consolidation (%)	Total settlement (cm)		Residual settlement (cm3)
							Without traffic load	Include traffic load	
NONE	-		0	1		90.71		59.44	5.52

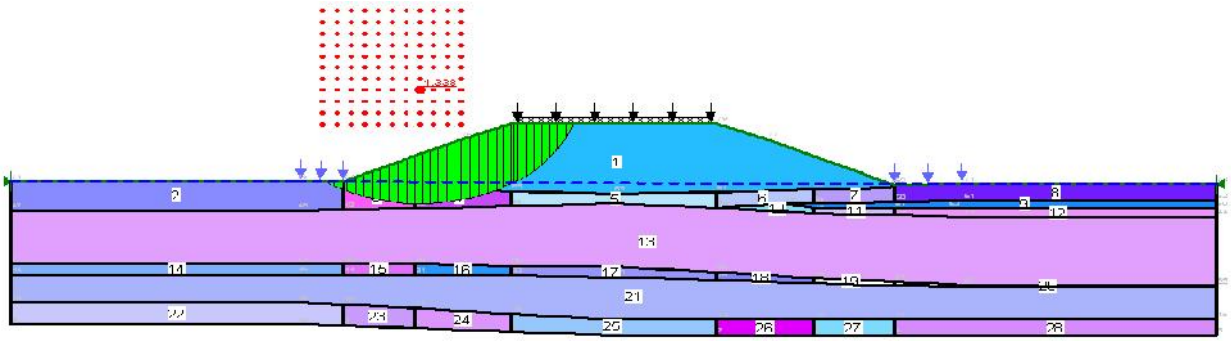
code			
section		AP02	
Treatment method	Surcharge height (m)	-	
	Stage	Filling height (m)	Waiting time (month)
	#3	-	0
	#2	-	0
	#1	FG+0.6	10
	Total(month)	14	
	CSB Thickness (m)	-	
	Reinforced Geo-textile	0 Layer/T=200KN/m	
	Type of vertical drain	NONE	
	Pattern and Spacing(m)	-	
	Treatment Depth(m)	-	

2) Slope Stability Analysis

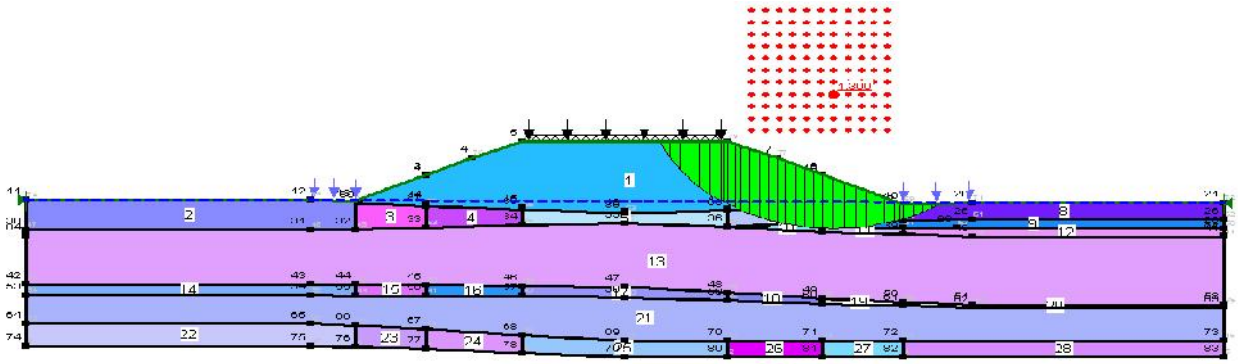
Content	Analysis Step				Remark
	Step 1	Step 2	Step 3	Final	
H(m)	FG+0.6	0	0	11.41	
FS	1.338	-	-	1.836	Left side
	1.309	-	-	1.743	Right side

