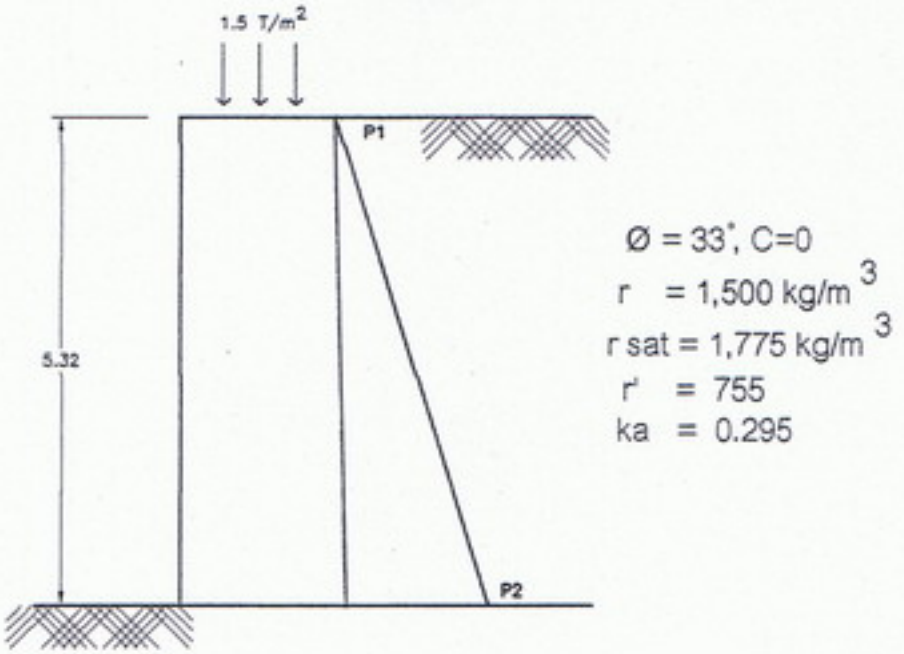
รายการคำนวณ

เขื่อนกันดิน

CASE A



$P_1 = K_a P$

$= 0.295 \times 1{,}500 = 442.50 \text{ kg/m}^2$

$P_2 = P_1 + K_a rh$

$= 442.50 + 0.295\ (1{,}500 \times 4.92)$

$= 2{,}620 \text{ kg/m}^2$

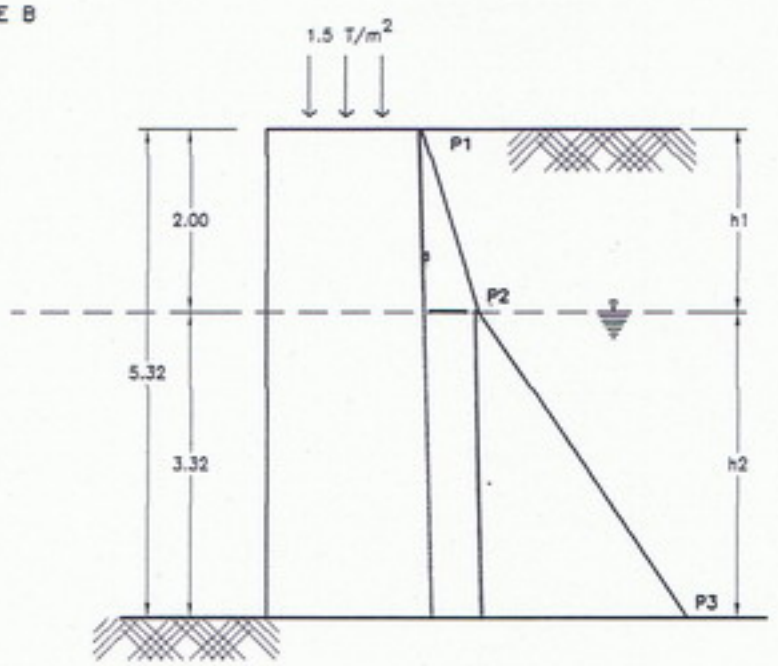
$V_{max} = \frac{1}{2}(442.50 + 2{,}620)\ 5.32$

$= 8{,}147 \text{ kg}$

$M_{max} = 442.50 \times \frac{5.32^2}{2} + \frac{1}{2}(2{,}620 - 442.50)\ \frac{5.32^2}{3}$

$= 16{,}534 \text{ kg} - \text{m}$

CASE B



Ø = 33° , C=0

r = 1,500 kg/m^3

r sat = 1,775 kg/m^3

r' = 755

ka = 0.295

$P_1 = K_aP$

$= 0.295 \times 1{,}500 = 442.50 \text{ kg/m}^2$

$P_2 = P_1 + K_a r h_1$

$= 442.50 + 0.295\,(1{,}500 \times 2)$

$= 1{,}327.50 \text{ kg/m}^2$

$P_3 = P_2 + K_a r' h_2$

$= 1{,}327.50 + 0.295\,(775 \times 3.32)$

$= 2{,}087 \text{ kg/m}^2$

$V_{max} = \frac{1}{2}(442.50 + 1{,}327.50)2 + \frac{1}{2}(1{,}327.50 + 2{,}087)3.32$

