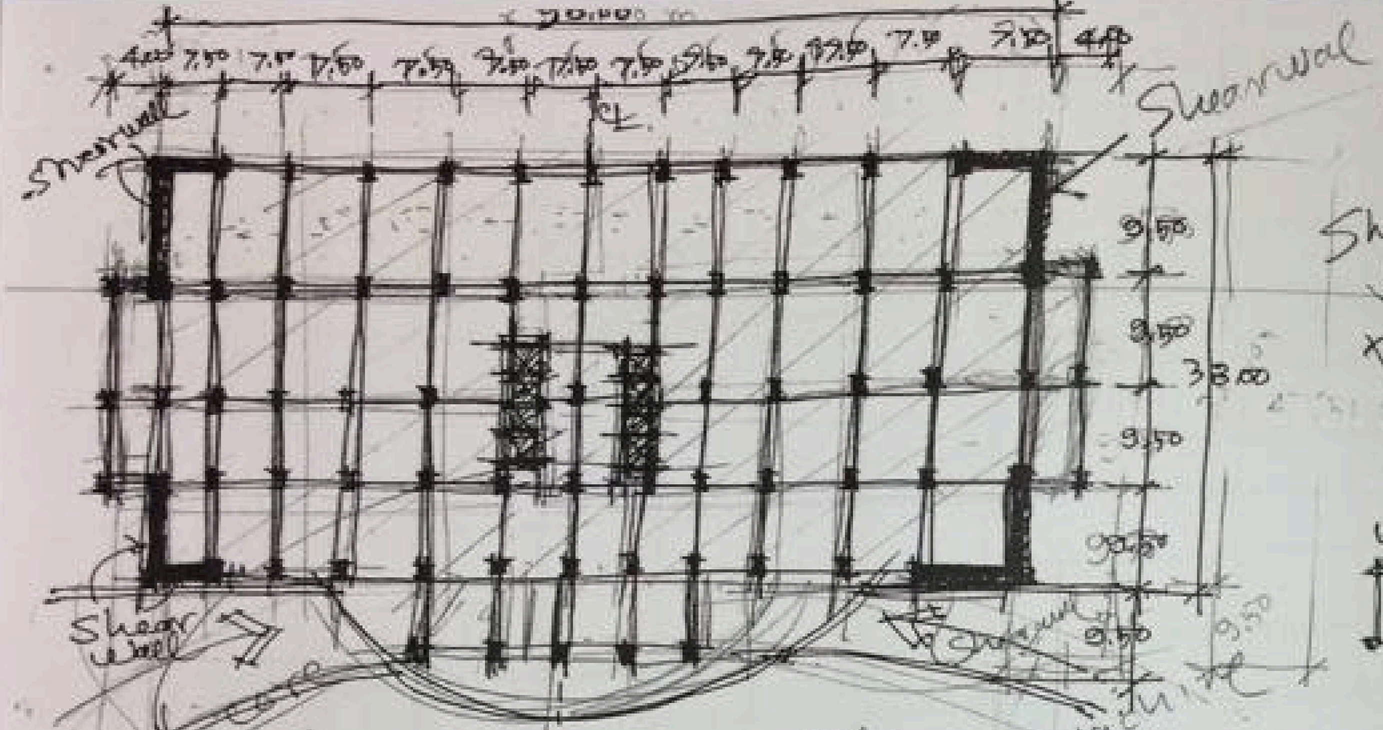
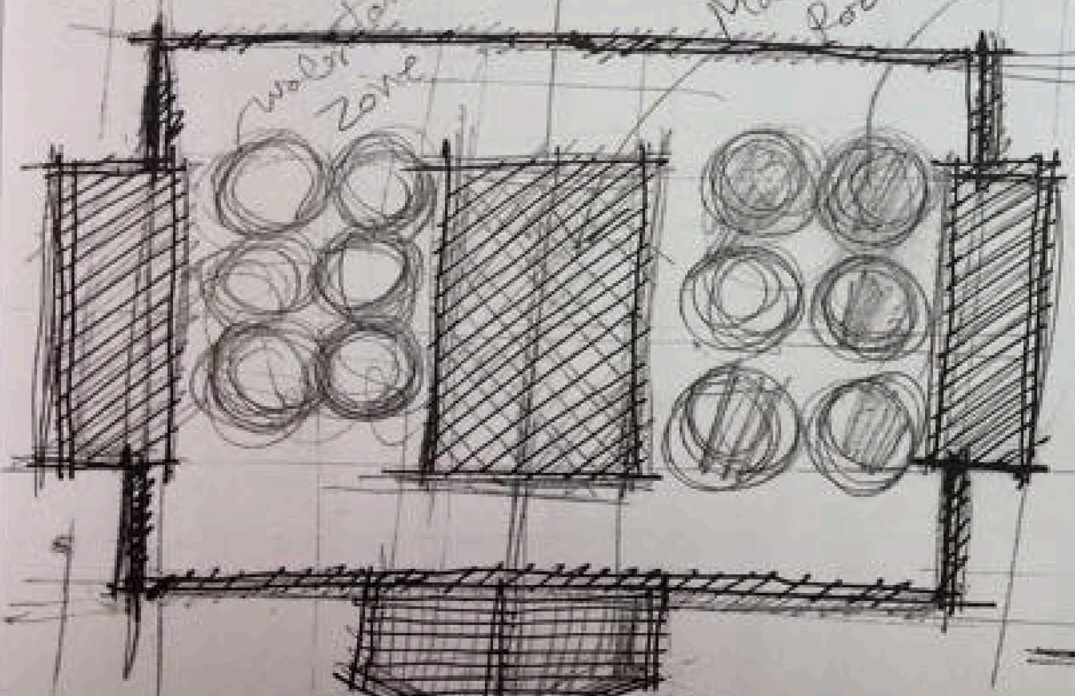
รายการคำนวณอาคารคอนโดมิเนียม 23 ชั้น

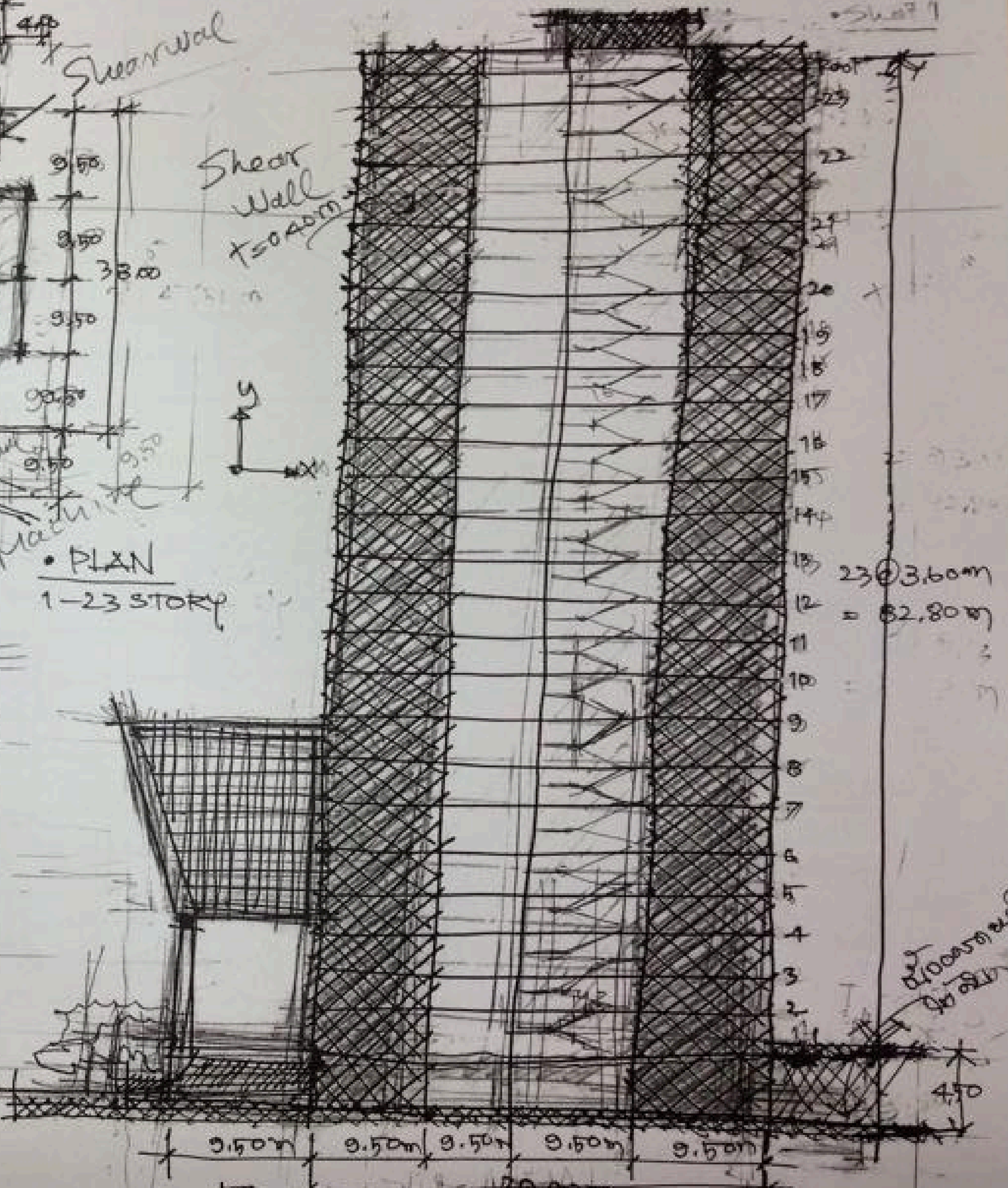
รวมลานจอดรถใต้ดิน



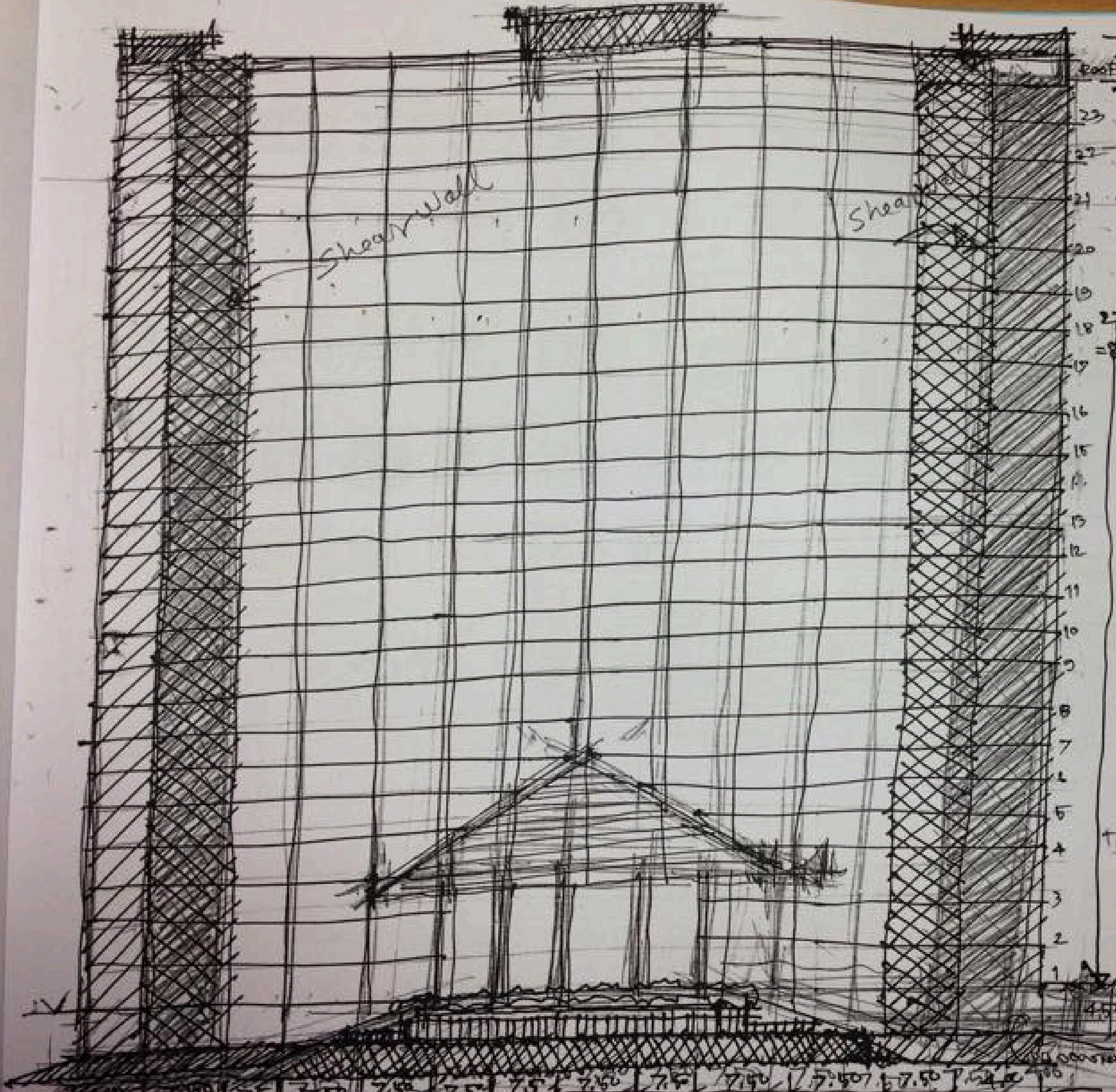
• PLAN
1–23 STORY



• ROOF PLAN



• SIDEVIEW



• Sheet 2

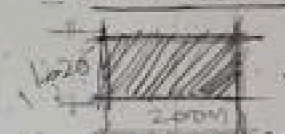
• อาคารคอนโดมิเนียม สูง 23 ชั้น
ชั้นใต้ดิน จอดรถยนต์ 1 ชั้น

• Design Project
ระบบพื้น flat slab with drop panel

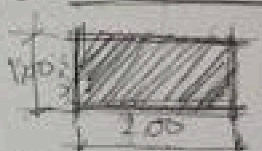
• แรงลมที่กระทำ
– กฎกระทรวง, ผลจ.
– UBC

• ขนาดเสา (column size)

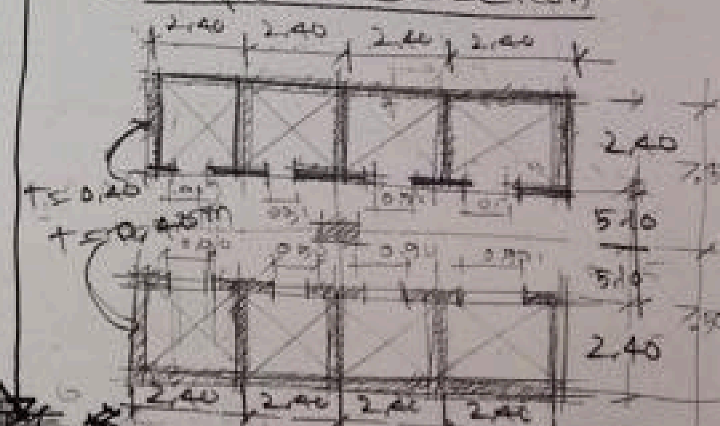
(1) ชั้นล่าง, ชั้นจอดรถใต้ดิน – ชั้นที่ 12



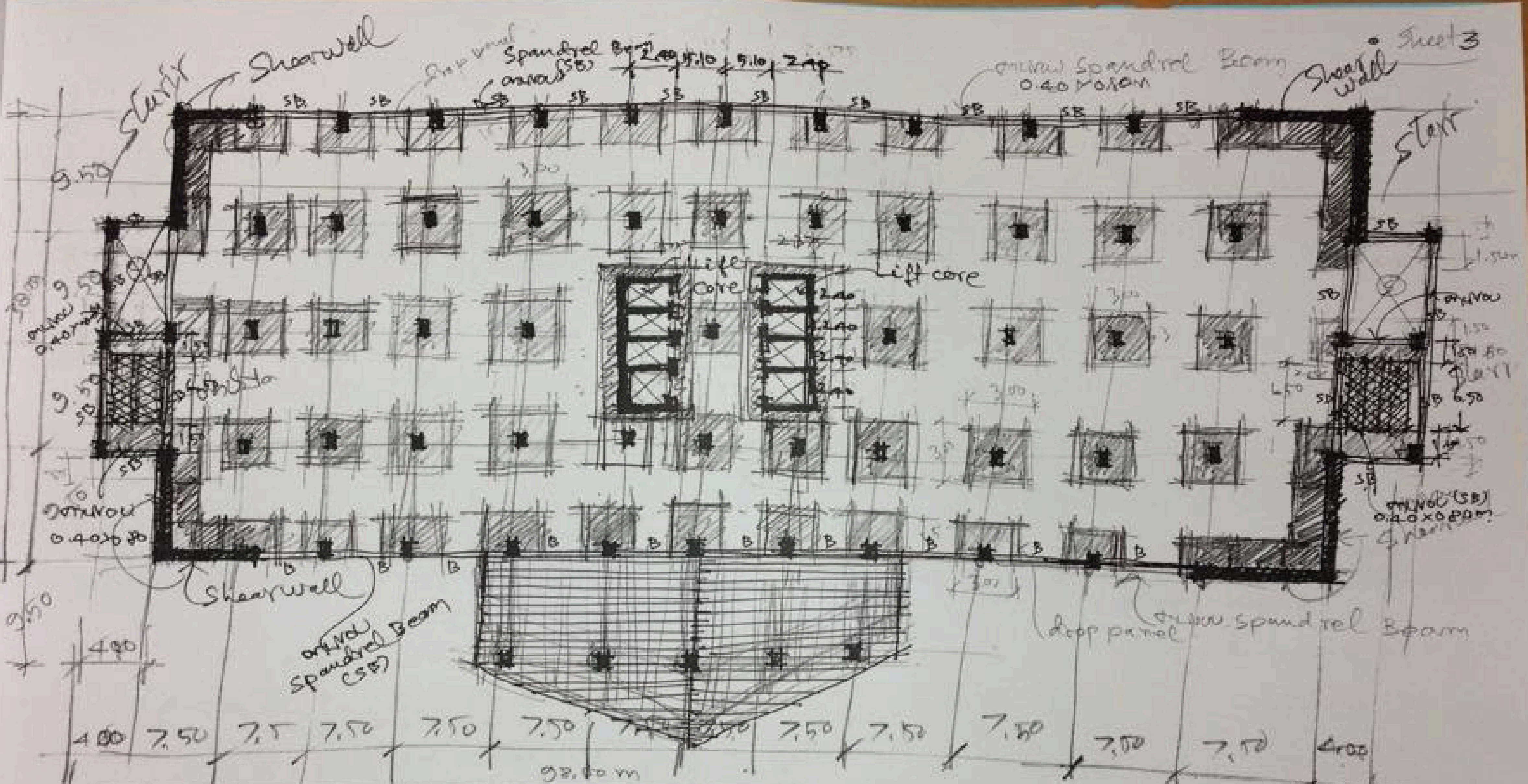
(2) ชั้นที่ (13) – หลังคา (ROOF)



