รายการคำนวณโครงสร้าง

โครงการ : อาคารพักอาศัย 24 ชั้น

สถานที่ : ซ.สุขุมวิท 62 กรุงเทพฯ

เจ้าของ : บ.ไฮเวย์ คอนโดวิลล์ จำกัด

วิศวกร : นาย พิบูล บุตรสง สย.3591

ต.ค 2534

Data Input

Plane Frame No 1.

Total Node = 114 Nodes.

Total Ele. = 194 Elements.

Mat. Properties - Concrete

$E = 2.0 \times 10^9$ Kg/m^2

Set	A (m^2)	I (m^3)	Element
1	1.00X1.20	0.100	1/6 25/30 49/54 73/78
2	1.00X1.00	0.083	7/15 31/39 55/63 79/87
3	1.00X0.80	0.064	16/19 40/43 64/67 88/91
4	1.00X0.70	0.058	20/22 44/46 68/70 92/94
5	0.80X0.70	0.047	23/24 47/48 71/72 95/96
6	0.80X0.80	0.054	97/99 103/105
7	0.70X0.70	0.020	100/101 106/107
8	0.60X0.60	0.011	102 108
9	0.22X9.00	0.008	109/194

Data Input

Shear Wall - Frame Interaction 1

Total Node = 300 Nodes.

Total ELement = 514 Ele.

Concrete Properties

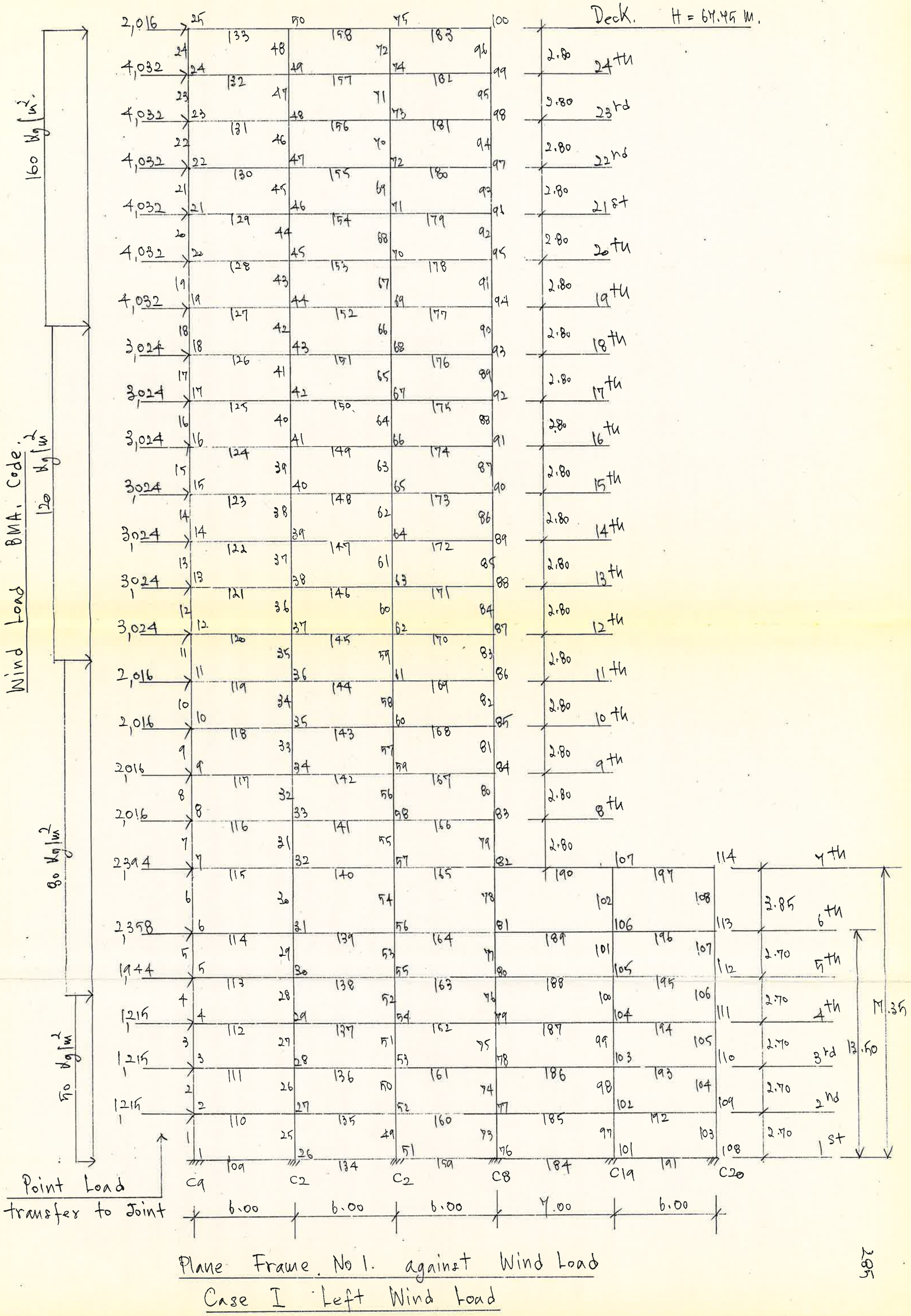
$$E = 2.0 \times 10^9 \quad Kg/m^2$$

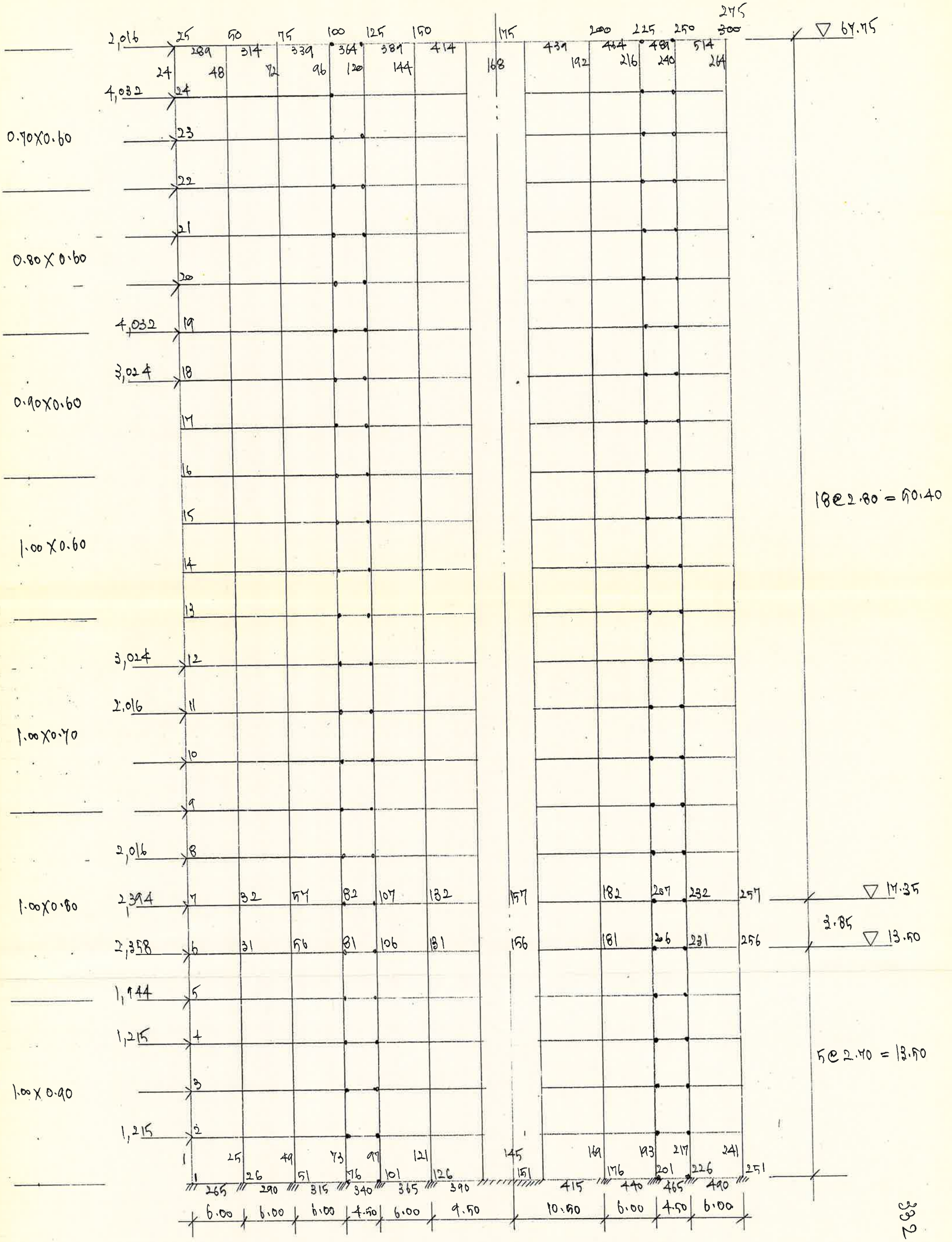
$$G = \frac{E}{2(1+0.15)} = 0.87 \times 10^9 \quad Kg/m^2.$$

Element Data

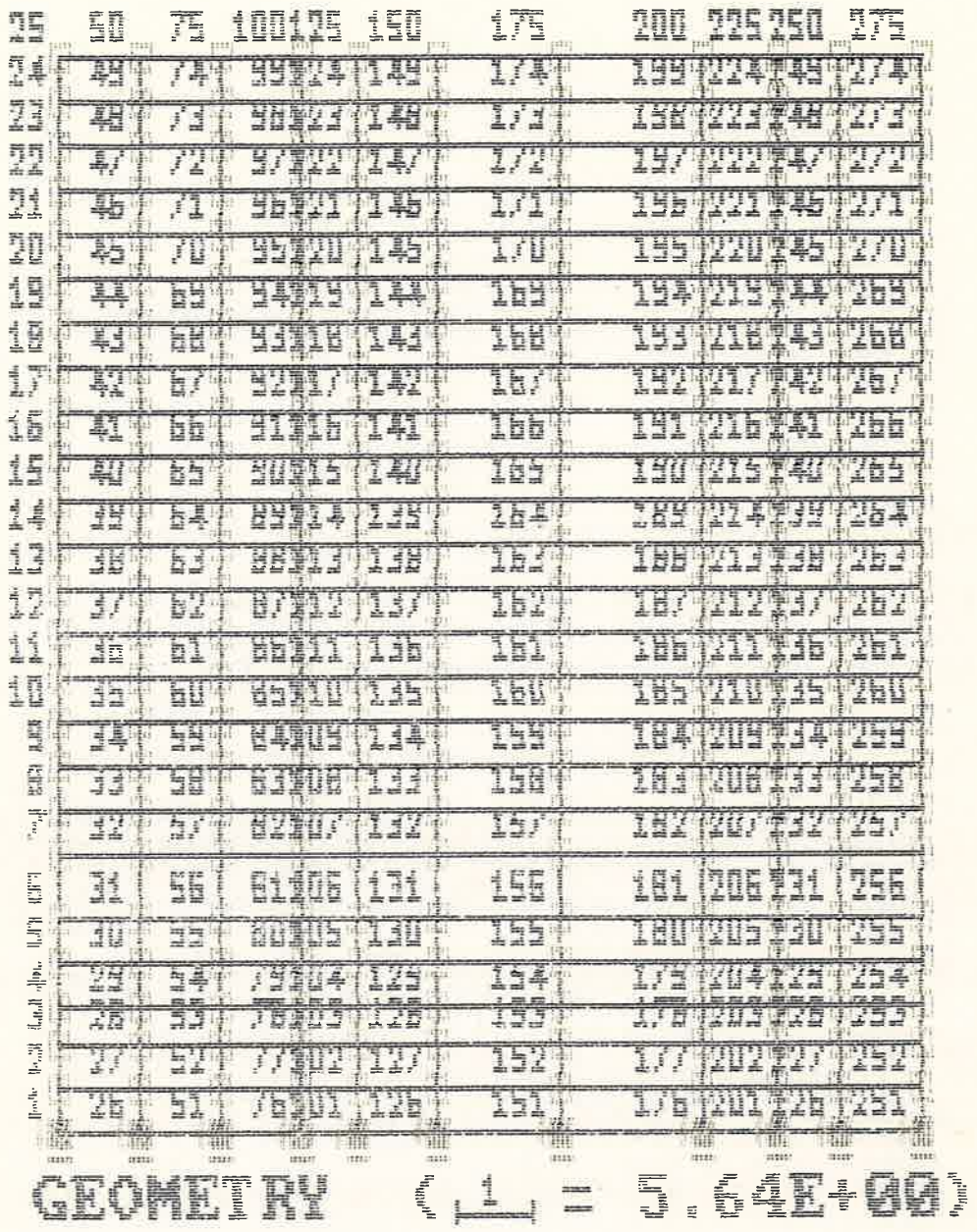
Set	A m^2	I m^4	Elements.	Struct. Part
1.	1.0x0.9	0.045	1/4 25/28 49/52 73/76 97/100 121/124 169/172 193/196 217/220 241/244	Column
2	1.0x0.8	0.067	5/8 29/32 53/56 77/80 101/104 125/128 173/176 197/200 221/224 245/248	"
3	1.0x0.7	0.058	9/12 33/36 57/60 81/84 105/108 129/132 177/180 201/204 225/228 249/252	"
4	1.0x0.6	0.05	13/15 37/39 61/63 85/87 109/111 133/135 181/183 205/207 229/231 253/255	"
5	0.9x0.6	0.036	16/18 40/42 64/66 88/90 112/114 136/138 184/186 208/210 232/234 256/258	"
6	0.8x0.6	0.026	19/21 43/45 67/69 91/93 115/117 139/141 187/189 211/213 235/237 259/261	"
7	0.7x0.6	0.017	22/24 46/48 70/72 94/96 118/120 142/144 190/192 214/216 238/240 262/264	"

8	0.22X4.90	0.004	265/389	440/514	Slab
9	0.22X4.90	0.004	390/414	(Right Rigid End Zone)	Slab
10	9.605	65.917	145/168		Shear Wall
11	0.22X0.40	0.004	415/439	(Left Rigid End Zone)	Slab


Deck. H = 64.45 M.
160 Kg/m²
120 Kg/m² Wind Load BMA. Code.
80 Kg/m²
50 Kg/m²
Point Load transfer to Joint
Plane Frame No 1. against Wind Load
Case I Left Wind Load



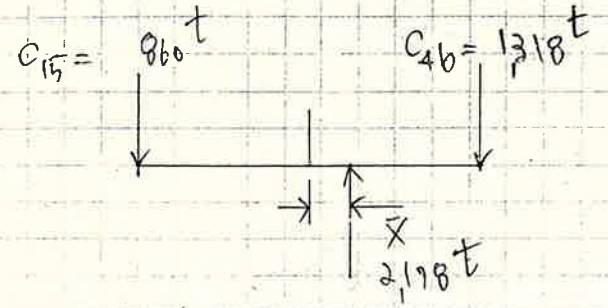
Shearwall - Frame Interaction



GEOMETRY (⌊ = 5.64E+00)

MOMENT (⊥ = 2.95E+06)

Footing 100 FM



Find C.G of Column Load

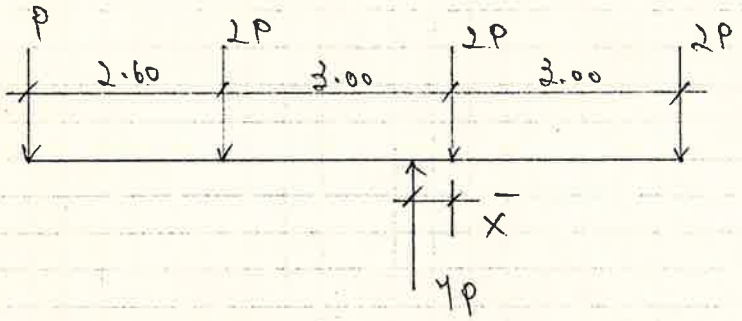
$$\bar{X} = \frac{(1318 - 860)2.25}{2,178} = 0.47 \text{ m.}$$

Total Column Load	=	2,178 t.
Footing Wt	=	220 t
ΣW	=	2,400 t

Use 7 – ϕ 1.00 m. Bored Pile

$$\text{Pile Load} = \frac{2,400}{7} = 343 \text{ t} < 400 \text{ t}$$

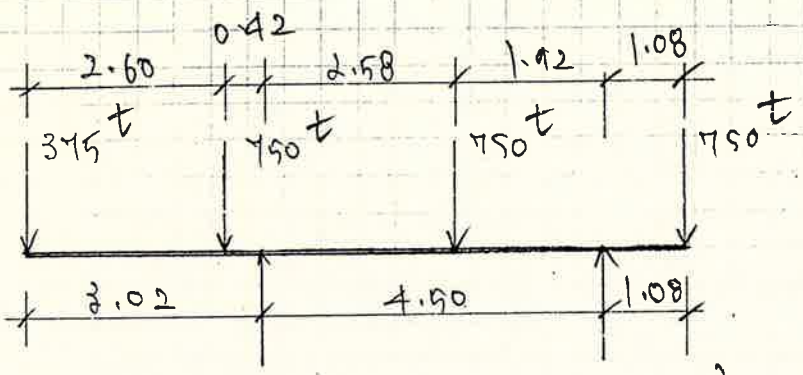
O.K



Find C.G of Pile Load

$$\bar{X} = \frac{5.6\,P}{7P}$$

$$= 0.80 \text{ M.}$$



$A = 5.00 \times 2.30 = 11.5 \ m^2$.

$I = \frac{1}{12} \times 5.00 \times 2.30^3 = 5.04 \ m^4$

$M_L = 1,20,000$ Kg-m. Long Span

$V_L = 450,000$ Kg. Long Span.

$M_T L = 0$

Use $d = 2.30$ m. $t = 2.50$ m.

$$A_{SL} = \frac{1,200,000 \times 100}{1400 \times 0.9 \times 230} = 341. \ cm^2.$$

$$\Sigma_{OL} = \frac{450,000}{16.43 \times 0.9 \times 230} = 214 \ cm$$

$$V_{bL} \text{ at } d = \frac{461,640}{500 \times 230} = 4.02 \ Kg/c.m. < 0.29\sqrt{280} = 4.9 \ Kg/c.m$$

$M_2 = 3 \times 450 \times 1.00 \times 1,000 = 2,250,000$ Kg-m.

$V_2 = 3 \times 450 \times 1,000 = 2,250,000$ Kg.

$$A_{SE} = \frac{2,250,000 \times 100}{1400 \times 0.9 \times 230} = 639 \ cm^2.$$

$$\Sigma_{OE} = \frac{2,250,000}{16.72 \times 0.9 \times 230} = 650 \ cm.$$

Use 104 – D28

Punching Shear.

