

**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**

## **TABLE OF CONTENTS**

### **VOLUME 1 (Structural Calculation)**

#### **Chapter 1 TAU HU - BEN NGHE CANAL IMPROVEMENT (PACKAGE A)**

##### **1.1 Civil Design**

#### **Chapter 2 PUMP DRAINAGE IMPROVEMENT (PACKAGE B)**

##### **2.1 Civil Design**

###### **2.1.1 Design Standard**

###### **2.1.2 Thanh Da Pumping Station**

###### **2.1.3 Ben Me Coc (1) Pumping Station**

##### **2.2 Architecture Design**

###### **2.2.1 Design Standard**

###### **2.2.2 Thanh Da Pumping Station**

###### **2.2.3 Ben Me Coc Pumping Station**

##### **2.3 Mechanical Equipment**

##### **2.4 Electrical Equipment**

#### **Chapter 3 INTERCEPTOR SEWER CONSTRUCTION (PACKAGE C)**

##### **3.1 Civil Design**

#### **Chapter 4 INTERMEDIATE WASTEWATER PUMPING STATION CONSTRUCTION (PACKAGE C)**

##### **4.1 Civil Design**

###### **4.1.1 Design Standard**

###### **4.1.2 Diaphragm Wall**

###### **4.1.3 Pumping Station**

###### **4.1.4 Spread Foundation**

###### **4.1.5 Grit Chamber Over Flow Weir**

###### **4.1.6 Slope Sliding**

##### **4.2 Architecture Design**

###### **4.2.1 Design Standard**

###### **4.2.2 Pumping Station**

###### **4.2.3 Generator Room**

##### **4.3 Mechanical Equipment**

##### **4.4 Electrical Equipment**

## **Chapter 5 CONVEYANCE SEWER CONSTRUCTION (PACKAGE D)**

### **5.1 Civil Design**

#### **5.1.1 Box Culvert**

#### **5.1.2 Siphon Chamber**

## **Chapter 6 EXISTING COMBINED SEWER IMPROVEMENT (PACKAGE D)**

### **6.1 Civil Design**

## **Chapter 7 WASTEWATER TREATMENT PLANT CONSTRUCTION (PACKAGE E)**

### **7.1 Civil Design**

#### **7.1.1 Design Standard**

#### **7.1.2 Lift Pumping Station**

#### **7.1.3 Treatment Plant**

#### **7.1.4 Distribution Tank**

#### **7.1.5 Disinfection Tank**

#### **7.1.6 Water Supply Facility**

#### **7.1.7 Effluent Pipe**

#### **7.1.8 Pipe Gallery**

#### **7.1.9 Main Building**

## **VOLUME 2 (Structural Calculation)**

#### **7.1.10 Blower Building**

#### **7.1.11 Dewatering Building**

#### **7.1.12 Gravity Thickener**

#### **7.1.13 Jetty Work**

#### **7.1.14 Bridge Structure**

#### **7.1.15 Pile Foundation**

#### **7.1.16 Road and Storm Water Discharge**

#### **7.1.17 Fermenting Vessel**

#### **7.1.18 Deodorizing Soil Filter**

#### **7.1.19 Temporary Structure**

##### **(1) Slope Sliding**

##### **(2) Sheet Pile**

### **7.2 Architecture Design**

- 7.2.1 Design Standard
- 7.2.2 Lift Pumping Station
- 7.2.3 Chlorination Storage Building
- 7.2.4 Blower Building
- 7.2.5 Main Building
- 7.2.6 Dewatering and Centrifugal Thickener Building
- 7.2.7 First Fermentation Tank
- 7.2.8 Second Fermentation Tank
- 7.2.9 Storage Vessel
- 7.2.10 Sub Storage Vessel
- 7.2.11 Guard House
- 7.2.12 Stair Case (A), (B)
- 7.3 Mechanical Equipment
- 7.4 Electrical Equipment
- 7.5 Capacity of Facility
- 7.6 Hydraulic Calculation