$= 7{,}439 \text{ kg}$

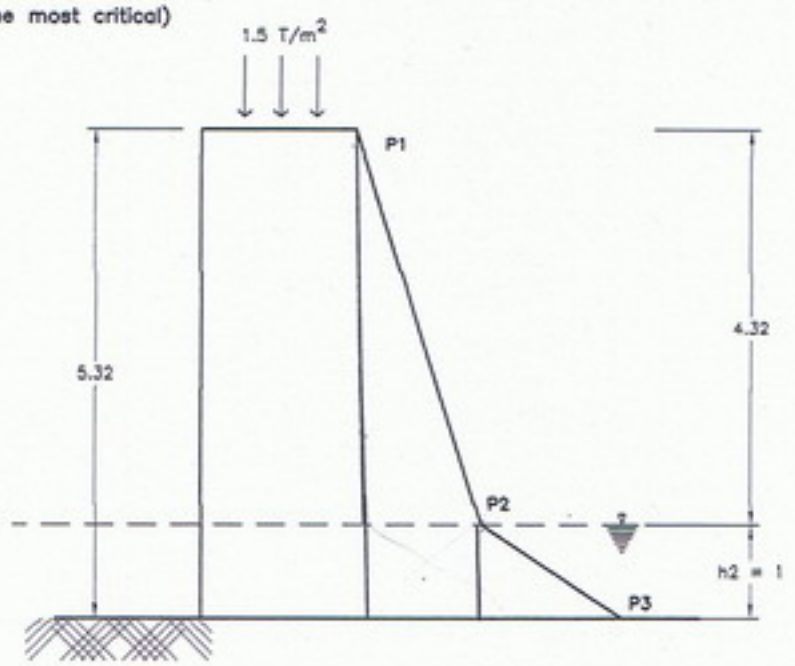
$M_{max} = \left(442.50 \times \frac{5.32^2}{2}\right) + \left(\frac{1}{2}(1{,}327.50 - 442.50) \times 2 \times \left(\frac{2}{3} + 3.32\right)\right.$

$\left. + \left((1{,}327.50 - 442.50) \times \frac{3.32^2}{2}\right) + \left(\frac{1}{2}(2{,}087 - 1{,}327.50) \times 3.32 \times \left(\frac{3.32}{3}\right)\right)\right)$

$= 6{,}261.91 + 3{,}528.20 + 4{,}877.42 + 1{,}395.25$

$= 16{,}063 \text{ kg - m}$

CASE C(The most critical)



Ø = 33°, C=0
r = 1,500 kg/m 3
r sat = 1,775 kg/m 3
r' = 755
ka = 0.295

$P_1 = K_aP$

$= 0.295 \times 1{,}500 = 442.50 \text{ kg/m}^2$

$P_2 = P_1 + K_a r h$

$= 442.50 + 0.295\,(1{,}500 \times 4.32)$

$= 2{,}354 \text{ kg/m}^2$

$P_3 = P_2 + K_a r' h_2 + r_w$

$= 2{,}354 + 0.295\,(775 \times 1) + 1{,}000(1)$

$= 3{,}583 \text{ kg/m}^2$

$V_{max} = \frac{1}{2}(442.50 + 2{,}354)4.32 + \frac{1}{2}(2{,}354 + 3{,}583)1$

$= 9{,}009 \text{ kg}$

$M_{max} = \left(442.50 \times \frac{5.32^2}{2}\right) + \left(\frac{1}{2}(2{,}354 - 442.50)\,4.32 \times \left(\frac{4.32}{3} + 1\right)\right)$

$+ \left((2{,}354 - 442.50) \times 1 \times 0.50\right) + \left(\frac{1}{2}(3{,}583 - 2{,}354) \times 1 \times \frac{1}{3}\right)$

$= 6{,}261.91 + 10{,}074.37 + 995.75 + 204.83$

$= 17{,}500 \text{ kg} - \text{m}$

Case	M_{max} (kg-m)	V_{max} (kg)
A	16,534	8,147
B	16,063	7,439
C	17,500	9,009
USE	17,500	9,009

Design Wall

USE fc' = 200 ksc, fy = 3,000 ksc, R = 14.76

$$d = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{17{,}500x100}{14.76x100}} = 34.43 \text{ cm}$$

USE t = 80 cm ; d = 68 cm

Check Shear

$$V_c = 0.29\sqrt{fc'}\,bd$$

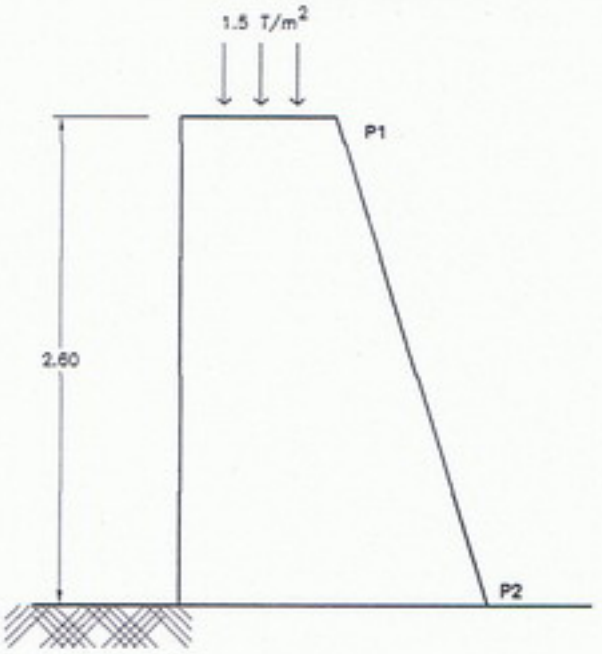
$$= 0.29\sqrt{200}\,(100)(68)$$

$$= 27{,}888 \text{ kg} > V_{max} = 9{,}009$$

$$As_{req} = \frac{M}{fsjd} = \frac{17{,}500x100}{1{,}500x0.878x68} = 19.54 \text{ cm}^2$$

$$As_{min} = \frac{14}{fy}bd = \frac{14}{3{,}000}(100 \times 68) = 31.73 \text{ cm}^2$$