(3). Lift core section



• FRONT ELEVATION



(38 × 98.00) + 2(1.5×4) = 3876 m²/ชั้น

• $T_{min} = \frac{L}{30} = \frac{9.5}{30} = 0.316 \approx 0.30$ m

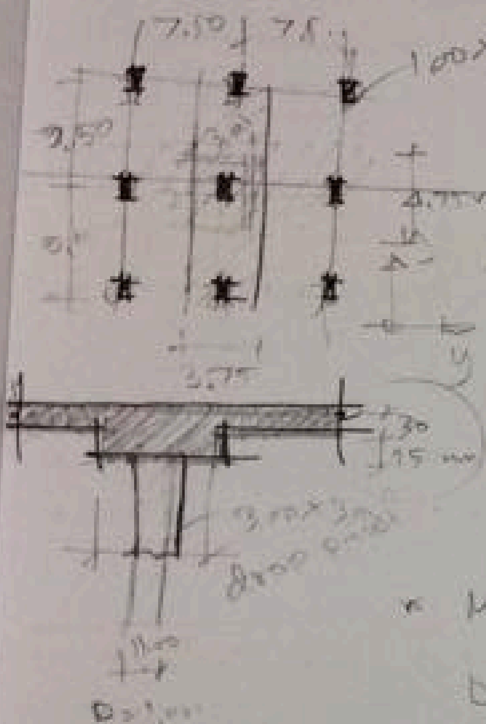
• Structural System Story 23 ชั้น 1 ชั้นใต้ดิน

1. Flat slab with drop panel
2. Shearwall Resisting wind load
3. Mat foundation or pile
   - เสาเข็ม Ø 1.00 m × 40.00 m Safe 400 T/ต้น
   - เสาเข็มเจาะแบบแห้ง Ø 1.00 × 30.00 m Safe load = 300 T/ต้น

• DROP PANEL PLAN

(Lift core), Stair & Spandrel Beam, Shearwall

• Step Design Slab



$f'_c = 280$ Ksc, $f_c = 126$ Ksc
$f_s = 1700$ Ksc, $P = 0.00139$
$K = 0.375$, $j = 0.875$, $R = 20.70$

$T_{min} = \frac{L}{36} = \frac{9.5}{36} = 0.263$ m

use t → 0.30 m

Load of Slab
DL = 0.30×2400 = 720 kg/m²
LL Live load = 250 kg/m²
FL Finishes = 50 kg/m²
walls = 140
Ceiling + Sanitary = 30 kg/m²
Total load = 1200 kg/m²

• $M_o = \frac{WL}{10}\left(L - \frac{2}{3}(D)\right)^2$ → y-y axis

D = 1.00 m, W = 1200 kg/m²

$D = \frac{L}{5} = \frac{9.5}{5} = 1.90$ m

$M_o = \frac{(1200)(9.50)}{10}\left[9.5 - \frac{2}{3}(1)\right]^2$ (8.833)

= 88944.953 kg-m

• Column Strip
⊖M = (0.50)(88944.953)
= 44472.476 kg-m
⊕M = (0.20)(88944.953)
= 17788.991 kg-m

• Middle Strip
⊖M = (0.15)(88944.953)
= 13341.742 kg-m

⊕M = (0.15)(88944.953)
= 13341.742 kg-m

$d_{min} = \sqrt{\frac{(44472.476)(100)}{(20.70)(375)}} = \sqrt{572.914}$; Slab t

= 23.90 cm

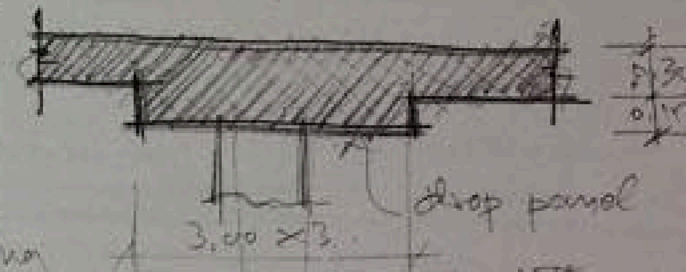
Try t = 30 cm ⇒ $d = 30 - 2.5 - \frac{1.6}{2} = 26.70$ cm > 23.90 cm

• Depth of Drop

$d_{max} = \sqrt{\frac{(44472.476)(100)}{(20.70)(300)}} = \sqrt{716.143}$

= 26.76 cm

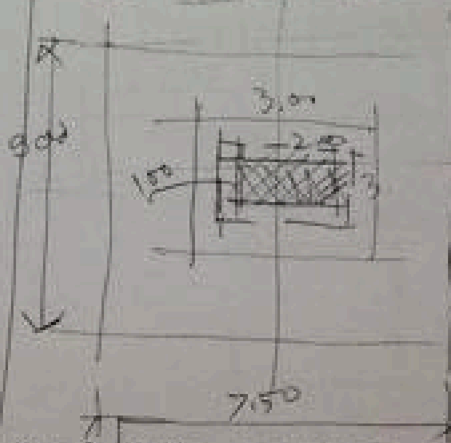
$T = 26.76 + 2.5 + \frac{1.6}{2} = 30$ cm →
= 25% — 30 → Thickness of Slab
37.5 — 0.45 m
(1.20 m — 1.05 m)



1080 + 0.45
480
1560 kg/m²
450
360

• Check punching Shear

① Critical Section in drop



$d = 45 - 2.5 - 1.6/2 = 41.70$ cm
$b_o = (2)(241.70) + 2(141.70)$
= 483.40 + 283.40
= 766.80 cm

$V = (7.50)(9.50)(1.20) + (3)(3)(0.840) - (2.267)(1.267)(1.56)$

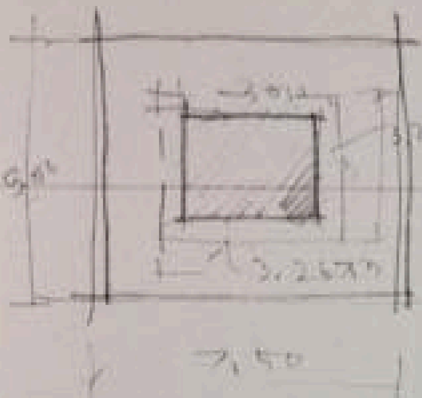
$T = 85.50 + 7.56 - 4.48 = 88.58$ T

$V_c = 0.53\sqrt{280} = 8.868$ Ksc.

$V_C = \frac{(88.50)(1000)}{(766.80)(41.70)} = 2.770$ Ksc
< 8.868 ok

Sheet 5

(b) Critical Section for Slab



$d = 26.70$ cm ✓

$b_o = (4)(326.7) = 1306.80$ cm

Load (V) = $[(7.50)(8.50) - 3.267^2] \times 1.2004$ t

$= 72.692$ t

$V_C = \dfrac{72.692 \times (1000)}{(1306.80)(26.70)}$

$= 2.083$ ksc $(< 8.68$ ksc$)$

Reinforcement

Column strip

(−) $A_S = \dfrac{(44472.476)(100)}{(1700)(0.875)(41.70)}$

$= 71.696$ cm²

– Steel per metre width $= \dfrac{71.696}{3.75} = 19.118$ cm²

– Spacing of 16 mm diameter Bar $= \dfrac{2.01 \times 100}{19.118} = 10.51$ cm

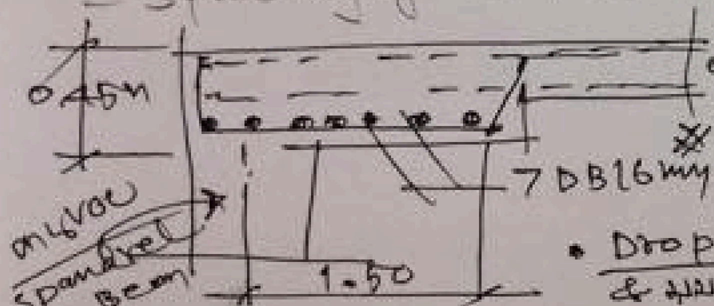
(+) $A_S = \dfrac{(17788.991)(100)}{(1700)(0.875)(26.70)}$

$= 44.79$ cm²

– Steel per metre width $= \dfrac{44.79}{3.75}$ cm

$= 11.944$ cm²

– Spacing of 16 mm diameter Bar $= \dfrac{(2.01)(100)}{11.944} = 16.82$ cm



• Drop panel ([illegible])

Middle Strip

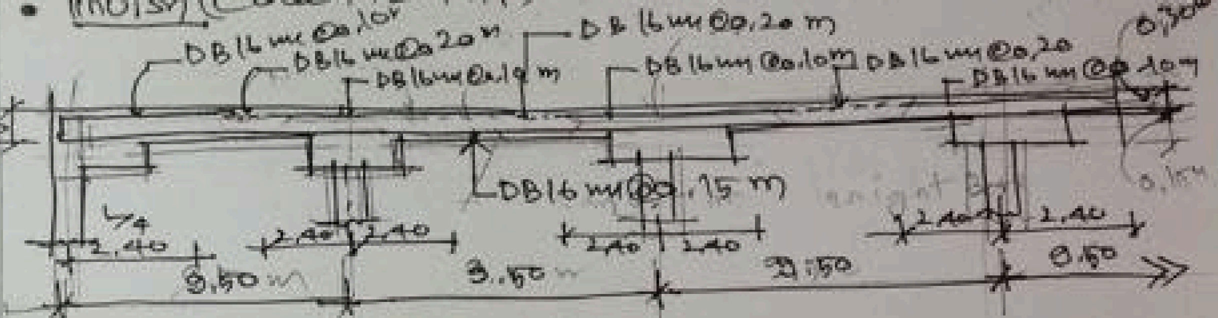
(+) $A_S = \dfrac{(13341.742)(100)}{(1700)(0.875)(26.70)} = 33.592$ cm²

Steel/metre $= 33.592 = 8.958$ cm²/m

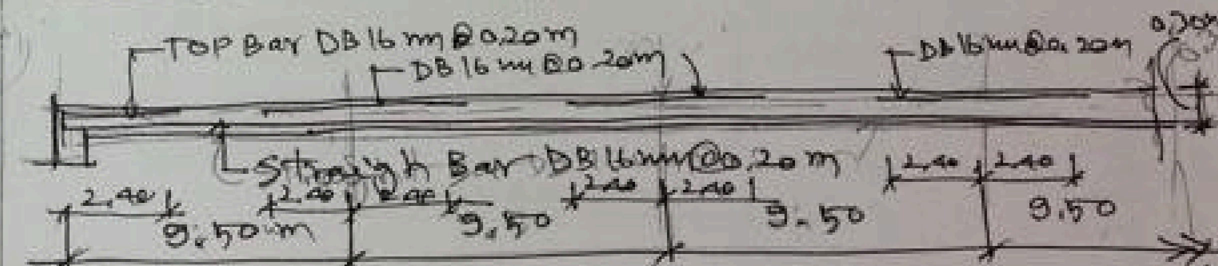
Spacing DB16 mm $= \dfrac{2.01 \times (2.01)(100)}{8.958} = 22.44$ cm

Detail of flat slab (y-y Axis)

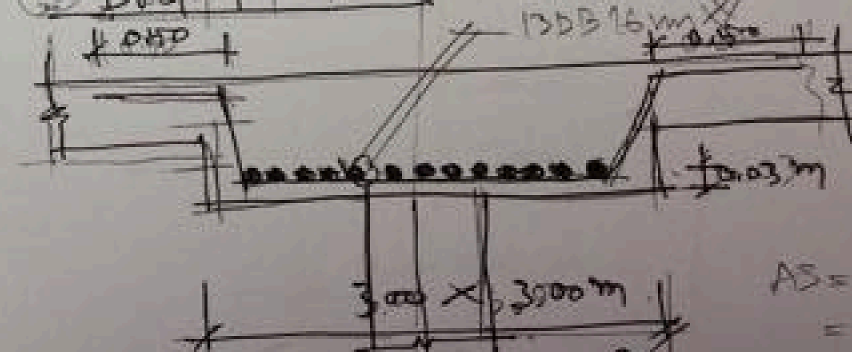
• [illegible] (Column Strip)



• [illegible] (Middle Strip)



• Drop panel (3.00 × 3.00 × 0.45 m)



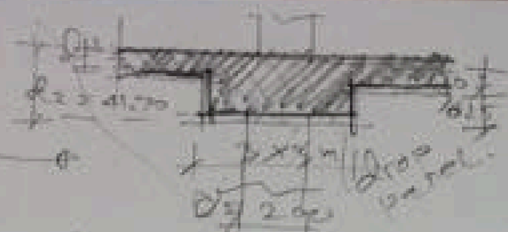
$A_S = (0.0018)(300)(45)$

$= 24.30$ cm²

13 DB16 mm

(Spacing DB16 mm $= \dfrac{300}{12} = 25$ cm)

• X-X Axis calculation



$$M_o = \frac{WL}{10}\left(L - \frac{2}{3}D\right)^2$$

D = 2.00 m, L = 7.50 m, W = 1200 kg/m

$$\therefore M_o = \frac{(1200)(7.50)}{10}\left[7.50 - \frac{2(2)}{3}\right]^2$$

$d_1 = 26.70$ cm
$d_2 = 41.70$ cm

= 34225 kg-m

• column strip (−) M = (0.50)(34225) = 17112.50 kg-m

(+) M = (0.20)(34225) = 6845 kg-m

• Middle strip (+) M = (0.15)(34225) = 5133.75 kg-m

$$d\text{-max} = \sqrt{\frac{(17112.50)(100)}{(20.70)(475)}} = \sqrt{174.04} = 13.19 \text{ cm}$$

< 26.7 cm

∴ t = 30 cm ok

• Reinforcement

• Column strip (−) $AS = \frac{(17112.50)(100)}{(1700)(0.875)(41.70)} = 27.72$ cm²

– steel/metre = $\frac{27.72}{4.75}$ = 5.835 cm²/m

– spacing DB16mm = $\frac{2.01 \times 100}{5.835}$ = 34.45 cm → 30 cm

(+) $AS = \frac{(6845)(100)}{(1700)(0.875)(26.70)} = 17.234$ cm²

– steel/metre = $\frac{17.234}{4.75}$ = 3.628 cm²

– spacing DB16mm = $\frac{2.01 \times 100}{3.628}$ = 55.40 cm → 30 cm

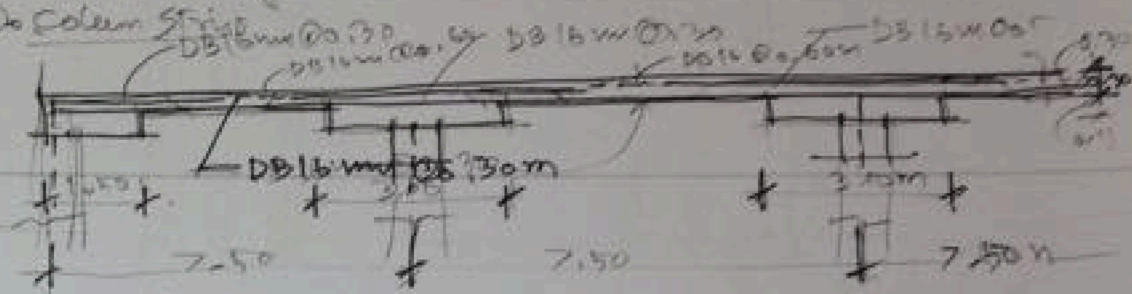
• Middle strip (+) $AS = \frac{(5133.75)(100)}{(1700)(0.875)(26.70)} = 12.926$ cm²