1. Step 1

Left side

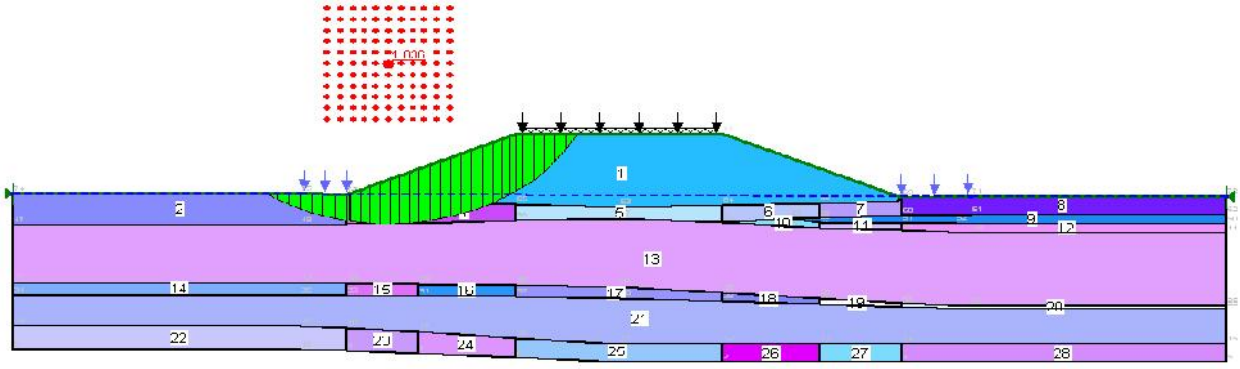


Right side

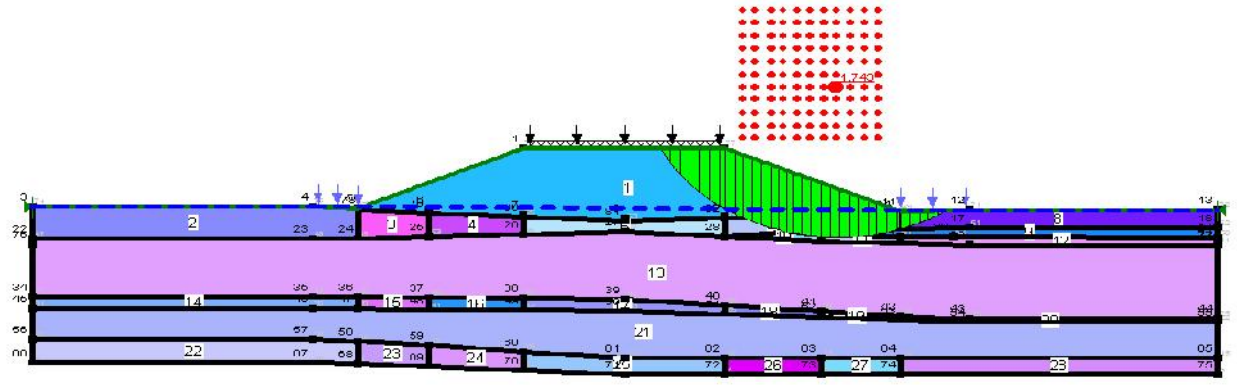


2. Final Step

Left side



Right side



3) Settlement analysis calculate output data

1.Input Data For Calculation Settlement

~~~~~~

▦ Analysis Control

~~~~~~~~~~~~~~~~~~~~

- Total Load Stage : 2
- Calculation Method :Total Load Method
- Calculation Max. Time : 720 day

▦ Node Coordinate Data

~~~~~~~~~~~~~~~~~~~~~~~~

- Total Node No. : 92

Node No.	X (m)	Y (m)	Node No.	X (m)	Y (m)	Node No.	X (m)	Y (m)
1	50.24	10.22	16	75.00	4.17	31	35.60	0.73
2	50.24	10.27	17	87.75	4.53	32	41.24	0.83
3	50.25	10.27	18	99.75	4.92	33	50.25	1.10
4	56.00	13.27	19	109.87	5.21	34	62.25	1.50
5	62.25	16.17	20	118.60	5.40	35	75.00	1.87
6	87.75	16.17	21	150.00	5.40	36	87.75	1.21
7	94.00	13.27	22	96.29	1.87	37	99.75	0.32
8	99.75	10.27	23	99.75	1.98	38	99.75	1.22
9	99.76	10.27	24	109.87	2.29	39	109.87	-0.05
10	99.76	10.22	25	118.60	2.50	40	118.60	-0.40
11	0.00	5.93	26	150.00	2.50	41	150.00	-0.40
12	35.60	5.93	27	109.87	1.05	42	0.00	-8.67
13	41.24	5.77	28	116.60	1.05	43	35.60	-8.67
14	50.25	5.36	29	150.00	1.00	44	41.24	-8.72
15	62.25	4.74	30	0.00	0.73	45	50.25	-8.85

Node No.	X (m)	Y (m)	Node No.	X (m)	Y (m)	Node No.	X (m)	Y (m)
46	62.25	-9.05	61	109.87	-12.54	76	41.24	-19.65
47	75.00	-9.23	62	118.60	-12.80	77	50.25	-20.10
48	87.75	-10.16	63	150.00	-12.80	78	62.25	-20.80
49	99.75	-11.18	64	0.00	-15.67	79	75.00	-21.43
50	109.87	-11.91	65	35.60	-15.67	80	87.75	-21.43
51	118.60	-12.40	66	41.24	-15.94	81	99.75	-21.43
52	150.00	-12.40	67	50.25	-16.62	82	109.87	-21.43
53	0.00	-10.67	68	62.25	-17.67	83	150.00	-21.43
54	35.60	-10.67	69	75.00	-18.63	84	0.00	-0.30
55	41.24	-10.71	70	87.75	-18.63	85	150.00	-0.30
56	50.25	-10.82	71	99.75	-18.63	86	41.74	5.27
57	62.25	-10.82	72	109.87	-18.63	87	50.25	4.86
58	75.00	-11.13	73	150.00	-18.63	88	62.25	4.24
59	87.75	-11.62	74	0.00	-19.47	89	75.00	3.67
60	99.75	-12.16	75	35.60	-19.47	90	87.75	4.03
~~~~~~~~~~~~~~~~~~~~~~~~

