JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PEOPLE'S COMMITTEE OF HO CHI MINH CITY (PCHCMC)
MINISTRY OF PLANNING AND INVESTMENT (MPI)
THE SOCIALIST REPUBLIC OF VIET NAM

THE DETAILED DESIGN STUDY ON HO CHI MINH CITY WATER ENVIRONMENT IMPROVEMENT PROJECT IN THE SOCIALIST REPUBLIC OF VIET NAM

FINAL REPORT

DESIGN REPORT

VOLUME 1

JUNE 2001

PACIFIC CONSULTANTS INTERNATIONAL

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CHAPTER 1

TAU HU - BEN NGHE CANAL IMPROVEMENT (PACKAGE A)

1.1

Civil Design

CALCULATION FOR SEWERS ALONG TAU HU - BEN NGHE CANAL

1. Loading

Sewers along Tau Hu - Ben Nghe resist the following loads:

- Seft load
- Soil load on cover slab
- Vehicle load
- Ground water
- Uplift

2.Calculation cases

- Sewers is calculated for reinforcing bar arragement
- Sewers is checked in case of uplift

3. Selection of typical sewer

Two box culverts and one sewer pipe is applied as typical sewers for calculation

- Box culvert H2800x 2400 at outlet TH - L10

(Big culvert, both soil load and vehicle load are high)

- Box culvert H3000x 1500 at outlet BN - R9

(Big culvert, vehicle load is very high)

- Sewer pipe D1500 at outlet BN - L12

(Big sewer, soil load is very high)

Analysis and calculation is described on next sections

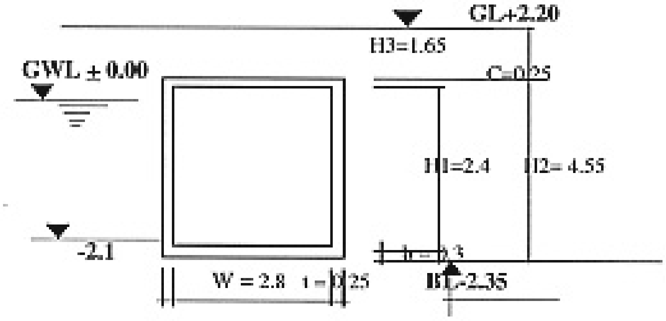
CALCULATION FOR BOX CULVERTS

I-Calculation for culvert 2.800x2.400 (TH - L10)

(The calculation based on Japanese standard - JIS1999)

1-Geometry dimensions for calculation :

(Calculation made for one m long of culvert):



2-Material properties and soil conditions:

Ground water level:	GWL=	±0.00
Concrete: Grade 250,	Rn =	70 kg/cm²
	RS=	3.6 kg/cm²
Reinforcement type JIS:	Ra=	1600 kg/cm²
Back fill sand:	g_s= 1.8T/m ; Coeficient of earth pressure at rest K_o=	0.5
Internal friction =		20°

3-Loading and calculation scheme:

3.1 Vehicle load:

Vehicle type: H30 So design load is calculated as following formula:

Pde=(1+i)X2P/Wo

Where: P,weight of back wheel 12.00T

Wo,width of occpied area of vehicle Wo= 2.75m

i, impact coefficent, i=0.3

Pde=2x12x(1+0.3)/2.75=11.35

W1=2h+0.2=2x1.65+0.2=3.50m

P1=Pde/W1=11.35/3.5=3.24T/m2

3.2 Soil load on cover slab

P2= H_3*g_s=1.65*1.8=2.97 T/m2

3.3 Horizontal load from vertical load P1+P2 on two side of culvert

PH= 1.9x 1.8x 0.5+0.5= 2.21T/m2

3.4 Horizontal triangle load due to earth from both side of the culvert

Pw1 =	(0.55-0)x 1.8x 0.5 = 0.5 T/m2
Pw2 =	2.21+0.5x0.8x2.25+1.0x2.255=5.36T/m2
Pw = Pw1+ Pw2=	0.5 T/m2 + 5.36 T/m2 = 5.86 T/m2