### VOLUME 3 (Quantity Estimation)

#### **Chapter 1 TAU HU - BEN NGHE CANAL IMPROVEMENT (PACKAGE A)**

#### **Chapter 2 PUMP DRAINAGE IMPROVEMENT (PACKAGE B)**

- 1. Thanh Da Pumping Drainage Area
- 2. Ben Me Coc (1) Pumping Drainage Area
- 3. Ben Me Coc (2) Pumping Drainage Area

#### **Chapter 3 INTERCEPTOR SEWER CONSTRUCTION (PACKAGE C)**

#### **Chapter 4 INTERMEDIATE WASTEWATER PUMPING STATION CONSTRUCTION (PACKAGE C)**

#### **Chapter 5 CONVEYANCE SEWER CONSTRUCTION (PACKAGE D)**

#### **Chapter 6 EXISTING COMBINED SEWER IMPROVEMENT (PACKAGE D)**

#### **Chapter 7 WASTEWATER TREATMENT PLANT CONSTRUCTION (PACKAGE E)**

- 1. Site Preparation Works
- 2. Earth Works

3. Structures Works
4. Other Works

***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



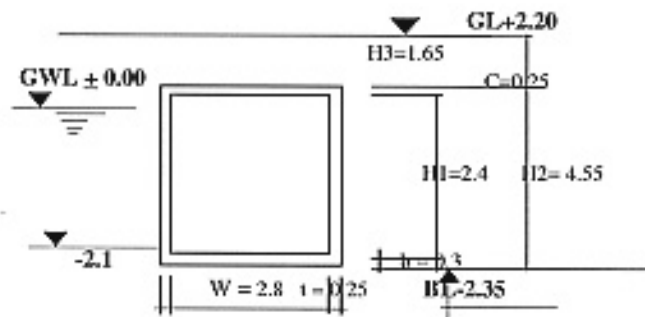
## CALCULATION FOR BOX CULVERTS

### 1-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,	Ra =	70 kg/cm <sup>2</sup>
	RS=	3.6 kg/cm <sup>2</sup>
Reinforcement type JIS:	Ra=	1600 kg/cm <sup>2</sup>
Back fill sand:	g <sub>s</sub> = 1.8T/m <sup>3</sup> ;	Coefficient of earth pressure at rest K <sub>0</sub> = 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:

$$Pde = (1+i) \times 2P / Wo$$

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

$$Pde = 2 \times 12 \times (1+0.3) / 2.75 = 11.35$$

$$W1 = 2h + 0.2 = 2 \times 1.65 + 0.2 = 3.50m$$

$$P1 = Pde / W1 = 11.35 / 3.5 = 3.24T/m^2$$

##### 3.2 Soil load on cover slab

$$P2 = H3 \times g_s = 1.65 \times 1.8 = 2.97 T/m^2$$

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

$$P11 = 1.9 \times 1.8 \times 0.5 + 0.5 = 2.21T/m^2$$

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

$$\begin{aligned}Pw1 &= (0.55-0) \times 1.8 \times 0.5 = 0.5 \text{ T/m}^2 \\Pw2 &= 2.21 + 0.5 \times 0.8 \times 2.25 + 1.0 \times 2.255 = 5.36 \text{ T/m}^2 \\Pw &= Pw1 + Pw2 = 0.5 \text{ T/m}^2 + 5.36 \text{ T/m}^2 = 5.86 \text{ T/m}^2\end{aligned}$$