– steel/metre = $\frac{12.926}{4.75}$ = 2.721 cm²/m

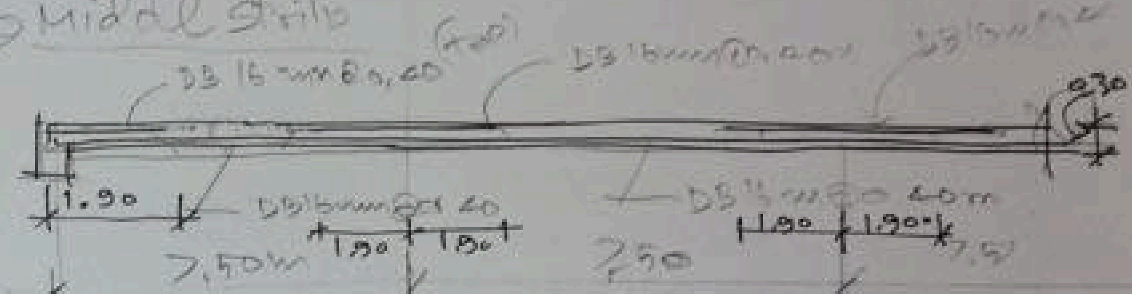
– spacing DB16mm = $\frac{(2.01)(100)}{2.721}$ = 73.80 cm → 40 cm

• Detail of Flat Slab (X-X Axis) Sheet 6

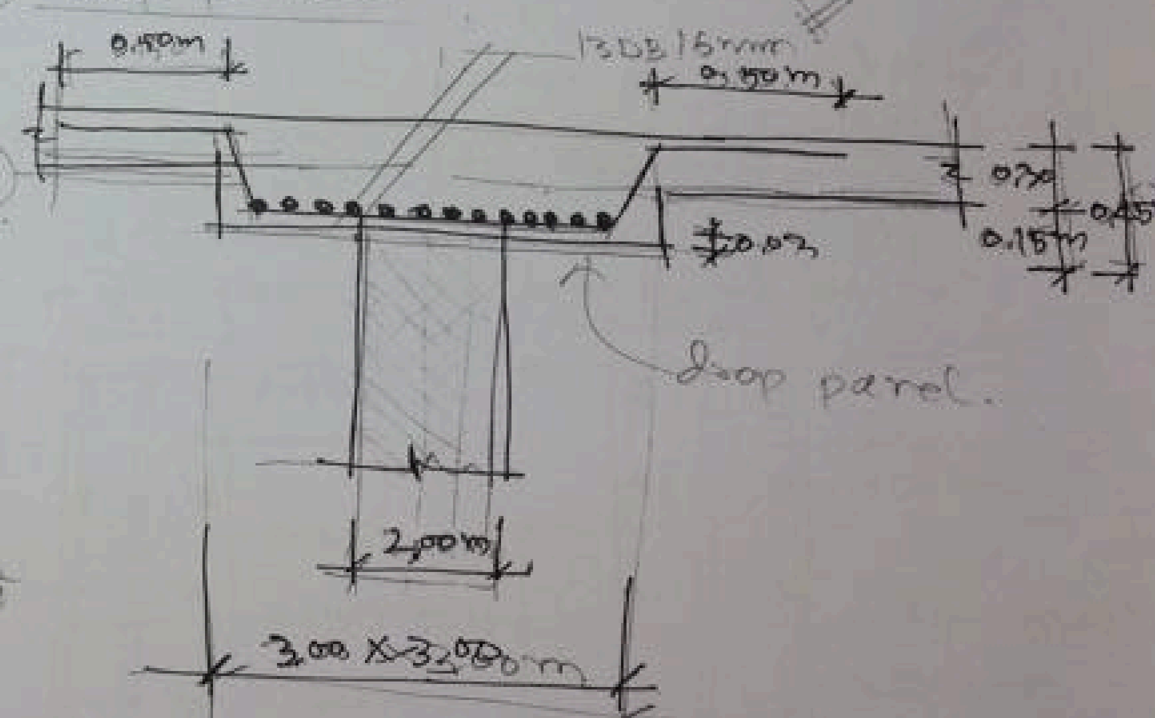
① Column Strip



② Middle strip



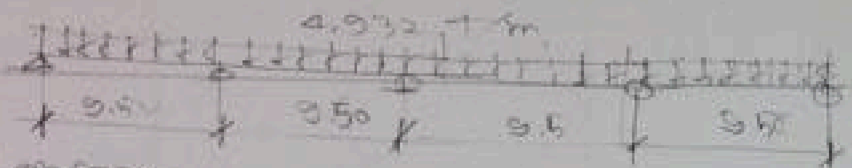
③ Drop panel



• Design spandrel Beam $\phi 28\ \frac{(3.14)(2.8)^2}{4} = 6.154$

ASS section 0.30 × 0.60 m

$L' = 9.50 - 1.00 = 8.50$ m



load on span

• $W_1 = 0.30 \times 0.60 \times 2400 / 1000 = 0.432$ t/m

• $W_0 = (1.20)(7.5) = 4.50$ t/m

• ACI - Coefficient $\frac{1}{21}$ 4.932 t/m — central point load.

• ⊕ M-max = $(0.077)(4.932)(9.5)^2 = 34.273$ t-m

• ⊖ M-max = $(0.107)(4.932)(9.5)^2 = 47.627$ t-m

• คำนวณจาก Sn (clear span) :

⊕ M-max $= \frac{1}{14}(4.932)(8.50)^2 = 25.452$ t-m ✓

⊖ M-max $= \frac{1}{10}(4.932)(8.50)^2 = 35.63$ t-m ✓

$MC = (20.76)(0.30)(55)^2 / 1000 = 18.785$ t-m

$M2 = 25.452 - 18.785 = 6.676$ t-m

$$\oplus AS = \frac{(18.785)(1000)(100)}{(1700)(0.875)(55)} + \frac{(6.676)(1000)(100)}{(1700)(55-5)}$$

$= 22.961 + 7.854$

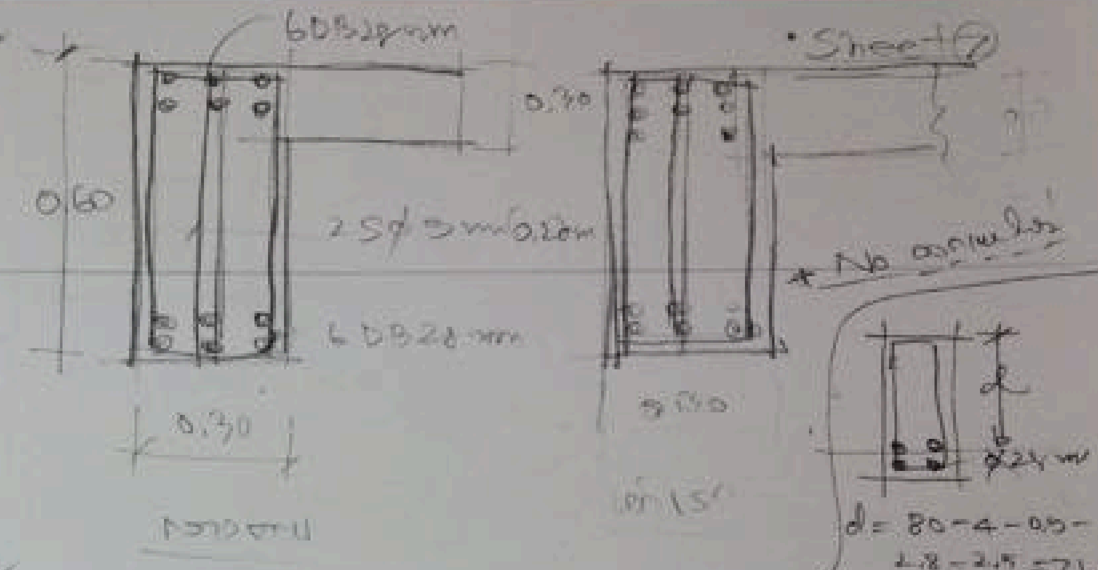
$= 30.815$ cm²

ใช้ 6DB28mm : $AS = 6.154 \times 6 = 36.924$ cm²

$$\ominus AS = 22.961 + \frac{(16.854)(1000)(100)}{(1700)(55-5)} = 40.986 \text{ cm}^2$$

(18.025)

ใช้ 8DB28mm ($AS = 6.154 \times 8 = 49.232$ cm²)



$d = 80 - 4 - 0.9 - 2.8 - \frac{2.5}{2} = 71.05$ cm

Tsy (0.40 × 0.80 m) m : $W_F = 5.268$ t/m

⊕ M-max $= (0.077)(5.268)(9.50)^2 = 36.608$ t-m

⊖ M-max $= (0.107)(5.268)(9.50)^2 = 50.871$ t-m

$MC = (20.76)(0.40)(71.05)^2 / 1000 = 41.798$ t-m

$$\oplus AS = \frac{(36.608)(1000)(100)}{(1700)(0.875)(71.05)} = 34.638 \text{ cm}^2$$

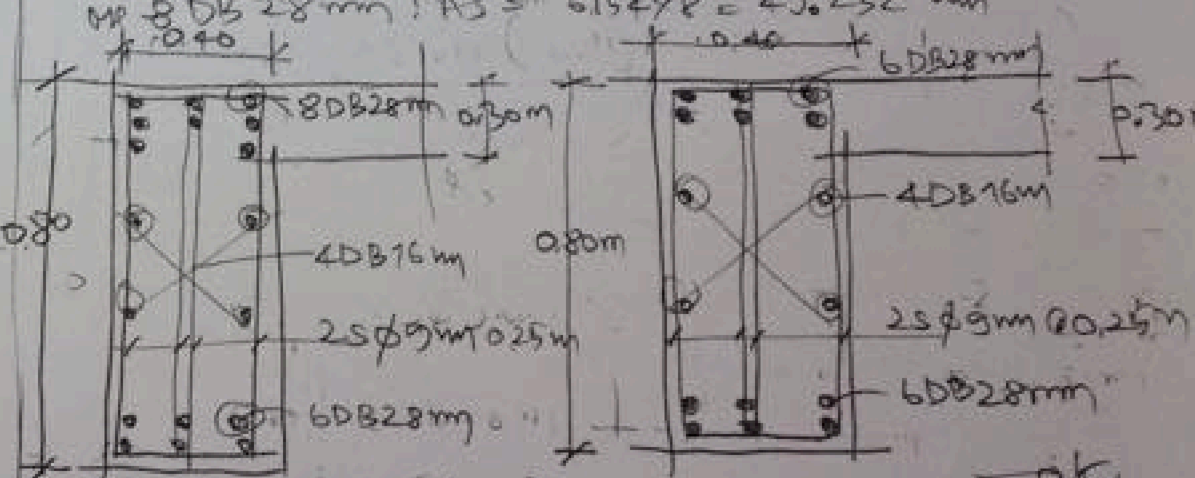
$= 34.638$ cm² (6DB28 $= 6.154 \times 6 = 36.924$ cm²)

$$\ominus AS = \frac{(41.798)(1000)(100)}{(1700)(0.875)(71.05)} + \frac{(9.073)(1000)(100)}{(1700)(71.05-5)}$$

66.05

$= 30.297 + 8.08 = 38.377$

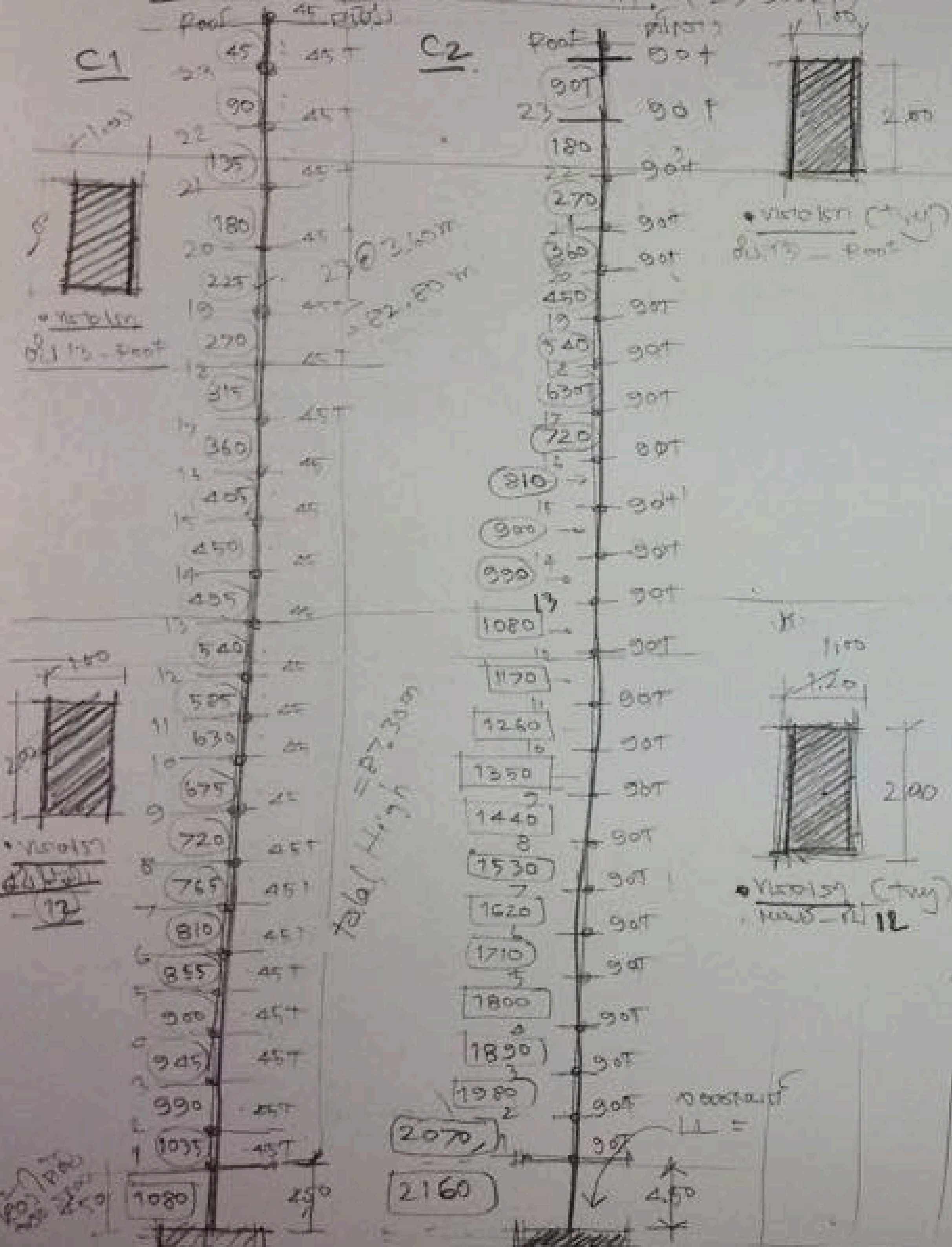
ใช้ 8DB28mm : $AS = 6.154 \times 8 = 49.232$ cm²



• (SB)

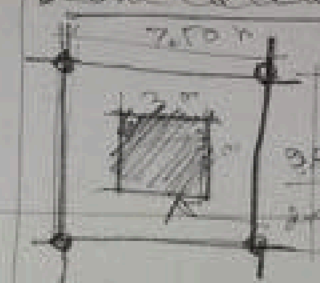
•

• Step 2 Design column (23 STORY)



• Load calculation

Sheet 8



$w_1 = (3)(5)(1.560) = 14.04$ T — ชั้น

$w_2 = (62.25\ m^2)(1.2\ T/m^2) = 74.70$ T

Σ Load = 88.74 T (DL+LL+FL)

Tributary Area 7.5×9.50

[1200 − 720 + 108 = 1560 kg/m² — ชั้น] - Let DL

[(7.50)(9.50) − 9 = 62.25 m² = 1.2 t/m²]

$w_1 = (14.04\ T/ชั้น)(19) = 266.76$ T

$w_2 = (14.004\ T)(32) = 449.28$ T

$w_3 = (3724\ m^2 + 152\ m^2) \times 1.20\ T/m^2 = 4651.20$ T

• Σ Load = 5367.24 T ≈ 5368 T

① Load /ชั้น = 1/2 (88.72) = 44.37 T = 45 T

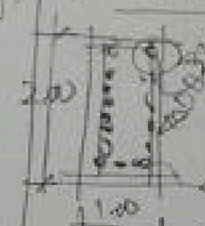
② Load /ชั้น = 88.74 T → 90 T

• $P_c = (0.2125)(280)(100)(200)/1000 = 1190$ ton

• $P_c = (0.2125)(280)(120)(200)/1000 = 1428$ T

(1). C1 — 1.00 × 2.00 m

• ชั้น 12 – (Roof)



$P_{max} = 270$ T

$P_c = 1190\ T > P_{max}$; Try $P_g = 1.5\%$

$P_g = \frac{A_s}{A_g}$

∴ $A_s = (0.015)(100)(200) = 300\ cm^2$

Ø25 = 4.906 cm²

Ø28 = 6.154 cm²

Ø32 mm = 8.04 cm²

ใช้ 40 DB 32 mm.