3.5 Reaction at the bottom slab of culvert

Pb= 3.24+2.97+0.63+ 3.1/3.05= 7.8 T/m2

4-Checking pressure to base soil

Total pressure to base soil

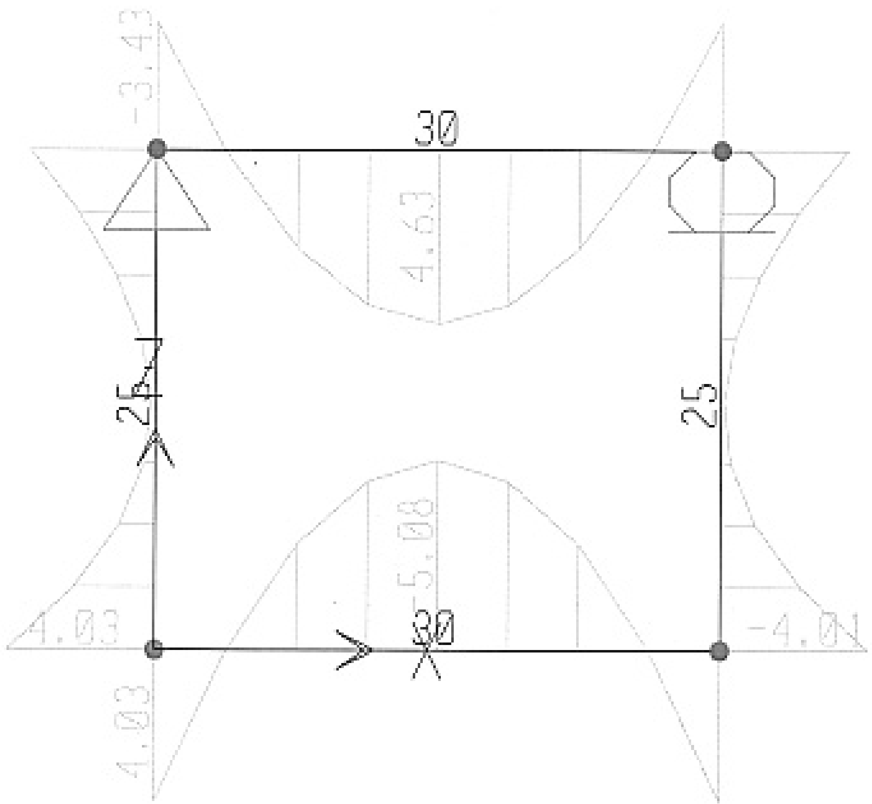
Ps= 7.8+0.30x2.5= 8.55 T/m2

So at the depth of 4.4m strength of base soil must be bigger than 8.43T/m2

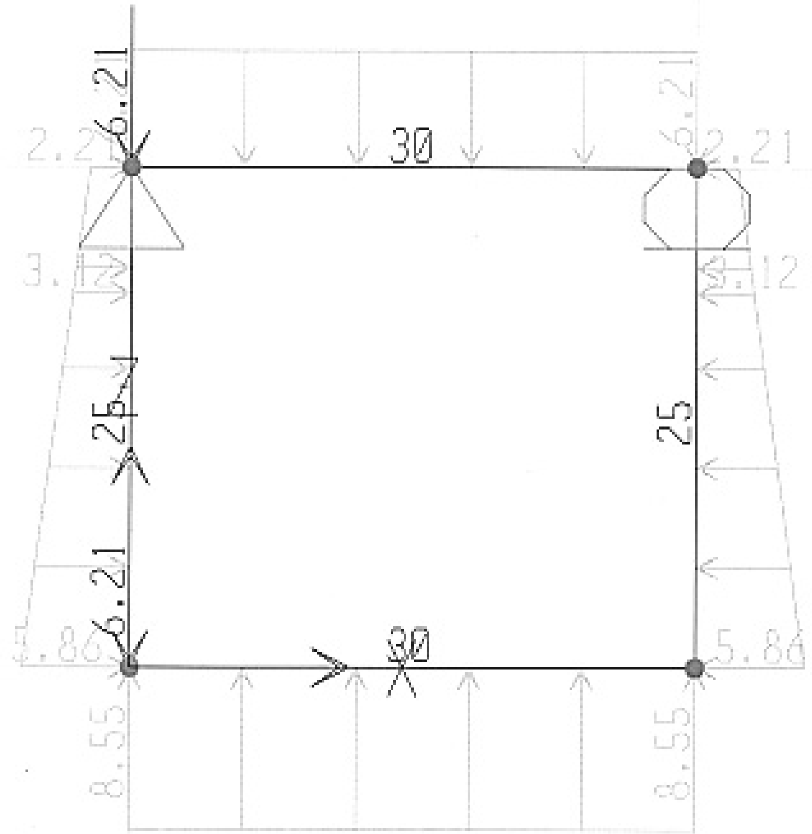
5-Checking uplift that due to ground water

Ground water level ± 0.00 and the culvert it empty

Total pressure : Ps=Psoil+Pself = 2.97+0.5x 2.5 = 4.22T/m2 >Puplift = 2.25 T/m2



SAP2000 v6.11 - File:Sluicetd - Moment 3-3 Diagram (LOAD1) - Ton-m Units



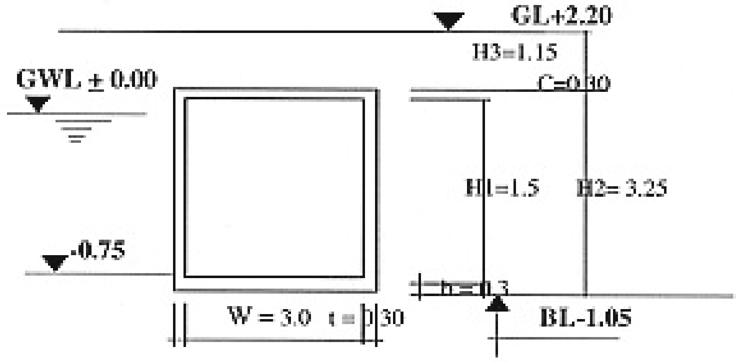
SAP2000 v6.11 - File:Sluicetd - Frame Span Loads (LOAD1) - Ton-m Units

II-Calculation for culvert H3.000x1.500 (Sewer outlet BN- R9)

(The calculation based on Japanese standard - JIS1999)

1-Geometry dimensions for calculation :

(Calculation made for one m long of culvert):



2-Material properties and soil conditions:

Ground water level:	GWL=	±0.00
Concrete: Grade 250,	Rn =	70 kg/cm²
	RS=	3.6 kg/cm²
Reinforcement type JIS:	Ra=	1600 kg/cm²
Back fill sand:	g_s= 1.8T/m³; Coeficient of earth pressure at rest K_o= 0.5	
Internal friction =		20°

3-Loading and calculation scheme:

3.1 Vehicle load:

Vehicle type: H30 So design load is calculated as following formula:

Pde=(1+I)X2P/Wo

Where: P,weight of back wheel 12.00T

Wo,width of occpied area of vehicle Wo= 2.75m

i, impact coefficent, i=0.3

Pde=2x12x(1+0.3)/2.75=11.35

W1=2h+0.2=2x1.15+0.2=2.50m

P1=Pde/W1=11.35/2.5=4.54T/m2

3.2 Soil load on cover slab

P2= H_3*g_s=1.15*1.8=2.07 T/m2

3.3 Horizontal load from vertical load P1+P2 on two side of culvert

PH= 1.15x 1.8x 0.5+0.5= 1.54T/m2

3.4 Horizontal triangle load due to earth from both side of the culvert

Pw1 = (1.05-0)x 1.8x 0.5 = 0.95 T/m2
Pw2 = 1.54+0.5x0.8x1.05+1.0x1.05=3.01T/m2
Pw = Pw1+ Pw2= 0.95 T/m2 + 3.01 T/m2 = 3.96 T/m2