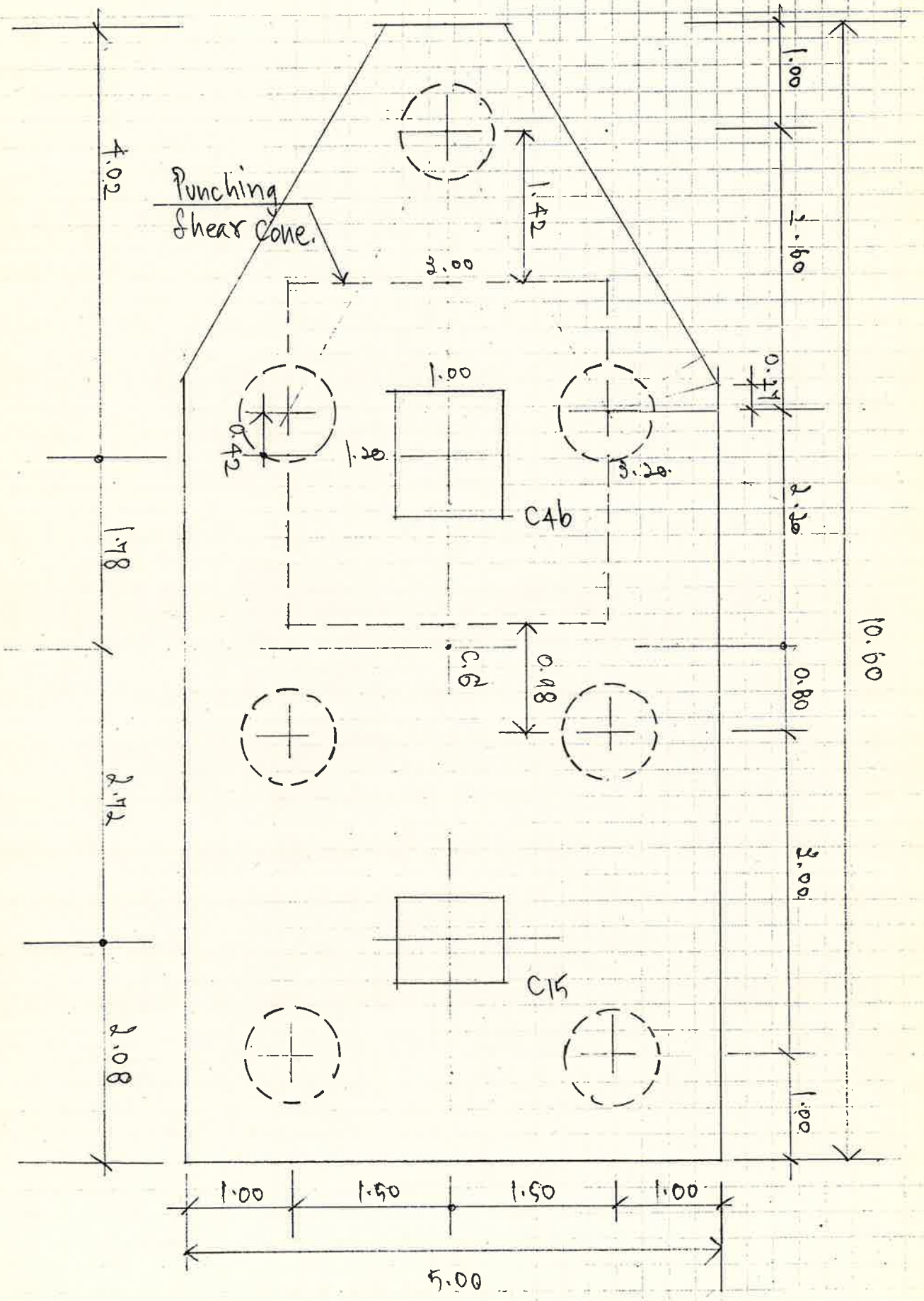
$$P' = \sum_{n=5} \frac{P_n}{dp}\left(x + \frac{dp}{2}\right)$$

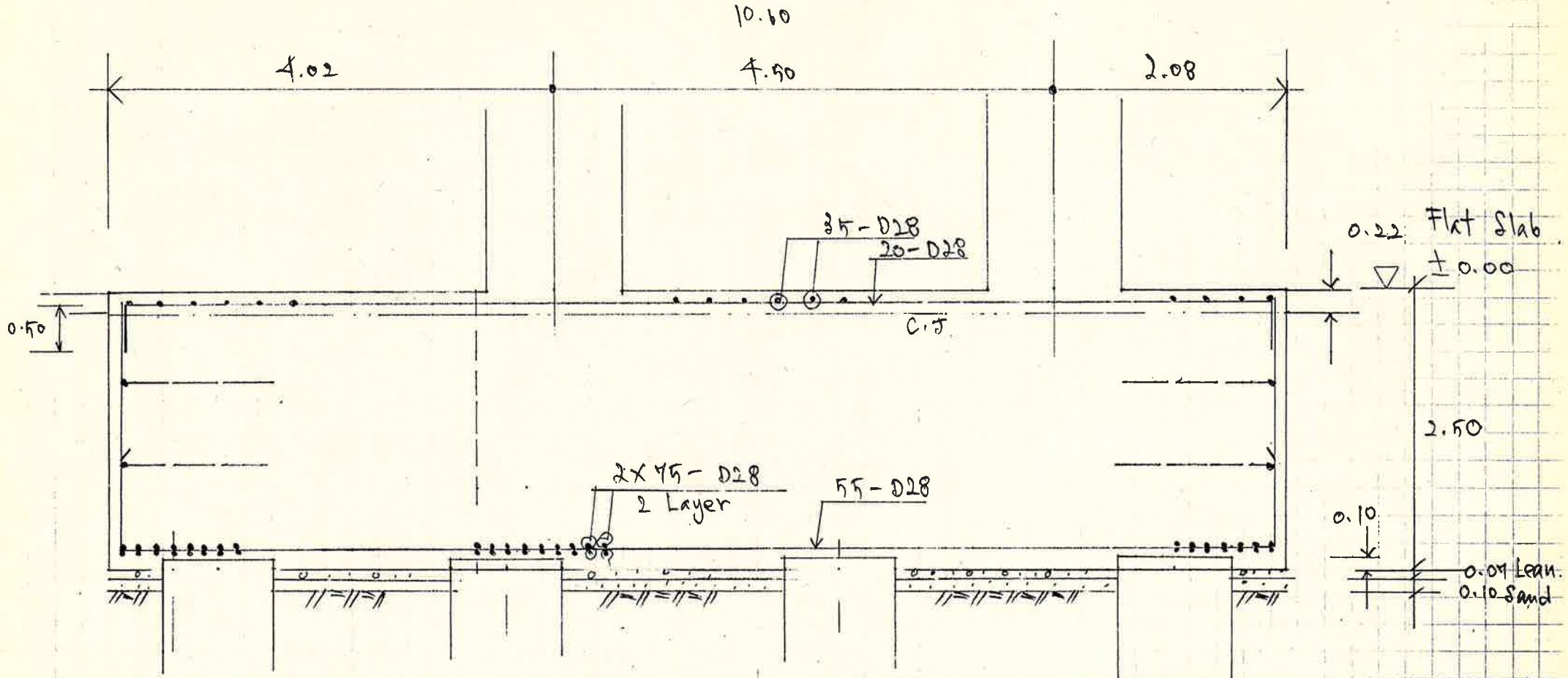
$$= \frac{375}{100}\left\{2(98+50) + 2(0+50) + 1(142+50)\right\}$$

$$= 2,205,000 \ Kg$$

$$V_p = \frac{2,205,000}{(200+320) \times 2 \times 230} = 7.72 \ Kg/c.m < 0.53\sqrt{2} = 8.86 \ Kg/c.m$$

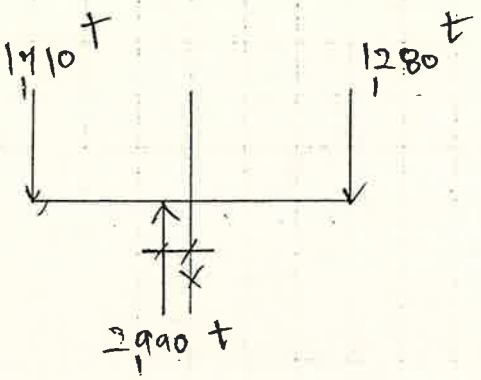
100 FM


Punching
Shear Cone.
4.02
1.42
2.00
1.00
1.60
0.42
1.00
0.42
1.20
3.20
0.42
C46
1.78
2.40
10.60
C.G
0.88
0.80
2.72
3.00
C15
2.08
1.00
1.00
1.50
1.50
1.00
5.00



Section, 100 FY
1 : 100

Footing 120 F4a



Find C.G of Column Load

$$X = \frac{(1,710 \times 3.00 - 1280 \times 3.00)}{2940}$$

$$= 0.43 \text{ m.}$$

Total Column Load = 2,940 t

Footing Wt = 310 t

ΣP = 3,300 t

Use 7- ϕ 1.20 m. Bored Pile

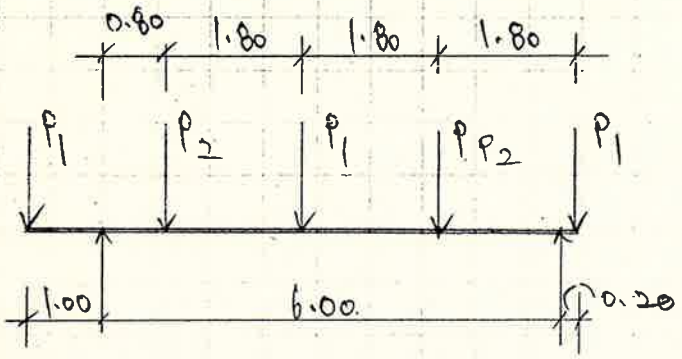
$$\text{Pile Load} = \frac{3,300}{7}$$

$$= 471 \text{ t} < 700 \text{ t} \quad \text{O.K.}$$

$$\text{Footing } A = (9.60 \times 8.64) - (2 \times 2.30 \times 4.00)$$

$$= 64.54 \text{ m}^2$$

Footing 120 FM a



$P_1 = 470$ t $P_2 = 940$ t

$I = \frac{1}{12} \times 8.64 \times 2.00^3 = 5.76$ m^4

$A = 2.00 \times 8.64 = 12.28$ m^2

$W = (8.64 \times 9.60 - \frac{1}{2} \times 3.95 \times 2.30 \times 4) \times 2.00 \times 1.4 = 311$ t

$M_1 = 470{,}000$ Kg-m.

$M_1 = 1{,}457{,}000$ "

$V_b = 454{,}330$ Kg

$f_b = \frac{454{,}330}{864 \times 230} = 2.29$ Ksc $<$ 4.85 Ksc.

$A_{sL} = \frac{470{,}000 \times 100}{1{,}400 \times 0.9 \times 230} = 133.6$ cm^2

Use 25 - D28

$A_{sL} = \frac{1{,}457{,}000 \times 100}{1{,}400 \times 0.9 \times 230} = 414.0$ cm^2

Use 40 - D28

$M_2 = 940 \times 2.52 \times 1{,}000 = 2{,}368{,}800$ Kg-m.

$A_{sB} = \frac{2{,}368{,}800 \times 100}{1{,}400 \times 0.9 \times 230} = 673$ cm^2

Use 110 - D28.

Punching Shear

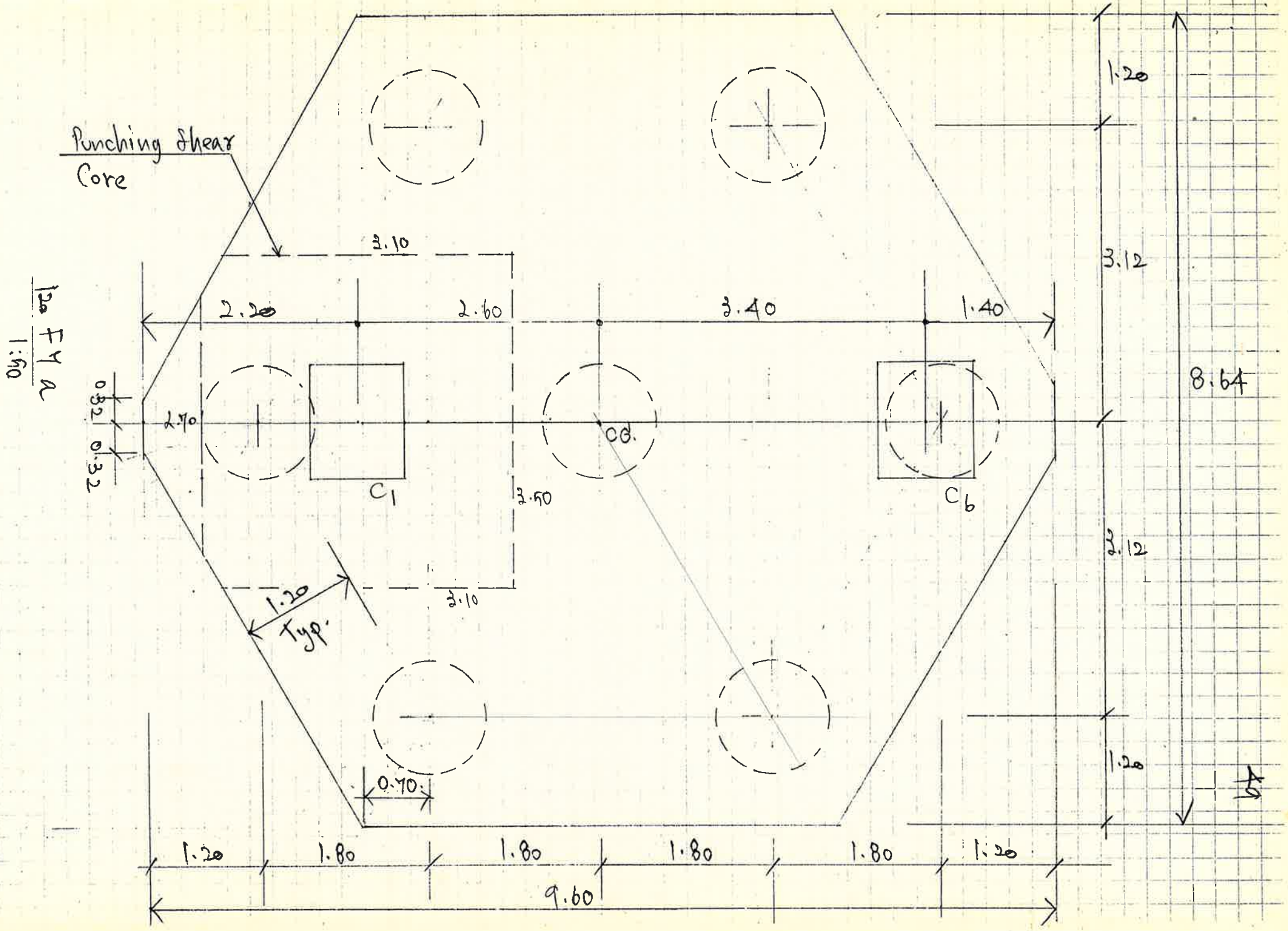
$$P' = \sum_{n=4} \frac{P_n}{dp}\left(x + \frac{dp}{2}\right)$$

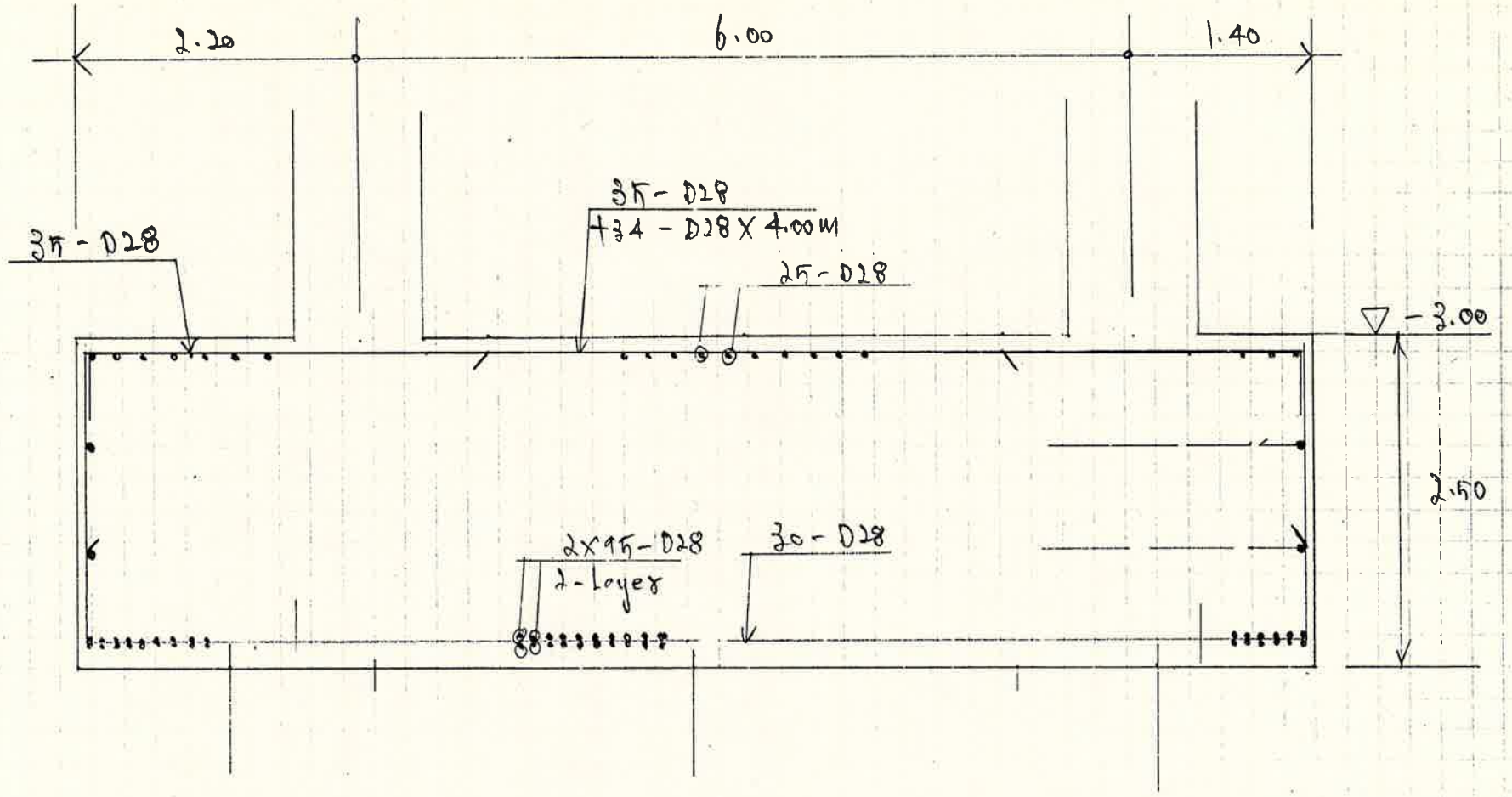
$$= \frac{470}{120}\left\{2(137+60) + (95+10) + (-60+60)\right\}$$

$$= 2,127,000 \quad Kg.$$

$$Vp = \frac{2,127,000}{\left\{(310\times2)+240+290\right\}\times230} = 4.46 \text{ Ksc.} < 8.80 \text{ Ksc}$$

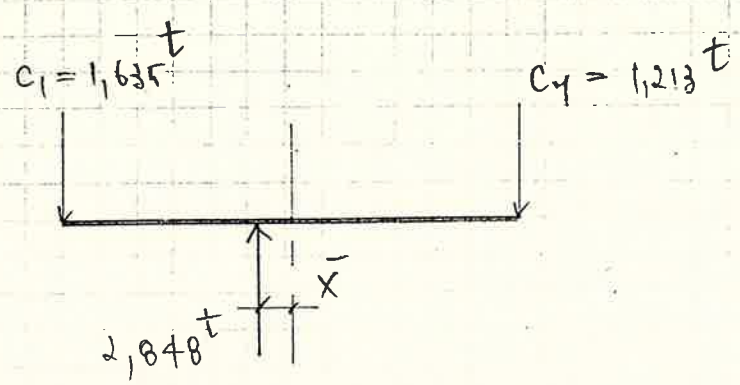
O.K


Punching shear
Core
3.10
2.20
2.60
3.40
1.40
1.20
3.12
8.64
2.12
1.20
0.32
0.32
2.70
CG.
C1
C6
3.50
3.10
1.20
Typ.
0.70
1.20
1.80
1.80
1.80
1.80
1.20
9.60



Section, 120 F M a
1:50

Footing 120 F-1b



Find C.G of Colown Load

$$\bar{X} = \frac{(1,635 - 1213) \times 3.00}{2848} = 0.44 \text{ M.}$$

Total Colown Load = 2,848 t

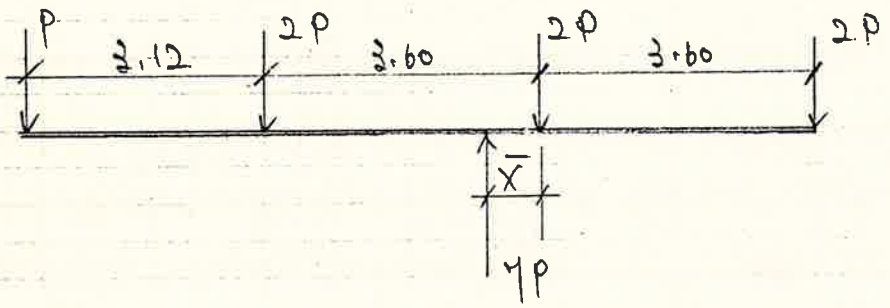
Footing Wt = 402 t

ΣN = 3,250 t

$$\text{Req'd Pile } \phi 1.20 \text{ M} = \frac{3,250}{500} = 6.5 \sim 7 \text{ Nos}$$

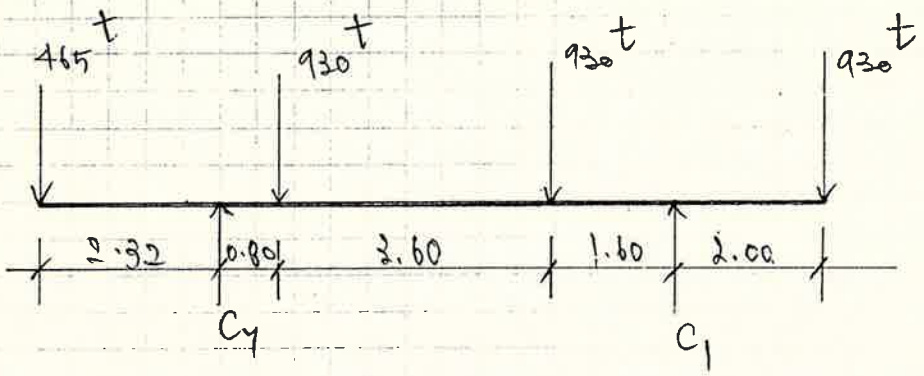
$$\text{Pile Load} = \frac{3,250}{7} = 465 \text{ t}$$

Find C.G of Pile Load



$$\bar{X} = \frac{6.42\,P}{7.P} = 0.96 \text{ M.}$$

Footing A = $(12.72 \times 6.00) - (2.30 \times 4.00)$ = 67.12 M^2.