USE ∅ 25 mm. @ 0.15 m. (As = 32.75 cm^2/m.)



At (-2.60 m)

$P_1 = K_a P$

$= 0.295 \times 1{,}500 = 442.50 \text{ kg/m}^2$

$P_{(-2.60)} = P_1 + K_a rh$

$= 442.50 + 0.295\,(1{,}500 \times 2.60)$

$= 1{,}593 \text{ kg/m}^2$

$V_{max} = \frac{1}{2}(442.50 + 1{,}593) \times 2.60$

$= 2{,}647 \text{ kg}$

$M_{max} = 442.50 \times \frac{2.60^2}{2} + \frac{1}{2}(2{,}647 - 1{,}593) \times \frac{2.6^2}{3}$

$= 1{,}495.65 + 1{,}187.51$

$= 2{,}683 \text{ kg} - \text{m}$

$d = \sqrt{\frac{2{,}683 x 100}{14.76 x 100}} = 13.48 \text{ cm}$

USE $t = 40$ cm ; $d = 28$ cm

$As_{req} = \frac{2{,}683 x 100}{1{,}500 x 0.875 x 28} = 7.30 \text{ cm}^2$

$As_{min} = \frac{14}{fy} bd = \frac{14}{3{,}000}(100 \times 28) = 13.07 \text{ cm}^2$

USE ∅ 25 mm. @ 0.30 m. (As = 16.37 cm^2/m.)

<u>เหล็กเสริมแนวนอน</u>

As = $0.002\ bd_{av}$

= $0.002 \times 100 \times 50$

= 10 cm^2/m

- ด้านสัมผัสดิน = $\frac{1}{3}(10)$ = 3.34 cm^2

USE $\varnothing$ 9 mm. @ 0.20 m.

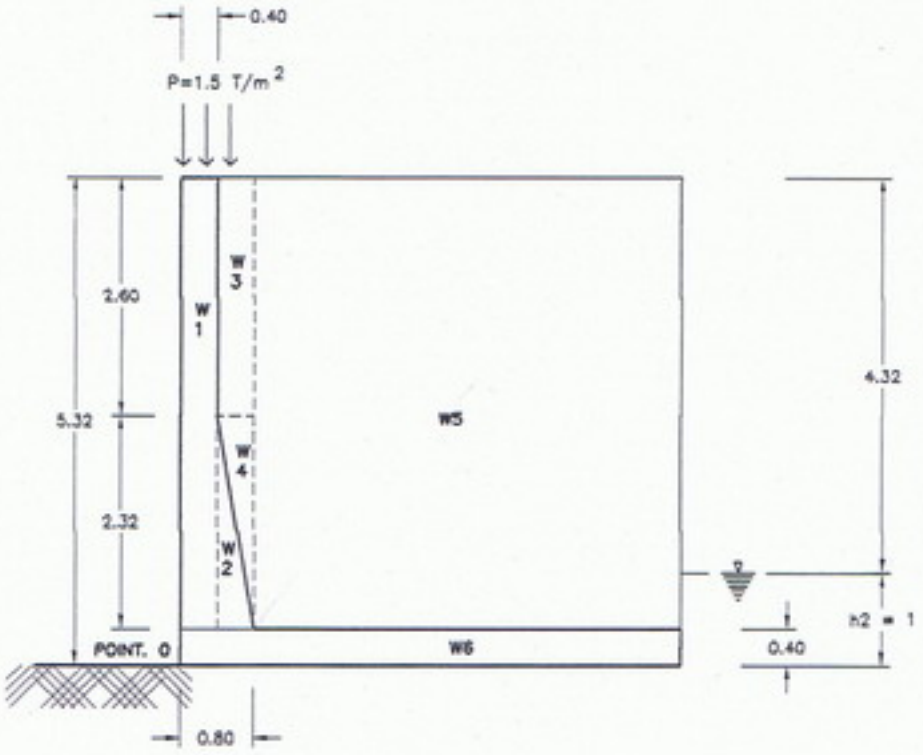
- ด้านไม่สัมผัสดิน = $\frac{2}{3}(10)$ = 6.67 cm^2

USE $\varnothing$ 12 mm. @ 0.15 m.

<u>เหล็กเสริมแนวตั้ง</u>

As = $\frac{2}{3}(0.0015)(100)(50)$ = 5 cm^2

USE $\varnothing$ 12 mm. @ 0.225 m.



W_1 = (0.40 x 4.92 x 1 x 2,400) = 4,723.20 kg/m

X_1 = 0.20 m.