3.5 Reaction at the bottom slab of culvert

Pb= 4.54+2.07+0.75+ 2.7/3.6 = 8.11T/m2

4-Checking pressure to base soil

Total pressure to base soil

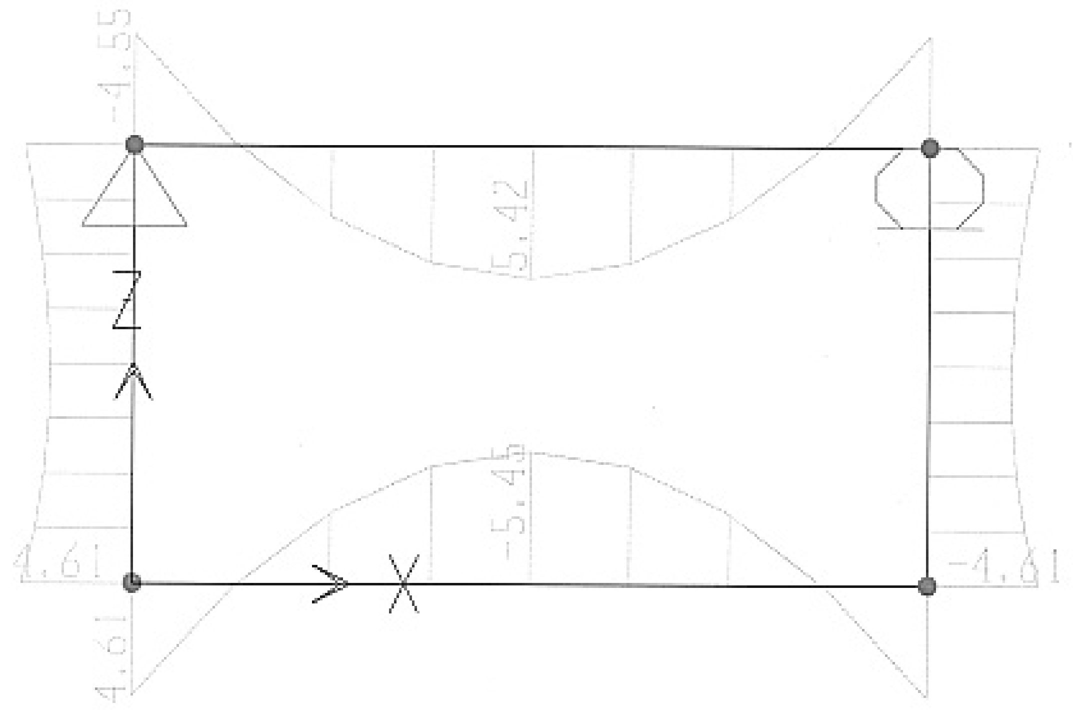
Ps= 8.11T/m2

So at the depth of 3.2m strength of base soil must be bigger than 8.28T/m2

5-Checking uplift that due to ground water

Ground water level ± 0.00 and the culvert it empty

Total pressure : Ps=Psoil+Pself = 2.07+0.6x 2.5 = 3.57T/m2 >Puplift = 1.05 T/m2



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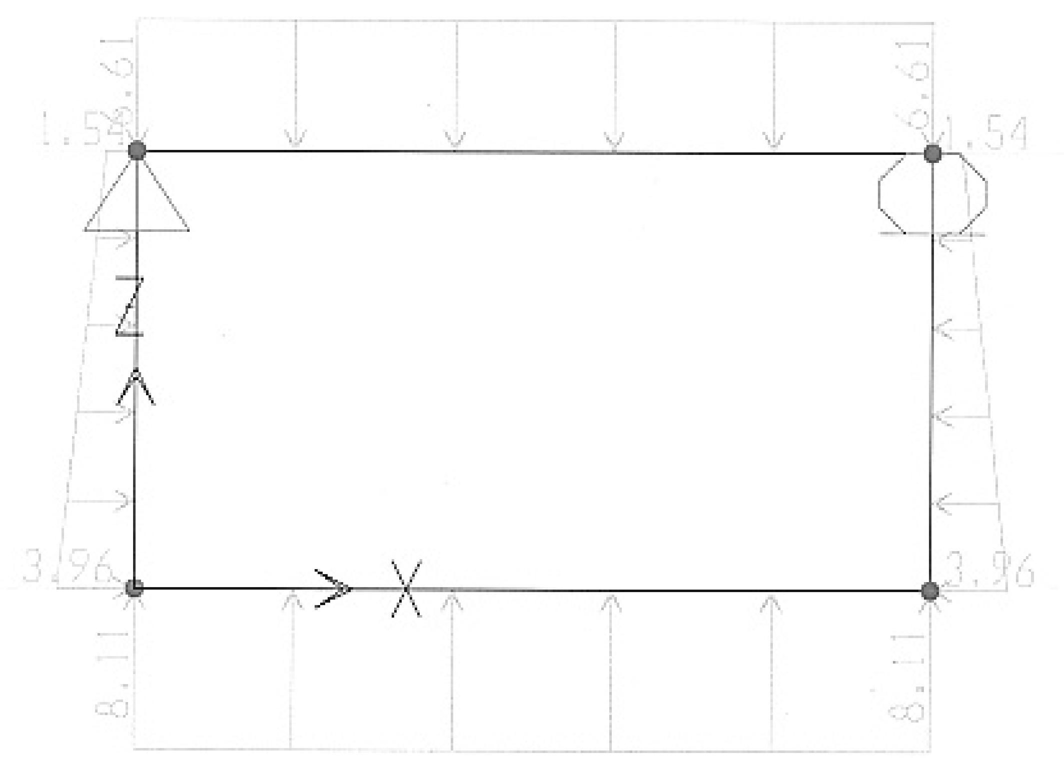


SAP2000 v6.11 - File:Sluicetd - Frame Span Loads (LOAD1) - Ton-m Units

Calculation for bar arrangement for typical box culvert

Base on attached results of shell forces analised by SAP2000, choosing the most dangerous forces for calculation:

$A_o = M/R_n b h_o^2$ Where, M: Maximum bending moment(T.m)

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

Required area of reinforcement:

Fa= M/γRaho Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

NAME OF ELEMENT	Values (T.m)	Ao	γ	Fa (cm^2)	Bar arrangement	
					ϕ(mm)	a(mm)
CULVERT 2800x2400 b=1.00 h=0.25	4.030 4.630 5.080	0.1439 0.1058 0.1161	0.922 0.944 0.938	13.66 12.26 13.54	16 16 16	**125** **125** **125**
CULVERT 3000x1500 b=1.00 h=0.30	5.420 5.450 4.610	0.1239 0.1246 0.1054	0.934 0.933 0.944	15.77 15.87 13.27	16 16 16	**125** **125** **125**