Node No.	X (m)	Y (m)
91	99.75	4.42
92	109.37	4.71

▦ Line Information

~~~~~~~~~~~~~~~~~~~~

- Total Line No. : 29

Line No.	Layer No.	Nodes On Line	rt (tf/㎥)	rsat (tf/㎥)	c (tf/㎡)	Friction Angle(deg)	Soil Type	Soil Mat.No
1		11-13 4-7 19-21	1.910	1.910	2.02	21.4	EMBANK	0
2	1	11-13 86-92 19-21	1.900	1.920	3.50	0.0	CLAY	1
3	2	30-32 13 86-92 19-21	1.900	1.920	3.50	0.0	CLAY	2
4	3	30-33 87-92 19-21	1.900	1.920	3.50	0.0	CLAY	3
5	4	30-34 88-92 19-21	1.900	1.920	3.50	0.0	CLAY	4
6	5	30-36 90-92 19-21	1.900	1.920	3.50	0.0	CLAY	5
7	6	30-36 22 23 91 92 19-21	1.900	1.920	3.50	0.0	CLAY	6
8	7	30-36 22 23 24 19-21	1.900	1.920	3.50	0.0	CLAY	7
9	8	30-36 22-26	1.910	1.910	0.00	32.3	SAND	8
10	9	30 31 32 33 34 35 36 22 38 27 28 29	1.900	1.920	3.50	0.0	CLAY	5
11	10	30-38 27 28 29	1.900	1.920	3.50	0.0	CLAY	6
12	11	30-37 39 27-29	1.900	1.920	3.50	0.0	CLAY	7
13	12	30-37 39 40 41	1.910	1.910	0.00	32.3	SAND	9
14	13	42-52	1.680	1.700	2.00	0.0	CLAY	10
15	14	53-55 44-52	1.680	1.700	2.00	0.0	CLAY	11
16	15	53-56 45-52	1.680	1.700	2.00	0.0	CLAY	12
17	16	53-57 46-52	1.680	1.700	2.00	0.0	CLAY	13
18	17	53-59 48-52	1.680	1.700	2.00	0.0	CLAY	14
19	18	53-60 49-52	1.680	1.700	2.00	0.0	CLAY	15
20	19	53-61 50-52	1.680	1.700	2.00	0.0	CLAY	16
21	20	53-63	1.830	1.830	0.00	28.4	SAND	17
22	21	64-73	1.710	1.730	2.10	0.0	CLAY	18
23	22	74-76 66-73	1.710	1.730	2.10	0.0	CLAY	19
24	23	74-77 67-73	1.710	1.730	2.10	0.0	CLAY	20
25	24	74-78 68-73	1.710	1.730	2.10	0.0	CLAY	21
26	25	74-80 70-73	1.710	1.730	2.10	0.0	CLAY	22
27	26	74-81 71-73	1.710	1.730	2.10	0.0	CLAY	23
28	27	74-82 72-73	1.710	1.730	2.10	0.0	CLAY	24
29	28	74-83	0.000	0.000	0.00	0.0	BEDROCK	25

▦ Embankment Step Information
~~~~~~~~~~~~~~~~~~~~