W_2 = $(\frac{1}{2} \times 0.40 \times 2.32 \times 1 \times 2{,}400)$ = 1,113.60 kg/m

X_2 = $(0.40 + \frac{0.40}{3})$ = 0.53 m.

W_3 = (0.40 x 2.60 x 1 x 1,500) = 1,560 kg/m

X_3 = 0.60 m.

W_4 = $(\frac{1}{2} \times 0.40 \times 2.32 \times 1 \times 2{,}400)$ = 696 kg/m

X_4 = $(\frac{2}{3} \times 0.40) + 0.40$ = 0.67 m.

W_5 = (10.70 x 4.32 x 1 x 1,500 + 0.60 x 10.70 x 1 x 1,775) = 80,731.50 kg/m

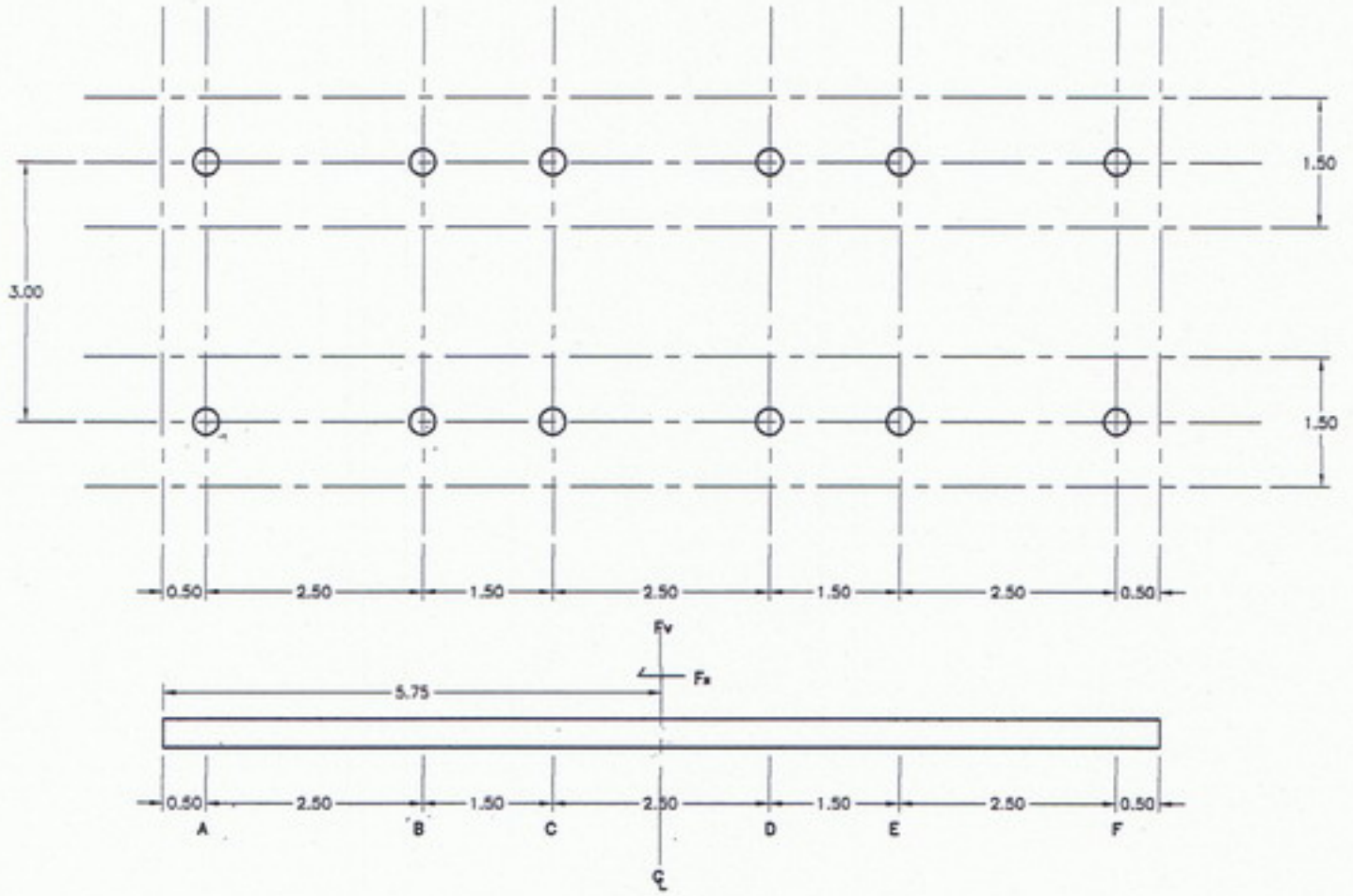
X_5 = 6.15 m.

W_6 = (0.40 x 11.50 x 1 x 2,400) = 11,040 kg/m

X_6 = 5.75 m.

W_7 = 1,500 kg/m

X_7 = 5.75 m.



F_H = 11.359 T/m

F_V = 101.37 T/m

e = 5.75 – 5.638 = 0.112 m.

$$Q = \frac{v}{n} + \frac{(v)(e)(x)}{\sum(\bar{x})^2}$$

At A, Q_A = $$\left[\frac{101.37}{6} + \frac{(101.37x0.112x5.25)}{(5.25^2 x2 + 2.75^2 x2 + 1.25^2 x2)}\right] x3$$

= 53.12 tons.