### 3.5 Reaction at the bottom slab of culvert

$$Pb = 3.24 + 2.97 + 0.63 + 3.1/3.05 = 7.8 \text{ T/m}^2$$

### 4-Checking pressure to base soil

Total pressure to base soil

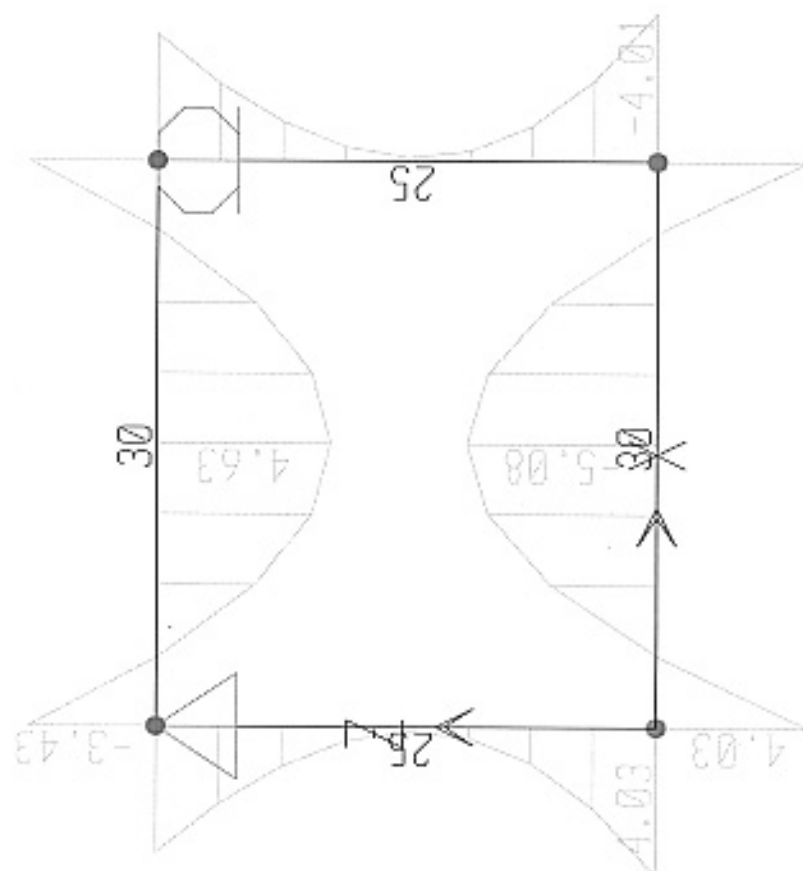
$$Ps = 7.8 + 0.39 \times 2.5 = 8.55 \text{ T/m}^2$$

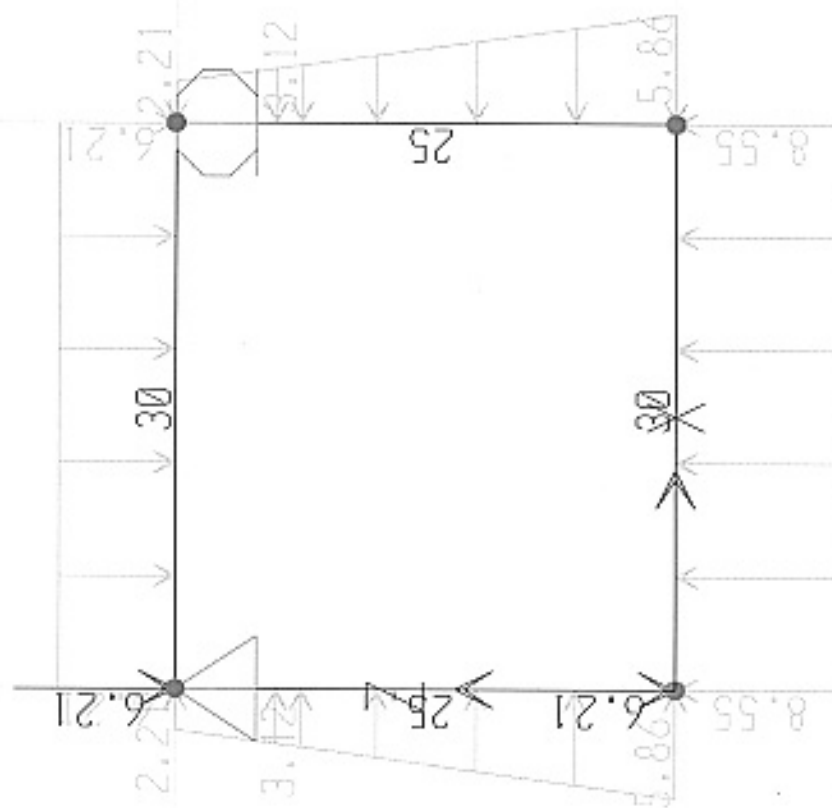
So at the depth of 4.4m strength of base soil must be bigger than  $8.43 \text{ T/m}^2$