(A_s = 8.04 × 40 = 321.60 cm²)

• ชั้นหลังคาถึงชั้นที่ 11 : Section 1.00×2.00 m — (C1)

P_max = 1080 T

$P_C = 0.2125 f_c' A_g = (0.2125)(280)(100)(200)/1000$

= 1190 T > P_max ; use P_g = 1.8%

$P_g = \frac{A_s}{A_g}$; $A_s = P_g \cdot A_g$

$A_s = (0.018)(100)(200) = 360\ cm^2$

use = 46 DB 32 mm ; $A_s = 46 \times 8.04 = 369.84\ cm^2$

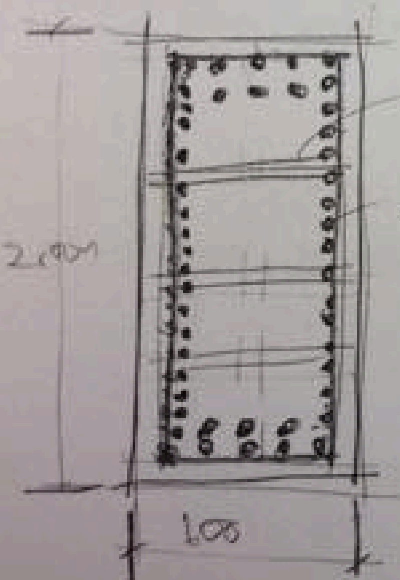
Stirrup Spacing ; DB12 mm stirrup

– (16)(3.2) = 51.20 cm

– (48)(1.2) = 57.60 cm

– width = 100 cm

use 4 ∮ 12 mm @ 0.50 m



$\frac{3.14 \times 3.2^2}{4} = 8.04$

• C1 – หลังคา – ชั้นที่ 11

• ออกแบบเสา (C2) ชั้นที่ 13 – Roof

Sheet (5)

P_max = 990 T ; 1.00×2.00 m

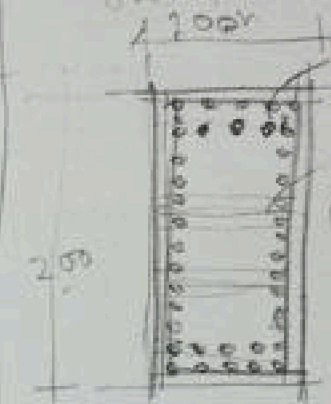
$P_C = (0.2125)(280)(100)(200)/1000 = 1190\ T > 990\ T$

ใช้ P_g = 1.5% = 0.015

$A_s = P_g \cdot A_g$

= (0.015)(200)(100) = 300 cm^2

ใช้ 40 DB 32 m



(C2) – ชั้น 13 – ชั้น Roof

ok

• ออกแบบ (C1) ชั้นล่าง ถึง ชั้นที่ (12) — 1.20 × 2.00 m

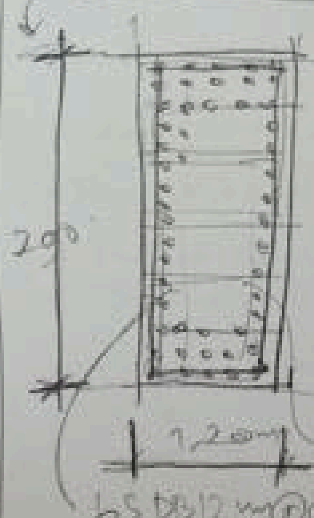
P_max = 2160 T

$P_C = (0.2125)(280)(120)(200)/1000 = 1428\ T$

$A_s = 2160 - 1428 = 732$ Ton

$A_s = \frac{(732)(1000)}{(0.85)(1700)} = 506.57\ cm^2$

ใช้ 64 DB 32 mm ; $A_s = 514.56\ cm^2$



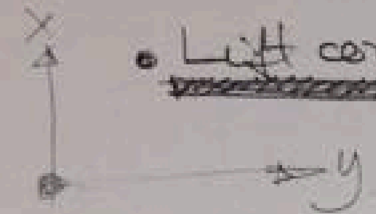
$P_g = \frac{A_s}{A_g} = \frac{514.56}{(120)(200)} = 0.021$

< 0.04

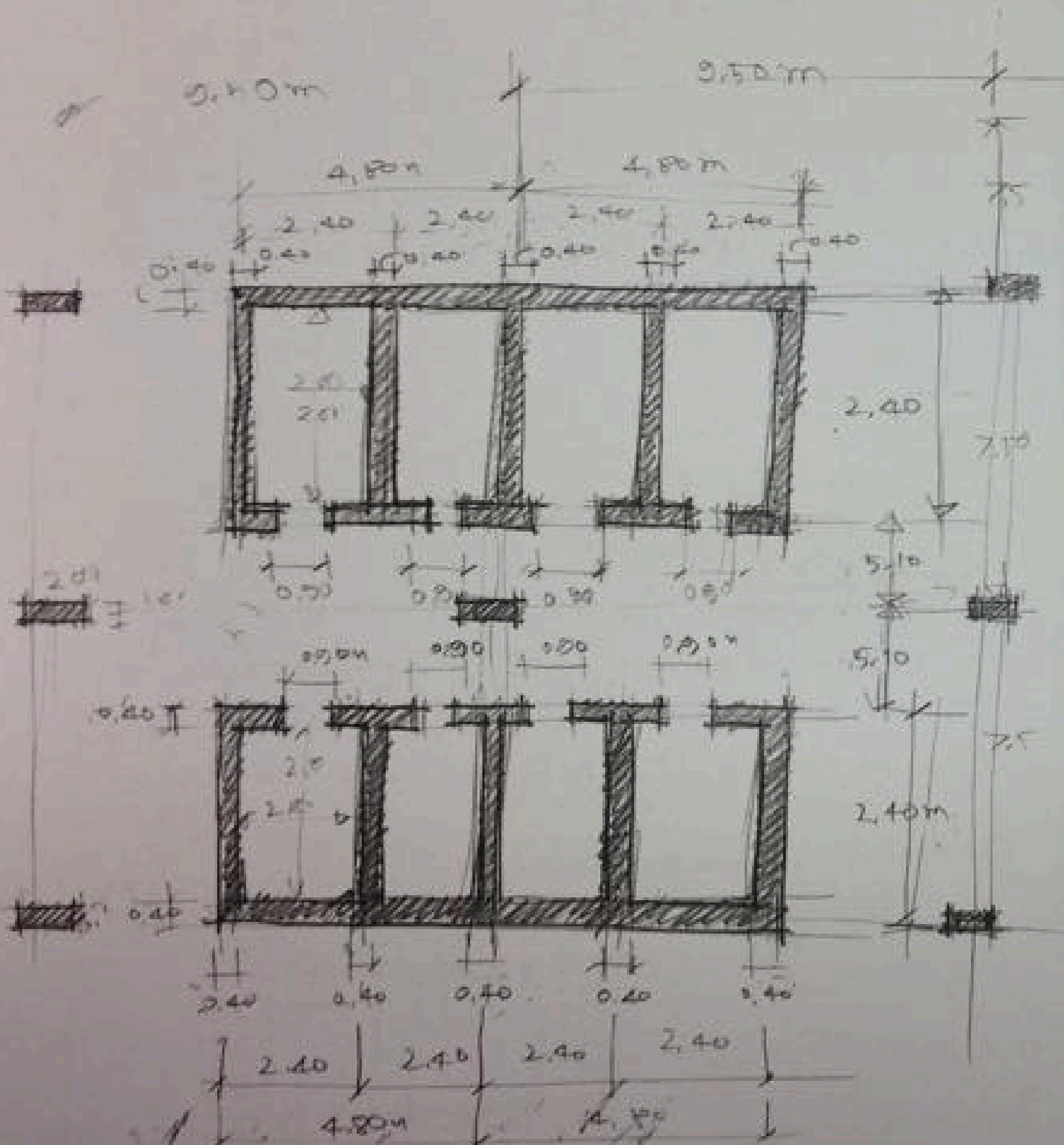
ok

ok

• C2 – หลังคา ถึง ชั้นที่ 12 :



• Lift core [illegible]



[illegible] column ([illegible]) • Sheet (10)

(1.20 x 2.00 m) P = 2160 T [illegible]

M = 48.802 T-m

V = 79 T

$Ag = 120 \times 200 = 24000$ cm²

$V_c = 0.464 \sqrt{(280)\left[1 + 0.057 \times \frac{2160 \times 1000}{24000}\right]}$

$= 0.464 \sqrt{(280)(6.13)}$

$= 0.464 \sqrt{1716.40}$

$= 19.223$ ✓

[illegible] $d = (0.90)(200) = 180$ cm

$V_r = (V_c)(b)d = (19.223)(120)(180)/1000$

$= 415.222$ T > 79 Ton

$M_c = \frac{(20.70)(120)(180)}{(1000)(100)} = 804.816$ T-m > 450 T-m

$A_s = \frac{(48.802)(1000)(100)}{(1700)(0.87)(180)} = 18.226$ cm²

• [illegible] 22 DB 32 mm. ($A_s = 8.04 \times 22 = 176.88$ cm²)

• [illegible]

$A_{st} = (44)(8.04) = 353.76$ cm² ; $P_g = \frac{A_s}{Ag} = \frac{353.76}{24000} = 0.0176$

$m = \frac{f_y}{0.85 f'_c} = \frac{4000}{(0.85)(280)} = 16.81$

$I = \frac{bh^3}{12} = \frac{(120)(200)^3}{12 \times 10^6} = 80 \times 10^6$ cm⁴

$h = 200$; $d' = 25$; $h - d' = 200 - 25 = 175$ cm

$\therefore e_b = (0.67 \times 0.0176 \times 16.81 + 0.17)(175)$

$= 64.44$ cm

$e_{oy} = \frac{M}{P} = \frac{(397)(100)}{2160} = 18.37$ cm < 64.44 cm

• [illegible]

[illegible] $\frac{fa}{Fa} + \frac{fb}{Fb} \le 1$ → ok

$Fa = (0.34)(1 + Pg \cdot m) fc'$

$= (0.34)(1 + 0.0176 \times 16.81)(280)$

$= 123.365$ ksc

$A = 120 \times 200 = 24000\ cm^2$

$fa = \frac{(2160)(1000)}{24000}$

$= 90$ ksc

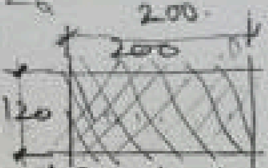
$Fb = (0.45)(280) = 126$ ksc

$fb = \frac{MC}{I} = \frac{(48.802)(100)(100)(100)}{80 \times 10^6}$

$= 6.11$ ksc

• [illegible] $\frac{fa}{Fa} + \frac{fb}{Fb} = \frac{90}{123.40} + \frac{6.11}{126} = 0.729 + 0.048$

$= 0.78 < 1.00$ — ok.



• [illegible]

- $V_{steel} = (0.0015)(100)(120) = 18\ cm^2/m$

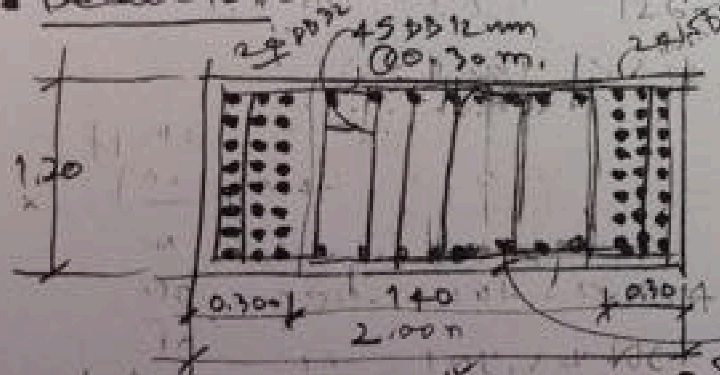
DB32mm spacing $= \frac{8.04\ cm^2}{18\ cm^2/m} = 0.44$ m

- $H_{steel} = (0.0025)(100)(120) = 30\ cm^2/m$

DB12 spacing $= \frac{8 \times 1.1304\ cm^2}{30\ cm^2/m} = 0.301$ m → 0.30 m

4J = 8 [illegible]

• Detail [illegible]



6x8 = 48
= 16
64 — 15 — ok

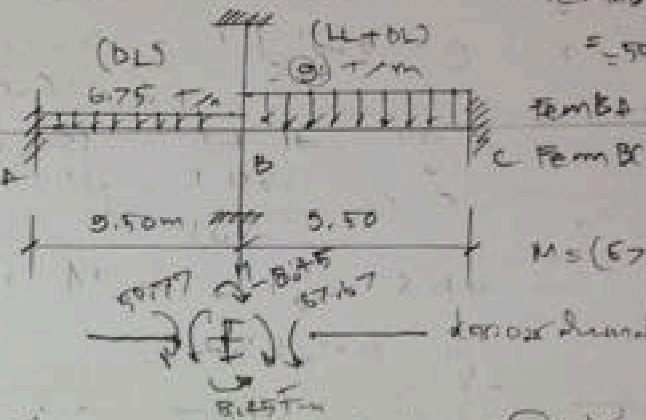
$\frac{140}{9} = 15.5$ cm ≈ 15 cm — ok

[illegible] CoD.

• Sum = 64DB32 mm [illegible]

• [illegible]

• (1). [illegible] gravity Load



$FemAB = -\frac{wL^2}{12} = \frac{(6.75)(9.5)^2}{12}$

$= -50.77$ T-m

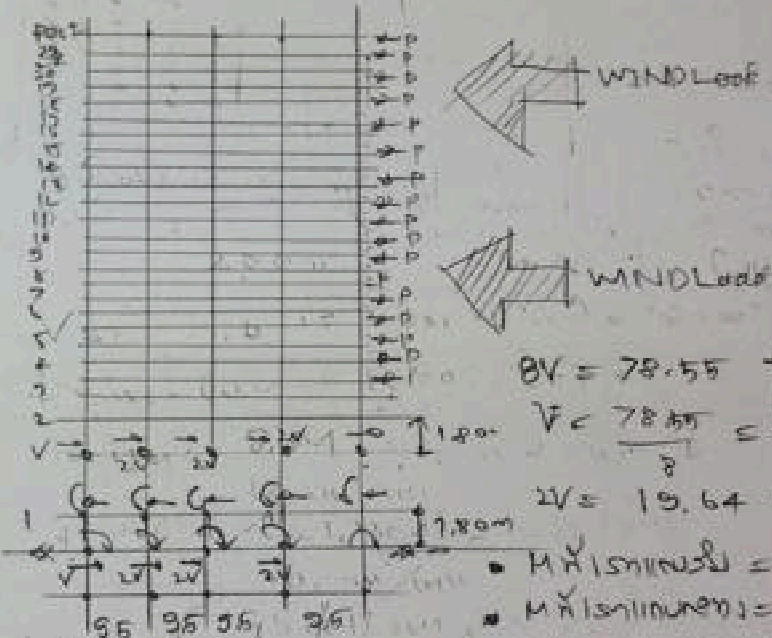
$FemBA = +50.77$ T-m

$FemBC = \frac{(9)(9.5)^2}{12}$

$= -67.67$ T-m

$M = \frac{(67.67 - 50.77)}{2} = 8.45$ T-m

(2) [illegible] (Wind Load) [illegible] Portal



$\Sigma V = 78.55$ T (1 Bay) — ok

$V = \frac{78.55}{8} = 9.82$ T — ok

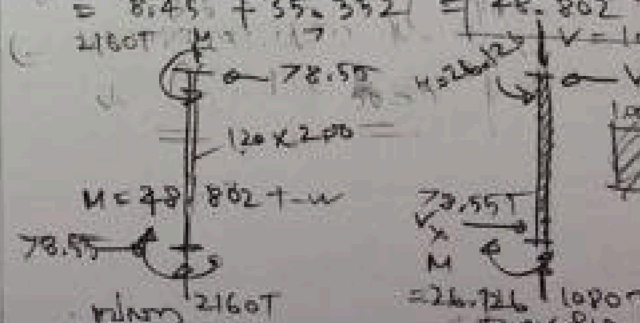
$2V = 19.64$ T

• M [illegible] $= 9.82 \times 1.8 = 17.676$ T-m

• M [illegible] $= 19.64 \times 1.8 = 35.352$ T-m

(3) [illegible] (gravity Load + Wind Load)

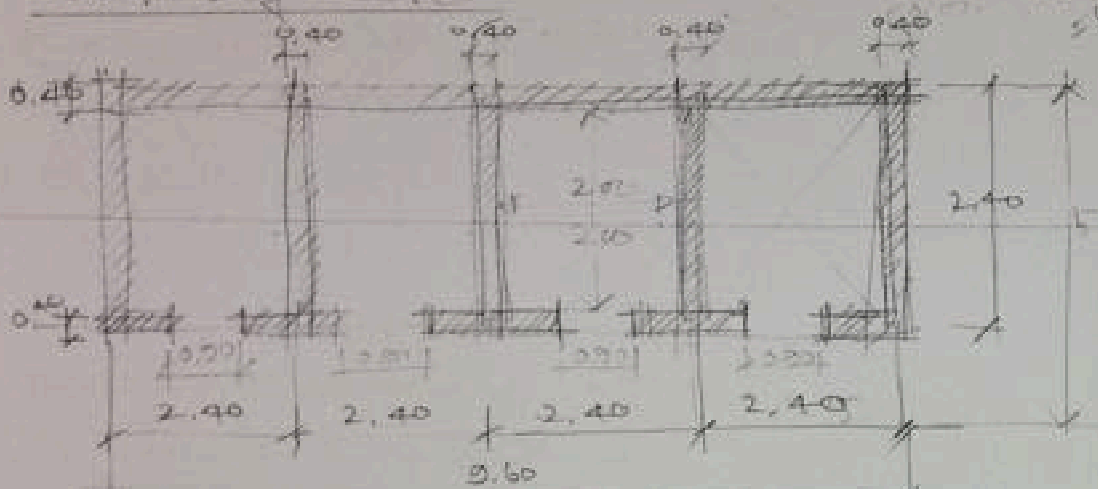
$= 8.45 + 35.352 = 48.802$ T-m — ok [illegible]