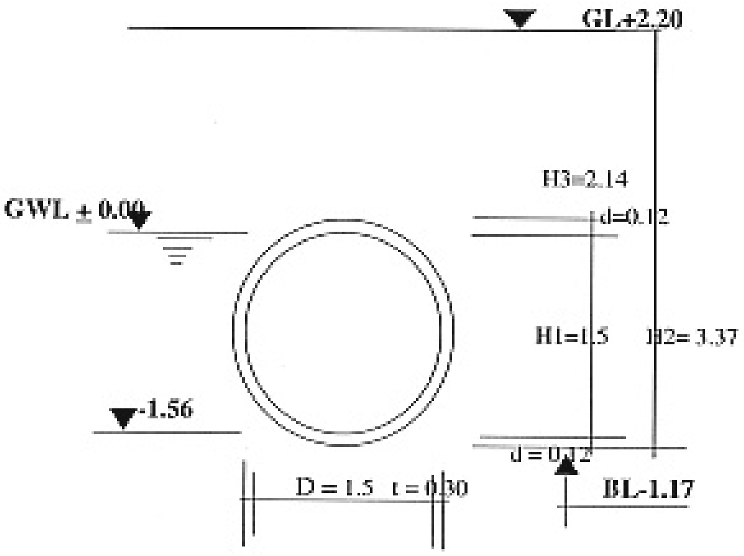
CALCULATION FOR SEWER PIPE

III-Calculation for sewer pipe D1500(Sewer outlet BN- L12)

(The calculation based on Japanese standard - JIS1999)

1-Geometry dimensions for calculation :

(Calculation made for one m long of pipe):



2-Material properties and soil conditions:

Ground water level:	GWL=	±0.00
Concrete: Grade 250,	Rn =	70 kg/cm^2
	RS=	3.6 kg/cm^2
Reinforcement type JIS:	Ra=	1600 kg/cm^2
Back fill sand:	g_s= 1.8T/m^3; Coeficient of earth pressure at rest	K_o= 0.5
Internal friction =		20°

3-Loading and calculation scheme:

3.1 Vehicle load:

Vehicle type: H30 So design load is calculated as following formula:

Pde=(1+i)X2P/Wo

Where:
- P,weight of back wheel 12.00T
- Wo,width of occpied area of vehicle Wo= 2.75m
- i, impact coefficent, i=0.3

Pde=2x12x(1+0.3)/2.75=11.35

W1=2h+0.2=2x 2.14+0.2= 4.48m

$P1 = Pde/W1 = 11.35/4.48 = 2.53 T/m2$

3.2 Soil load on cover slab

P2= $H3 * g_s = 2.14 * 1.8 = 3.85$ T/m2

3.3 Horizontal load from vertical load P1+P2 on two side of culvert

Pit= 2.14x 1.8x 0.5+0.5= 2.43T/m2

3.4 Horizontal triangle load due to earth from both side of the culvert

Pw = 2.53+0.5x0.8x1.77+1.0x1.77= 5.00T/m2

3.5 Reaction at the bottom slab of culvert

Pb= 2.53+3.85+(0.12x 2.5)/1.5 = 6.58T/m2

4-Checking pressure to base soil

Total pressure to base soil

Ps= 6.58+0.3x2.5 = 7,33T/m2

So at the depth of 3.2m strength of base soil must be bigger than 7.33T/m2

5-Checking uplift that due to ground water

Ground water level $\pm$ 0.00 and the culvert it empty

Total pressure : Ps=Psoil+Pself = 3.85+0.2 = 4.05T/m2 >Puplift = 1.5 T/m2

6, Reinforcing area

Maximum moment is calculated by equation

$Mmax = (qr^2/4) - (r^2/48) \times (5p1+7p2)$. Where

q1 = P1+P2 = 2.53 + 3.85 = 6.38T/m2

r = 1.5/ 2 = 0.75m

p1 = 5, p2 = 2.43

$Mmax = (6.38 \times 0.75^2/4) - (0.75^2/48) \times (5 \times 5 + 7 \times 2.43) = 0.3$ Tm

$Ro = ho/(M/Rub)^{1/2} = 4.34 \Rightarrow \gamma = 0.975$

$Fa = M/\gamma hoRa = 2.13$ cm2

CALCULATION FOR REVETMENT FROM SLIDING

1. Typical cross section

Typical sections having at least one of the folowing condition

- Weak soil condition. It is the most important factor
- Big filling volume including high depth and large width
- Stiff slope revetment