### 5-Checking uplift that due to ground water

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

$$\text{Total pressure : } Ps = P_{\text{soil}} + P_{\text{self}} = 2.97 + 0.5 \times 2.5 = 4.22 \text{ T/m}^2 > P_{\text{uplift}} = 2.25 \text{ T/m}^2$$



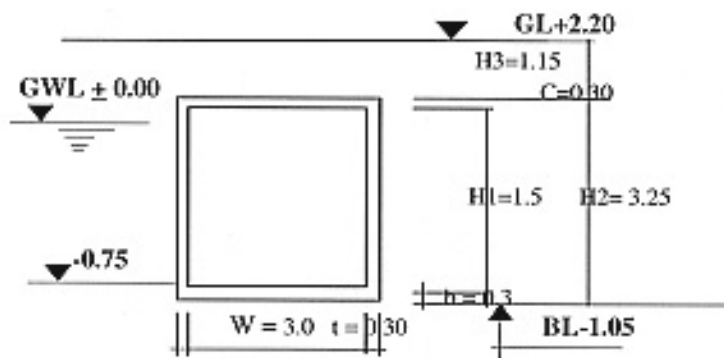


## II- Calculation for culvert H3.000x1.500 (Sewer outlet BN- R9)

(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/cm <sup>3</sup>
	RS=	3.6 kg/cm <sup>3</sup>
Reinforcement type JIS:	Ra=	1600 kg/cm <sup>2</sup>
Back fill sand:	ga= 1.8T/m <sup>3</sup> ;	Coefficient of earth pressure at rest K <sub>0</sub> = 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:

$$Pdc=(1+i)X2P/Wo$$

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

$$Pdc=2x12x(1+0.3)/2.75=11.35$$

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

$$P1=Pdc/W1=11.35/2.5=4.54T/m^2$$

### 3.2 Soil load on cover slab

$$P_2 = H_3 \cdot g_s = 1.15 \cdot 1.8 = 2.07 \text{ T/m}^2$$

### 3.3 Horizontal load from vertical load $P_1 + P_2$ on two side of culvert

$$P_{H1} = 1.15 \times 1.8 \times 0.5 + 0.5 = 1.54 \text{ T/m}^2$$

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

$$P_{w1} = (1.05 - 0) \times 1.8 \times 0.5 = 0.95 \text{ T/m}^2$$

$$P_{w2} = 1.54 + 0.5 \times 0.8 \times 1.05 + 1.0 \times 1.05 = 3.01 \text{ T/m}^2$$

$$P_w = P_{w1} + P_{w2} = 0.95 \text{ T/m}^2 + 3.01 \text{ T/m}^2 = 3.96 \text{ T/m}^2$$