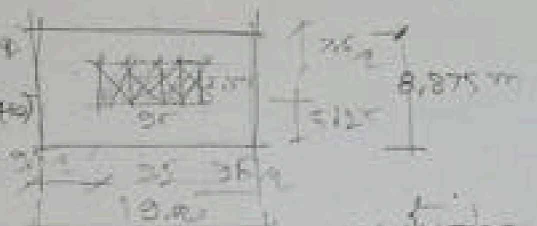
$M = 17.676 + 8.45$

$= 26.126$ T-m

• Design Lift core



• Tributary Area



$A = (8.875)(19) - (9.60)(2.40)$

$= 168.625 - 23.04\ m^2$

$= 145.585\ m^2$

5 Load 2300 = $(145.585\ m^2)(2.4)(1.20) = \boxed{4192.848}$ Tons

(Area lift core) $= [2.80 \times 5 + (10.00) \times 2 - (4 \times 0.90)](0.40\ m)$ [L = 34 m]

$= 12.16\ m^2$

$Wt = (12.16\ m^2)(2.40)(3.60)(23) = \boxed{2416.44\ T}$

• Total Wt = $\dfrac{4192.848 + 2416.44}{3} = \boxed{6609.288}$ Design load

$f_c = 0.225 f'_c \left[1 - \dfrac{h}{40t}\right]^3$; (h = 360 cm, t = 40 cm)

$= (0.225)(280)\left[1 - \dfrac{360}{(40 \times 40)}\right]^3$

$= 29.325$ KSC

$P_c = f_c \cdot A = (29.325)(12.60\ m^2)(100 \times 100)/1000$

$= \boxed{3565.92}$ T

• Sheet 12

$P_s = 6609.288 - 3565.92 = 3043.3681\ T$

$A = \dfrac{P}{(0.85) f_s} = \dfrac{(3043.3681)(1000)}{(0.85)(1700)} = 2106.13\ cm^2$

• ใช้ 344 DB 28 mm ; $A_s = 6.154 \times 344 = 2116.976\ cm^2$

(L = 34 m) ; spacing DB28 mm $= \dfrac{2 \times 34}{344} = 0.197$ m

or • ใช้ 430 DB 25 mm ; $A_s = 430 \times 4.906 = 2109.58\ cm^2$

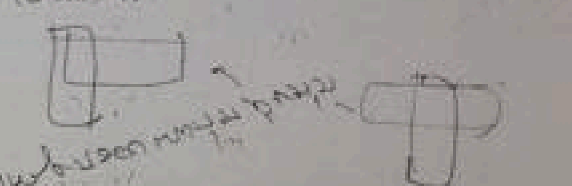
(L = 34 m) ; spacing $= \dfrac{2 \times 34}{430} = 0.158$ m

• CODE

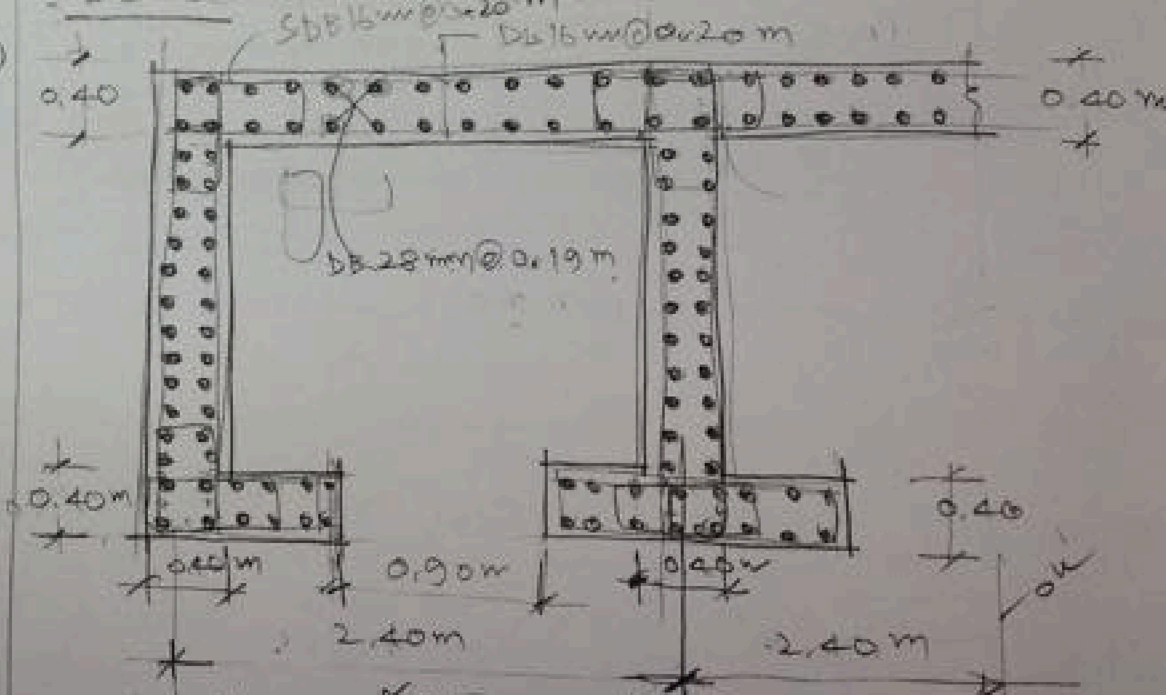
$A_{s\,min} = (0.0025)(100)(40) = 10\ cm^2/m < 61.945\ cm^2/m$

$A_{sb} = (0.0025)(100)(40) = 10\ cm^2/m$

[DB16 mm spacing $= \dfrac{2.01\ cm^2}{10\ cm^2/m} = 0.201$ m ⇒ 0.20 m



• Detail



• Lift core ... Sheet 12

• Design Lift core ชั้นที่ 13 - หลังคา (Roof)

$P\_max = \frac{6609.288}{2} = 3304.644$ T

PC = 3565.92 T

PC > P_max

• $As_{min} = (0.0025)(100)(40) = 10\ cm^2/m$

Use DB25 mm Spacing = $\frac{4.906\ cm^2}{10\ cm^2/m} = 0.491$ m

(use DB25 mm @0.30 m)

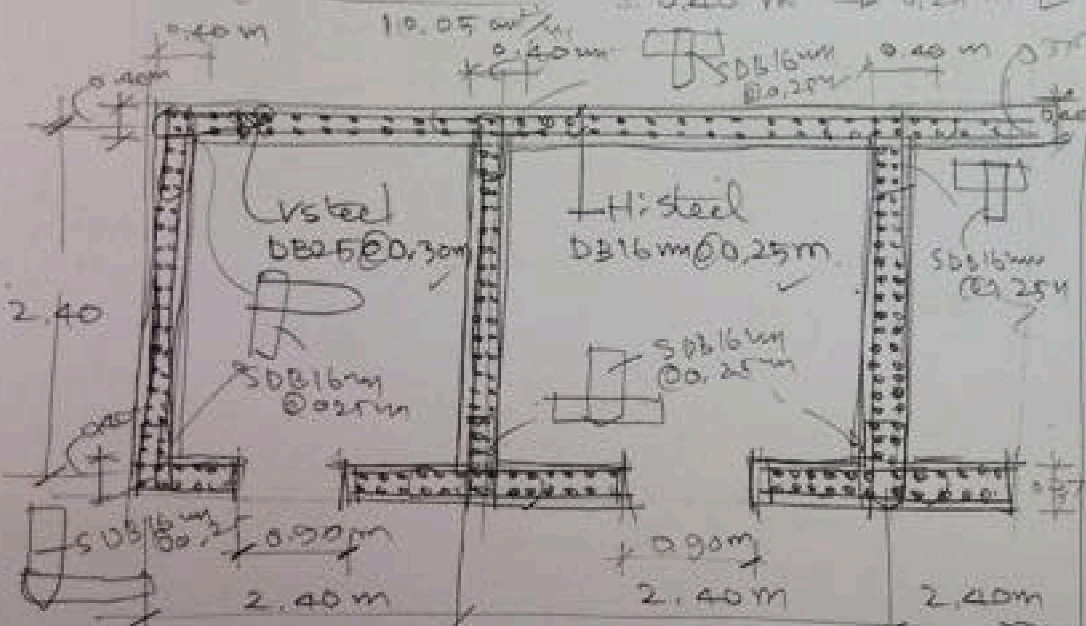
• Use DB25 mm @0.30 m V steel ✓ ok

• $Asb = (0.0025)(240)(40) = 24.00\ cm^2$

Use 12 DB16 mm ; $As = 2.01 \times 12 = 24.12\ cm^2$

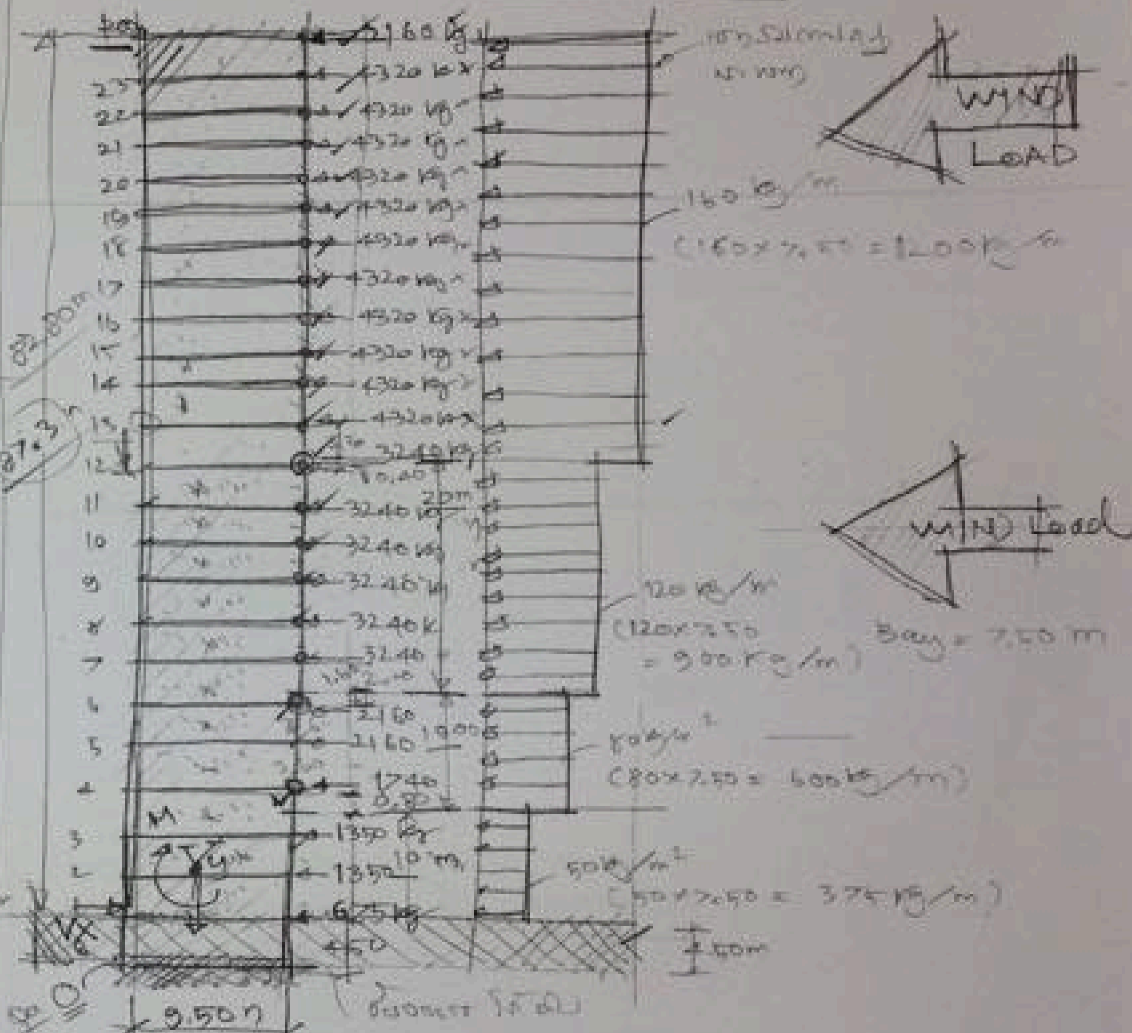
$\therefore Asb/m = \frac{24.12}{2.40} = 10.05\ cm^2/m$

Spacing = $\frac{(2) \times 2.01\ cm^2}{10.05\ cm^2/m} = 0.40$ m → 0.25 m



• Lift core ชั้นที่ 13 - ชั้นหลังคา

• ออกแบบผนังรับแรงเฉือน (Shear wall) • Sheet (13)



• $F_{W12} = (1.20 \times 1200) + (0.4 \times 900) + (1.60 \times 900) = 1440 + 360 + 1440$
$= 3240$ kg →

• $F_{W6} = (2+1.60)(600) = 2160$ kg

• $F_{W4} = (0.80+1.60)(600) + (0.8 \times 375) = 1440 + 300 = 1740$ kg

• Try Shear wall thickness = 0.40 m

• $W_{stem} = (82.80+4.50)(9.50)(0.40)(2.40) = 787.056$ T

$W_{slab} = 1080$ T

Sum Load = 1080 + 788 = 1886 T →

Design Shear Wall

Shear Wall 0.40 × 9.50 × 87.60 — Sheet 17

ระดับชั้น	Mact (T-m)	M react (T-m)
Roof	= 188.568	(0.40 × 9.50 × 87.60 wall × 2.4) × 9.5/2
23	= 361.584	
22	= 346.032	= 3794.732 T-m
21	= 330.48	
20	= 314.928	
19	= 299.376	
18	= 283.824	∴ SF = Mreact / Mact
17	= 268.272	
16	= 252.72	= 3794.732 / 3703.91
15	= 237.168	
14	= 221.616	= 1.01 < 1.50
13	= 206.064	
12	= 142.884	(ต้องคิดรวมนน.ฟุต)
11	= 131.22	
10	= 119.556	
9	= 107.892	
8	= 96.228	(7.5/2 × 9.50 × 0.90 T/m² × 24 ชั้น = 769.5 T)
7	= 84.504	M = 769.5 × 9.5/2
6	48.60	= 3655.125 (รวมนน.ฟุต)
5	40.824	∴ SF = 7449.857 / 3703.91 = 2.01 > 1.50
4	20.622	
3	15.795	
2	10.935	
1	3.038	
รวม =	3703.91 T-m	3794.732

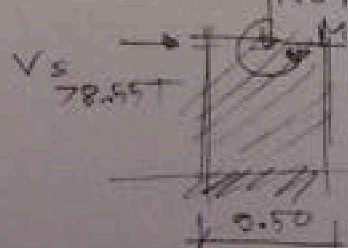
$$\sum F_x = 0,\ V_x = 2.16 + 11(4.32) + 6(3.24) + 2(2.16) + 1.74 + 2(1.35) + 0.675$$

$= 78.55$ (T)

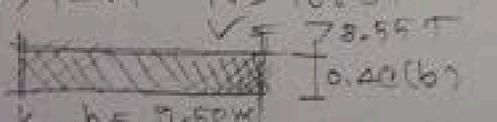
M = 3745 T-m

- Model for Analysis (0.40 × 9.50 m)

N = 1886 T, M = 397 T-m, Vs = 78.55 T



N = 1886 T, V = 78.55 T



∴ Ag = 38000 cm²

M = 397 T-m

- Sheet 14

$$V_c = 0.444\sqrt{(280)\left[1 + 0.057 \times \frac{1886 \times 1000}{38000}\right]}$$

$= 0.444\sqrt{1072.12}$

$= 15.192$ ksc

$V_c = v_c \cdot b \cdot d = (15.192)(40)(0.90 \times 950)/1000$

$= 544.464$ T > 78.55 T — ok

$$M_c = \frac{(20.70)(40)(855)^2}{(1000)(100)} = 6052.887 \text{ T-m} > M = 397 \text{ T-m}$$

$$A_s = \frac{(397)(1000)(100)}{(1700)(0.60 \times 950)} = 40.97 \text{ cm}^2$$

(3.21) [illegible]

ใช้ 20DB25 mm ; As = 4.906 × 20 = 98.12 cm²

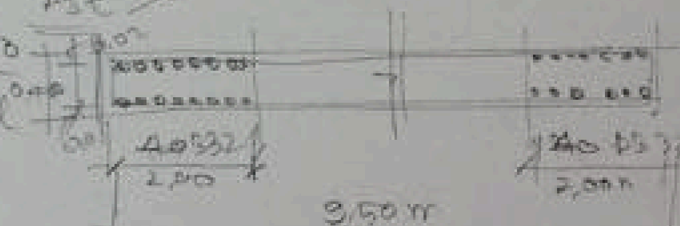
Ast = 40DB25 mm × 4.906 = 196.24 cm²

$$P_g = \frac{A_s}{A_g} = \frac{196.24}{38000} = 0.005 > 1.00 \rightarrow \text{ใช้ } 1.5\%$$