At F, Q_F = $$\left[\frac{101.37}{6} + \frac{(101.37x0.112x(-5.25))}{(5.25^2 x2 + 2.75^2 x2 + 1.25^2 x2)}\right] x3$$

= 48.25 tons.

Check Horizontal Force

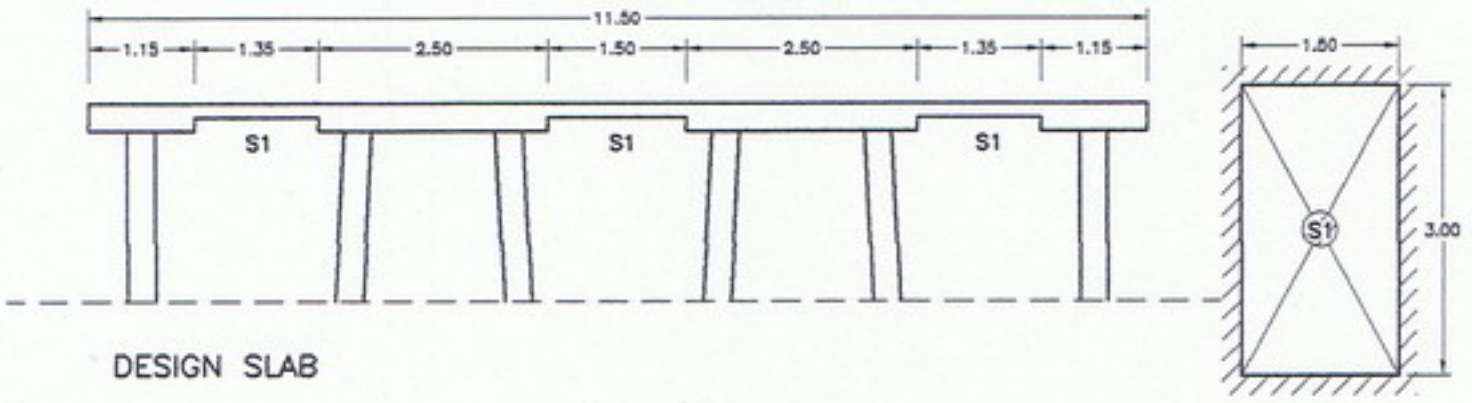
F_H = 11.359 x 3 = 34.10 tons.

เสาเข็มตำแหน่ง B, C, D, E รับแรงแนวนอน

ตอกเสาเข็มเอียง 1 : 4 ($Q_F + Q_B$ = 60 T/P USE F.S. = 2)

$$R_H = 60\left(\frac{1}{4.123}\right) x 4 = 58.21 \text{ tons} > F_H$$

Design Slab



DESIGN SLAB

LL = [(4.92 x 1,500) + (1,500)] x 1 = 8,800 kg-m.

DL = 0.40 x 2,400 x 1 = 960 kg-m.

W = 960 + 8,880 = 9,840 kg-m.

$M_{max} = \frac{1}{8} wl^2 = \frac{1}{8}(9,840)(1.35^2) = 2,242$ kg-m.

$d = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{(2,242)(100)}{14.76x100}} = 12.32$ cm.

USE d = 30 cm ; t = 40 cm.

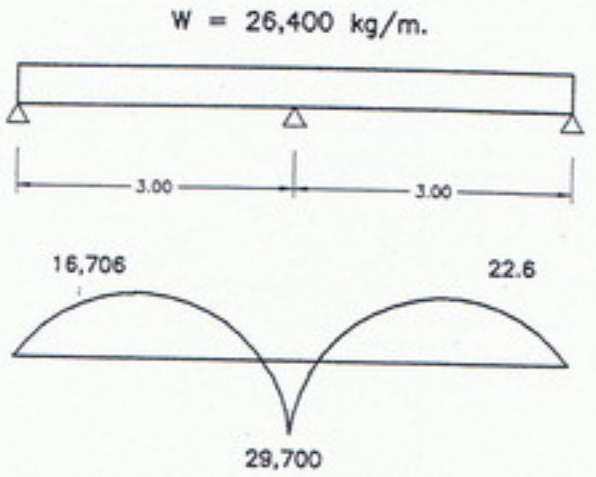
$As = \frac{M}{fjd} = \frac{(2,242)(100)}{1,500x0.875x30} = 5.69$ cm^2

USE ∅ 9 mm. @ 0.125 m. (2 ชั้น)

As^t = 0.0025 x 100 x 30 = 7.5 cm^2

USE ∅ 9 mm. @ 0.10 m. (2 ชั้น)

DESIGN CAB BEAM 2.5 m.



BMD (UNIT IN T-M)

W = (4.92 x 1,500) + (1,500) + (0.70 x 2,400) x 2.50 = 26,400 kg/m.