### 3.5 Reaction at the bottom slab of culvert

$$P_b = 4.54 + 2.07 + 0.75 + 2.7/3.6 = 8.11 \text{ T/m}^2$$

### 4-Checking pressure to base soil

Total pressure to base soil

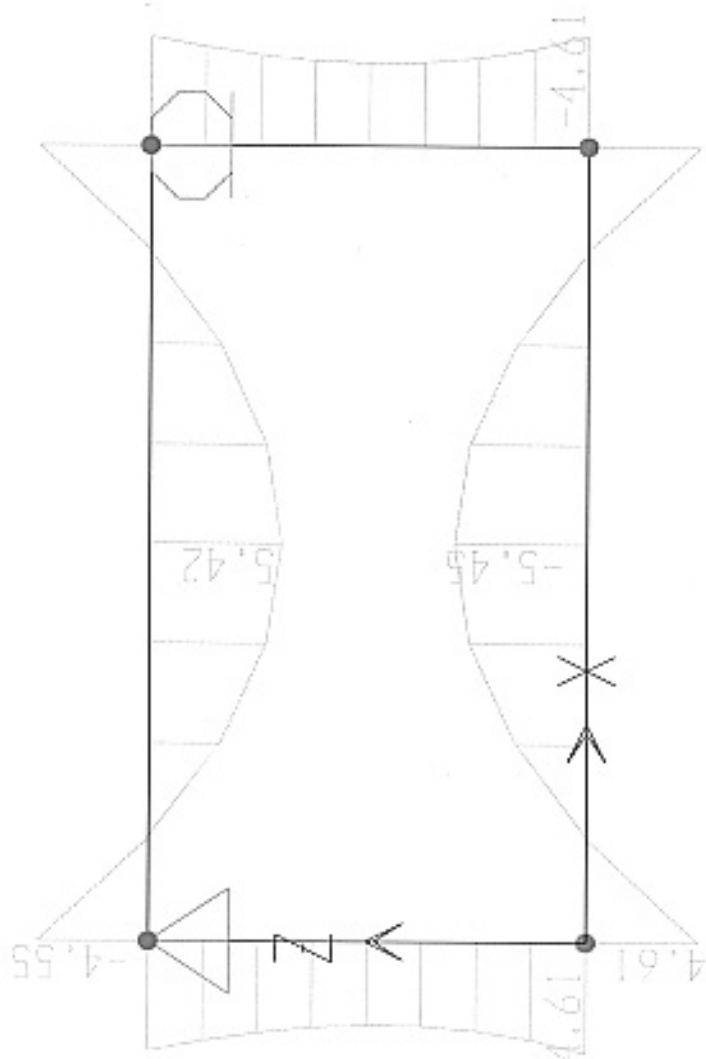
$$P_s = 8.11 \text{ T/m}^2$$

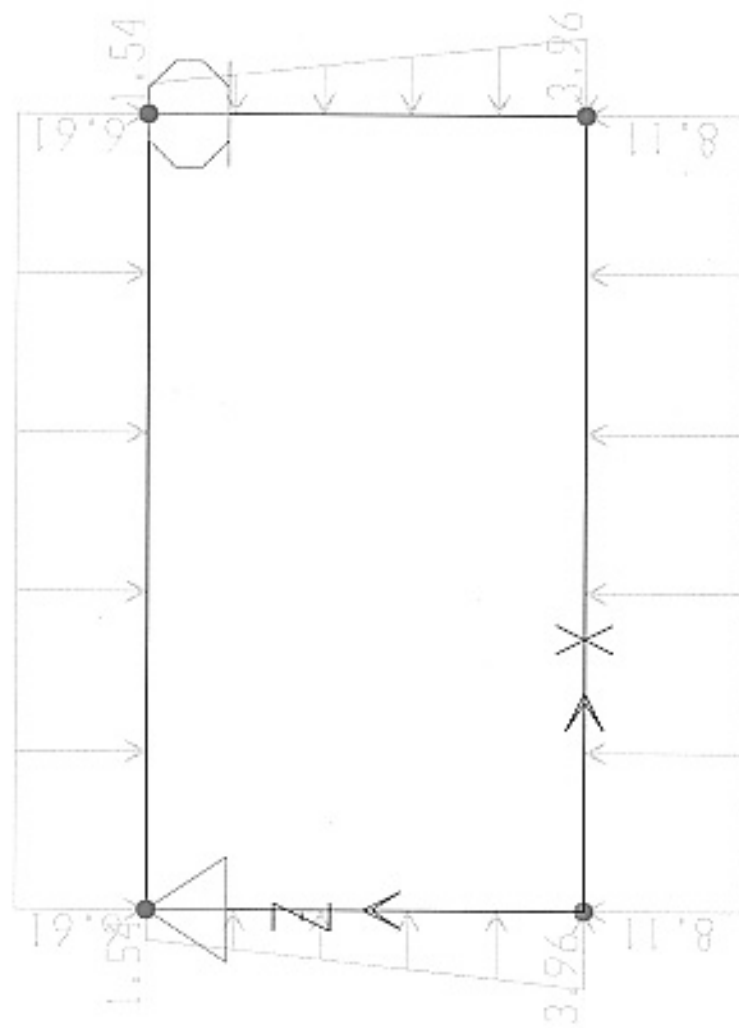
So at the depth of 3.2m strength of base soil must be bigger than  $8.28 \text{ T/m}^2$