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Total Step No. : 1

Step No.	Line No.	Type
1	1	EMBANK

▦ Soil Properties

~~~~~~~~~~~~~~~~~~~~

- Total Soil No. : 25

Soil No.	Soil Type	Cal.Method	Drainage Condition	Rebound Coefficient	Cu'/P	Ca	(ts/tp)
1	CLAY	Cc	Single	0.000	0.250	0.000	0.00
2	CLAY	Cc	Single	0.000	0.250	0.000	0.00
3	CLAY	Cc	Single	0.000	0.250	0.000	0.00
4	CLAY	Cc	Single	0.000	0.250	0.000	0.00
5	CLAY	Cc	Single	0.000	0.250	0.000	0.00
6	CLAY	Cc	Single	0.000	0.250	0.000	0.00
7	CLAY	Cc	Single	0.000	0.250	0.000	0.00
8	SAND	Debeer		0.000	0.250	0.000	0.00
9	SAND	Debeer		0.000	0.250	0.000	0.00
10	CLAY	Cc	Both	0.000	0.250	0.000	0.00
11	CLAY	Cc	Both	0.000	0.250	0.000	0.00
12	CLAY	Cc	Both	0.000	0.250	0.000	0.00
13	CLAY	Cc	Both	0.000	0.250	0.000	0.00
14	CLAY	Cc	Both	0.000	0.250	0.000	0.00
15	CLAY	Cc	Both	0.000	0.250	0.000	0.00
16	CLAY	Cc	Both	0.000	0.250	0.000	0.00
17	SAND	NONE		0.000	0.000	0.000	0.00
18	CLAY	Cc	Both	0.000	0.250	0.000	0.00
19	CLAY	Cc	Both	0.000	0.250	0.000	0.00
20	CLAY	Cc	Both	0.000	0.250	0.000	0.00
21	CLAY	Cc	Both	0.000	0.250	0.000	0.00
22	CLAY	Cc	Both	0.000	0.250	0.000	0.00
23	CLAY	Cc	Both	0.000	0.250	0.000	0.00
24	CLAY	Cc	Both	0.000	0.250	0.000	0.00
25	BEDROCK	NONE		0.000	0.000	0.000	0.00

Soil No.	Soil Type	N-Value	Cc	Cs	Pc (tf/㎡)	OCR	e-logP No.	logMv -logP	logCv -logP

1	CLAY	0.0	0.136	0.030	1.19	1.00	1	0	1
2	CLAY	0.0	0.136	0.030	1.19	1.00	1	0	1
3	CLAY	0.0	0.136	0.030	1.19	1.00	1	0	1
4	CLAY	0.0	0.136	0.030	1.19	1.00	1	0	1
5	CLAY	0.0	0.136	0.030	1.19	1.00	1	0	1
6	CLAY	0.0	0.136	0.030	1.19	1.00	1	0	1
7	CLAY	0.0	0.136	0.030	1.19	1.00	1	0	1
8	SAND	11.0	0.000	0.000	0.00	1.00	0	0	0
9	SAND	11.0	0.000	0.000	0.00	1.00	0	0	0
10	CLAY	3.0	0.606	0.102	1.05	1.00	2	0	2
11	CLAY	3.0	0.606	0.102	1.05	1.00	2	0	2
12	CLAY	3.0	0.606	0.102	1.05	1.00	2	0	2
13	CLAY	3.0	0.606	0.102	1.05	1.00	2	0	2
14	CLAY	3.0	0.606	0.102	1.05	1.00	2	0	2
15	CLAY	3.0	0.606	0.102	1.05	1.00	2	0	2
16	CLAY	3.0	0.606	0.102	1.05	1.00	2	0	2
17	SAND	0.0	0.000	0.000	0.00	0.00	0	0	0
18	CLAY	4.0	0.479	0.146	2.06	1.00	3	0	3
19	CLAY	4.0	0.479	0.146	2.06	1.00	3	0	3
20	CLAY	4.0	0.479	0.146	2.06	1.00	3	0	3
21	CLAY	4.0	0.479	0.146	2.06	1.00	3	0	3
22	CLAY	4.0	0.479	0.146	2.06	1.00	3	0	3
23	CLAY	4.0	0.479	0.146	2.06	1.00	3	0	3
24	CLAY	4.0	0.479	0.146	2.06	1.00	3	0	3
25	BEDROCK	0.0	0.000	0.000	0.00	0.00	0	0	0

▦ Water Table Information

~~~~~~~~~~~~~~~~~~~~~~~~~~

- Consideration Of Buoyancy : No
- Unit Weight Of Water :1.000 (tf/㎥)
- Nodes On Water Surface :11 12 20 21

Node No.	X (m)	Y (m)
11	0.00	5.93
12	35.60	5.93
20	118.60	5.40
21	150.00	5.40

▦ External Load

~~~~~~~~~~~~~~~~~~

▶ Strip Load

- Total Strip Load No. : 1

Load No.	Left			Right			Used State
	X (m)	Y (m)	Load (tf/㎡)	X (m)	Y (m)	Load (tf/㎡)	
1	63.25	16.17	1.53	86.75	16.17	1.53	Used

▦ Loading Stage Information

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Total Loading Stage No. : 2

Stage No.	Load			Construction Time	
	Loading Type	Load Type	Embankment Step No. or External Load No.	Start (day)	End (day)
1	재하	EMBANK	1	0	120
2	재하	STRIP	1	121	122

▦ Information Of Vertical Drain

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Calculation Method Of the Consolidation :

⇒ Only the degree Uh Of Horizontal Consolidation

Soil Mat. No.	Drain Type	Cal. Method	Well /Smear	Drain			Well Resistance		Soil		Smear Zone	
				Patt -ern	Dis. (m)	Dia. (cm)	Vertical Drainage	Kw (cm/sec)	α (Cv/Ch)	Kh (cm/sec)	Dia. (cm)	Ks (cm/sec)
1	NONE											
2	NONE											
3	NONE											
4	NONE											
5	NONE											
6	NONE											
7	NONE											
8	NONE											
9	NONE											
10	NONE											
11	NONE											
12	NONE											
13	NONE											

14	NONE										
15	NONE										
16	NONE										
17	NONE										
18	NONE										
19	NONE										
20	NONE										
21	NONE										
22	NONE										
23	NONE										
24	NONE										

Drain Type --> SD:SAND DRAIN, PD:PAPER BOARD DRAIN, SCP:SAND COMPACTION PILE, PACK:PACK DRAIN
GCP:GRAVEL COMPACTION PILE, CD:CYLINDRICAL DRAIN,FIBER:FIBER DRAIN,NONE:None Drain

Well/Smear --> NONE:None Consideration both Smear and Well Resistance.
W/S:Both Consideration Well Resistance and Smear Effect
SMEAR:Only Consideration Smear Effect. WELL:Only Consideration Well Resistance

▦ Testing Result Curve