$\bar{M}_L$ = 930 X 1.50 X 1,000 = 1,395,000 Kg-m.

M^+_L = $\frac{930 \times 1.60 (3.60 + 1.60)}{6.00} - \left(1,048.8 + \frac{781.2 \times 4.40}{6.00}\right)$

= 1,289.6 − 1,651.68 = − 362,080 Kg-m.

$\bar{M}_3$ = 3 X 465 X 1.20 X 1,000 = 1,674,000 Kg-m

$\bar{A}_{sL}$ = $\frac{1,395,000 \times 100}{1,400 \times 0.9 \times 230}$ = 396 cm²

Use 65 - D28

$\bar{A}_{s3}$ = $\frac{1,674,000 \times 100}{1,400 \times 0.9 \times 230}$ = 476 cm².

Use 80 - D28

Punching Shear

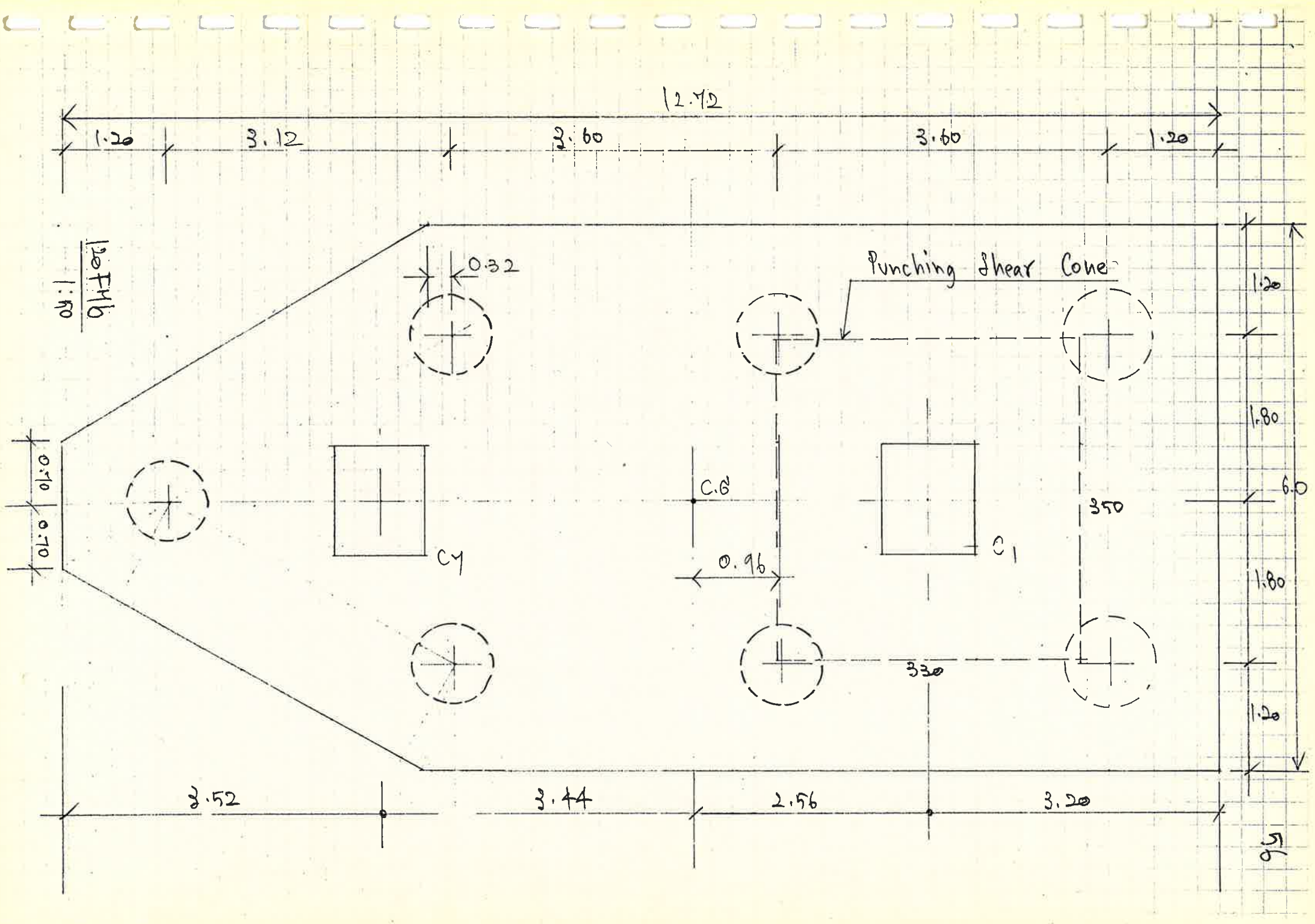
$$P' = \sum_{n=4}^{1} \frac{P_n}{dp} \left(x + \frac{dp}{2}\right)$$

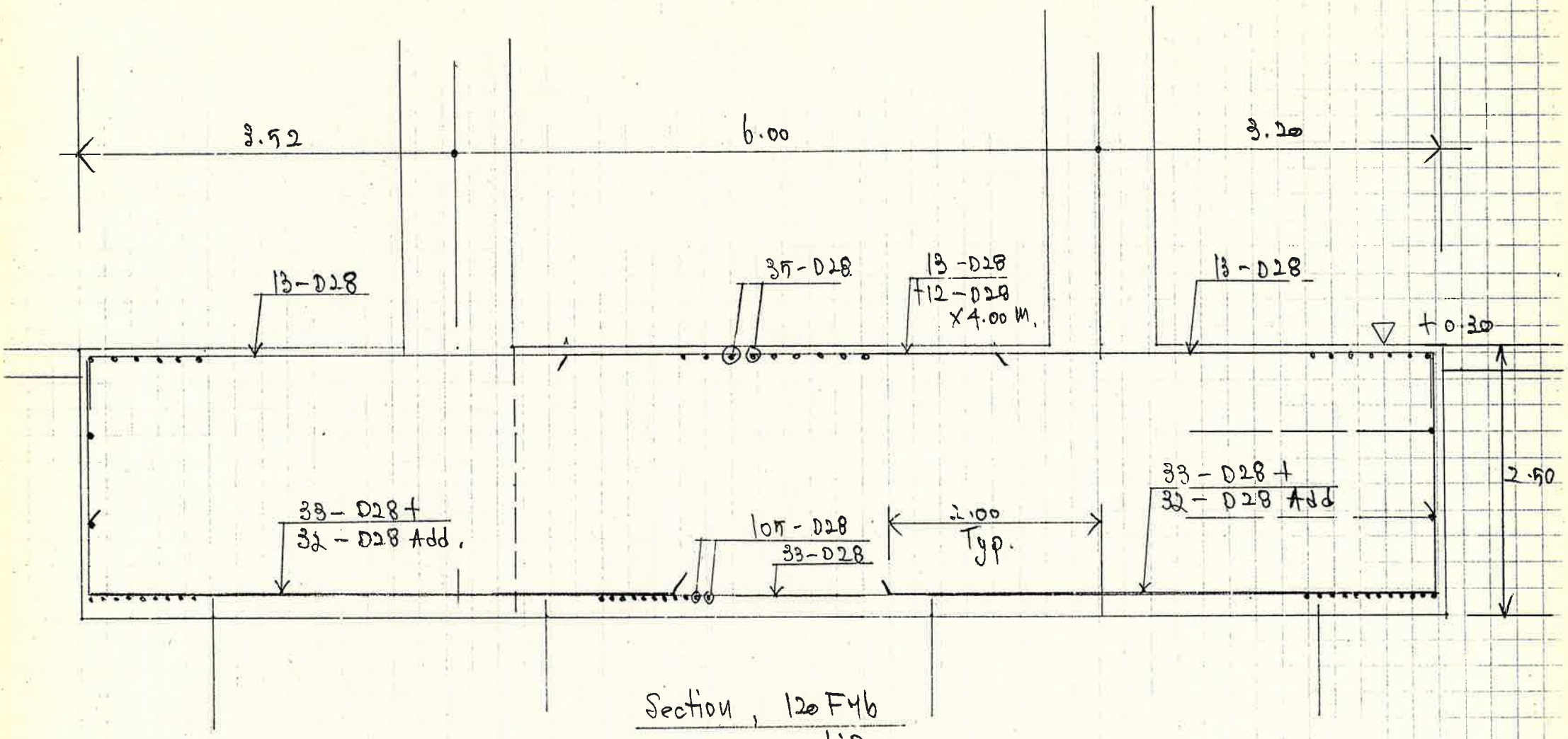
= $\frac{465}{120} \left\{ (35+60)2 + (5+60)2 \right\}$

= 1,240,000 Kg.

V_p = $\frac{1,240,000}{2(330+350) \times 230}$ = 3.96 Ksc < 8.86 Ksc

O.K

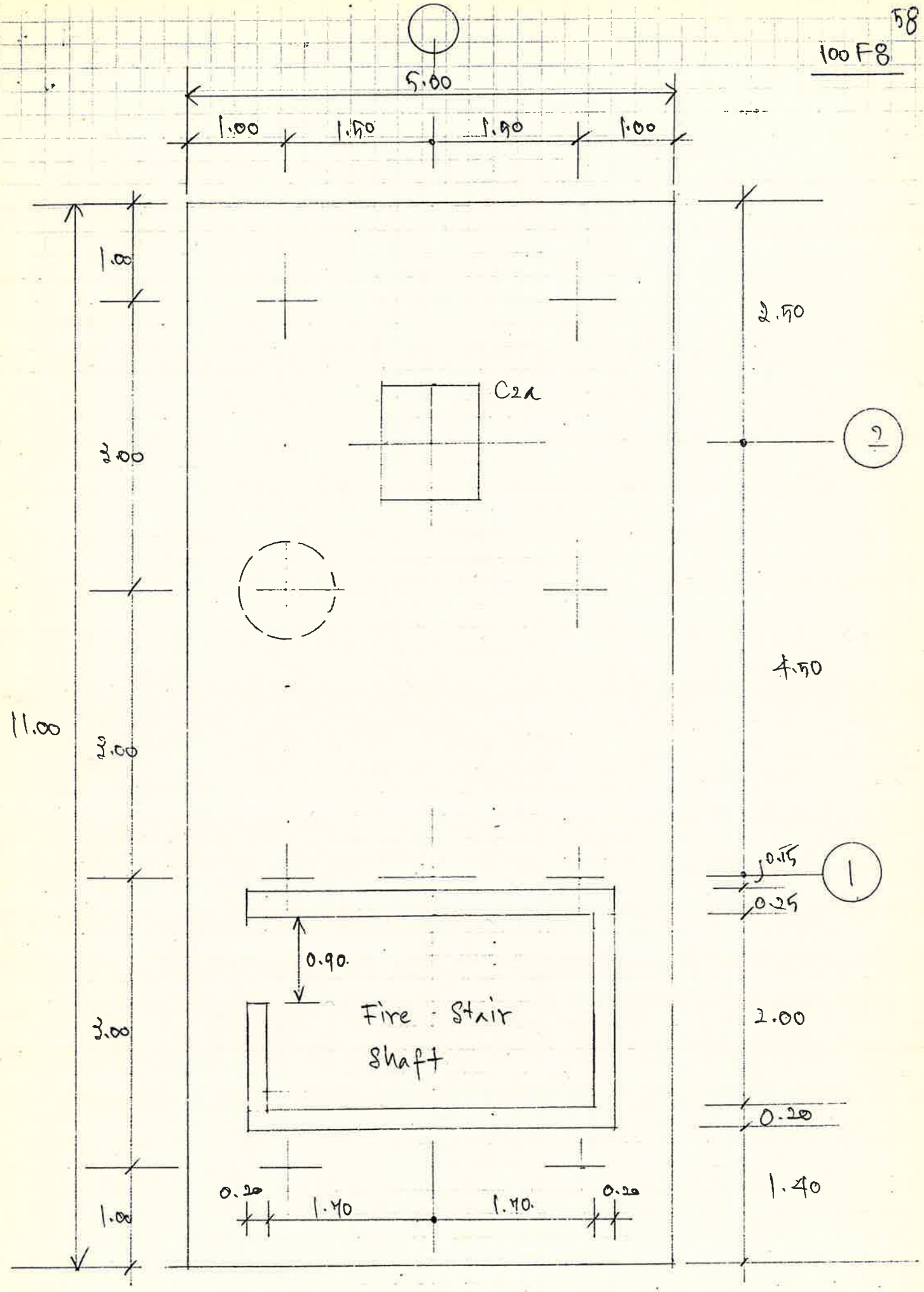

12.72
1.20
3.12
3.60
3.60
1.20
4:1
0.32
Punching Shear Cone
1.20
1.80
6.0
350
C.G
0.96
C4
C1
0.70
0.70
330
1.80
1.20
3.52
3.44
2.56
3.20
9.5



Section, 120 F46

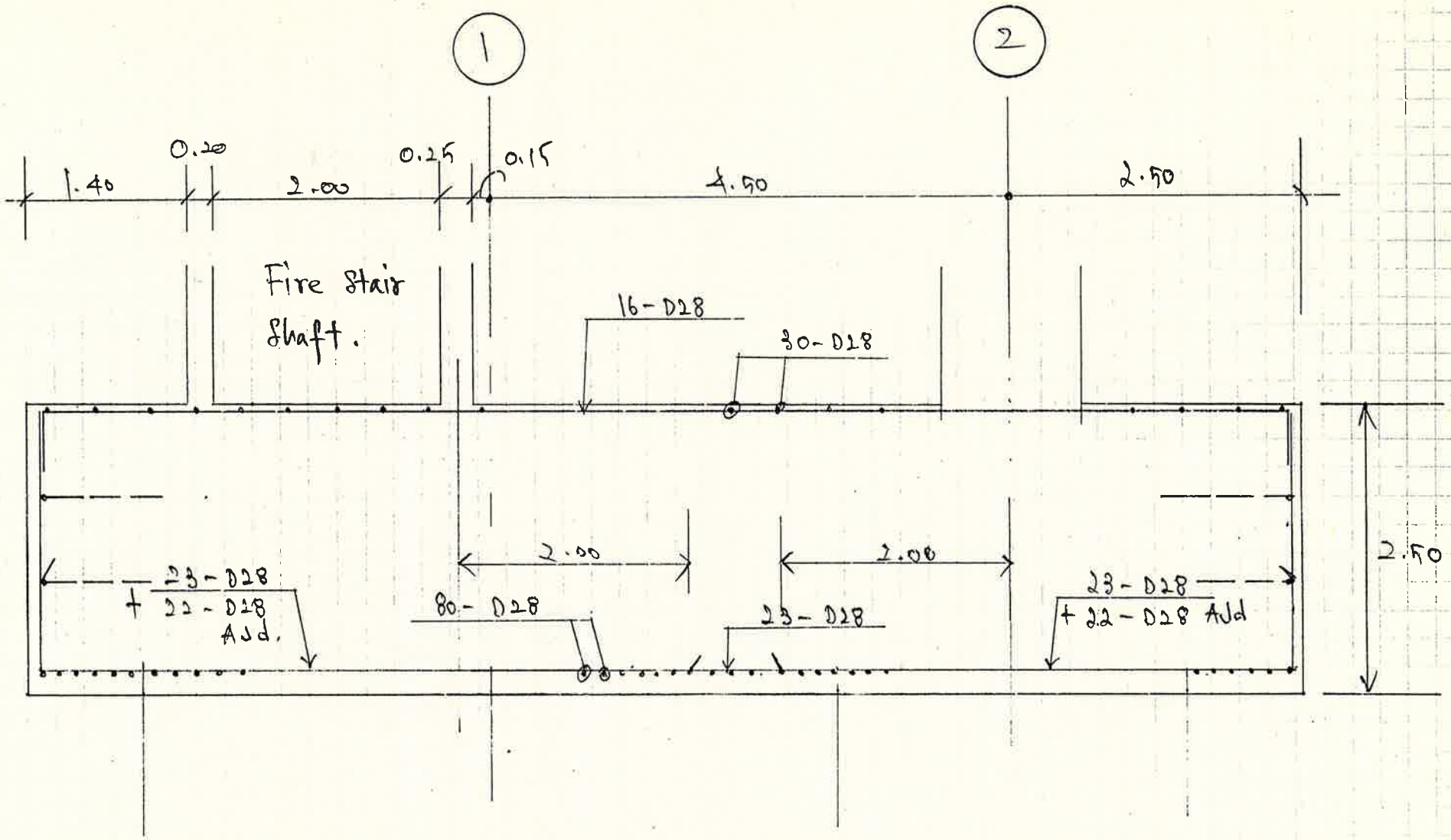
1:50

100 F8



100 F8

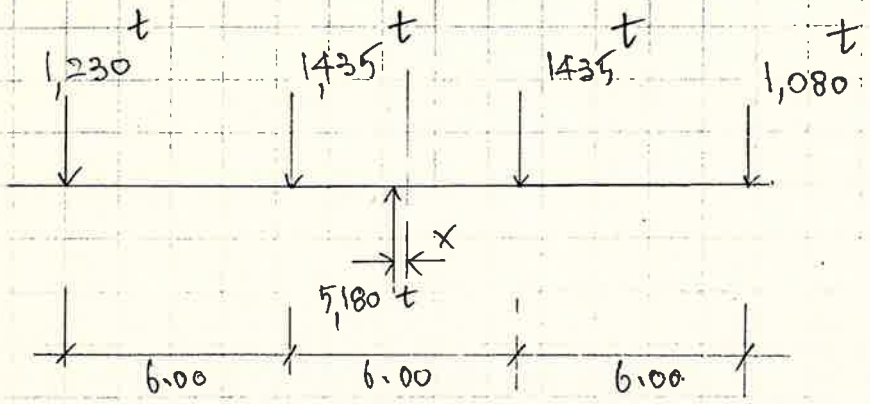
1:50



Section , 100 F 8

1:50

Footing 120 F12



Find C.G of Column Load

$$1{,}435(3.00+X) + 1{,}080(9.00+X) = 1{,}230(9.00-X) + 1{,}435(3.00-X)$$

$$4{,}305 + 1435X + 9{,}720 + 1{,}080X = 11{,}070 - 1{,}230X + 4{,}305 - 1{,}435X$$

$$5{,}180X = 1{,}350$$

$$X = 0.26 \text{ m.}$$

Total Column Load = 5,180 t

Footing Wt = 770 t

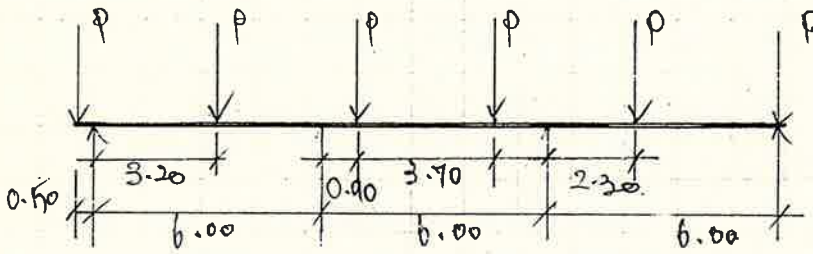
ΣP = 5,950 t

Use 12 - ϕ 1.20 m. Bored Pile

Pile Load = $\frac{5{,}950}{12}$

= 496 t < 500 t

O.K.