### 5-Checking uplift that due to ground water

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

$$\text{Total pressure : } P_s = P_{\text{soil}} + P_{\text{self}} = 2.07 + 0.6 \times 2.5 = 3.57 \text{ T/m}^2 > P_{\text{uplift}} = 1.05 \text{ T/m}^2$$







## Calculation for bar arrangement for typical box culvert

Base on attached results of shell forces analysed 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:

$$F_a = M/\gamma R_n h_o$$

Where:  $\gamma = 0.5 + ((1-2A_o)^{1/2})/2$

NAME OF ELEMENT	Values (T.m)	A <sub>o</sub>	$\gamma$	F <sub>a</sub> (cm <sup>2</sup> )	Bar arrangement	
					$\phi$ (mm)	a(mm)
CULVERT 2800x2400 b=1.00 h=0.25	4.030	0.1439	0.922	13.66	16	125
	4.630	0.1058	0.944	12.26	16	125
	5.080	0.1161	0.938	13.54	16	125
CULVERT 3000x1500 b=1.00 h=0.30	5.420	0.1239	0.934	15.77	16	125
	5.450	0.1246	0.933	15.87	16	125
	4.610	0.1054	0.944	13.27	16	125

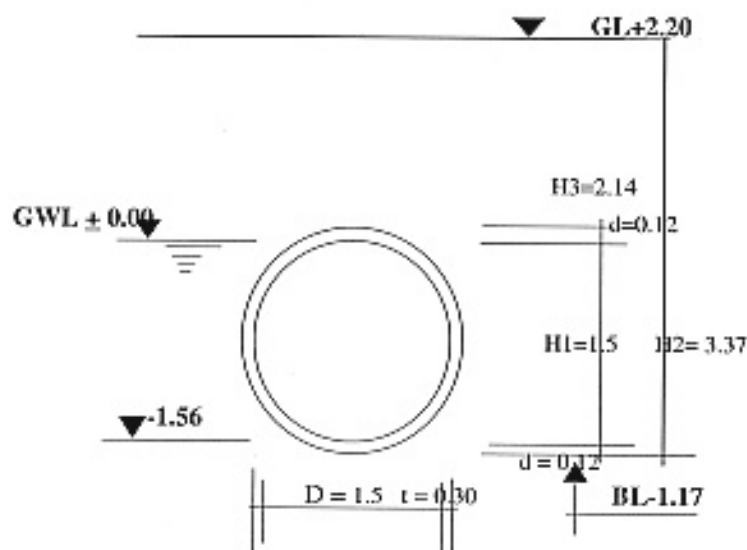
## CALCULATION FOR SEWER PIPE

### 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,	R <sub>n</sub> =	70 kg/cm <sup>2</sup>
	RS=	3.6 kg/cm <sup>2</sup>
Reinforcement type JIS:	R <sub>a</sub> =	1600 kg/cm <sup>2</sup>
Back fill sand:	g <sub>s</sub> = 1.8T/m <sup>3</sup> ; Coefficient of earth pressure at rest K <sub>0</sub> = 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:

$$Pdc=(1+i) \times 2P/Wo$$

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

$$Pdc=2 \times 12 \times (1+0.3)/2.75=11.35$$

$$W1=2h+0.2=2 \times 2.14+0.2=4.48m$$

$$P1 = P_{de}/W1 = 11.35/4.48 = 2.53 \text{ T/m}^2$$

### 3.2 Soil load on cover slab

$$P2 = H3 \cdot g_s = 2.14 \cdot 1.8 = 3.85 \text{ T/m}^2$$

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

$$P_{Ht} = 2.14 \times 1.8 \times 0.5 + 0.5 = 2.43 \text{ T/m}^2$$

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

$$P_w = 2.53 + 0.5 \times 0.8 \times 1.77 + 1.0 \times 1.77 = 5.00 \text{ T/m}^2$$