~~~~~~~~~~~~~~~~~~~~~~

▶ e-logP Curve

- Curve No. : 1 => 1
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
e	0.830	0.820	0.798	0.763	0.723	0.679	0.641		

- Curve No. : 2 => 2
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
e	1.377	1.341	1.285	1.219	1.094	0.948	0.770		

- Curve No. : 3 => 3
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
~~~~~~~~~~~~~~~~~~~~~~

P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
e	1.210	1.176	1.118	1.051	0.961	0.833	0.689		

▶ logCv-logP Curve

- Curve No. : 1 => 1
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
Cv(㎠/day)	144.720	139.360	114.310	111.110	108.350	104.890	102.730		

- Curve No. : 2 => 2
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
Cv(㎠/day)	54.600	46.740	42.160	40.180	28.430	26.780	25.750		

- Curve No. : 3 => 3
- Data No. : 7

No.	1	2	3	4	5	6	7	8	9
P (kgf/㎠)	0.130	0.250	0.500	1.000	2.000	4.000	8.000		
Cv(㎠/day)	51.840	46.570	43.980	43.720	40.090	26.780	26.350		

2. Settlement Result

▶ Settlement each Calculation Point

⦿ Calculation Point 1 : x = 75 m

- Total Layer No. : 5

Layer No.	Soil Mat.No	Soil Type	Cal.Method	Height (m)	rt (tf/㎥)	rsat (tf/㎥)	Po (tf/㎡)	△P (tf/㎡)	Settlement (Sf,cm)

4	4	CLAY	Cc	1.80	1.900	1.920	0.83	23.56	18.01
12	9	SAND	Debeer	11.10	1.910	1.910	6.71	22.69	0.00
16	13	CLAY	Cc	1.90	1.680	1.700	12.42	20.97	22.69
20	17	SAND	NONE	7.50	1.830	1.830	16.20	19.48	0.00
24	21	CLAY	Cc	2.80	1.710	1.730	20.33	17.84	18.74

∑= 59.44 cm

Layer No.	Soil Mat.No	eo	e1	Mv (㎠/kgf)	Cc	Cs	Drain Type	Drainage Condition	Cv (㎠/day)
4	4	0.830	0.000	0.000	0.136	0.030	NONE	Single	110.180
12	9	0.000	0.000	0.000	0.000	0.000	NONE		0.000
16	13	1.180	0.000	0.000	0.606	0.102	NONE	Both	28.100
20	17	0.000	0.000	0.000	0.000	0.000	NONE		0.000
24	21	0.958	0.000	0.000	0.479	0.146	NONE	Both	32.130

- Settlement and Ratio of Consolidation at Calculation Time : 420 day

Layer No.	Soil Mat.No	Soil Type	Cal. Time(day)	U (%)	Settlement (St,cm)	Residual Settlement (Sr,cm)
4	4	CLAY	420	95.95	17.28	0.73
12	9	SAND	420	0.00	0.00	0.00
16	13	CLAY	420	94.76	21.50	1.19
20	17	SAND	420	0.00	0.00	0.00
24	21	CLAY	420	80.79	15.14	3.60

[U = 90.71 % ∑St = 53.92 cm ∑Sr = 5.52 cm]

3. Time and Settlement for Ratio Of Consolidation at each calculation Point

⦿ Calculation Point 1 : x = 75 m

~~~~~~

▶ Degree Of Consolidation and Settlement with time at converted 1 layer

[Calculation Method]

*** Terzaghi's Solution ***

∴Cv x t = Tv x H²

- Tv <= 0.224

∴ Ur = 100 * √(4 * Tv / π)

- Tv > 0.224

∴ Ur = 100 - 10 ^ ((1.781 - Tv) / 0.933)