Design as Invert Beam supported by Columns

$P = 2 \times 496 = 992$ t

$\bar{M}_L = 1,041,400$ Kg-m.

$M^+_L = 709,400$ "

$V_b = 590,200$ Kg.

$$f_b = \frac{590,200}{600 \times 230} = 4.28 \text{ Ksc} < 4.85 \text{ Ksc.}$$

$$\bar{A}_{sL} = \frac{1,041,400 \times 100}{1,400 \times 0.9 \times 230} = 295.9 \text{ cm}^2$$

Use 11 - D28

$$A^+_{sL} = \frac{709,400 \times 100}{1,400 \times 0.9 \times 230} = 201.6 \text{ cm}^2.$$

Use 8 - D28.

$\bar{M}_S = 6 \times 416 \times 1.20 = 3,571,200$ Kg-m.

$$\bar{A}_S = \frac{3,571,200 \times 100}{1,400 \times 0.9 \times 230} = 1,014.8 \text{ cm}^2$$

Use 16 - D28

Punching Shear

$$P' = \sum_{n=1}^{4} \frac{P_n}{d_p}(X + \frac{d_p}{2})$$

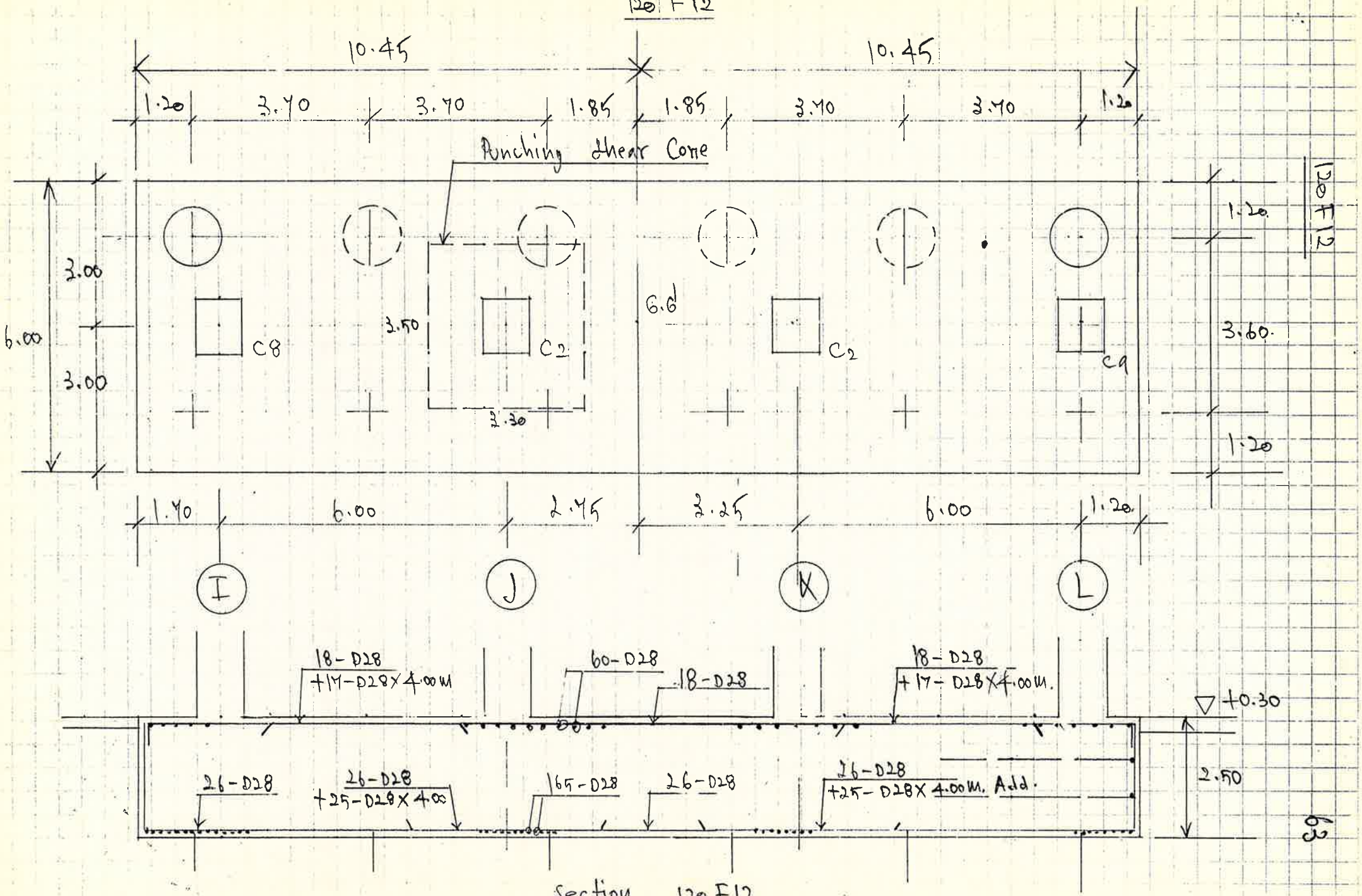
$$= \frac{496}{120}\{2(75 + 60) + 2(120 + 60)\}$$

$$= 2,025,000 \quad Kg.$$

$$V_p = \frac{2,025,000}{2(350+330) \times 230} = 6.47 \text{ Ksc.} < 8.86 \text{ Ksc.}$$

O.K

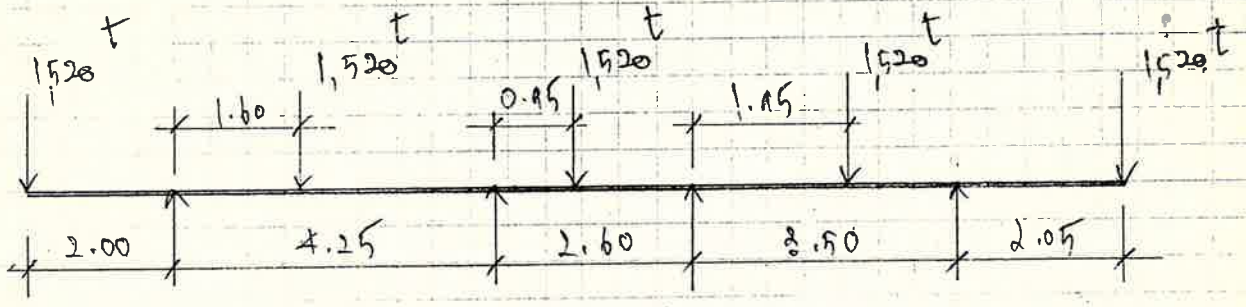
120 F12



Section, 120 F12
1:100

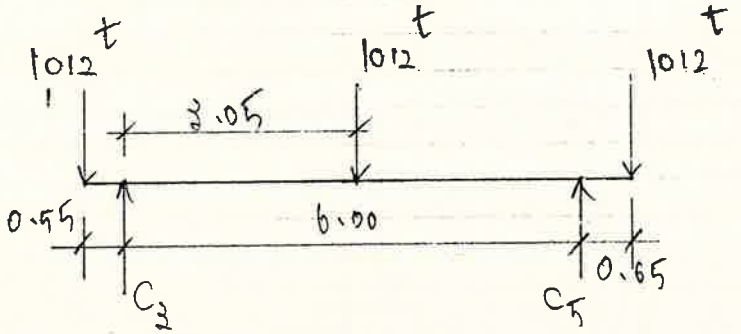
Footing 120 F15

Long Span

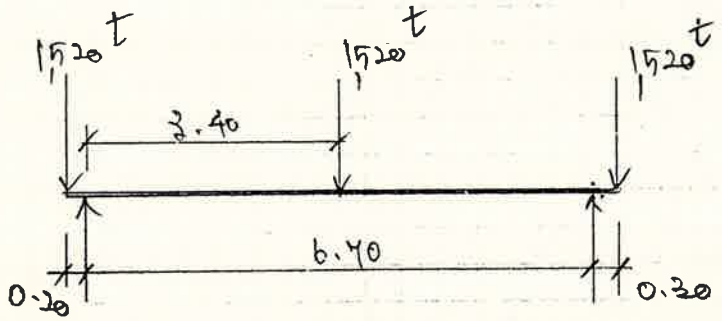


$A = 9.60 \times 2.30 = 22.08 \ m^2$

$I = \frac{1}{12} \times 9.60 \times 2.30^3 = 9.73 \ m^4$



Short Span 1
Column Zone



Short Span 2
Core Zone

$$M^-_{s1} = 1{,}012 \times (0.65 - 0.5) = 151.8 \text{ t-m}$$

$$M^+_{s1} = \frac{1{,}012 \times 6.00}{4} - 151.8 = 1{,}366.2 \text{ "}$$

$$V_b = \frac{1{,}012}{2} = 506 \text{ t}$$

$$A_{s1} = \frac{151.8 \times 1{,}000 \times 100}{1{,}400 \times 0.9 \times 230} = 43.1 \text{ cm}^2 \text{ , } 10 - D28$$

$$A^+_{s2} = \frac{1{,}366.2 \times 1{,}000 \times 100}{1{,}400 \times 0.9 \times 230} = 388.2 \text{ cm}^2 \text{ , } 65 - D28$$

$$v_b = \frac{506 \times 1{,}000}{660 \times 230} = 3.33 \text{ Kgc} < 4.85 \text{ Kgc.}$$

$$M^-_{s2} = 1{,}520 \times (0.30 - 0.15) = 228 \text{ Kg-m}$$

$$M^+_{s2} = \frac{1{,}520 \times 6.40}{4} - 152 = 2{,}394 \text{ "}$$

$$V_b = 760 + 760$$

$$A_{s2} = \frac{228 \times 1{,}000 \times 100}{1{,}400 \times 0.9 \times 230} = 64.8 \text{ cm}^2 \text{ , } 12 - D28$$

$$A^+_{s2} = \frac{2394 \times 1000 \times 100}{1400 \times 0.9 \times 230} = 680.3 \text{ cm}^2 \text{ , } 115 - D28$$

$$v_b = \frac{760 \times 1{,}000}{1{,}020 \times 230} = 3.24 \text{ Kgc} < 4.85 \text{ Kgc.}$$

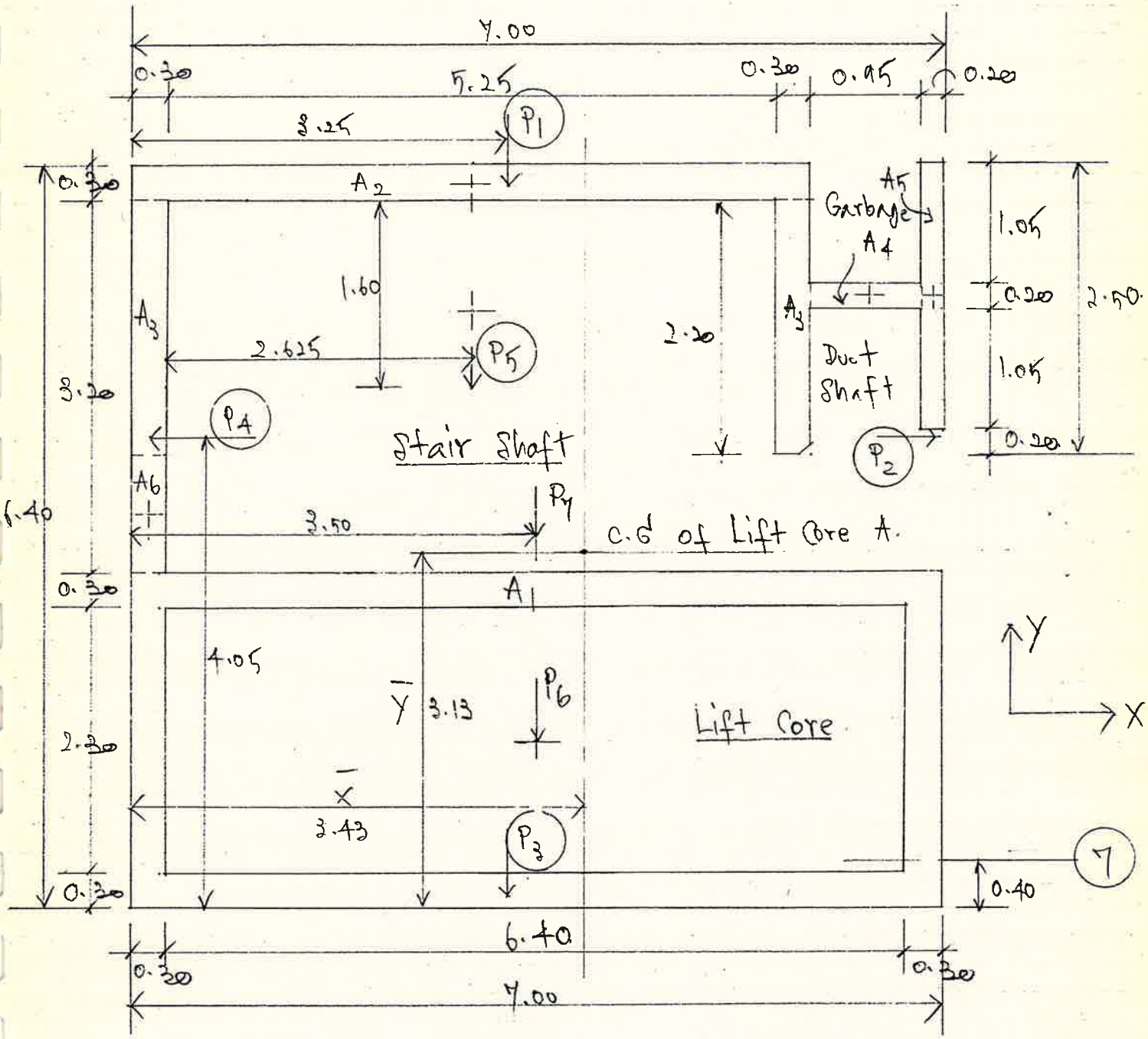
Punching Shear

$$P' = \sum_{n=4}^{} \frac{P_n}{d_p} \left(x + \frac{d_p}{2}\right)$$

$$= \frac{506}{120} \left\{ (25+60) + \frac{2}{2}(125+60) + (-25+60) \right\}$$

$$= 1{,}328{,}000 \text{ Kg.}$$

$$V_p = \frac{1{,}328{,}000}{2(330+320) \times 230} = 4.44 \text{ Kgc.} < 8.86 \text{ Kgc.}$$



Plan of Lift Core and Stair Shaft

1:50

$P_1 - P_5$ = Floor Loads transfer to Core.

P_6 = Machine Rm. Load.

P_4 = Roof Load

1) Find C.G of Lift Core Area

$A_1 = (4.00 \times 2.90) - (1.40 \times 2.30) = 8.58$ m^2

$A_2 = 8.85 \times 0.30 = 1.755$ "

$A_3 = 2 \times 2.20 \times 0.30 = 1.32$ "

$A_4 = 0.95 \times 0.20 = 0.19$ "

$A_5 = 2.30 \times 0.20 = 0.46$ "

$A_6 = 1.00 \times 0.30 = 0.30$ "

$\Sigma A = 9.605$ "

$$\bar{X}_1 = \frac{3.50A_1 + 2.925A_2 + 2.925A_3 + 6.325A_4 + 6.90A_5 + 0.15A_6}{\Sigma A}$$

$$= \frac{32.945}{9.605} = 3.43 \text{ m.}$$

$$\bar{Y}_1 = \frac{1.45A_1 + 6.25A_2 + 8.00A_3 + 8.25A_4 + 8.25A_5 + 3.40A_6}{\Sigma A}$$

$$= \frac{30.092}{9.605} = 3.13 \text{ m.}$$

Total Wt of Lift Core $= (9.605 \times 72.00 \times 2.4)$

$-(3 \times 0.80 \times 1.80 \times 0.30 \times 2.4 \times 24)$

$= 1585$ t

Moment of Inertia of Lift Core

$I_y = \Sigma I + Ad^2$

$I_1 = \frac{1}{12} \times 2.90 \times 7.00^3 - \frac{1}{12} \times 2.30 \times 6.40^3 = 32.647 \ m^4$

$I_2 = \frac{1}{12} \times 0.30 \times 5.85^3 = 5.005 \ m^4$

$I_3 = \frac{1}{12} \times 2.20 \times 0.30^3 = 0.005 \ m^4$

$I_4 = \frac{1}{12} \times 0.20 \times 0.95^3 = 0.014 \ m^4$

$I_5 = \frac{1}{12} \times 2.30 \times 0.20^3 = 0.002 \ m^4$

$I_6 = \frac{1}{12} \times 1.00 \times 0.30^3 = 0.002 \ m^4$

$I_y = 32.647 + (5.58 \times 0.07^2) + 5.005 + (1.955 \times 0.505^2)$
$+ 0.005 + (1.32 \times 3.28^2) + 0.005 + (1.32 \times 2.27^2)$
$+ 0.014 + (0.64 \times 2.895^2) + 0.002 + (0.46 \times 3.47^2)$
$+ 0.002 + (0.32 \times 3.28^2)$

$= 69.517 \ m^4.$

Floor Load Transfer to Core

$P_4 = 4.00 \times 6.40 \,(1.0 + 0.6) = 42$ t

$P_6 = 4.00 \times 2.60 \,(0.5 + 0.6) = 10$ t

$A_1 = \frac{1}{2}\,(13.00 + 4.00)\,2.75 = 24.50$ m^2

$A_2 = \frac{1}{2}\,(12.20 + 6.40)\,2.75 = 25.575$ "

$A_3 = \frac{1}{2}\,(13.00 + 4.00)\,2.05 = 10.25$ "

$A_4 = \frac{1}{2}\,(12.20 + 6.40)\,3.25 = 30.225$ "