As = (0.015)(38000) = 570 cm²

ใช้ 80DB32 mm ; As = 8.04 × 80 = 643.20 cm² (P_g = 0.0169)

Ast



$$m = \frac{F_y}{0.85 f'_c} = \frac{4000}{(0.85)(280)} = 16.81$$

$$I = \frac{40 \times 950^3}{12} = 285791 \times 10^6 \text{ cm}^4$$

h = 950 cm, d' = 25 cm, h − d' = 950 − 25 = 925 cm

$e_b = (0.67 \times 0.0169 \times 16.81 + 0.17)\,925$

$= 333.31$ cm

$$e_d = \frac{M}{P} = \frac{(397)(100)}{1886} = 21.04 \text{ cm} < 333.31$$

— ok

- [illegible]

เงื่อนไข $\frac{f_a}{F_a} + \frac{f_b}{F_b} \le 1$ — ⊕

$F_a = (0.34)(1 + \rho_g m) f_c'$

$= (0.34)(1 + 0.0169 \times 16.81)(280) = 122.245$ ksc

$f_a = \frac{P}{A} = \frac{(1886)(1000)}{(38000)} = 49.631$ ksc

$F_b = 0.45(280) = 126$ KSC

$f_b = \frac{Mc}{I} = \frac{(397)(1000)(100)(475)}{2857.91 \times 10^6} = 6.598$ ksc

ดังนั้น $\frac{f_a}{F_a} + \frac{f_b}{F_b} = \frac{49.631}{122.245} + \frac{6.598}{126}$

$= 0.406 + 0.0523$

$= 0.458 < 1.00$ ok

- เหล็กเสริม [illegible]

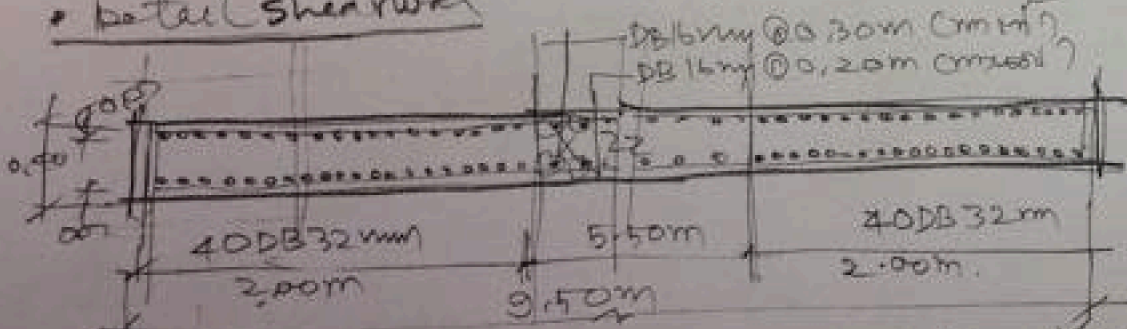
V steel $= (0.0015)(100)(40) = 6\ cm^2/m$

H steel $= (0.0025)(100)(40) = 10\ cm^2/m$

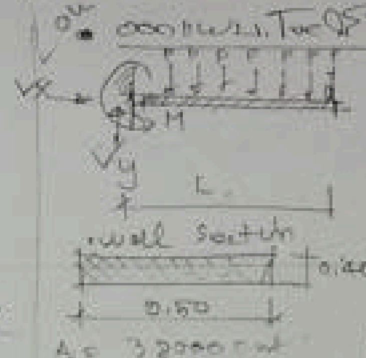
V spacing DB16mm $= \frac{2.01\ cm^2}{6\ cm^2/m} = 0.335\ m \Rightarrow 0.30\ m$ ⊕

H steel DB16mm $= \frac{2.01\ cm^2}{10\ cm^2/m} = 0.201\ m \Rightarrow 0.20\ m$

• Detail shear wall



• [illegible] - Sheet [illegible]



$V_x = P = 1886$ T

$M = (4140)$ T-m → ok

$V_c = 0.464\sqrt{(280)}\left[1 + (0.057)\frac{(1886 \times 1000)}{(38000)}\right]$

$= 15.192$ ksc

$V_C = v_c b d = (15.192)(40)(0.90 \times 950)/1000$

$= 544.464\ T > 78.55\ T$ → ok

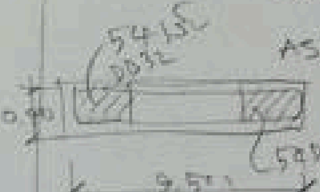
$M_C = \frac{(20.78)(40)(855)^2}{(1000)(100)} = 6052.877$ T-m > 4140 T-m → ok

$A_s = \frac{(4140)(1000)(100)}{(1700)(0.60 \times 950)} = 427.244\ cm^2$ (54DB32mm) ✓

fs, jd or 0.9d

$A_s = \frac{(4140)(1000)(100)}{(1700)(0.877)(855)} = 325.57\ cm^2$ (42DB32mm) ✗

ใช้ 54DB32mm $[A_s = 54 \times 8.04 = 434.16\ cm^2]$



$A_{st} = 54 \times (2) \times 8.04 = 868.32\ cm^2$

$\rho_g = \frac{868.32}{38000} = 0.0228$ →

$m = \frac{f_y}{0.85 f_c'} = \frac{4000}{(0.85)(280)} = 16.81$

$I = \frac{40 \times 950^3}{12} = 2857.916 \times 10^6\ cm^4$

$h = 950$ cm; $d' = 25$ cm; $h - d' = 950 - 25 = 925$ cm

$e_b = (0.67 \times 0.0228 \times 16.81 + 0.17)925 = 394.78$ cm

$e_{ob} = \frac{(4140)(100)}{1886} = 219.51$ cm $< e_b = 394.78$ cm

- [illegible] เงื่อนไข $\frac{f_a}{F_a} + \frac{f_b}{F_b} \le 1$

$F_a = (0.34)(1 + \rho_g m) f_c' = (0.34)(1 + 0.0228 \times 16.81)(280)$

$= 131.627$ KSC ✓

$f_a = \frac{P}{A} = \frac{(1886)(1000)}{38000} = 49.631$ KSC ✓

$F_b = (0.45)(280) = 126$ KSC ✓

$f_b = \frac{Mc}{I} = \frac{(4140)(1000)(100)(475)}{2857.916 \times 10^6} = 68.808$ KSC ✓

• ออกแบบกำแพงเฉือน (Shearwall)

แทนค่า $\dfrac{f_a}{F_a} + \dfrac{f_b}{F_b} = \dfrac{40.631}{131.687} + \dfrac{68.808}{126} = 0.376 + 0.546$

$= 0.922 < 1.00 \rightarrow$ O.K.

• เหล็กเสริมขั้น

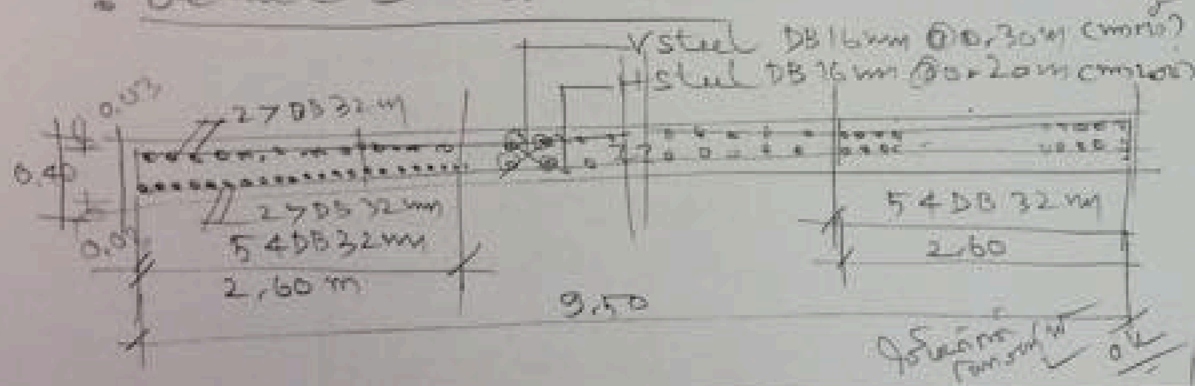
V steel $= (0.0015)(100)(40) = 6\ cm^2/m$

∴ spacing DB16mm $= \dfrac{2.01\ cm^2}{6\ cm^2/m} = 0.335\ m \Rightarrow 0.30\ m$

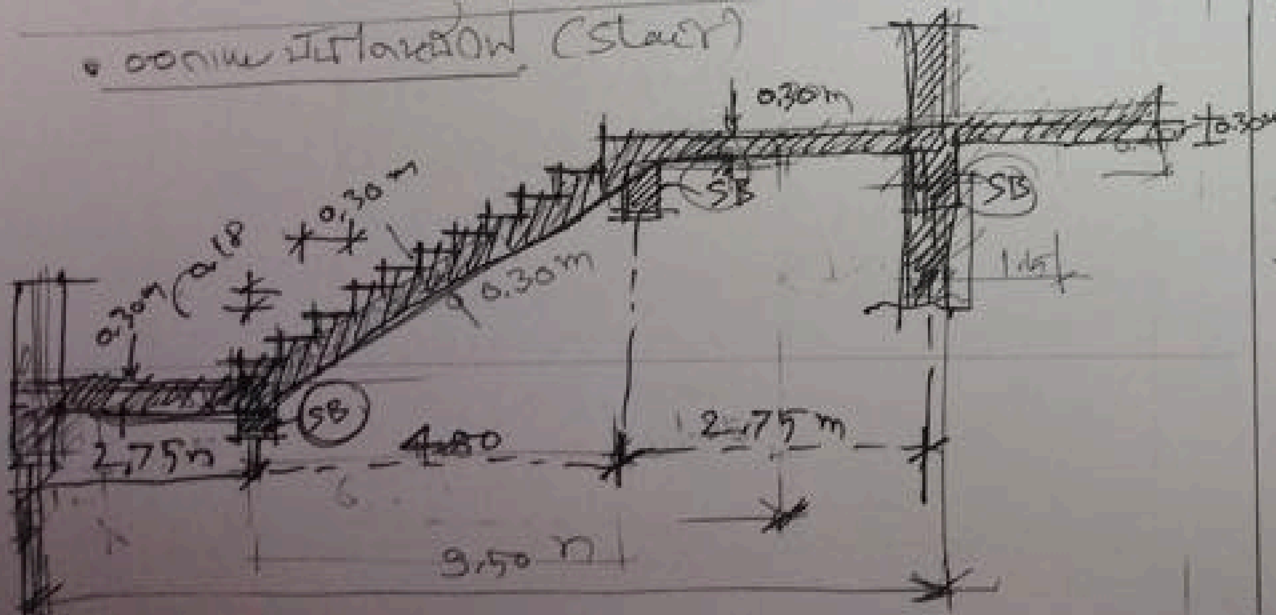
H steel $= (0.0025)(100)(40) = 10\ cm^2/m$

∴ spacing DB16mm $= \dfrac{2.01\ cm^2}{10\ cm^2/m} = 0.201\ m \Rightarrow 0.20\ m$

• Detail Shearwall



• ออกแบบบันไดลอยฟ้า (Stair)



Sheet (46)

b = ลูกนอน = 0.30 m , h = ลูกตั้ง = 0.18 m

Try T = 0.30 m

เลือกใช้ความกว้างของบันได 1.0 m

$W_D = 1200\left(1 + \dfrac{0.025}{b}\right)h + 2400\,t\sqrt{1 + \left(\dfrac{h}{b}\right)^2}$

$= 1200\left(1 + \dfrac{0.025}{0.30}\right)0.18 + 2400 \times 0.30\sqrt{1 + \left(\dfrac{0.18}{0.30}\right)^2}$ — 1.36

$= 233.90 + 839.657 = 1073.557\ kg/m$

$W_L = 300\ kg/m$

$W = 1073.557 + 300 = 1373.557\ kg/m$

$M = \frac{1}{8}(1373.557)(4.00)^2 = 2747.114\ kg\text{-}m$

$M_C = (20.70)(100)(27.50)^2 = 15654.375\ kg\text{-}m > M$

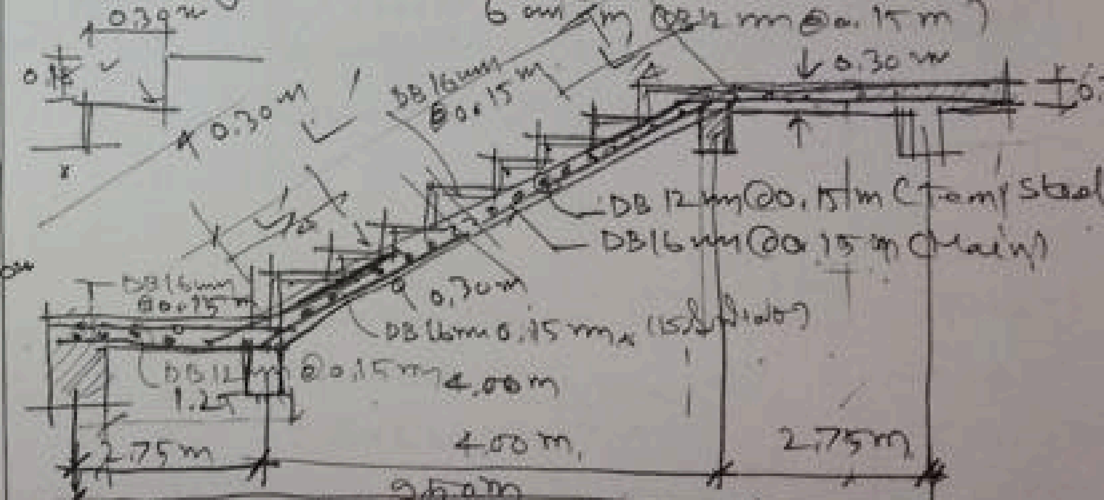
$A_S = \dfrac{(2747.114)(100)}{(1700)(0.875)(27.50)} = 6.715\ cm^2/m$

ใช้ 5 DB16mm ; $A_S = 5 \times 2.01 = 10.05\ cm^2/m$

Spacing DB16 $= \dfrac{2.01\ cm^2}{10.05\ cm^2/m} = 0.20\ m \Rightarrow 0.15\ m$ (DB16mm @0.10 m)

$A_{St} = (0.002)(100)(30) = 6\ cm^2/m$

Spacing DB12 $= \dfrac{1.1304\ cm^2}{6\ cm^2/m} = 0.188\ m \Rightarrow 0.15\ m$ (DB12mm @0.15 m)



• Detail Stair (บันไดลอยฟ้า ชุดนั้น)

Sheet (17)

- ตรวจสอบความมั่นคงต่อแรงพลิกคว่ำ เนื่องจากแรงลม
- หาค่าโมเมนต์ความมั่นคงต่อแรงพลิกคว่ำของโครงสร้างตามแนวยาว.