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BEAM # CAP BEAM
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>SPAN 1  -  section 2.5 x .7  ,  L= 3 m.
 ----
  w(for MOMENT)= 26400  kg/m  :  w(for SHEAR)= 26400  kg/m
     ML = 0  kgm  /  As = 0  sq.cm.
     MR = 29700  kgm  /  As = 34.8  sq.cm.
     VL = 29700  kg. : VR = 49500  kg. /  STIR.#6mm.@ .35
     M+ = 16706  kgm  /  As = 19.58  sq.cm.
       at 1.13  m. from left support
     R 1  = 29700  kg.
>SPAN 2  -  section 2.5 x .7  ,  L= 3 m.
 ----
  w(for MOMENT)= 26400  kg/m  :  w(for SHEAR)= 26400  kg/m
     ML =-29700  kgm  /  As = 34.8  sq.cm.
     MR = 0  kgm  /  As = 0  sq.cm.
     VL = 49500  kg. : VR = 29700  kg. /  STIR.#6mm.@ .35
     M+ = 16706  kgm  /  As = 19.58  sq.cm.
       at 1.88  m. from left support
     R 2  = 99000  kg.
     R 3  = 29700  kg.
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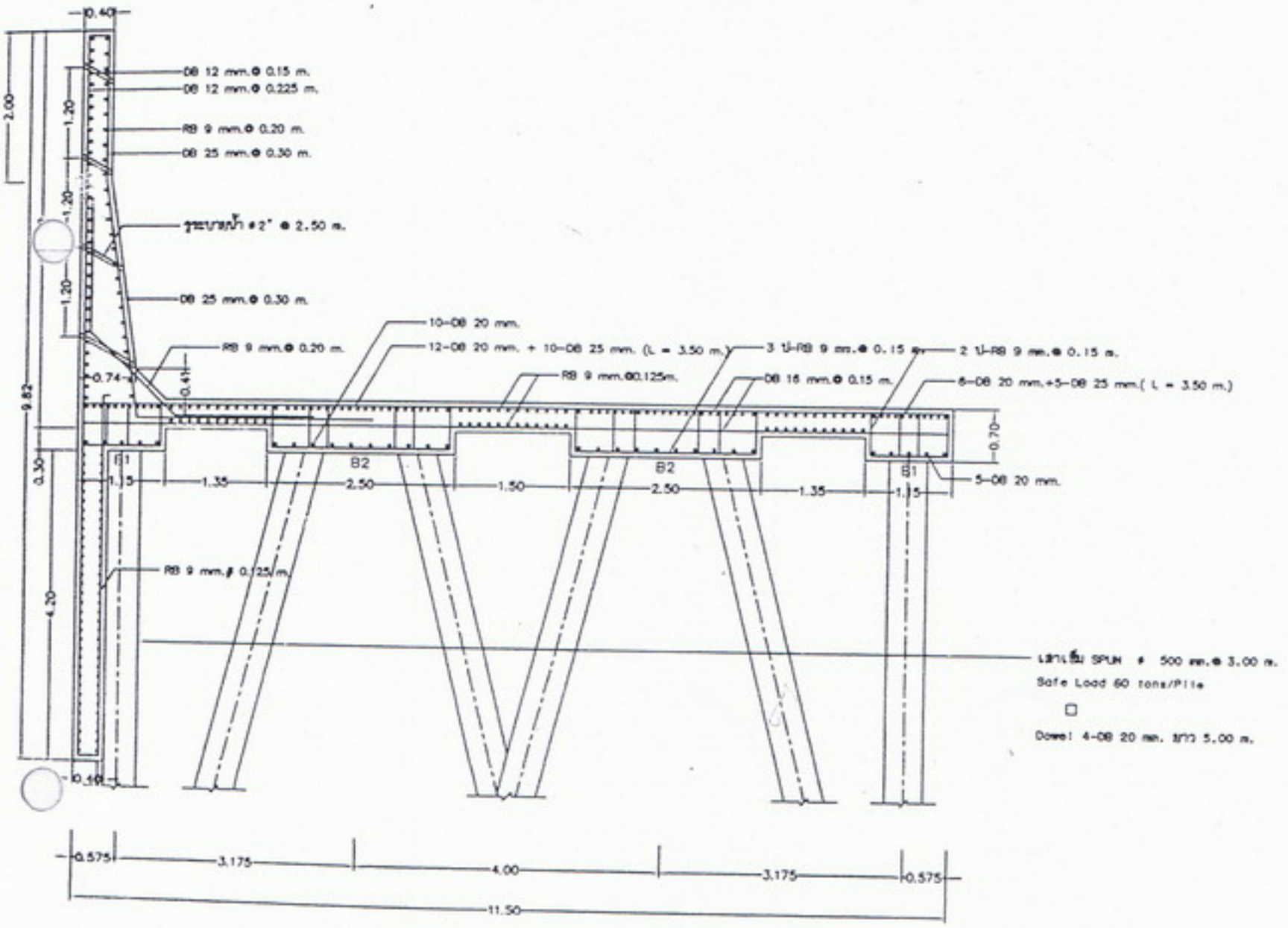
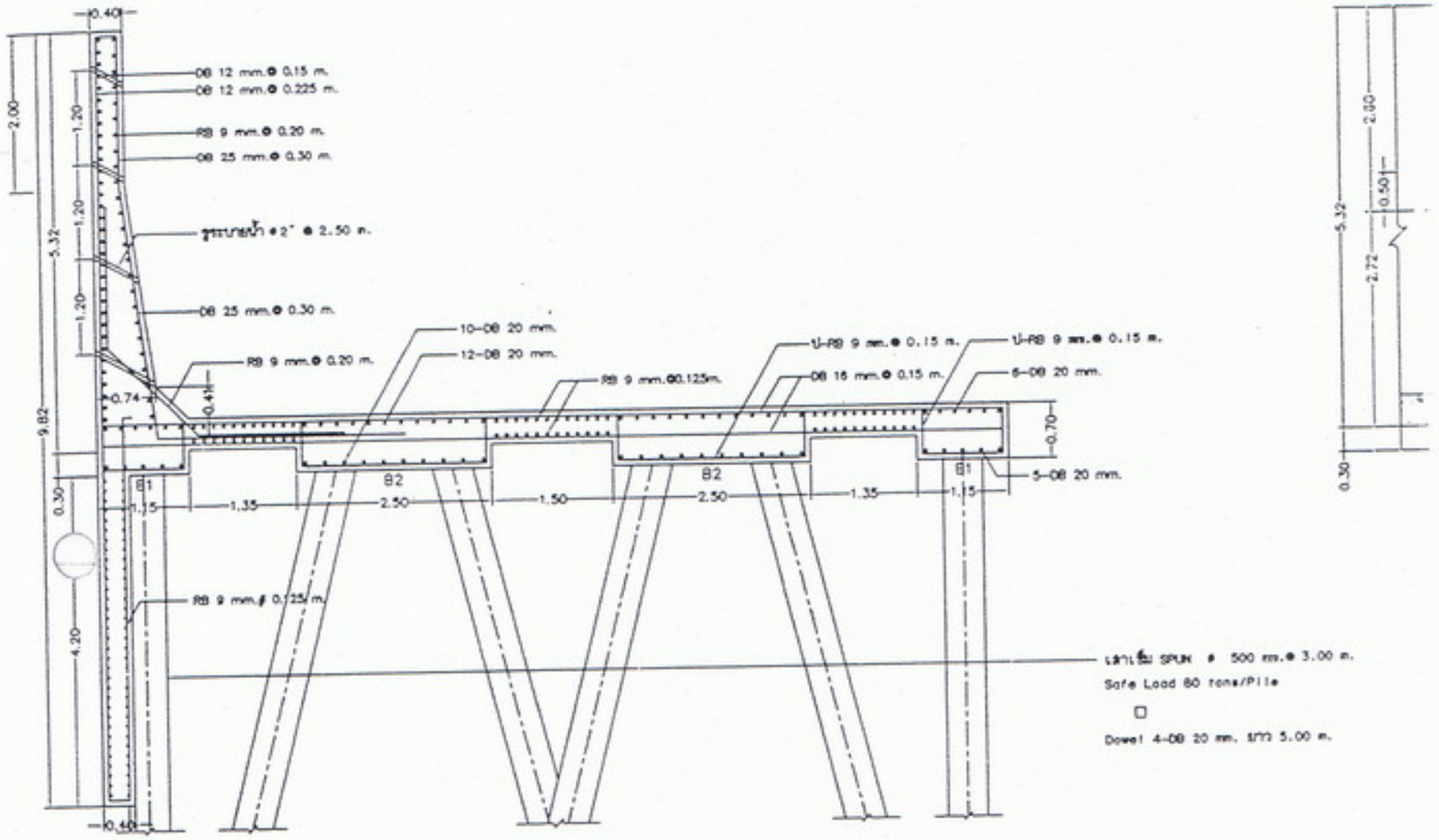