With these requirements, there are four (4) cases will be selected to calculate for prevention of sliding, that is:

a, Case1 (Cross section No7): Very weak soil condition, high depth of filling

As mentioned on Fig1.1/4. This case base on soil condition at boreholes SS-02 and SC-01

b, Case 2 (Cross section No.24) Weak soil condition, high depth of filling

AS shown in Fig. 1.2/4. This case is calculated due to soil condition at borehole SS-08

c, Case 3 (Cross section No.82) Weak soil condition, very high depth of filling

AS shown in Fig. 1.3/4. This case is calculated due to soil condition at borehole SS-10

c, Case 4 (Cross section No.120) Stiff revetment, high depth of filling

Above sectiona will be selected to calculate prevention of sliding

2. Calculation method

Japanese software of FOFUM8 is applied for calculation. The calculation procedure is

a, Calculation in existing soil condition condition (no strengthen)

b, Calculation when strengthen soil condition by pilling. Wooden pile $\phi80$ - $\phi100$, L = 4,5m is applied. In this case there are 5 sub-cases are inputed for calculation

- Density of penetreted woodenpile is 6 pcs/m^2
- Density of penetreted woodenpile is 9 pcs/m^2
- Density of penetreted woodenpile is 16 pcs/m^2
- Density of penetreted woodenpile is 25 pcs/m^2

With the changing density of wooden piles, C_u is changed as below:

Number of pile (Pcs/m^2)	0	6	9	16	25
C_u of 1:1.5slope Revetment	0.65	0.90	0.995	1.225	1.50
C_u of 1:0.5slope Revetment	0.65	0.70	0.80	0.90	1.02

(Note this table is caculated by Dr. Chau Ngoc from HCMC Technical University)

3. Input data

3.1 Filling material

Filling material is sandy soil or clayed soil with characteristics as below:

- Specific gravity $\gamma = 1.6$ (T/m^3)
- Cohesion Cu = 1.5 (T/m^2)
- Internal friction angle $\Phi = 30°$

3.2 Soil condition

Characteristics of the lollowing soil layers are necessary for caculation

Layer OH: Made ground – clay sand or gravelly sand with cobbles of stone, brick, concrete

Main characteristics of OH layer is listed below;

- Wet density $\gamma_w = 1,461 - 1.7g/cm_3$
- Natural moisture 95%
- Unconfined compressive strength $q_u = 0,175kg/cm^2$
- Compression idex $C_c = 1,274$
- Coefficient of consolidation $C_v = 3,65 \times 10^{-4}$

Layer CL: Very soft, high plasticity blackish or gravelly sand with cobble of stone, brick and concrete

Main characteristics of OH layer is listed below:

- Wet density $\gamma_w = 1,963g/cm_3$
- Natural moisture 20 - 35%
- Unconfined compressive strength $q_u = 1,202kg/cm^2$
- Compression idex $C_c = 0,181$
- Coefficient of consolidation $C_v = 6,88 \times 10^{-4}$

Layer SC: Medium dense, whitish grey, yellowish brown clayeysand

Main characteristics of OH layer is listed below:

- Wet density $\gamma_w = 1,98g/cm_3$
- Natural moisture 12 - 25%
- Unconfined compressive strength $q_u = 0,928kg/cm^2$
- Compression idex $C_c = 0,155$
- Coefficient of consolidation $C_v = 9,28 \times 10^{-4}$

The depth of layers at each section is shown in fig.25 and fig2.6

4. Result

Result of calculation from sliding of banks is attached at table 2.3 (1/4) – 2.3(4/4)