Safety factor against overturning $= \dfrac{M_{react}}{M_{act}}$

$= \dfrac{116964}{3703.91} = 31.57 > 1.50$ ok

1200
− 300

ระดับชั้น	Mact (t-m)	Mreact (T-m)
ROOF	(2.16)(87.3) = 188.568	(7.5×38)(6900) /1 Bay 7.50
23	(4.32)(83.70) = 361.584	× (24.00)
22	(4.32)(80.10) = 346.032	× 19 (ชั้น)
21	(4.32)(76.50) = 330.48	
20	(4.32)(72.90) = 314.928	= 116964 t-m
19	(4.32)(69.3) = 299.376	(น้ำหนัก LL) (100% DL)
18	(4.32)(65.70) = 283.824	
17	(4.32)(62.10) = 268.272	
16	(4.32)(58.50) = 252.72	
15	(4.32)(54.90) = 237.168	
14	(4.32)(51.30) = 221.616	
13	(4.32)(47.70) = 206.064	2875.752 ✓
12	(3.24)(44.10) = 142.884	
11	(3.24)(40.5) = 131.22	
10	(3.24)(36.90) = 119.556	
9	(3.24)(33.30) = 107.892	
8	(3.24)(29.70) = 96.228	
7	(3.24)(26.10) = 84.564	
6	(2.16)(22.50) = 48.60	
5	(2.16)(18.90) = 40.824	3674.142 ✓
4	(1.74)(15.30) = 26.622	
3	(1.35)(11.70) = 15.795	
2	(1.35)(8.10) = 10.935	
1	(0.675)(4.50) = 3.038	
G	—	
Σ =	3703.91	116964 T-m

- คำนวณหาค่าแรงเฉือน (Qi) (38 × 90 m)

ระดับชั้น	แรงลม (Fi) - T	แรงเฉือนที่ระดับ Qi
ROOF	(160)(3.6/2)(90)/1000	25.92 T
23	(160)(3.60)(90)/1000	51.84 T
22	"	51.84 T
21	"	51.84 T
20	"	51.84 T
19	"	51.84 T
18	"	51.84 T
17	"	51.84 T
16	"	51.84 T
15	"	51.84 T
14	"	51.84 T
13	"	51.84 T
12	$\frac{(1.4)(160\times90)}{1000}$ (= 20.16 T) + $\frac{(0.4+1.80)(120)(90)}{1000}$ (23.76)	= 43.92 T
11	(120 × 3.60)(90)/1000	= 38.88 T
10		38.88 T
9		38.88 T
8		38.88 T
7	(120 × 3.20)(90)/100 (34.56) + $\frac{(0.4\times90\times80)}{1000}$ (2.88)	37.44 T
6	(80 × 3.60 × 90)/1000	25.92 T
5	(80 × 3.60 × 90)/1000	25.92 T
4	$\frac{(80\times2.30\times90)}{1000}$ (16.56) + $\frac{(50\times1.30\times50)}{1000}$ (3.25)	19.81 T
3	(50 × 3.60)(90)/1000	16.20 T
2	(50 × 3.60)(90)/1000	16.20 T
1.	(50 × 1.8 × 90)/1000	8.10 T

• [illegible] Qi   • Drift Index (di) = $\frac{1.89 \text{ cm}}{87.60 \times 100}$ = 0,000215 < [illegible]

2.15×10^{-4} cm = 0,000215

• [illegible]   • Sheet 18

[illegible]

ระดับชั้น	แรงลม (Fi) (T)	แรงเฉือนที่ระดับ Qi (T)
Roof	25.92	25.92
23	51.84	77.76
22	51.84	129.60
21	51.84	181.44
20	51.84	233.28
19	51.84	285.12
18	51.84	336.96
17	51.84	388.80
16	51.84	440.64
15	51.84	492.48
14	51.84	544.32
13	51.81	596.16
12	43.92	640.08
11	38.88	678.96
10	38.88	717.84
9	38.88	756.72
8	38.88	795.60
7	37.44	833.04
6	25.92	858.96
5	25.92	884.88
4	19.81	904.69
3	16.20	920.89
2	16.20	937.09
1	8.10	945.19

H = 87.60 m

ระดับชั้น	แรงเฉือน (Vi) (T)	Ki (T/cm)	δi (cm)		drift Δh (cm)	
Roof	25.92	23547.57	0,0011	0.003	0.5292	1.89
23	77.76		0.0033	0.01	0.5087	1.88
22	129.60		0.0055	0.017	0.5054	1.87
21	181.44		0.0077	0.024	0.4990	1.86
20	233.28		0.0099	0.031	0.4922	1.835
19	285.12	7450	0.0121	0.04	0.4823	1.805
18	336.96		0,0143	0.05	0.4702	1.765
17	388.80		0.0165	0.05	0.4537	1.715
16	440,64		0.0187	0.06	0.4372	1.663
15	492,48		0.021	0.07	0.4185	1.603
14	544,32		0.0231	0.07	0.3975	1.533
13	596.16		0.0253	0.08	0.3704	1.46
12	640.08	28257.08	0.0224	0.09	0.3491	1.38
11	678.96		0.024	0.09	0.3265	1.29
10	717.84		0.0254	0.10	0.3025	1.20
9	756.72		0.0267	0.11	0.2769	1.09
8	795.60		0.0281	0.11	0.2502	0.98
7	833.04		0.0295	0.12	0.2222	0.87
6	858.96		0.0303	0.12	0.1927	0.75
5	884.88		0.0313	0.12	0.1624	0.63
4	904.69		0.032	0.12	0.1311	0.51
3	920.89		0.0325	0.13	0.0991	0.39
2	937.09		0.0332	0.13	0.0666	0.26
1	945.19		0.0334	0.13	0.0334	0.13

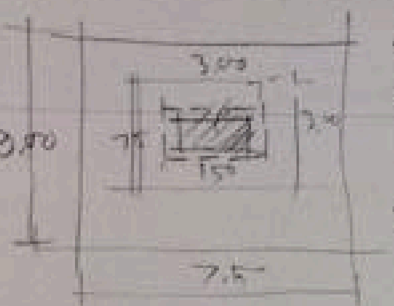
87.60 m

6 $K_i = \frac{12 \times 2.3 \times 10^5}{(315)^3} \cdot \frac{(100)(200)^3 \times 4}{12 \times 1000} =$ 23,547.57 T/cm

• Sheet 19

• Check punching Shear (ใหม่)

(1). critical Section in drop



$d = 45 - 2.5 - 1.6/2 = 41.70$ mm

$b_o = (2)(116.70) + (2)(191.70)$

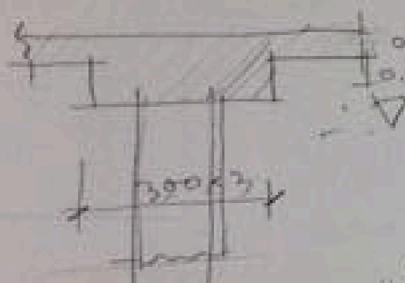
$= 233.40 + 383.40 = 616.80$ cm

$V = (7.50)(9.50)(1.20 \ T/m^2) + (3\times3)(0.840 \ T/m^2)$

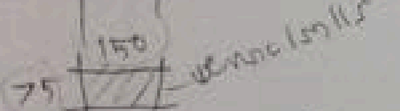
$- (1.167m \times 1.917m \times 1.56 \ T/m^2)$

$= 93.06 - 3.489$

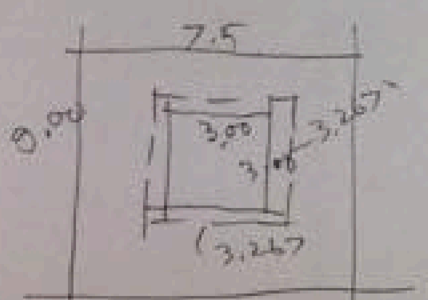
$= 89.571$ T



$\therefore V_C = \dfrac{(89.571)(1000)}{(616.80)(41.70)} = 3.482$ ksc $< 0.53\sqrt{280} = 8.868$



(2) critical Section in slab



$d = 26.70$ cm

$b_o = (4)(326.70) = 1306.80$ cm

Load $V = [7.50 \times 9.50 - 3.267^2] \ 1.20 \ T$

$= 72.692$ T

$V_C = \dfrac{(72.692)(1000)}{(1306.80)(26.70)}$

$= 2.083$ ksc < 8.868 ksc

• สรุปเรื่องหาเสา

(1) [illegible] 0.75×1.50 m → [illegible] 1.00×2.00 [illegible] 10 [illegible]

(2) [illegible] 12 [illegible]

(2.1) → [illegible] 1.20×2.00 [illegible]

(2.2) → [illegible] 1.00×2.00 [illegible]

(3) [illegible] 13 [illegible] 1.00×2.00 [illegible] 10 [illegible]

(4) [illegible]

• Design Mat foundation on pile

• Try Mat footing thickness = 1.50 m.

$W_1 = (1.50)(2.40) = 3.60 \ T/m^2$

$W_2 = LL$ (ของจรดิน) $= 0.50 \ T/m^2$

→ 4.10 T/m²

∴ [illegible] = **4.10 T/m²**

* แรงดันน้ำ [illegible] $= \gamma H \cdot A$

$= (1.0 \ T/m^3)(4.50m)(3439 \ m^2)$

= 15475.5 T

(A) นน. อาคาร.

$W_1 = Wall = 1886 \times 4 = 7544$ T (ผนังทึบ) [illegible] wall

$W_2 = 1080 \times 17 = 18360$ T

$W_3 = 2160 \times 26 = 56160$ T

$W_4 = 6380 \times 2 = 12760$ T

$W_5 = 1080 \times 6 = 6480$ T

$W_6 = 1.20 \times 2.00 \times 67.2 \times 47 \times 2.40 \ T/m^3 = 18354.80$ T

$W_7 = 1.00 \times 2.00 \times 5 \times 3.60 \times 2.4 = 86.4$ T

$\Sigma = $ **119745.20 T**

* นน. อาคาร (รวม) = 119745.20 T

- [illegible] = 15475.50

∴ นน. อาคารสุทธิ = **104269.70**

• ใช้ spun pile ø 100 m Safe load = 300 T/ต้น

No. of pile = 104269.20 / 300 = 347.56

[illegible] 487 ต้น

∴ [illegible] = 104270 / 487 = 214.11 T

(B) นน. Mat/[illegible]

• นน. Mat [illegible] x-x Axis

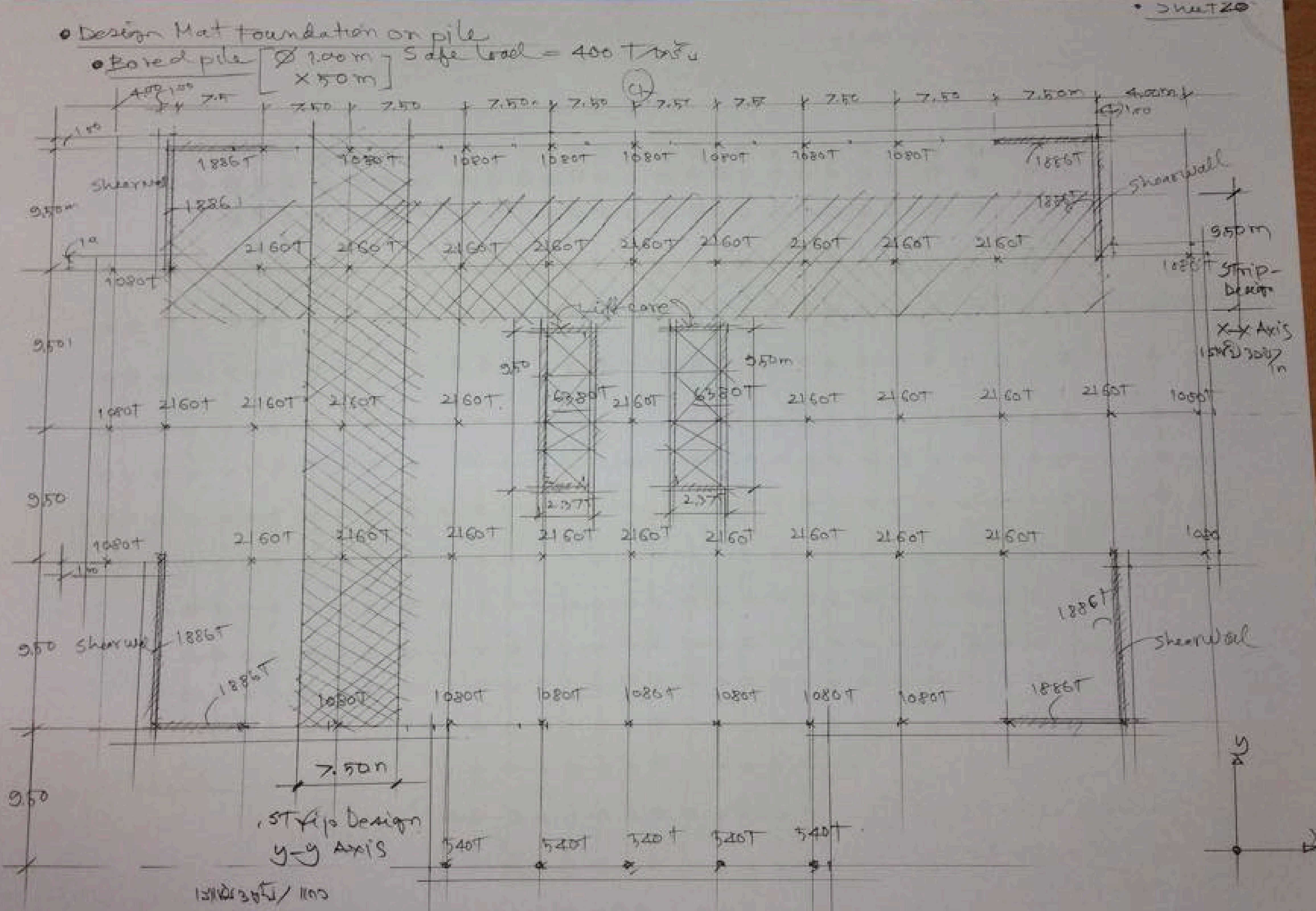
$= (4.10)(9.50) =$ **38.95 T/m**

• นน. Mat [illegible] y-y Axis

$= (4.10)(7.50) =$ **30.75 T/m**

• Design Mat foundation on pile

• Bored pile [Ø 1.00 m × 50 m] Safe load = 400 T/ต้น

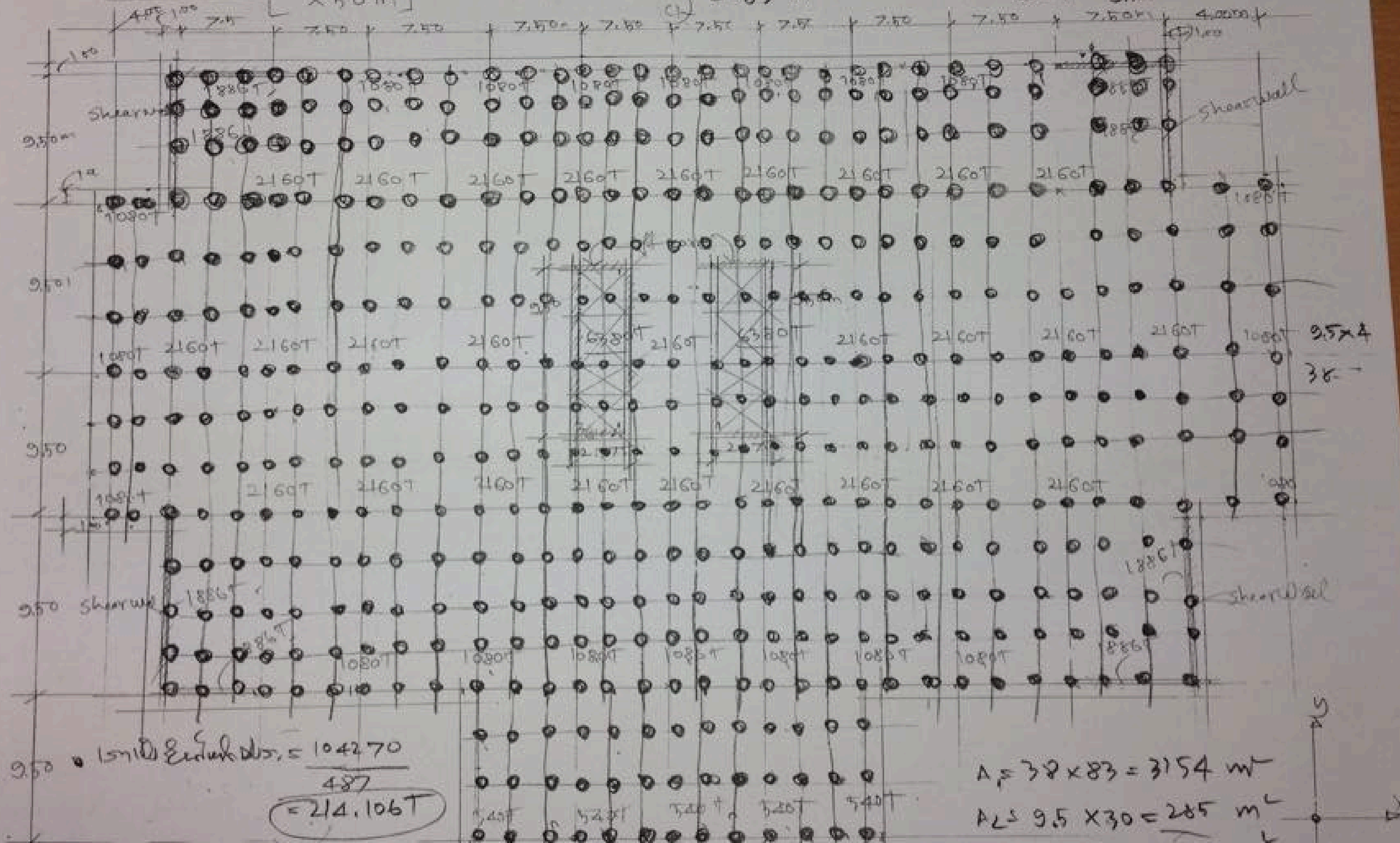


• Design Mat foundation on pile :

• Bored pile [Ø 1.00 m × 50 m] Safe load = 400 T/ต้น

• [* Spun pile Ø 1.00 × 50 m → 300 T • Sheet 21 ; N = 104270 / 300 = 357.5 ; ✓ = 487 [illegible] O.K.]