$P_1 = \{24.50\,(0.20 + 0.58) + (13.00 \times 2.60 \times 0.18)\} \times 18 = 536$ t

$\{24.50 \times (0.40 + 0.58)\} \times 5 = 183$ t

$\{24.50 \times (0.40 + 0.58) + 6.08\} \times 1 = 43$ t

$\Sigma P_1 = 862$ t

$P_2 = \{25.575\,(0.20 + 0.58) + (2.80 \times 2.60 \times 0.18)\} \times 17 = 362$ t

$25.575\,(0.20 + 0.58) \times 1 = 20$ t

$25.575\,(0.40 + 0.58) \times 6 = 151$ t

$\Sigma P_2 = 533$ t

$P_3 = \{(10.25 - 0.40)(0.20 + 0.58) + 2.80 \times 2.60 \times 0.18\} \times 17 = 149$ t

$10.25 \times (0.30 + 0.58) \times 1 = 10$ t

$10.25 \times (0.40 + 0.58) \times 6 = 60$ t

$\Sigma P_3 = 219$ t

$P_4 = \{(30.225 - 0.225)(0.20 + 0.58) + (4.60 \times 2.60 \times 0.18)\} \times 16 = 409$ t

$\{30.225\,(0.30 + 0.58) + (4.00 \times 0.18)\} \times 2 = 54$ t

$30.225\,(0.40 + 0.58) \times 6 = 148$ t

$\Sigma P_4 = 644$ t

$P_7 = 0.80 \times 5.25 \times 3.20 \times 25 = 336^{t}$

$\sum P_{1-7} = 2,676^{t}$

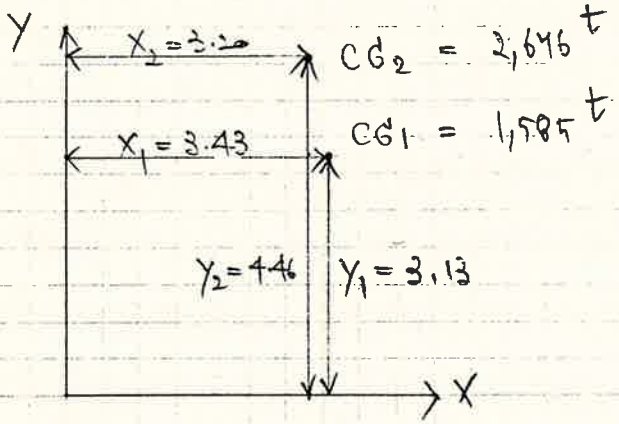
Find C.G of Floor Load

$$\bar{X}_2 = \frac{3.25P_1 + 6.90P_2 + 3.25P_3 + 0.15P_4 + 2.925P_5 + 3.50P_6 + 3.90P_7}{2676}$$

$$= \frac{8,554}{2,676} = 3.20 \text{ m}$$

$$\bar{Y}_2 = \frac{6.25P_1 + 4.05(P_2 + P_4) + 0.15P_3 + 4.50P_5 + 1.45P_6 + 3.20P_7}{2676}$$

$$= \frac{11,944}{2676} = 4.46 \text{ m.}$$

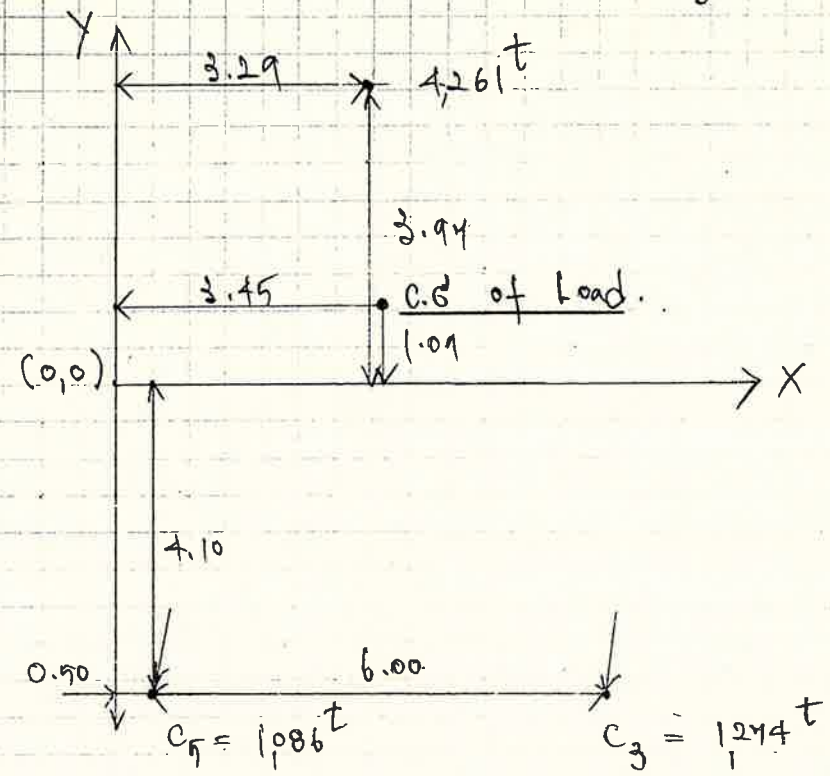


Find C.G of Lift Core & Stair Shaft load

$$\bar{X} = \frac{(2,676 \times 3.20) + (1,585 \times 3.43)}{4,261} = 3.29 \text{ m.}$$

$$\bar{Y} = \frac{(2,676 \times 4.46) + (1,585 \times 3.13)}{4,261} = 3.94 \text{ m.}$$

∴ Find C.G of All Load transfer to Footing



$$\bar{X} = \frac{(4261 \times 3.29) + (1,086 \times 0.50) + (1,274 \times 6.50)}{6,621}$$

$$= 3.45 \text{ m.}$$

$$\bar{Y} = \frac{(4,261 \times 3.94) - (1086 + 1,274)\,4.10}{6,621}$$

$$= 1.09 \text{ m.}$$

Total Load	=	6,621	t
Footing Load	=	968	t
ΣW	=	7,589	t

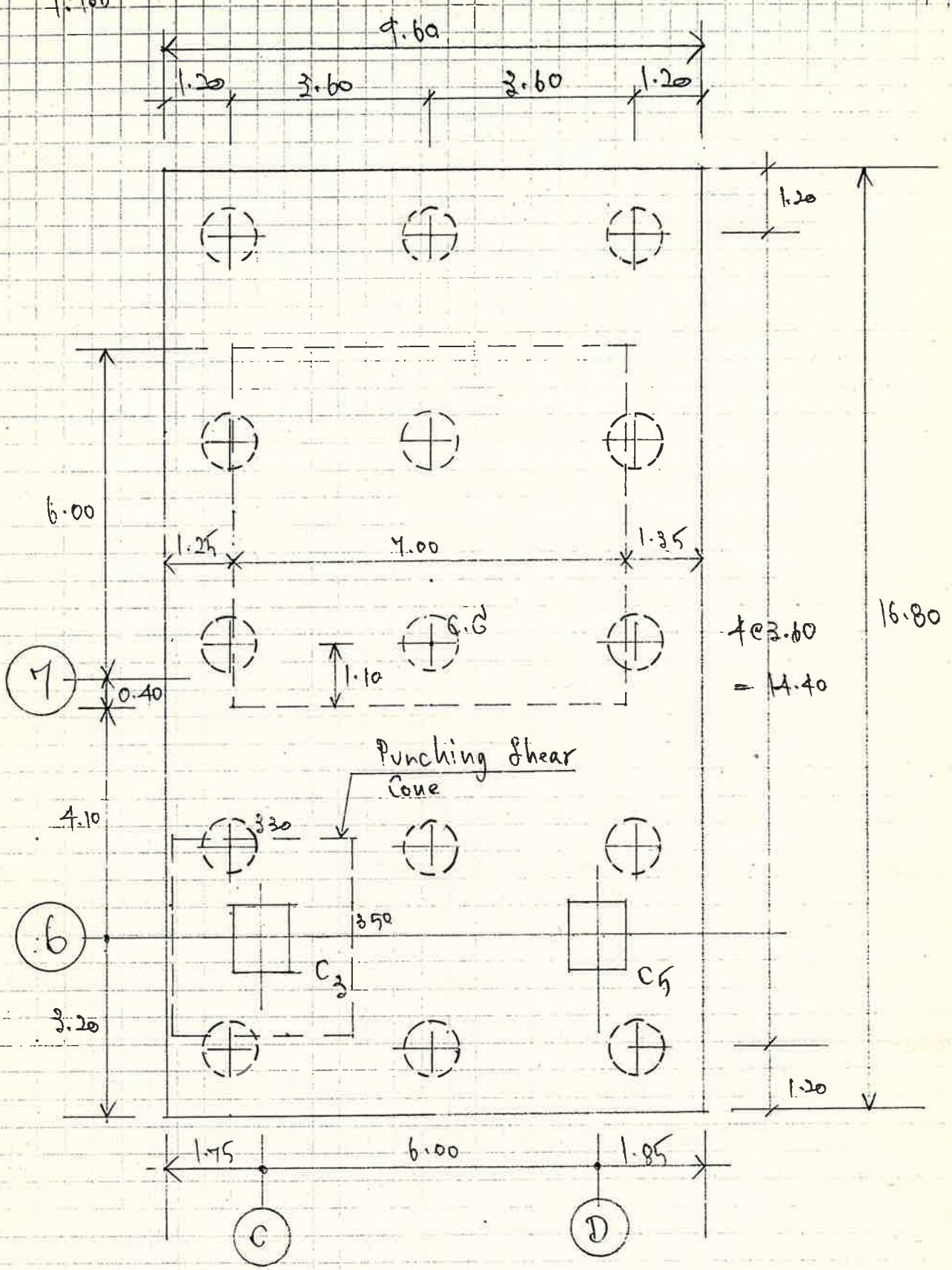
Req'd ϕ 1.20 m Pile = $\frac{7,589}{500}$ = 15.18

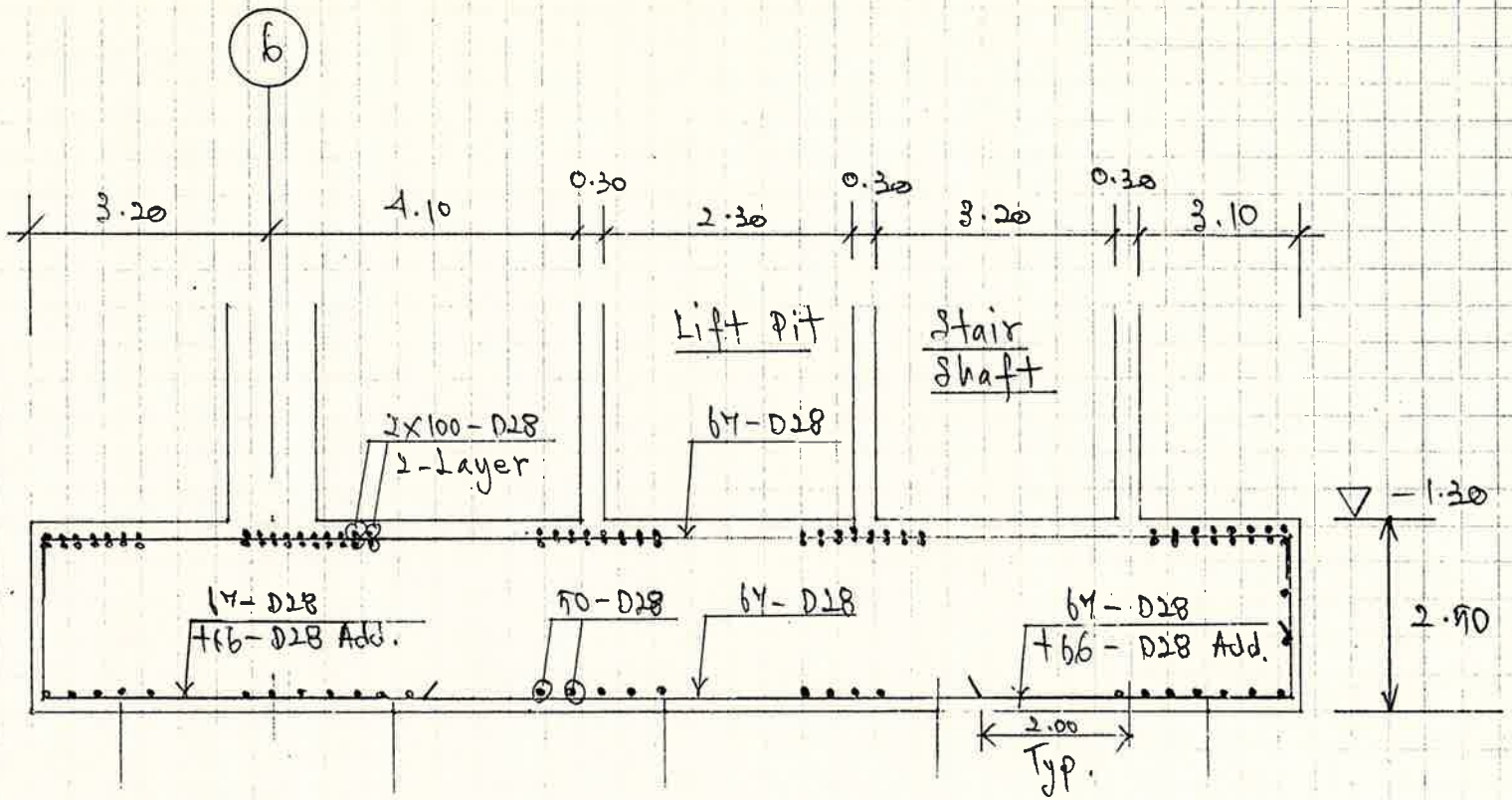
≈ 15 Nos

Pile Load = $\frac{7,589}{15}$ = 506 t

12 OF 15

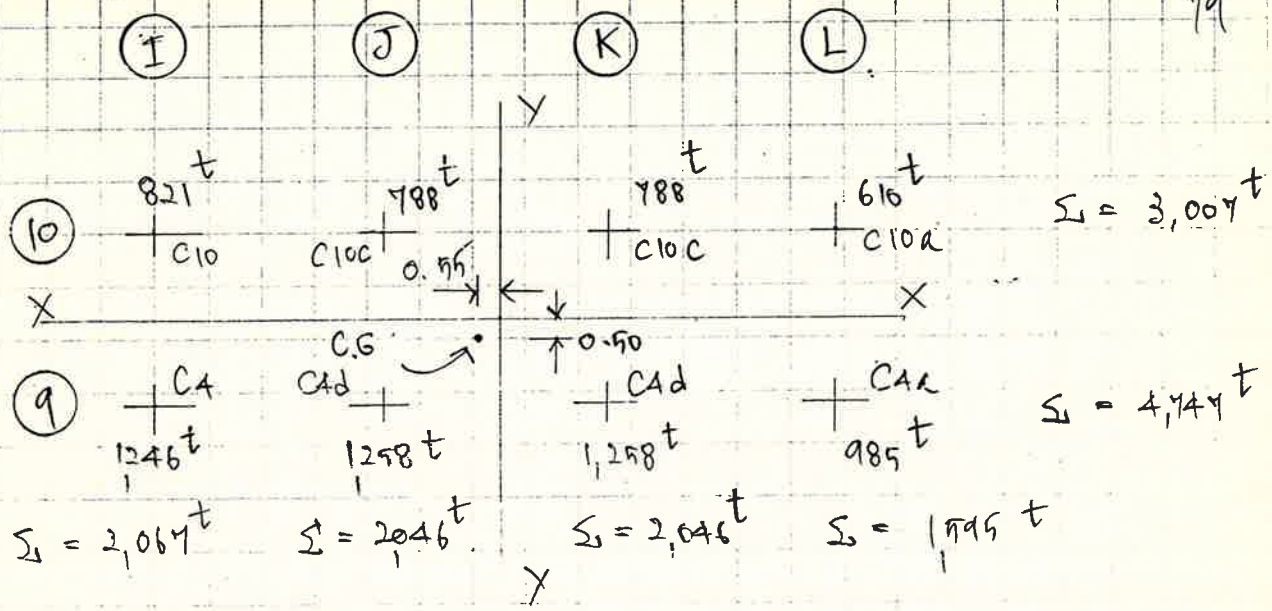
1 : 100


9.60
1.20
3.60
3.60
1.20
1.20
6.00
1.25
7.00
1.35
G.C
1.10
4@3.60
= 14.40
16.80
7
0.40
4.10
Punching Shear
Cone
330
350
6
C3
C5
3.20
1.20
1.75
6.00
1.85
C
D



Section of 12 of 15

Footing 120 F18



Find C.G of Column load

$$\bar{X} = \frac{(1,246 - 985)\,9.00}{4744} = 0.55 \text{ m.}$$

$$\bar{Y} = \frac{(4744 - 3,007)\,2.25}{4744} = 0.50 \text{ m.}$$

Total Column load = 4744 t

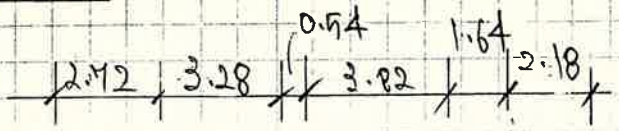
Footing Wt = 1,239 t

$\Sigma W = 8,993$ t

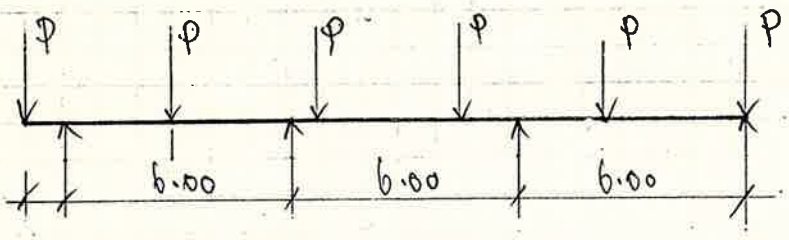
Use 18 - ϕ 1.20 m. Bored Pile

Pile load = $\frac{8993}{18}$ = 500 t

Footing 120F18



Long Span



$P = 3 \times 900 = 1,900\ t$

$A = 9.60 \times 2.30 = 22.08\ m^2$

$I = \frac{1}{12} \times 2.30^3 \times 9.60 = 9.14\ m^4$

$\bar{M}_L = 1,630,200$ Kg-m.

$M^+_L = 836,990$ "

$V_L = 931,000$ Kg at "d"

Use $d = 2.30$ m. $t = 2.50$ m.

$\bar{A}_{sL} = \frac{1,630,200 \times 100}{1,400 \times 0.9 \times 230} = 462\ cm^2$

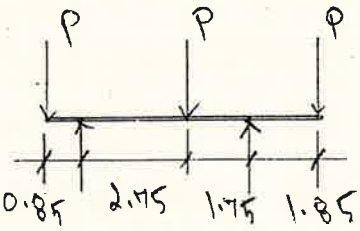
Use 16 - D28 = 468.16 cm^2 $\Sigma_o = 668.8$ cm.

$V_{beam} = \frac{931,000}{960 \times 230} = 4.22$ Ksc. $< 0.29\sqrt{280} = 4.85$ Ksc.

$A^+_{sL} = \frac{836,990 \times 100}{1,400 \times 0.9 \times 230} = 238\ cm^2$

Use 10 - D28 = 246.4 cm^2

Short Span



$P = 6 \times 500,000 = 3,000,000$ Kg

$\bar{M}_S = 3,000,000 \times (1.85 - 0.60) = 3,750,000$ Kg-m.