- Drain Type : None
~~~~~~

- Vertical drainage condition of clay : Single
- Conversion Coefficient Of Consolidation of clay(Cv') : 110.18 ㎠/day
- Converted Lengh Of Clay(H') : 1.8 m
- Vertical drainage path length of clay(H=H') : 1.8 m

▤ Summation of the time and settlement at each layer

☞ at 4 Layer : CLAY(Soil Material No. --> 4)

U(%)	5	10	15	20	25	30	35	40	45	50
Time	25.80	40.86	53.63	65.00	75.33	85.10	94.30	103.10	111.55	119.73
Sett.	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.01

U(%)	55	60	65	70	75	80	85	90	95	100
Time	132.71	146.67	162.60	181.00	202.75	229.33	263.50	312.00	394.00	--
Sett.	9.91	10.81	11.71	12.61	13.51	14.41	15.31	16.21	17.11	18.01

▤ U & Time & Settlement Of Conversion 1 layer at each Calculation Point

U(%)	5	10	15	20	25	30	35	40	45	50
Time	25.80	40.86	53.63	65.00	75.33	85.10	94.30	103.10	111.55	119.73
Sett.	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.01

U(%)	55	60	65	70	75	80	85	90	95	100
Time	132.71	146.67	162.60	181.00	202.75	229.33	263.50	312.00	394.00	--
Sett.	9.91	10.81	11.71	12.61	13.51	14.41	15.31	16.21	17.11	18.01

▶ Degree Of Consolidation and Settlement with time at converted 2 layer

[Calculation Method]

*** Terzaghi's Solution ***

∴Cv x t = Tv x H²

- Tv <= 0.224

∴ Ur = 100 * √(4 * Tv / π)

- Tv > 0.224

∴ Ur = 100 - 10 ^ ((1.781 - Tv) / 0.933)

- Drain Type : None
- Vertical drainage condition of clay : Both
- Conversion Coefficient Of Consolidation of clay(Cv') : 28.1 ㎠/day

- Converted Lengh Of Clay(H') : 1.9 m
- Vertical drainage path length of clay(H=H'/2) : 0.95 m

▤ Summation of the time and settlement at each layer

☞ at 16 Layer : CLAY(Soil Material No. --> 13)

U(%)	5	10	15	20	25	30	35	40	45	50
Time	26.67	42.38	55.50	67.30	78.00	88.18	97.67	106.85	115.54	126.67
Sett.	1.13	2.27	3.40	4.54	5.67	6.81	7.94	9.08	10.21	11.35

U(%)	55	60	65	70	75	80	85	90	95	100
Time	140.13	155.43	172.83	192.83	216.75	245.67	283.33	336.00	427.00	--
Sett.	12.48	13.61	14.75	15.88	17.02	18.15	19.29	20.42	21.56	22.69

▤ U & Time & Settlement Of Conversion 2 layer at each Calculation Point

U(%)	5	10	15	20	25	30	35	40	45	50
Time	26.67	42.38	55.50	67.30	78.00	88.18	97.67	106.85	115.54	126.67
Sett.	1.13	2.27	3.40	4.54	5.67	6.81	7.94	9.08	10.21	11.35

U(%)	55	60	65	70	75	80	85	90	95	100
Time	140.13	155.43	172.83	192.83	216.75	245.67	283.33	336.00	427.00	--
Sett.	12.48	13.61	14.75	15.88	17.02	18.15	19.29	20.42	21.56	22.69

▶ Degree Of Consolidation and Settlement with time at converted 3 layer

[Calculation Method]

*** Terzaghi's Solution ***

∴$Cv \times t = Tv \times H^2$

- $Tv <= 0.224$

∴ $Ur = 100 * \sqrt{(4 * Tv / \pi)}$

- $Tv > 0.224$

∴ $Ur = 100 - 10 ^ ((1.781 - Tv) / 0.933)$

- Drain Type : None
- Vertical drainage condition of clay : Both
- Conversion Coefficient Of Consolidation of clay(Cv') : 32.13 ㎠/day
- Converted Lengh Of Clay(H') : 2.8 m
- Vertical drainage path length of clay(H=H'/2) : 1.4 m