L = 83 m



• [illegible] = 104270 / 487 = 214.106 T

• 30 = 3 × 0.80 = 2.40

14 × 30 = 420 + 14 + 14 + 39 = 487

$A_1 = 38 \times 83 = 3154\ m^2$

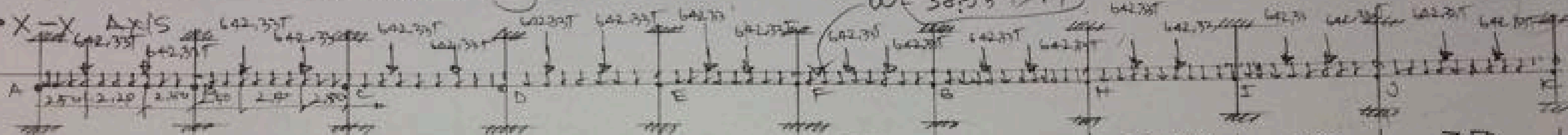
$A_2 = 9.5 \times 30 = 285\ m^2$

$\Sigma = 3439\ m^2$

- # Moment Distribution Analysis

• Oma722

- X–X Axis



Span	7.50m		7.50		7.50m		7.50m		7.50		7.50		7.50m		7.50m		7.50		7.50	
Joint	A	B	B	C	C	D	D	E	E	F	F	G	G	H	H	I	I	J	J	K
Member	A-B	B-A	B-C	C-B	C-D	D-C	D-E	E-D	E-F	F-E	F-G	G-F	G-H	H-G	H-I	I-H	I-J	J-I	J-K	K-J
DF	1/2	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/2
COF	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
FEM	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13	-1253.13	+1253.13
..																				-625.50
DM	+626.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COM	0	+313.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-313.25	0
DM	0	-104.42	-104.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+104.09	+104.20	0
COM	-52.21	0	0	-52.21	0	0	0	0	0	0	0	0	0	0	0	0	+52.05	0	0	+52.21
COM	+26.11	0	0	+26.11	+26.11	0	0	0	0	0	0	0	0	0	0	-26.11	-26.11	0	0	-26.11
DM	0	-13.06	+13.06	0	0	+13.06	0	0	0	0	0	0	0	0	-13.06	0	0	-13.11	-13.11	0
M	-652.73	+1475.02	-1334.27	+1227.03	-1227.02	+1266.19	-1253.23	+1253.13	-1253.33	+1253.33	-1252.33	+1253.37	-1253.83	+1253.83	-1266.19	+1227.12	-1227.03	+1334.27	-1475.02	+652.73
Mmid	+275.821		+599.151		+633.196		+626.671		+626.671		+626.671		+626.671		+611.409		+599.151		+275.827	

- $Fem\ AB = -\left(\frac{WL^2}{12} + \frac{P_1 ab^2}{L^2} + \frac{P_2 a^2 b}{L^2}\right) = -\left(\frac{38.55 \times 7.5^2}{12} + \frac{642.33 \times 2.5 \times 5^2}{7.5^2} + \frac{642.33 \times 5 \times 2.5^2}{7.5^2}\right) = -(182.578 + 713.7 + 356.85)$

  (1879.801)

  $= -1253.128\ T\text{-}m$

- $M_{mid\,(AB)} = \frac{WL^2}{8} + \frac{PL}{3} - \left(\frac{M_1 + M_2}{2}\right) = \frac{(38.55)(7.5)^2}{8} + \frac{(642.33)(7.5)}{3} - \left(\frac{652.73 + 1475.02}{2}\right)$ $= 273.876 + 1605.825 - 1603.88$

  $= +275.827\ T\text{-}m$

- $-M_{max} = 1475.02\ T\text{-}m$
- $+M_{mid} = 626.671\ T\text{-}m$

Sheet 23

- M_{max} = 1475.02 t-m ; B = 750 cm

$$d_{max} = \sqrt{\frac{(1475.02)(1000)(100)}{(20.70)(750)}} = \sqrt{9500.33} = 97.46\ cm$$

- Try T = 130 cm ; $d = 130 - 10 - 3 - \frac{3.2}{2} = 115.40$ cm > 97.46 cm

- Check punching shear

$V_c = 0.53\sqrt{f'_c} = 0.53\sqrt{280} = 8.868$ KSC

$V_{max} = 1701.065$ T (RB)

120+115.4 = 235.40 ; 200+115.40 = 315.40

$b_o = (2)(235.40) + (2)(315.40)$
$= 470.8 + 630.80 = 1101.60$ cm

d = 115.40 cm

$$V_c = \frac{V}{b_o d} = \frac{(1701.065)(1000)}{(1101.60)(115.40)} = 13.381\ KSC$$

= 13.381 KSC > 8.868 KSC → No pass

- Try T = 150 cm ; $d = 150 - 10 - 3 - \frac{3.2}{2} = 135.40$ cm

$b_o = (2)(255.40) + (2)(335.4) = 510.80 + 670.80 = 1181.60$ cm

d = 135.40 cm

$$V_c = \frac{V}{b_o d} = \frac{(1701.065)(1000)}{(1181.60)(135.40)} = 10.632\ KSC > 8.868\ KSC$$

No pass

- Try T = 165 cm ; $d = 165 - 10 - 3 - \frac{3.2}{2} = 151.40$ cm

$b_o = (2)(271.4) + (2)(351.4) = 542.8 + 702.80 = 1245$ cm

d = 151.40 cm

$$V_c = \frac{V}{b_o d} = \frac{(1701.065)(1000)}{(1245)(151.40)} = 9.024\ KSC > 8.868$$

No pass

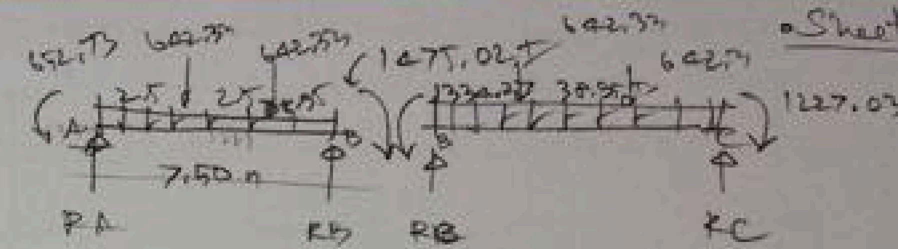
- Try T = 180 cm ; $d = 180 - 10 - 3 - \frac{3.2}{2} = 165.40$

$b_o = (2)(285.40) + (2)(365.4) = 570.80 + 730.80 = 1301.6$

d = 165.40 cm

$$V_c = \frac{(1701.065)(1000)}{(1301.6)(165.40)} = 7.901\ KSC < 8.868\ KSC$$

— ok



- Memb AB

$\Sigma F_y = 0$; RA + RB = (2)(642.50) + (38.95)(7.50)
= 1285 + 292.125
RA + RB = 1577.125 —— (1)

$\Sigma M_A = 0$; 7.5 RB + 652.73 = 1475.02 + 642.5 × 2.5 + 642.5 × 5 + 292.125 × 7.5/2
= 1475.02 + 1606.25 + 3212.5 + 1095.46

7.5 RB + 652.73 = 7389.23

RB = 898.20 T
RA = 678.925 T

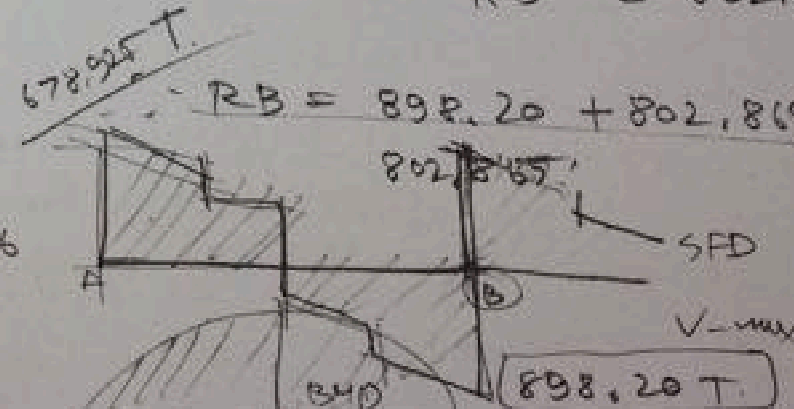
- Member BC

$\Sigma F_y = 0$; RB + RC = 1577.125 —— (1)

$\Sigma M_B = 0$; 7.5 RC + 1334.27 = 1227.03 + 5914.21

∴ RC = 774.26 T
RB = 802.865 T

∴ RB = 898.20 + 802.865 = 1701.065 T



$A_{32mm} = 8.0384\ cm^2$

• หาปริมาณเหล็กเสริมในแนวแกน X–X AXIS

∴ ใช้ความหนา Mat foundation = 180 cm ; d = 165.40 cm

⊖ Max = 1475.02 T–m

⊕ Max = 626.671 T–m

⊖ $A_s = \dfrac{(1475.02)(1000)(100)}{(1700)(0.875)(165.40)} = 599.522\ cm^2$ / 7.50 m strip

• ใช้ 75 DB 32 mm ; $A_s = 75 \times 8.04 = 603\ cm^2$ / strip

steel per metre $= \dfrac{603\ cm^2}{7.50} = 80.4\ cm^2/m$

• spacing DB 32 mm $= \dfrac{8.04\ cm^2}{80.4\ cm^2/m} = 0.10\ m$

• ใช้ DB32 mm @ 0.10 m (–As, X–X AXIS)

⊕ $A_s = \dfrac{(626.671)(1000)(100)}{(1700)(0.875)(165.40)} = 254.71\ cm^2$ / strip

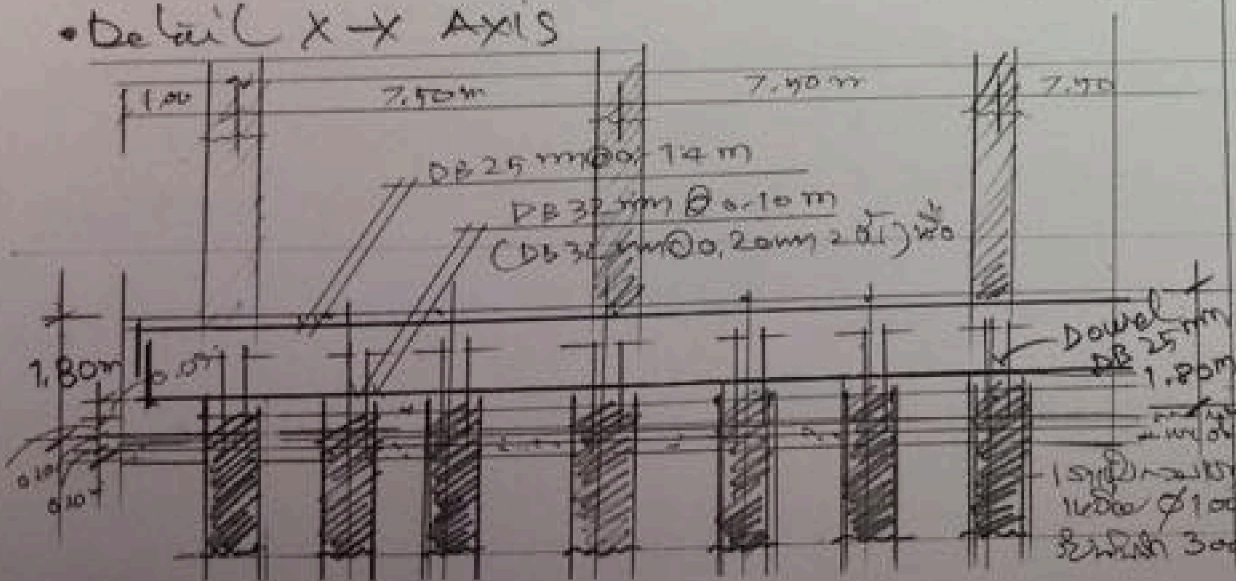
• ใช้ 53 DB 25 mm ; $A_s = 53 \times 4.906 = 260.018\ cm^2$

steel per metre $= \dfrac{260.018}{7.50\ m} = 34.67\ cm^2/m$

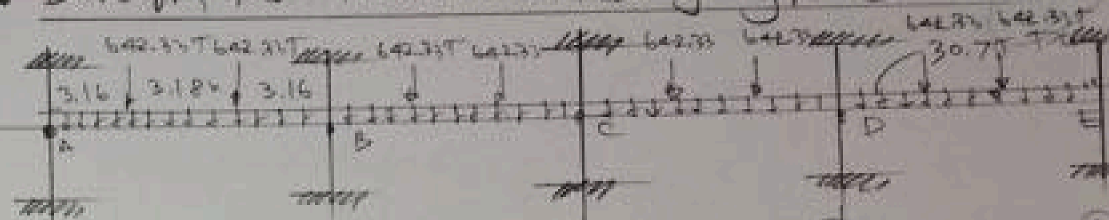
spacing DB 25 mm $= \dfrac{4.906\ cm^2}{34.67\ cm^2/m} = 0.1415\ m \rightarrow 0.14\ m$

• $A_{s\,min} = (0.0018)(100)(180) = 32.4\ cm^2/m < 34.67\ cm^2/m$

• Detail X–X AXIS



• Design Mat foundation แนว y–y AXIS • ต่อที่ 24



Joint	Ⓐ	9.50	Ⓑ	9.50	Ⓒ	9.50	Ⓓ	9.50	Ⓔ
ช่วง	A–B	B–A	B–C	C–B	C–D	D–C	D–E	E–D	
DF	1/2	1/3	1/3	1/3	1/3	1/3	1/3	1/2	
COF	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
FEM	–1565.86	+1565.86	–1565.86	+1565.86	–1565.86	+1565.86	–1565.86	+1565.86	
DM	+782.93	0	0	0	0	0	0	–782.93	
COM	0	+391.50	0	0	0	0	–391.65	0	
DM	0	–130.50	–130.50	0	0	+130.5	+130.50	0	
COM	–65.25	0	0	–65.25	+65.25	0	0	+65.25	
M	–848.18	+1826.86	–1606.36	+1500.61	–1500.61	+1696.36	–1827.01	+848.18	
Mmid	+1255.432		+782.467		+782.467		1255.432		

• $Fem_{AB} = -\left(\dfrac{(30.75)(9.5)^2}{12}\right) - \left(\dfrac{642.33 \times 3.16 \times 6.34^2}{9.50^2}\right) - \left(\dfrac{642.33 \times 6.34 \times 3.16^2}{9.50^2}\right)$

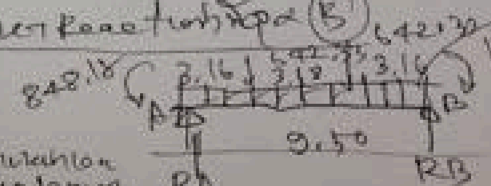
$= -231.265 - 904.016 - 450.582 = -1585.863\ T\text{–}m$

• $M_{mid} = \dfrac{(30.75)(9.5)^2}{8} + \dfrac{(642.33)(9.50)}{3} - \left(\dfrac{848.18 + 1826.86}{2}\right)$

$= 346.898 + 2034.054 - 1155.52$

$= 2380.952 - 1155.52 = +1225.432\ T\text{–}m$

• หา Reaction ที่จุด Ⓑ



$\Sigma F_y = 0 ;\ R_A + R_B = (2)(642.33) + (30.75)(9.50)$

∴ $R_A + R_B = 1576.785\ T$ — ①

$\Sigma M_A = 0 ;\ 9.50 R_B + 848.18 = 1826.86 + 642.33 \times 6.34 + 642.33 \times 3.16 + \dfrac{30.75 \times 9.5^2}{2}$

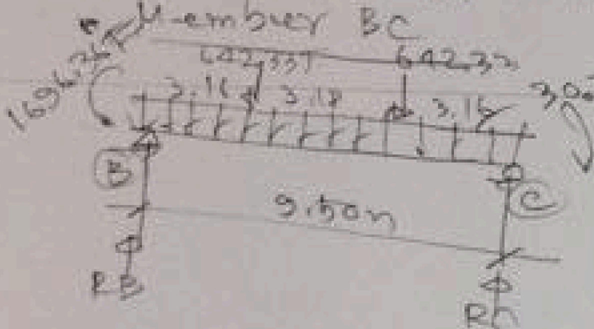
$9.50 RB + 848.18 = 1826.86 + (4072.372 + 2029.763)$

$9.50 RB = 8468.408$

$\therefore RB = 891.411$ T

$AR = 1576.785 - 891.411 = 685.737$ T

• Member BC



$\Sigma F_y = 0 : RB + RC = 1576.875$

$\Sigma M_B = 0 : 9.5 RC + 1696.36$

$= 1500.61 + 7489.728$

$\therefore RC = \frac{7293.978}{9.50} = 767.787$

$\therefore RB = 1576.875 - 767.787$

$= \boxed{809.088 \text{ T}}$

∴ [RB = 891.411 + 809.088
V_{max} = 1700.498 T-m < 1701.065 T-m]

• [T = 180 cm ; d = (165.40 cm)] → ผ่าน check punching shear sheet (23)

ok

• ผลิตเหล็กเสริมแกน y-y Axis

(+) $AS = \frac{(1826.86)(1000)(100)}{(1700)(0.875)(165.40)} = 742.527 \text{ cm}^2$/strip 9.50

• ใช้ 93 DB32 mm ; $AS = 93 \times 8.04 = 747.72 \text{ cm}^2$/strip

• Steel/metre = $\frac{747.72}{9.50} = 78.707 \text{ cm}^2$

• spacing DB32 mm = $\frac{8.04}{78.707} = 0.102$ m → 0.10 m

(−) $AS = \frac{(1255.432)(1000)(100)}{(1700)(0.875)(165.40)} = 510.27 \text{ cm}^2$/strip

• ใช้ 105 DB25 mm ; $AS = 105 \times 4.906 = 515.13 \text{ cm}^2$/strip

• Steel/metre = $515.13 / 9.50 = 54.22 \text{ cm}^2$

• Spacing DB25 mm = $\frac{4.906}{54.22} = 0.09$ m ใช้

Sheet 25

ใช้ DB32 mm ; As = 8.04 cm²/ใช้

• ใช้ 65 DB32 mm ; $AS = 8.04 \times 65 = 522.60 \text{ cm}^2$/Strip 9.50 m

• Steel/metre = $\frac{522.60 \text{ cm}^2}{9.50 \text{ m}} = 55.01 \text{ cm}^2/\text{m}$ (> 32.40 cm²/m)

spacing DB32 mm = $\frac{8.04 \text{ cm}^2}{55.01 \text{ cm}^2/\text{m}} = 0.146$ m → 0.14 m

• Detail Mat Foundation y-y Axis