$M^+_S = \frac{3,000,000 \times 2.75 \times 1.75}{4.90} - \frac{3,750,000}{2} = 1,333,333$ Kg-m

$$A_{ss}^{-} = \frac{3,750,000 \times 100}{1,400 \times 0.9 \times 230} = 1,066 \text{ cm}^2$$

Use 180 - D28 = 1,108.8 cm².

$$A_{ss}^{+} = \frac{1,333,333 \times 100}{1,400 \times 0.9 \times 230} = 378.9 \text{ cm}^2$$

Use 65 - D28 = 400.4 cm².

$$\Sigma_0 = \frac{3,000,000}{16.4 \times 0.9 \times 230} = 413 \text{ cm}^2. \quad \underline{\text{O.K.}}$$

V_b = 1,166,667 Kg at "d"

$$\tau_b = \frac{1,166,667}{2,190 \times 230} = 2.36 \text{ Ksc.} < 4.85 \text{ Ksc.}$$

O.K

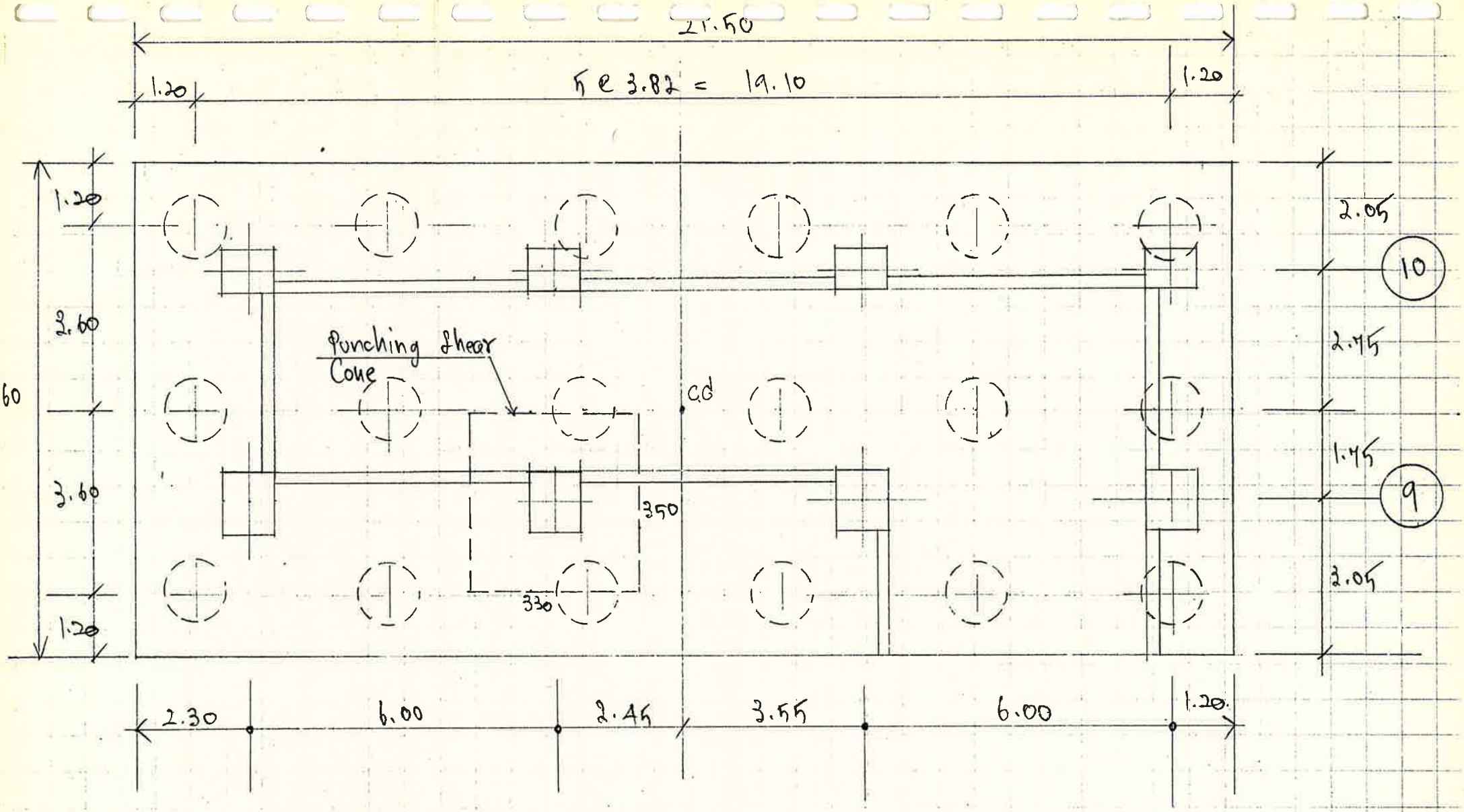
Punching Shear

$$P' = \frac{500}{120}\left\{(5+60)2 + \frac{2}{2}(180+60) + \frac{2}{2}(280+60)\right\}$$

$$= 2,604,000 \text{ Kg.}$$

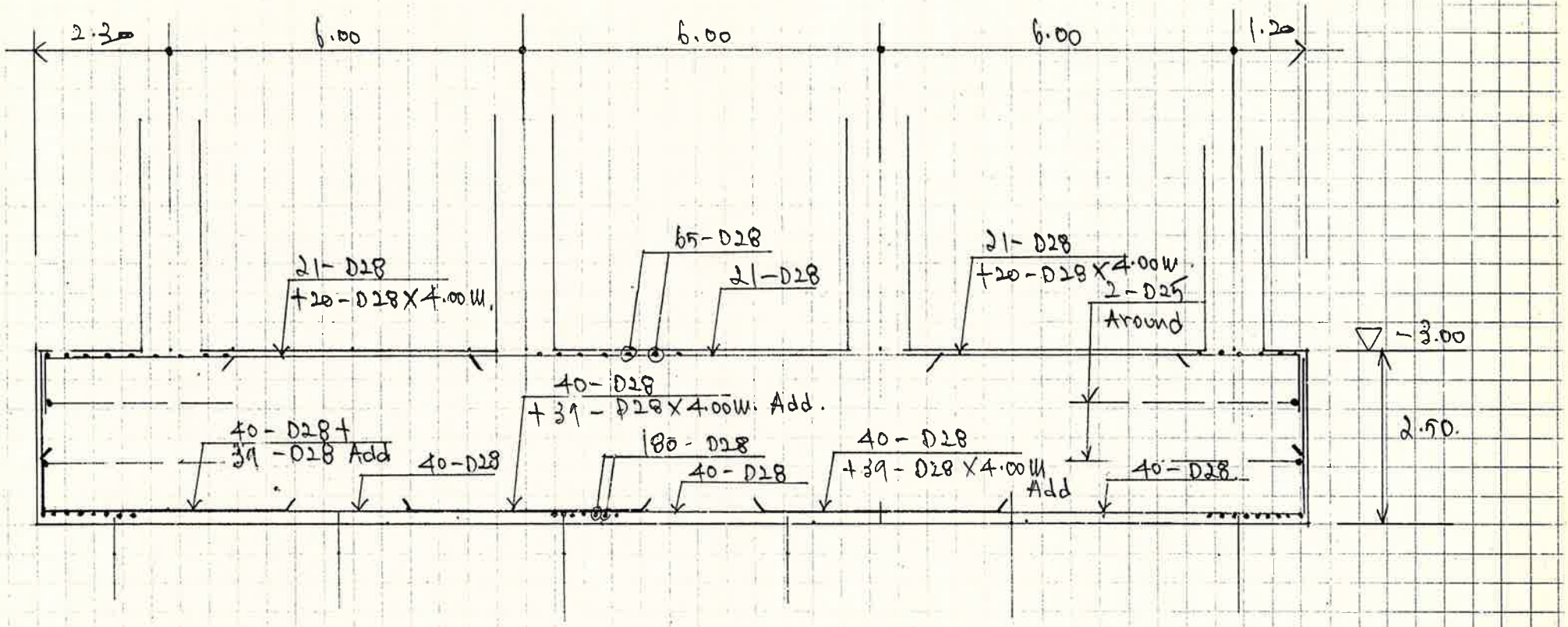
$$V_p = \frac{2,604,000}{2(330+350) \times 230} = 8.32 \text{ Ksc} < 8.86 \text{ Ksc.}$$

O.K


21.50
1.20
5 @ 3.82 = 19.10
1.20
1.20
2.60
3.60
1.20
9.60
Punching Shear Cone
cg
350
330
2.05
10
2.45
1.45
9
2.05
2.30
6.00
2.45
3.55
6.00
1.20

120 F 18

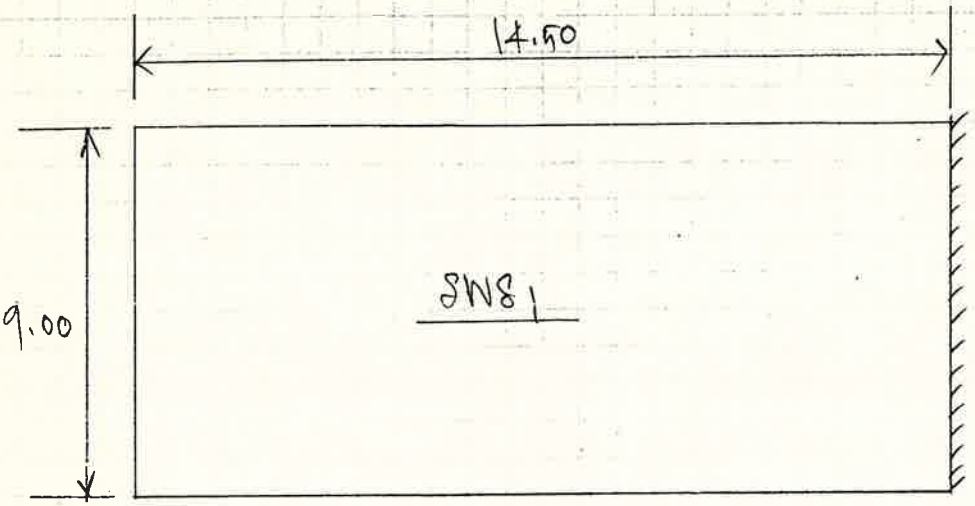
1:100



Section , 120 F 18

1 : 100.

Swimming Pool Slab



$$m = \frac{9.00}{14.50} = 0.62$$

$$t_{min} = \frac{9.0 + 14.5}{90} = 0.26 \text{ m.}$$

Use $t = 0.30$ $d = 0.24$

Load

D.L	$0.30 \times 2,400$	$= 720$	Kg/m²
Water	$1.85 \times 1,000$	$= 1,850$	"
F.F Mat		$= 90$	"
L.L		$= 190$	"
		$W = 2,850$	"

$\bar{C}_c = 0.089$ $\bar{C}_d = 0.044$ $C^+ = 0.066$

$\bar{M}_c = 0.089 \times 2,850 \times 9.00^2 = 19,103$ Kg-M

$\bar{M}_d = 0.044 \times 2,850 \times 9.00^2 = 9,445$ "

$M^+ = 0.066 \times 2,850 \times 9.00^2 = 14,167$ "

$M_c = 10.9 \times 1.00 \times 24^2 = 4,501$ "

$\bar{A}_{sc} = \frac{19,103 \times 100}{1,400 \times 0.9 \times 24} = 46.24$ cm²

D20 @ 0.075 #

$\bar{A}_{scc} = \frac{11,594 \times 100}{1,400 \times 24} = 34.52$ cm²

D20 @ 0.10 #

$A_s^+ = \frac{14,167 \times 100}{1,400 \times 0.9 \times 24} = 34.29$ cm²

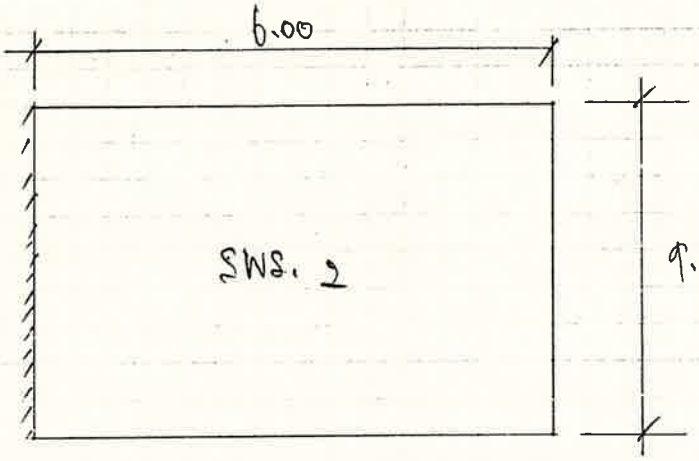
D20 @ 0.10 #

$A_{sc}^+ = \frac{6,658 \times 100}{1,400 \times 24} = 19.82$ cm²

D20 @ 0.15 #

$$\bar{A}_{sd} = \frac{9,445 \times 100}{1,700 \times 0.9 \times 27} = 22.86 \text{ cm}^2$$

D20 @ 0.15



$$m = \frac{6.00}{9.00} = 0.67$$

$$t_{min} = \frac{6.00 + 9.00}{90} = 0.16 \text{ m.}$$

Use $t = 0.25$ $d = 0.22$.

Load				
D.L	$0.25 \times 2,400$	=	600	kg/m²
Water	$0.90 \times 1,000$	=	900	"
FF. Mat		=	90	"
L.L		=	150	"
		W =	1,700	"

$\bar{C}_c = 0.085$ $\bar{C}_d = 0.043$

$C^+ = 0.065$

$\bar{M}_c = 0.085 \times 1,700 \times 6.00^2 = 5,202$ kg-m.

$\bar{M}_d = 0.043 \times 1,700 \times 6.00^2 = 2,631$ "

$M^+ = 0.065 \times 1,700 \times 6.00^2 = 3,978$ "

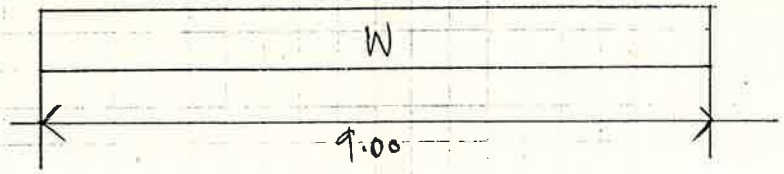
$M_c = 10.3 \times 1.00 \times 22^2 = 4,985$ "

$\bar{A}_{sc} = \frac{5,202 \times 100}{1,700 \times 0.9 \times 22} = 15.45$ cm²

D20 @ 0.20

$A_s^+ = \frac{3,978 \times 100}{1,700 \times 0.9 \times 22} = 11.82$ cm².

D20 @ 0.2 #



Load D.L = 0.60 X 1.25 X 2,400 = 1,800 Kg-m

$SW.S_1 - L = \frac{2,690 \times 9.00}{3}$ = 7,950 "

$SW.S_2 - L = \frac{2,650 \times 6.00}{3} \left(3 - \frac{0.67^2}{2}\right)$ = 6,760 "

W = 16,510 "

$M = \frac{1}{8} \times 16,510 \times 9.00^2$ = 167,164 Kg-m.

M_c = 10.3 X 0.60 X 120^2 = 88,992 "

$A_s = \frac{167,164 \times 100}{1,700 \times 110}$ = 89.39 cm^2.

Use 16 - D28 Top & Bott.

R = 16,510 X 4.10 = 74,295 Kg.

V_c = 4.2 X 60 X 115 = 28,980 Kg.

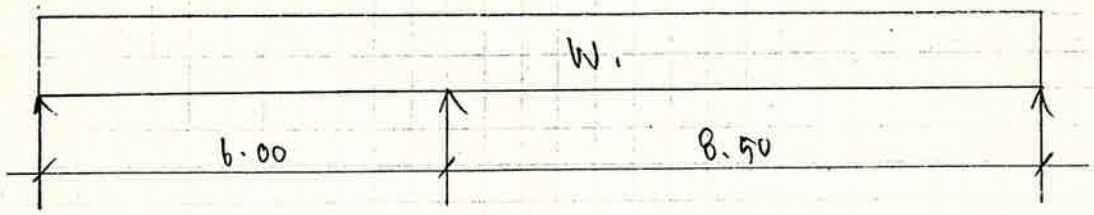
V' = 45,315 Kg.

$45,315 = \frac{1.13 \times 2 \times 2 \times 1,700 \times 115}{S}$

S = 19.5 cm.

2 - D12 @ 0.20 O.K.

WS 1. (Swiming Pool)



Load D.L = $0.30 \times 2.15 \times 2,400$ = 1,548 Kg/m.

SWS.L = $\frac{2,690 \times 6.00}{3} \frac{(3 - 0.62^2)}{2}$ = 6,921 "

W = 8,479 "

$M^- = 0.125 \times 8,479 \times 4.25^2$ = 55,410 Kg-m.

$M^+ = 0.07 \times 8,479 \times 4.25^2$ = 31,197 "

$M_c = 10.2 \times 0.30 \times 20^2$ = 129,852 "

$A_s = \frac{55,410 \times 100}{1,400 \times 0.9 \times 20}$ = 17.76 cm^2

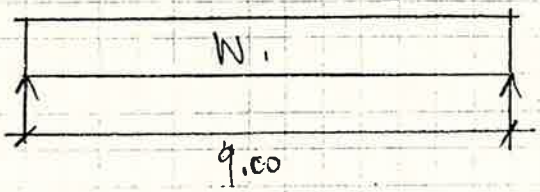
Use 6 - D25

R = $1.2 \times 4.25 \times 8,479$ = 73,467 Kg

Y = 44,260 Kg.

D12 @ 0.20 O.K.

NS 2 (Swiming Pool)



Load D.L = 0.30 X 1.20 X 2,400 = 864 Kg/m.

$SSW_2 = \frac{1,700 \times 6.00 \times (3 - 0.6^2)}{2} = 5,100$ "

$W = 5,164$ "

$M^+ = \frac{1}{8} \times 5,164 \times 9.00^2 = 60,286$ Kg-m.