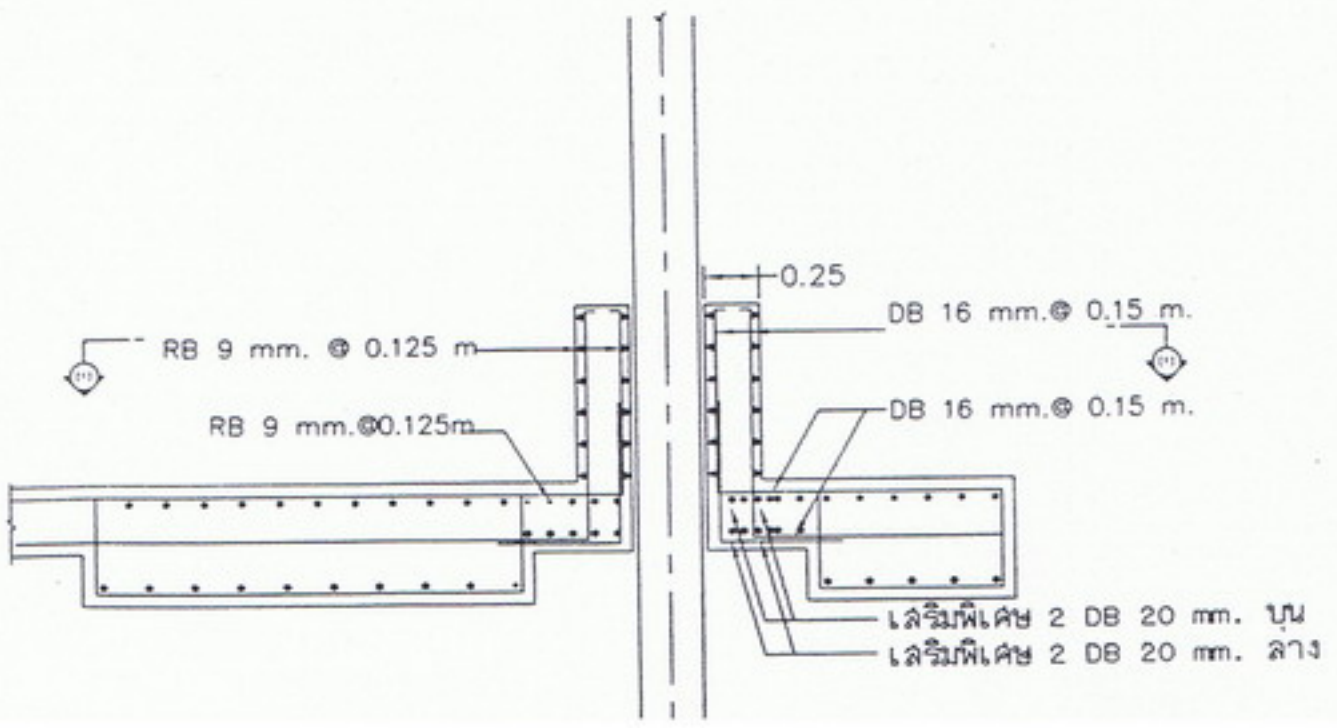
Section A - A

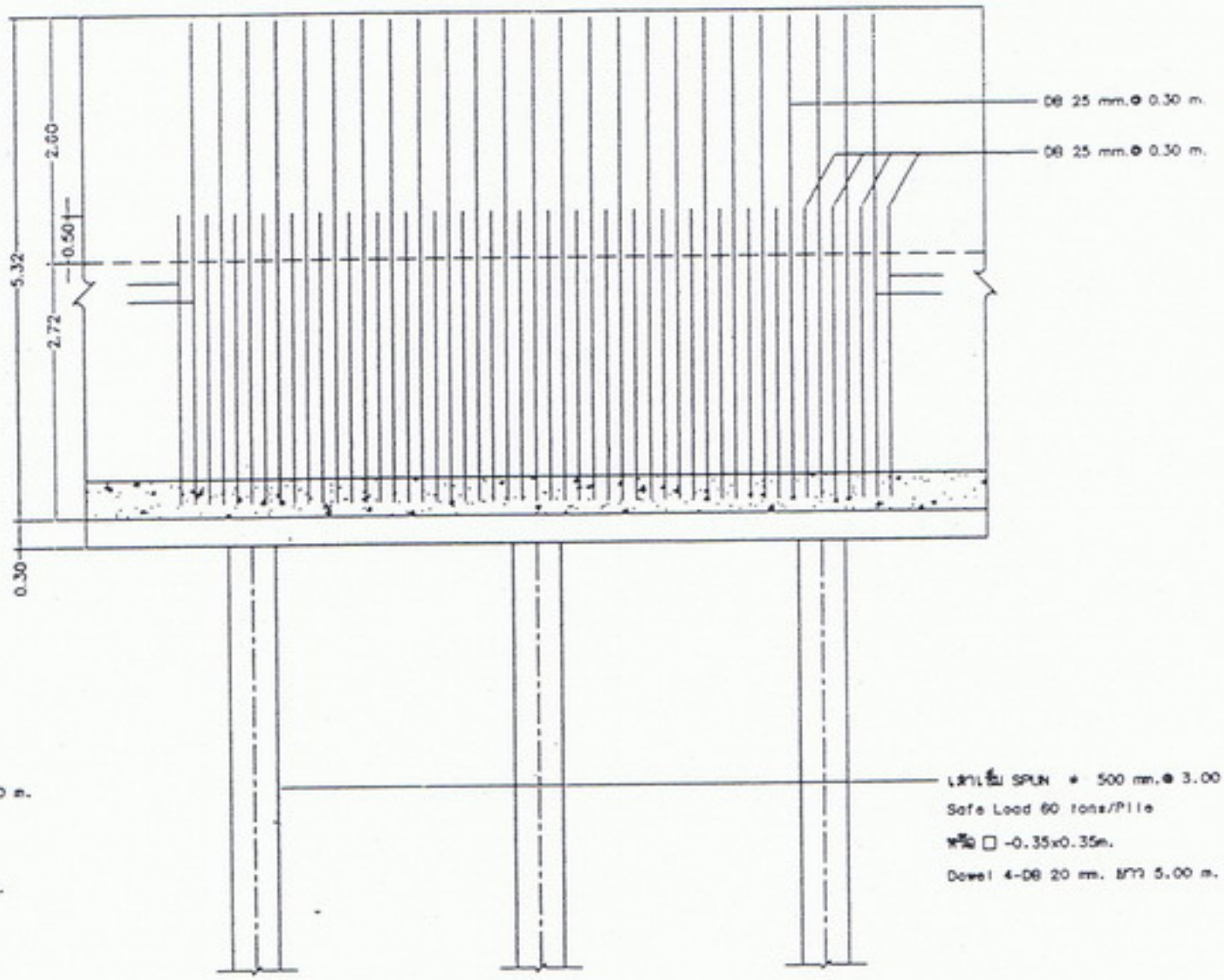
Scale 1 : 100



Typical Section

Scale 1 : 100





mm.@ 0.15 m.

mm.

ø 20 mm.

เสาเข็ม SPUN ø 500 mm.@ 3.00 m.

Safe Load 60 tons/Pile

□

Dowel 4-DB 20 mm. ยาว 5.00 m.

แบบขยายรูปตัดตามยาวเขื่อนกันดิน

Scale 1 : 100

14.