### 3.5 Reaction at the bottom slab of culvert

$$P_b = 2.53 + 3.85 + (0.12 \times 2.5)/1.5 = 6.58 \text{ T/m}^2$$

### 4-Checking pressure to base soil

Total pressure to base soil

$$P_s = 6.58 + 0.3 \times 2.5 = 7.33 \text{ T/m}^2$$

So at the depth of 3.2m strength of base soil must be bigger than 7.33 T/m<sup>2</sup>

### 5-Checking uplift that due to ground water

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

$$\text{Total pressure : } P_s = P_{\text{soil}} + P_{\text{self}} = 3.85 + 0.2 = 4.05 \text{ T/m}^2 > P_{\text{uplift}} = 1.5 \text{ T/m}^2$$

### 6, Reinforcing area

Maximum moment is calculated by equation

$$M_{\max} = (qr^2/4) - (r^2/48) \times (5p1 + 7p2). \text{ Where}$$

$$q1 = P1 + P2 = 2.53 + 3.85 = 6.38 \text{ T/m}^2$$

$$r = 1.5/2 = 0.75 \text{ m}$$

$$p1 = 5, p2 = 2.43$$

$$M_{\max} = (6.38 \times 0.75^2/4) - (0.75^2/48) \times (5 \times 5 + 7 \times 2.43) = 0.3 \text{ Tm}$$

$$R_o = h_o/(M/R_{ub})^{1/3} = 4.34 \Rightarrow \gamma = 0.975$$

$$F_a = M/\gamma h_o R_a = 2.13 \text{ cm}^2$$

## CALCULATION FOR REVETMENT FROM SLIDING

### 1. Typical cross section

Typical sections having at least one of the following 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  $\phi 80 - \phi 100$ , 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<sup>2</sup>
- Density of penetreted woodenpile is 9 pcs/m<sup>2</sup>
- Density of penetreted woodenpile is 16 pcs/m<sup>2</sup>
- Density of penetreted woodenpile is 25 pcs/m<sup>2</sup>

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

Number of pile (Pcs/m <sup>2</sup> )	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<sup>3</sup>)
- Cohesion  $C_u = 1.5$  (T/m<sup>2</sup>)
- Internal friction angle  $\Phi = 30^\circ$

#### 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  $\gamma_w = 1,461 - 1.7 \text{ g/cm}_3$
- Natural moisture 95%
- Unconfined compressive strength  $q_u = 0,175 \text{ kg/cm}^2$
- Compression index  $C_c = 1,274$
- 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  $\gamma_w = 1,963 \text{ g/cm}_3$
- Natural moisture 20 - 35%
- Unconfined compressive strength  $q_u = 1,202 \text{ kg/cm}^2$
- Compression index  $C_c = 0,181$
- Coefficient of consolidation  $C_v = 6,88 \times 10^{-4}$

**Layer SC: Medium dense, whitish grey, yellowish brown clayey sand**

Main characteristics of OH layer is listed below:

- Wet density  $\gamma_w = 1,98 \text{ g/cm}_3$
- Natural moisture 12 - 25%
- Unconfined compressive strength  $q_u = 0,928 \text{ kg/cm}^2$
- Compression index  $C_c = 0,155$
- Coefficient of consolidation  $C_v = 9,28 \times 10^{-4}$

The depth of layers at each section is shown in fig.25 and fig.2.6

#### 4. Result

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