▤ Summation of the time and settlement at each layer

☞ at 24 Layer : CLAY(Soil Material No. --> 21)

U(%)	5	10	15	20	25	30	35	40	45	50
Time	33.00	52.40	68.67	83.29	96.71	109.13	122.20	140.20	160.50	183.25
Sett.	0.94	1.87	2.81	3.75	4.69	5.62	6.56	7.50	8.43	9.37

U(%)	55	60	65	70	75	80	85	90	95	100
Time	209.25	238.00	271.33	309.50	355.00	409.50	481.00	582.00	--	--
Sett.	10.31	11.24	12.18	13.12	14.06	14.99	15.93	16.87	--	18.74

▤ U & Time & Settlement Of Conversion 3 layer at each Calculation Point

U(%)	5	10	15	20	25	30	35	40	45	50
Time	33.00	52.40	68.67	83.29	96.71	109.13	122.20	140.20	160.50	183.25
Sett.	0.94	1.87	2.81	3.75	4.69	5.62	6.56	7.50	8.43	9.37

U(%)	55	60	65	70	75	80	85	90	95	100
Time	209.25	238.00	271.33	309.50	355.00	409.50	481.00	582.00	--	--
Sett.	10.31	11.24	12.18	13.12	14.06	14.99	15.93	16.87	17.80	18.74

◈ Total time & settlement & U at each Calculation Points ◈

☞ Total degree of consolidation at each calculation points(ratio of settlement) :

==>[consideration both consolidation settlement and immeadiately settlement of sandy soil]

U(%)	5	10	15	20	25	30	35	40	45	50
Time	28.00	44.45	58.29	70.63	81.93	92.52	102.53	112.09	122.61	136.75
Sett.	2.97	5.94	8.92	11.89	14.86	17.83	20.80	23.78	26.75	29.72

U(%)	55	60	65	70	75	80	85	90	95	100
Time	152.83	171.12	192.14	216.91	246.60	283.86	333.40	406.33	539.00	--
Sett.	32.69	35.66	38.64	41.61	44.58	47.55	50.52	53.50	56.47	59.44

4). Calculation increase of undrain shear strength.

1. Step1

Zone No.	Layer No.	Drain Mat.No	Soil Type	Treat method	dP (t/㎡)	cons (%)	m	friction (Ø,°)	Co (Co,t/㎡)	Co+ C (t/㎡)
1	1	1	CLAY	NONE	-	-	0.250	0.00	3.50	3.50
2	2	2	CLAY	NONE	4.80	23.17	0.250	0.00	3.50	3.82
3	3	3	CLAY	NONE	15.48	28.40	0.250	0.00	3.50	4.62
4	4	4	CLAY	NONE	22.38	51.02	0.250	0.00	3.50	6.31
5	5	5	CLAY	NONE	16.08	26.69	0.250	0.00	3.50	4.57
6	6	6	CLAY	NONE	5.16	39.95	0.250	0.00	3.50	4.01
7	0	7	CLAY	NONE	-	-	0.250	0.00	3.50	3.50
8	0	8	SAND	NONE	-	-	0.250	32.30	0.00	0.00
9	9	5	CLAY	NONE	15.93	26.79	0.250	0.00	3.50	4.67
10	10	6	CLAY	NONE	5.23	84.93	0.250	0.00	3.50	5.12
11	0	7	CLAY	NONE	-	-	0.250	0.00	3.50	3.50
12	12	9	SAND	NONE	-	-	0.250	32.30	0.00	0.00
13	13	10	CLAY	NONE	-	-	0.250	0.00	2.00	2.00
14	14	11	CLAY	NONE	6.49	49.32	0.250	0.00	2.00	4.32
15	15	12	CLAY	NONE	13.71	49.97	0.250	0.00	2.00	5.20
16	16	13	CLAY	NONE	20.20	48.80	0.250	0.00	2.00	5.85
17	17	14	CLAY	NONE	14.08	73.67	0.250	0.00	2.00	6.98
18	18	15	CLAY	NONE	6.94	94.15	0.250	0.00	2.00	6.91
19	0	16	CLAY	NONE	-	-	0.250	0.00	2.00	2.00
20	20	17	SAND	NONE	-	-	0.000	28.40	0.00	0.00
21	21	18	CLAY	NONE	-	-	0.250	0.00	2.10	2.10
22	22	19	CLAY	NONE	7.34	29.35	0.250	0.00	2.10	3.95
23	23	20	CLAY	NONE	12.53	30.86	0.250	0.00	2.10	4.46
24	24	21	CLAY	NONE	17.24	35.47	0.250	0.00	2.10	5.25
25	25	22	CLAY	NONE	12.79	36.06	0.250	0.00	2.10	4.97
26	26	23	CLAY	NONE	7.60	36.91	0.250	0.00	2.10	4.60
27	0	24	CLAY	NONE	-	-	0.000	0.00	2.10	2.10

2. Final Step