$M_c = 10.3 \times 0.30 \times 110^2 = 37,289$ "

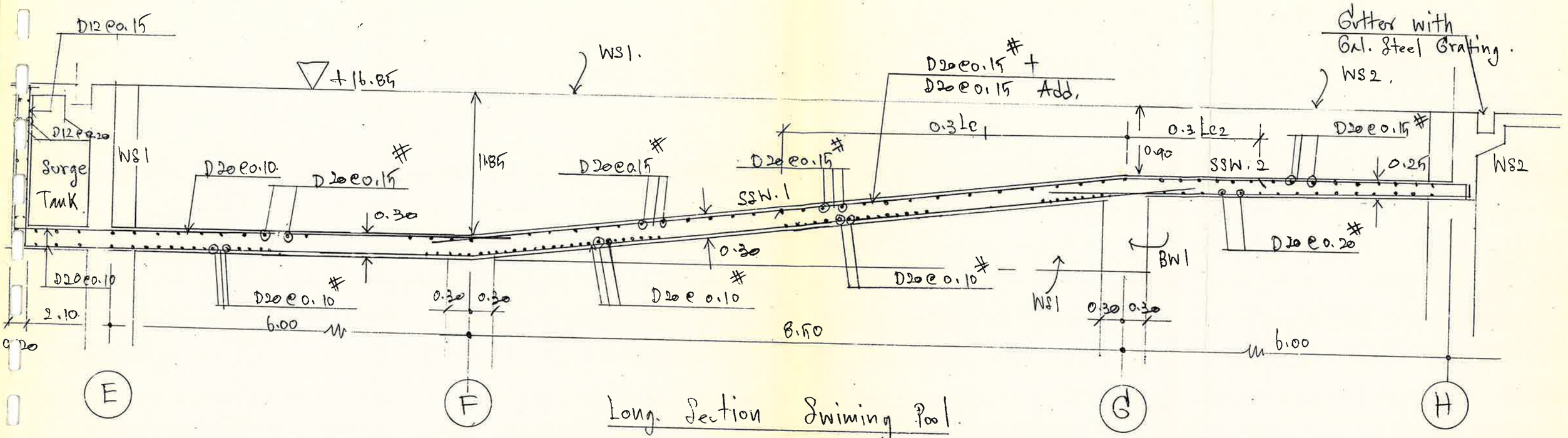
$A_s^+ = \frac{60,286 \times 100}{1,700 \times 0.9 \times 110} = 35.98$ "

Use 8-025

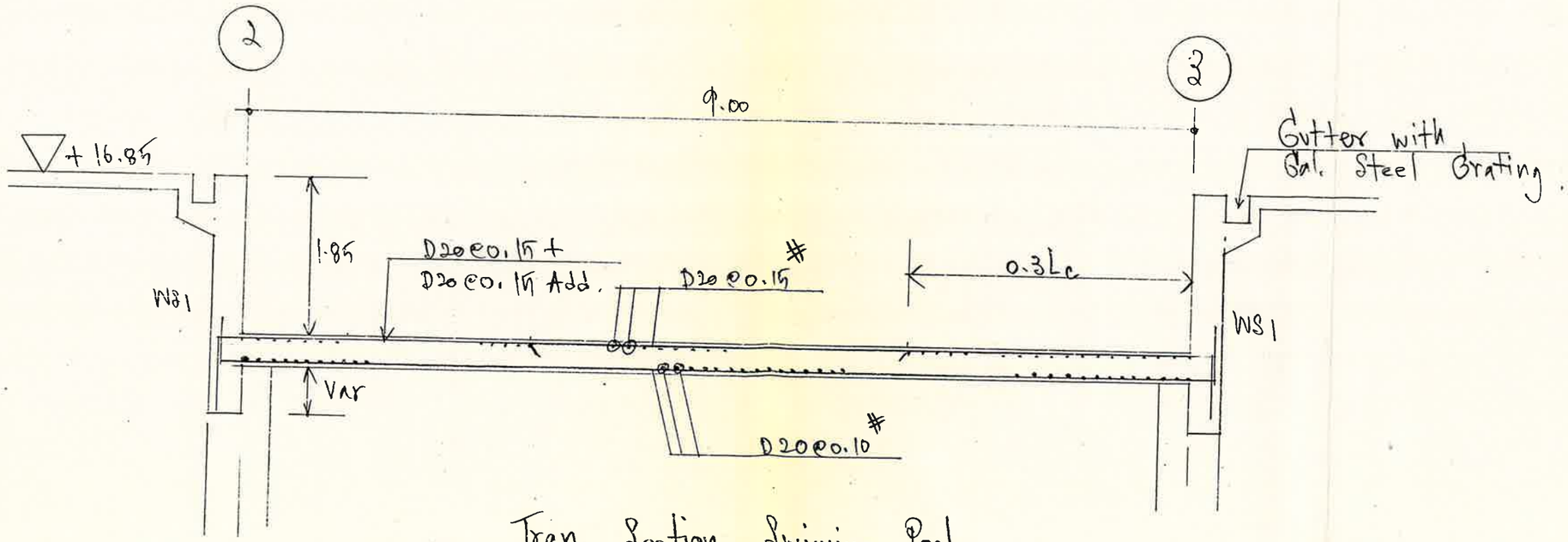
R - V = 5,164 X 4.50 = 26,838 Kg.

V_c = 4.2 X 30 X 110 = 13,860 "

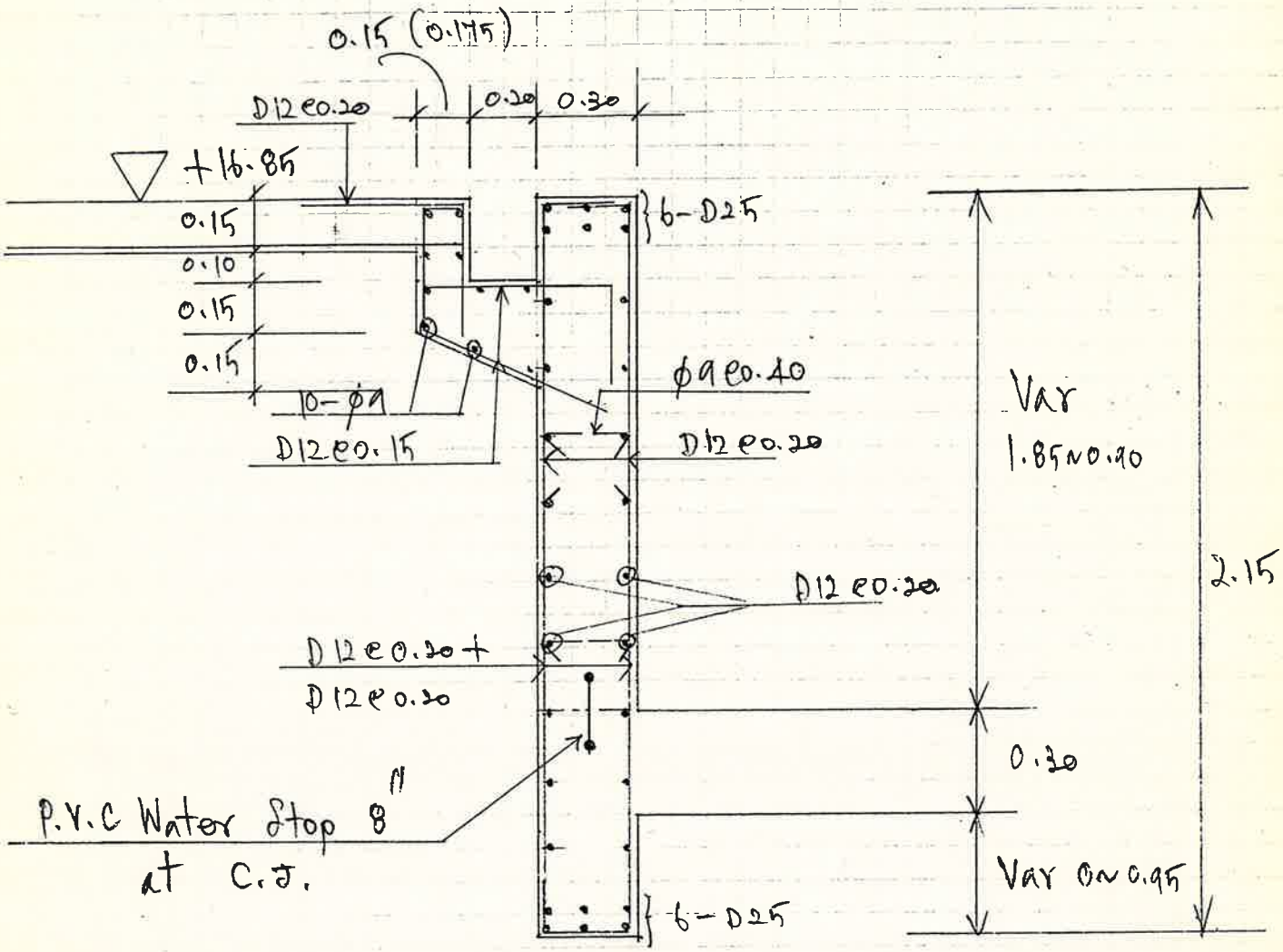
; D12 @ 0.20.



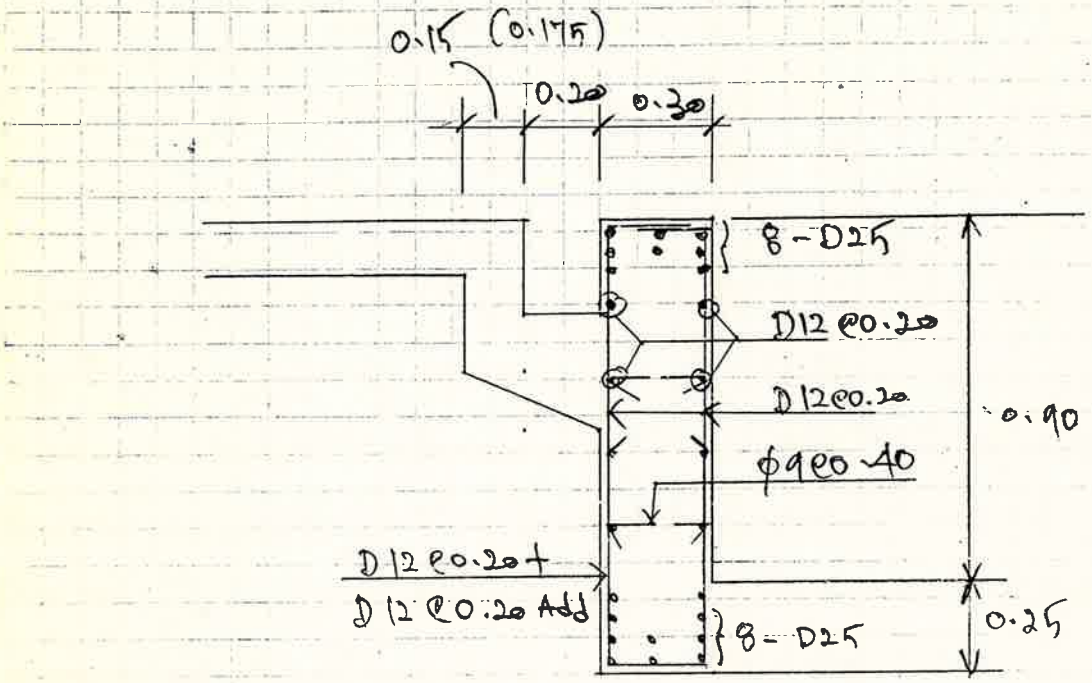
Long. Section Swiming Pool.



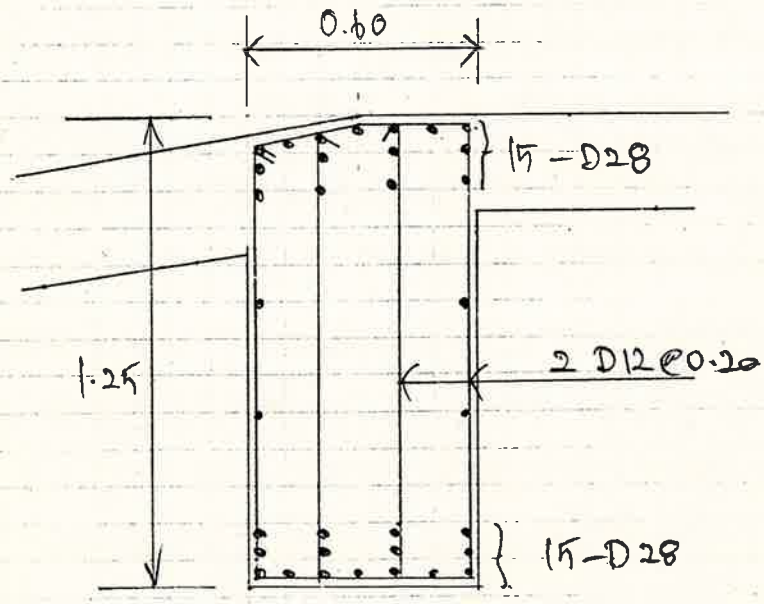
Tran. Section Swiming Pool


0.15 (0.175)
D12 e0.20
0.20
0.30
+16.85
0.15
0.10
0.15
0.15
6-D25
10-φ9
φ9 e0.10
D12 e0.15
D12 e0.20
Var
1.85 N 0.90
D12 e0.20
2.15
D12 e0.20 +
D12 e0.20
0.30
P.V.C Water Stop 8"
at C.J.
Var ON 0.95
6-D25

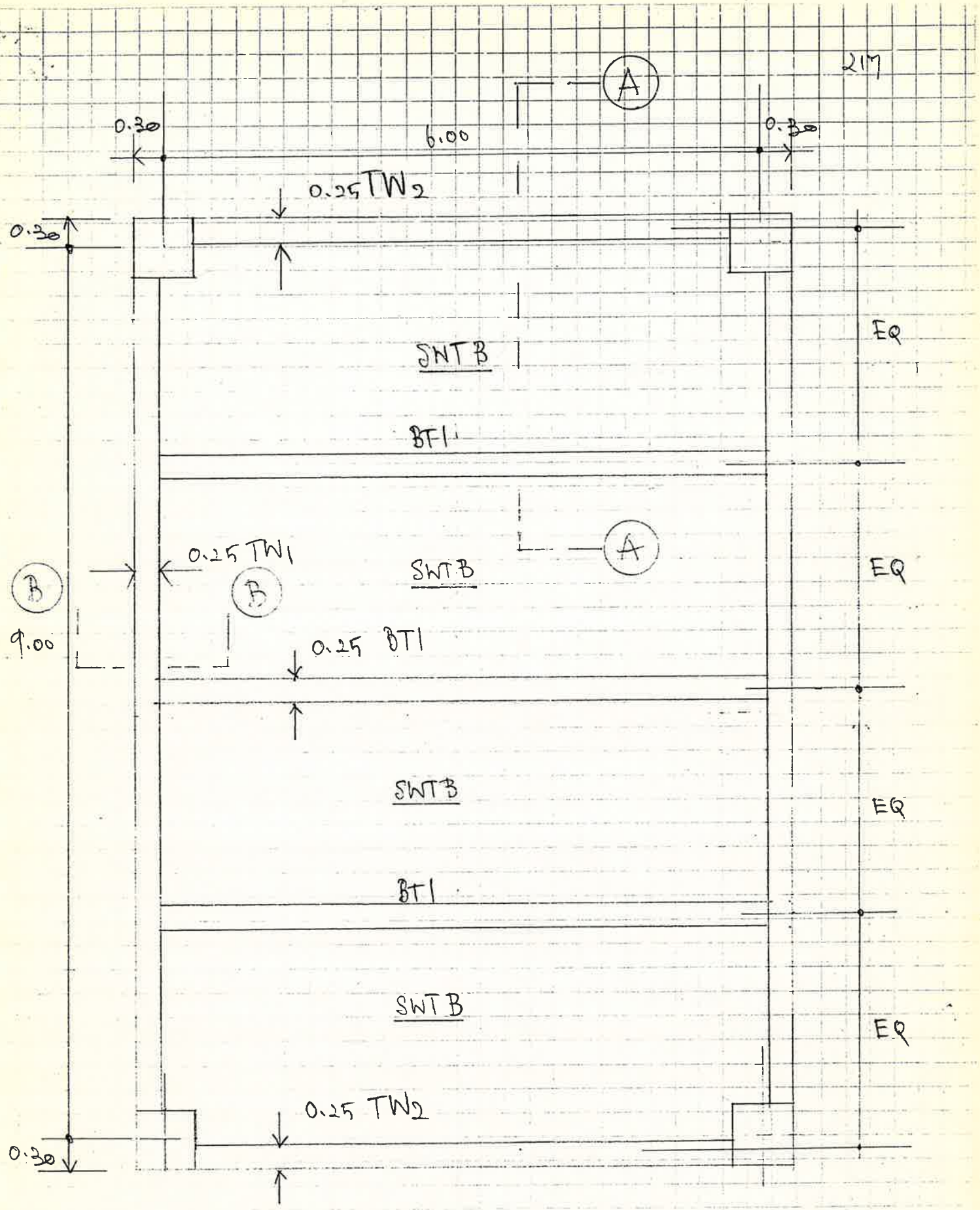
W8 1


0.15 (0.175)
0.20
0.30
8-D25
D12@0.20
D12@0.20
0.90
φ9@0.40
D12@0.20+
D12@0.20 Add
8-D25
0.25