FIG 2.4 TYPICAL REVETMENTS FOR TAU HU - BEN NGHE CANAL

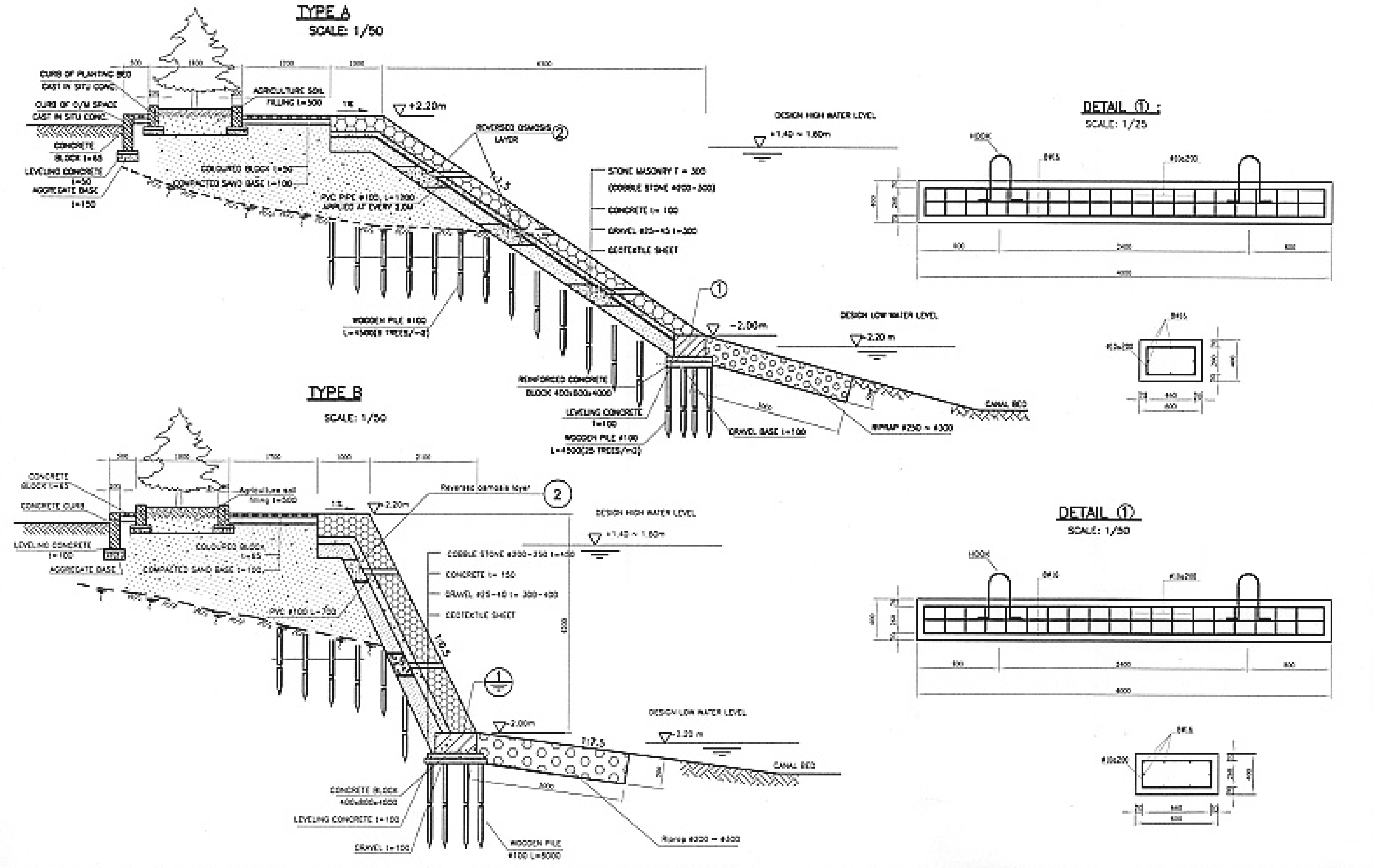


FIG 2.5 PREVNTTON WORK FROM SLIDING DUETO FILLING