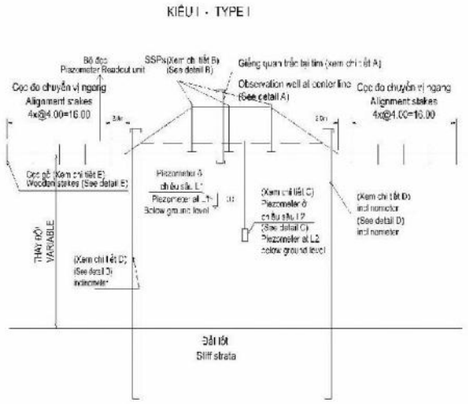
Zone No.	Layer No.	Drain Mat.No	Soil Type	Treat method	dP (t/㎡)	cons (%)	m	friction (Ø,°)	Co (Co,t/㎡)	Co+ C (t/㎡)
1	1	1	CLAY	NONE	-	-	0.250	0.00	3.50	3.50
2	2	2	CLAY	NONE	4.87	74.07	0.250	0.00	3.50	4.53
3	3	3	CLAY	NONE	15.78	85.42	0.250	0.00	3.50	6.94
4	4	4	CLAY	NONE	23.56	99.67	0.250	0.00	3.50	9.28

5	5	5	CLAY	NONE	16.38	82.22	0.250	0.00	3.50	6.86
6	6	6	CLAY	NONE	5.22	97.29	0.250	0.00	3.50	4.75
7	0	7	CLAY	NONE	-	-	0.250	0.00	3.50	3.50
8	0	8	SAND	NONE	-	-	0.250	32.30	0.00	0.00
9	9	5	CLAY	NONE	16.26	82.30	0.250	0.00	3.50	7.17
10	10	6	CLAY	NONE	5.32	100.00	0.250	0.00	3.50	5.44
11	0	7	CLAY	NONE	-	-	0.250	0.00	3.50	3.50
12	12	9	SAND	NONE	-	-	0.250	32.30	0.00	0.00
13	13	10	CLAY	NONE	-	-	0.250	0.00	2.00	2.00
14	14	11	CLAY	NONE	6.69	99.59	0.250	0.00	2.00	6.73
15	15	12	CLAY	NONE	14.12	99.58	0.250	0.00	2.00	8.48
16	16	13	CLAY	NONE	20.97	99.47	0.250	0.00	2.00	10.04
17	17	14	CLAY	NONE	14.50	100.00	0.250	0.00	2.00	8.86
18	18	15	CLAY	NONE	7.14	100.00	0.250	0.00	2.00	7.27
19	0	16	CLAY	NONE	-	-	0.250	0.00	2.00	2.00
20	20	17	SAND	NONE	-	-	0.000	28.40	0.00	0.00
21	21	18	CLAY	NONE	-	-	0.250	0.00	2.10	2.10
22	22	19	CLAY	NONE	7.58	86.82	0.250	0.00	2.10	7.62
23	23	20	CLAY	NONE	12.93	89.16	0.250	0.00	2.10	9.00
24	24	21	CLAY	NONE	17.84	94.29	0.250	0.00	2.10	10.61
25	25	22	CLAY	NONE	13.19	94.77	0.250	0.00	2.10	9.73
26	26	23	CLAY	NONE	7.84	95.38	0.250	0.00	2.10	8.60
27	0	24	CLAY	NONE	-	-	0.000	0.00	2.10	2.10

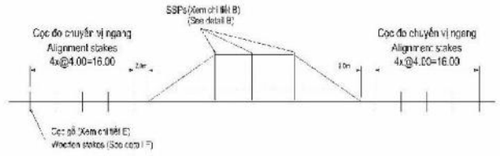
7.3 Monitoring instrument drawing

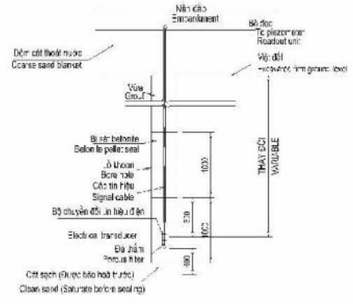
BỐ TRÍ THIẾT BỊ QUAN TRẮC
INSTRUMENT PLAN

KIỂU I - TYPE I

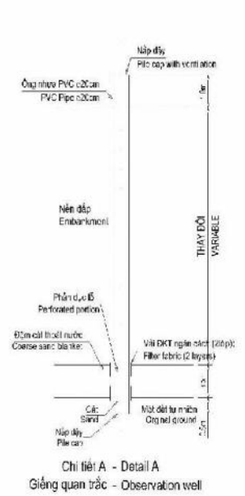


KIỂU II - TYPE II

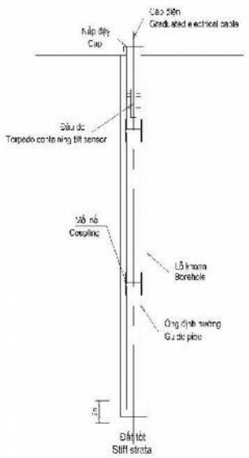


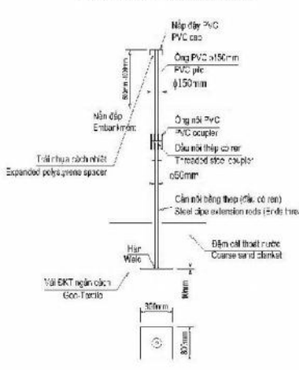


Chi tiết C - Detail C
Typical installation of electrical (Piezometer) - Lắp đặt thiết bị đo áp lực nước lỗ rỗng (Piezometer)

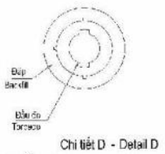


Chi tiết A - Detail A
Giếng quan trắc - Observation well





Chi tiết B - Detail B
Bàn đo lún bề mặt (SSP) - Surface settlement plate (SSP)



Chi tiết D - Detail D
Thiết bị đo chuyển vị ngang sâu - Inclinometer

Chi tiết E - Detail E
Cọc gỗ - Wooden stake

For A1 Abutment

Station	Type I	Type II	L1 (m)	L2 (m)
16+900		x		
16+960		x		

For A2 Abutment

Station	Type I	Type II	L1 (m)	L2 (m)
18+040		x		
18+100		x		

MINISTRY OF TRANSPORT VIETNAM VIETNAM EXPRESSWAY CORPORATION PROJECT MANAGEMENT UNIT NO.85	The Joint Venture of Nippon Koei Co., Ltd. Nippon Engineering Consultants Co., Ltd. Chodai Co., Ltd. Thai Engineering Consultants Co., Ltd.	REMARKS: NOTES:	Consulting Service for Detailed Design for Danang Quang Ngai Expressway Development Project Project ID No. P106235 IDA Credit No. 3843-VN

	PREPARED BY	CHECKED BY	APPROVED BY	DRAWING TITLE	BỐ TRÍ THIẾT BỊ QUAN TRẮC INSTRUMENT PLAN	
NAME						
SIGNATURE				SCALE	DRAWING NO.	REV. NO.
DATE					VUGE0070	