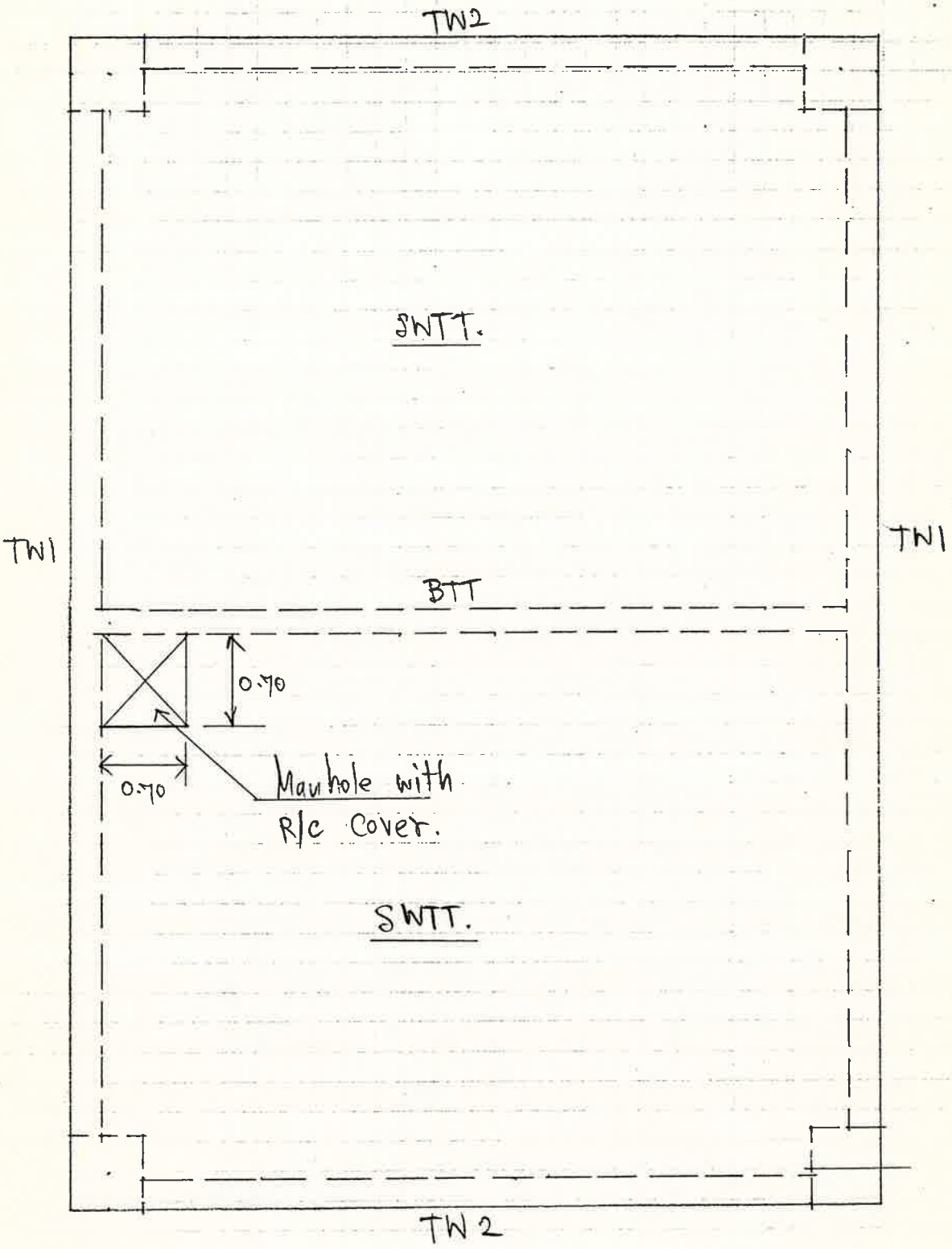
WS2


0.60
15-D28
1.25
2 D12@0.20
15-D28

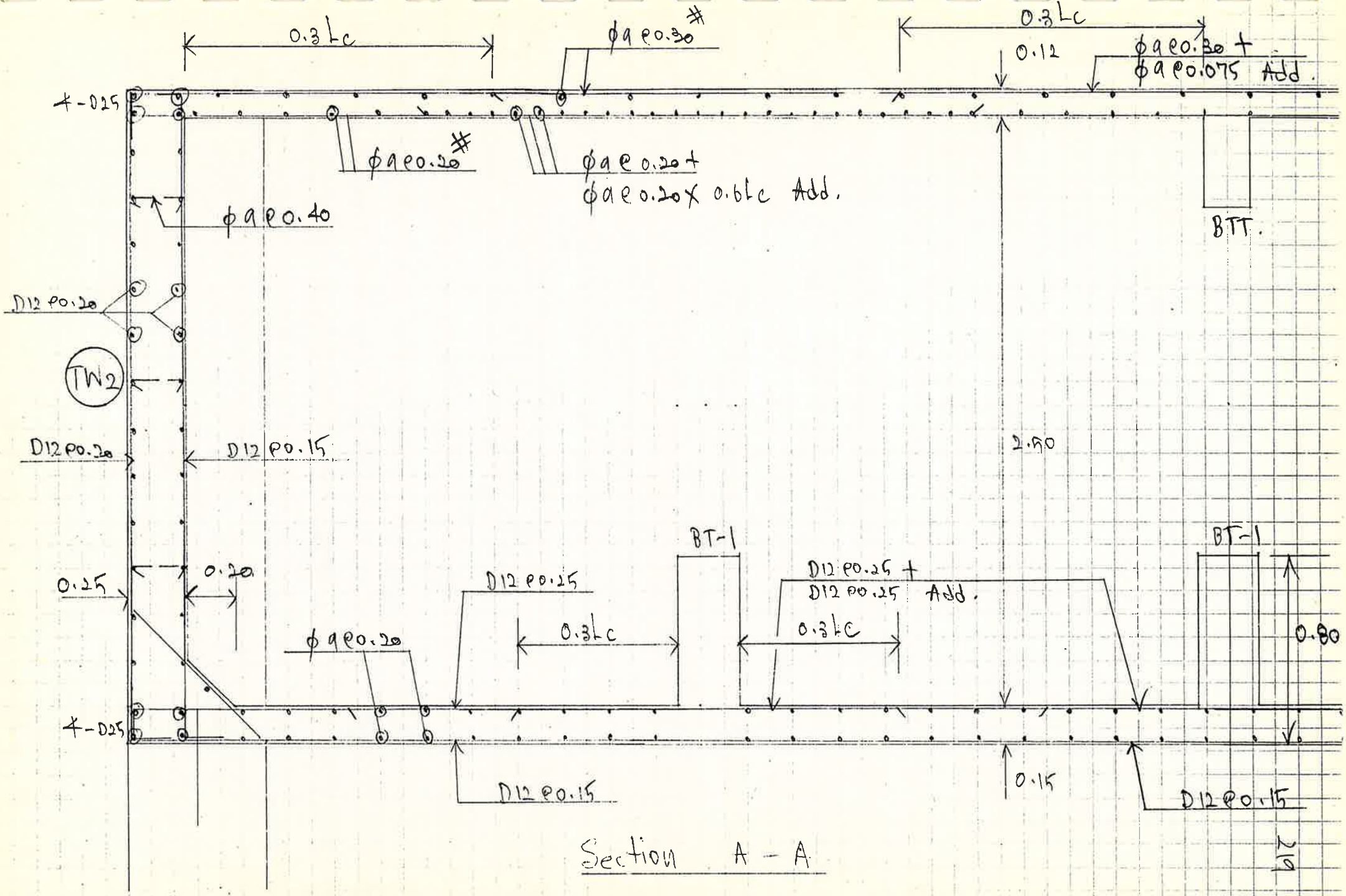
BW1



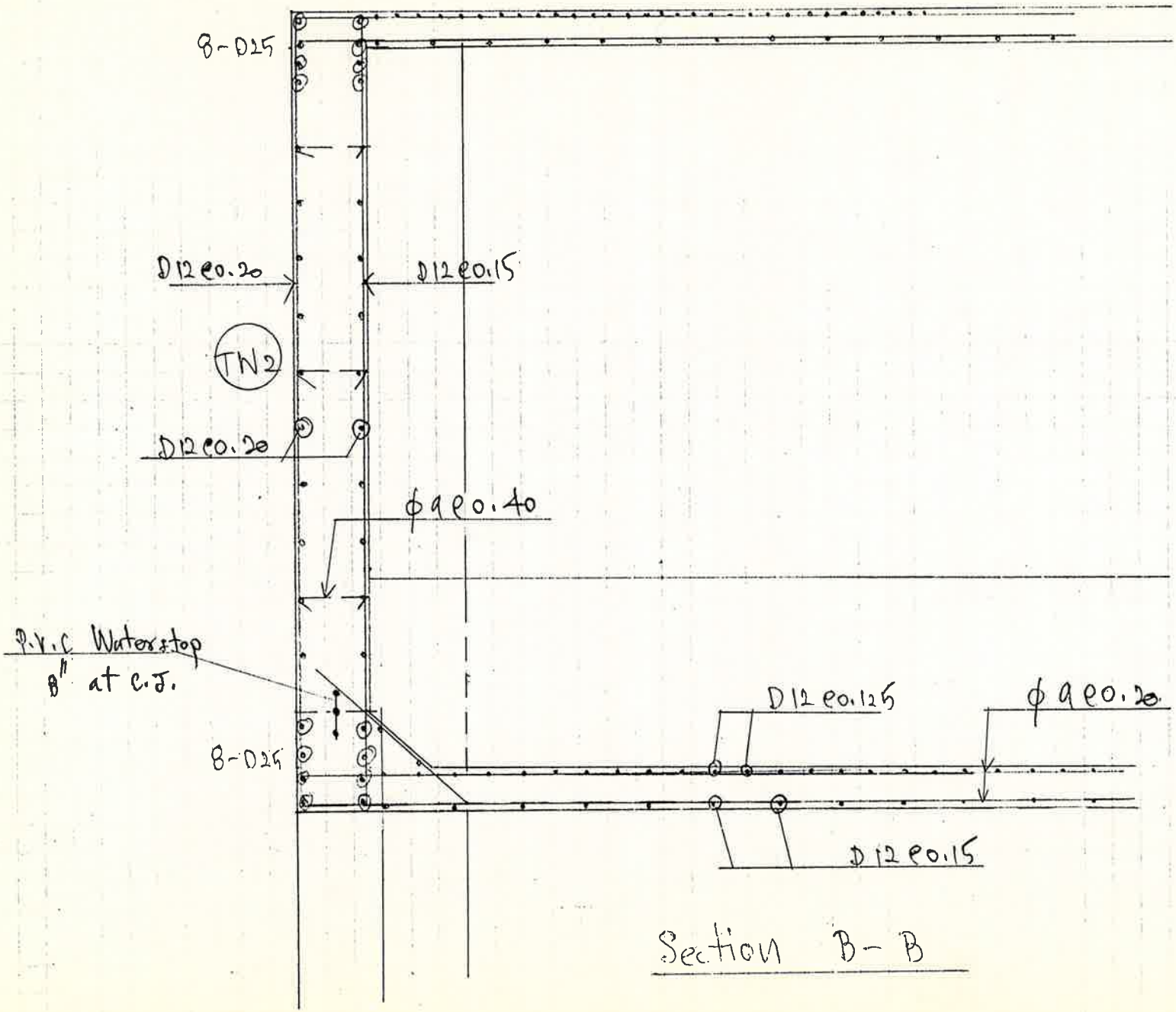
PLAN OF ELEVATED WATER TANK (BOTTOM SLAB)



Plan of Elevated Water Tank (Top Slab)

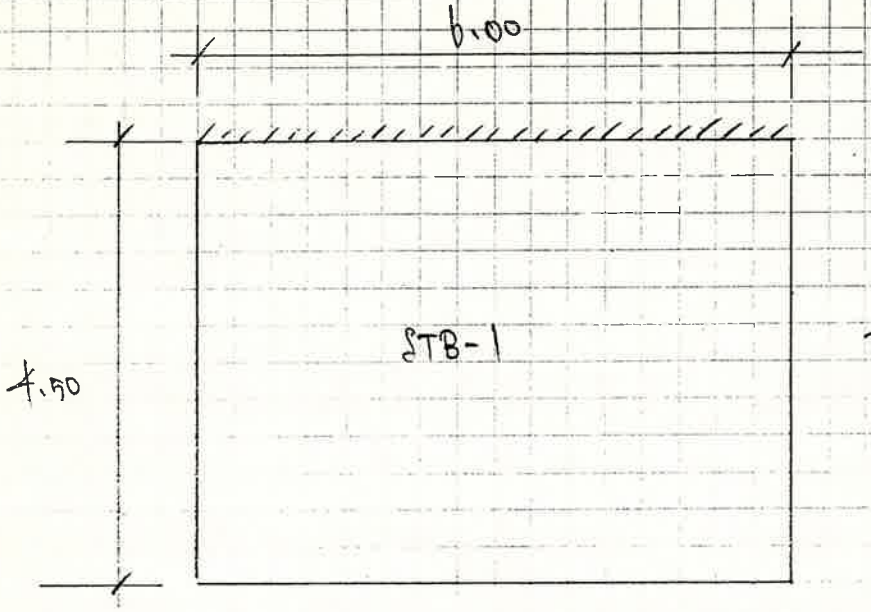

0.3Lc
φaP0.30#
0.3Lc
0.12
φaP0.30+
φaP0.075 Add.
4-D25
φaP0.20#
φaP0.20+
φaP0.20×0.6Lc Add.
φaP0.40
BTT.
D12 P0.20
TW2
D12 P0.20
D12 P0.15
2.50
BT-1
BT-1
0.25
0.20
D12 P0.25
D12 P0.25+
D12 P0.25 Add.
φaP0.20
0.3Lc
0.3Lc
0.80
4-D25
D12 P0.15
0.15
D12 P0.15

Section A - A


8-D25
D12 e0.20
D12 e0.15
TN2
D12 e0.20
ϕ9 e0.40
P.V.C Waterstop
8" at C.J.
8-D25
D12 e0.125
ϕ9 e0.20
D12 e0.15

Section B-B

Water Tank Top Slab. SWTT



$m = \frac{4.50}{6.00} = 0.75$

$t_{min} = \frac{4.50 + 6.00}{90}$

$= 0.12$

Use $t = 0.12$ $d = 0.09$

Load

D.L	$= 0.12 \times 2,400$	$= 288$	Kg/m²
L.L	$= 100$	$= 100$	"
		$W = 388$	"

$C_c^- = 0.078$ $C_d^- = 0.039$ $C^+ = 0.059$

$M_c^- = 0.078 \times 460 \times 4.50^2 = 727$ Kg-m.

$M_d^- = 0.039 \times 460 \times 4.50^2 = 363$ "

$M^+ = 0.059 \times 460 \times 4.50^2 = 550$ "

$d_{req} = \sqrt{\frac{727}{10.3}} = 8.40$ cm. $<$ 9.00 cm.

$M_c = 10.3 \times 1.00 \times 12^2 = 1,483$ Kg-m.

$A_{sc}^- = \frac{727 \times 100}{1,200 \times 0.83 \times 9} = 8.11$ cm²

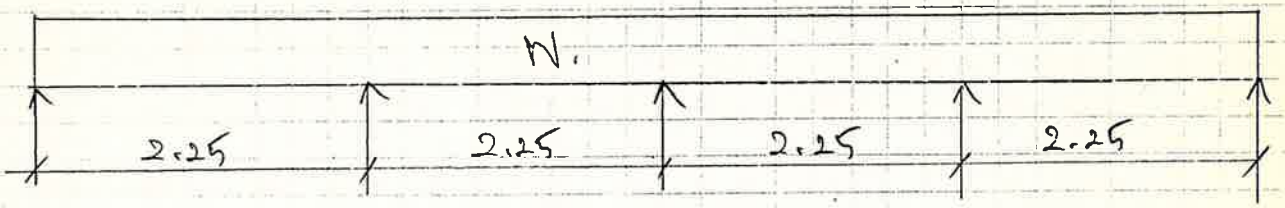
$\phi 9$ @ 0.075 = 8.57 cm²

$A_{sd}^- = 4.06$ cm² $\phi 9$ @ 0.15 = 4.24 cm².

$A_s^+ = \frac{550 \times 100}{1,200 \times 0.83 \times 9} = 6.14$ cm²

$\phi 9$ @ 0.10 # 0.K.

Water Tank Bottom Slab : SWTB



Load D.L = 0.15 X 2,400 = 360 Kg/m².
Water = 2.50 X 1,000 = 2,500 "
W = 2,860 "

$M^- = 0.107 \times 2{,}860 \times 2.25^2 = 1{,}549$ Kg-m.
$M^+ = 0.077 \times 2{,}860 \times 2.25^2 = 1{,}115$ "

$d_{req} = \sqrt{\frac{1{,}549}{10.3}} = 12.3$ cm.

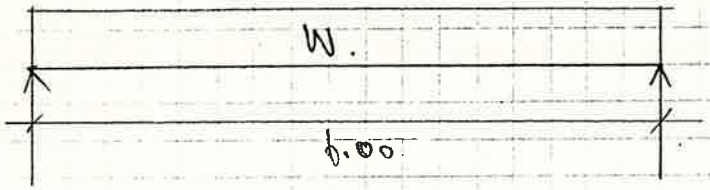
Use t = 0.15 d = 0.12

$A_s^- = \frac{1{,}549 \times 100}{1{,}700 \times 0.9 \times 12} = 8.74$ cm²
D12 @ 0.125 = 9.06 cm²

$A_s^+ = \frac{1{,}115 \times 100}{1{,}700 \times 0.9 \times 12} = 6.04$ cm².
D12 @ 0.15 = 7.53 cm².

$R_{MAX} = 1.14 \times 2{,}860 \times 2.25 = 7{,}336$ Kg
V = 4,402 Kg.
V_c = 5,040 Kg. > V O.K.

BT-1



Load D.L = 0.25 X 0.80 X 2,400 = 420 Kg/m.

S.L = 4,336 Kg/m.

W = 4,756 "

$M = \frac{1}{8} \times 4,756 \times 6.00^2 = 34,902$ Kg-m.

$M_c = 10.3 \times 0.25 \times 45^2 = 14,484$ "

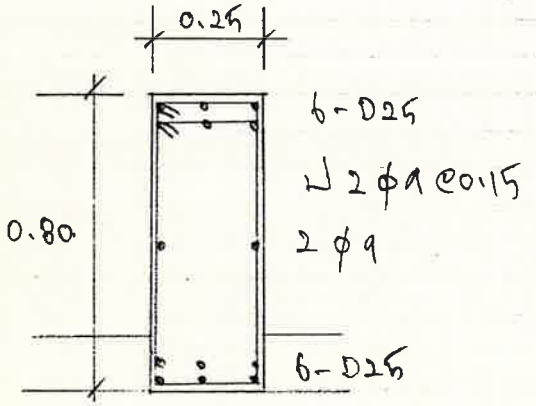
$A_s = \frac{34,902 \times 100}{1,400 \times 40} = 29.33$ cm^2.

Use 6 - D25 Top & Bott.

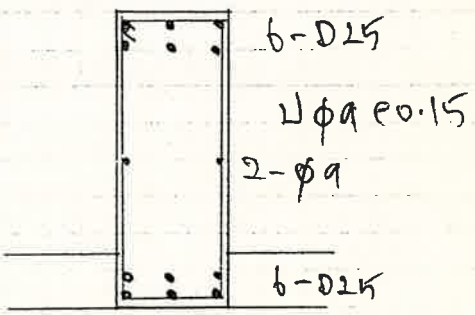
R = V = 4,756 X 3.00 = 23,268 Kg.

Vc = 4,845 Kg. V' = 15,393 Kg.

Use 2 - φ9 @ 0.15 = 15,264 Kg.

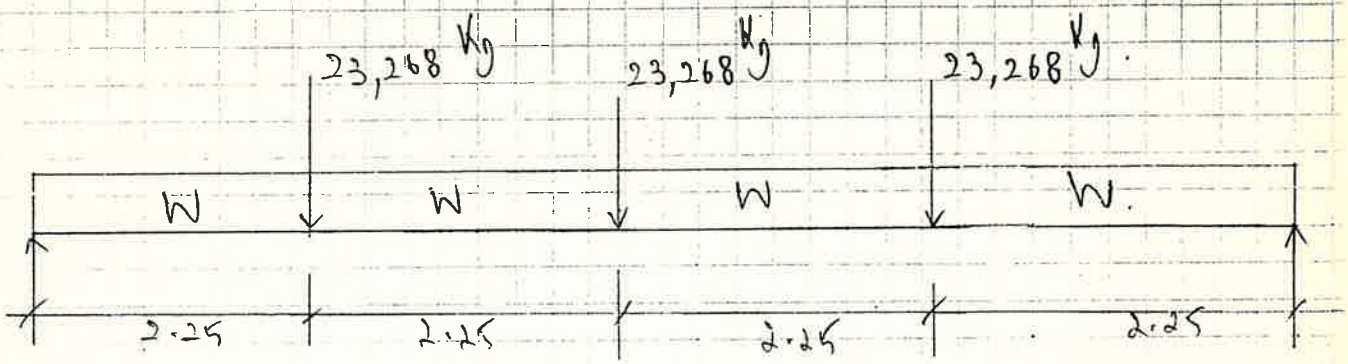


End.



Mid

TW-1



Load D.L = $0.25 \times 2.50 \times 2,400$ = 1,500 Kg/m.

W = 1,500 "

$$M = \frac{1}{8} \times 1,500 \times 9.00^2 + 23,268 \times 2.25 + \frac{23,268 \times 9.00}{4}$$

$$= 119,894 \quad Kg\text{-}m.$$

$$M_c = 10.3 \times 0.25 \times 230^2 = 136,218 \quad Kg\text{-}m.$$

$$A_s = \frac{119,894 \times 100}{1,700 \times 0.9 \times 240} = 32.66 \quad cm^2$$

Use 8 - D25

$$R = V = 23,268 \times 1.5 + 1,500 \times 4.50$$

$$= 41,652 \quad Kg.$$

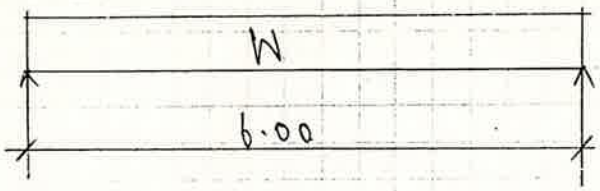
$$V_c = 4.2 \times 25 \times 240 = 25,200 \quad Kg.$$

$$V' = 16,452 \quad Kg.$$

D12 @ 0.15

$$V_s = \frac{2 \times 1.13 \times 1,500 \times 240}{15} = 813,600 \quad Kg.$$

.ลาย.



Load

D.L = $0.20 \times 0.50 \times 2,400$ = 240 Kg/m.

L.L = $\frac{388 \times 4.50}{3} \frac{(3 - 0.75^2)}{2} \times 2$ = 1,419 "

W = 1,179 "

$M = \frac{1}{8} \times 1,179 \times 6.00^2$ = 5,306 Kg-m.

M_c = 4,172 Kg-m.

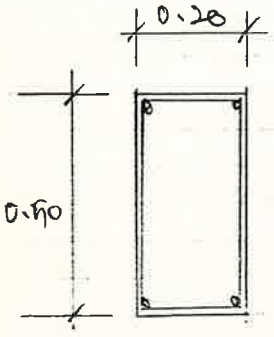
$A_s = \frac{5,306 \times 100}{1,400 \times 0.9 \times 46}$ = 9.54 cm^2

Use 4-D20.

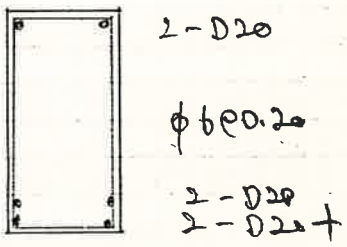
R = V = $1,179 \times 3.00$ = 3,537 Kg.

V_c = 3,864 Kg.

ϕ 6 @ 0.20.



End



Mid