DETAIL DESIGN
FOR
LABORATORY BUILDING
OF
DESALINATION RESEARCH PROJECT
IN
THE KINGDOM OF SAUDI ARABIA

VOLUME 4 of 6 VOLUMES

AUGUST, 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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VOLUME 4 OF 6 VOLUMES

TECHNICAL DOCUMENTS

STRUCTURAL CALCULATIONS
MATERIAL TAKE OFF

AUGUST 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

M P N
C R (3)
87 - 118

STRUCTURAL CALCULATIONS

TEST PLANT BUILDING

CONTENTS

SC-1. GENERAL.

1-1. Type of Structure ; Reinforced Concrete Structure.

1-2 Application Codes, Specifications ect.

a) Reinforced Concrete Structure ; BS. CP110

b) Live Load & Wind Load ; BS. CP3

1-3 Materials

a) Concrete (For Column & Girder) ; Grade 25, $f_{cu} = 25 N/mm^2$

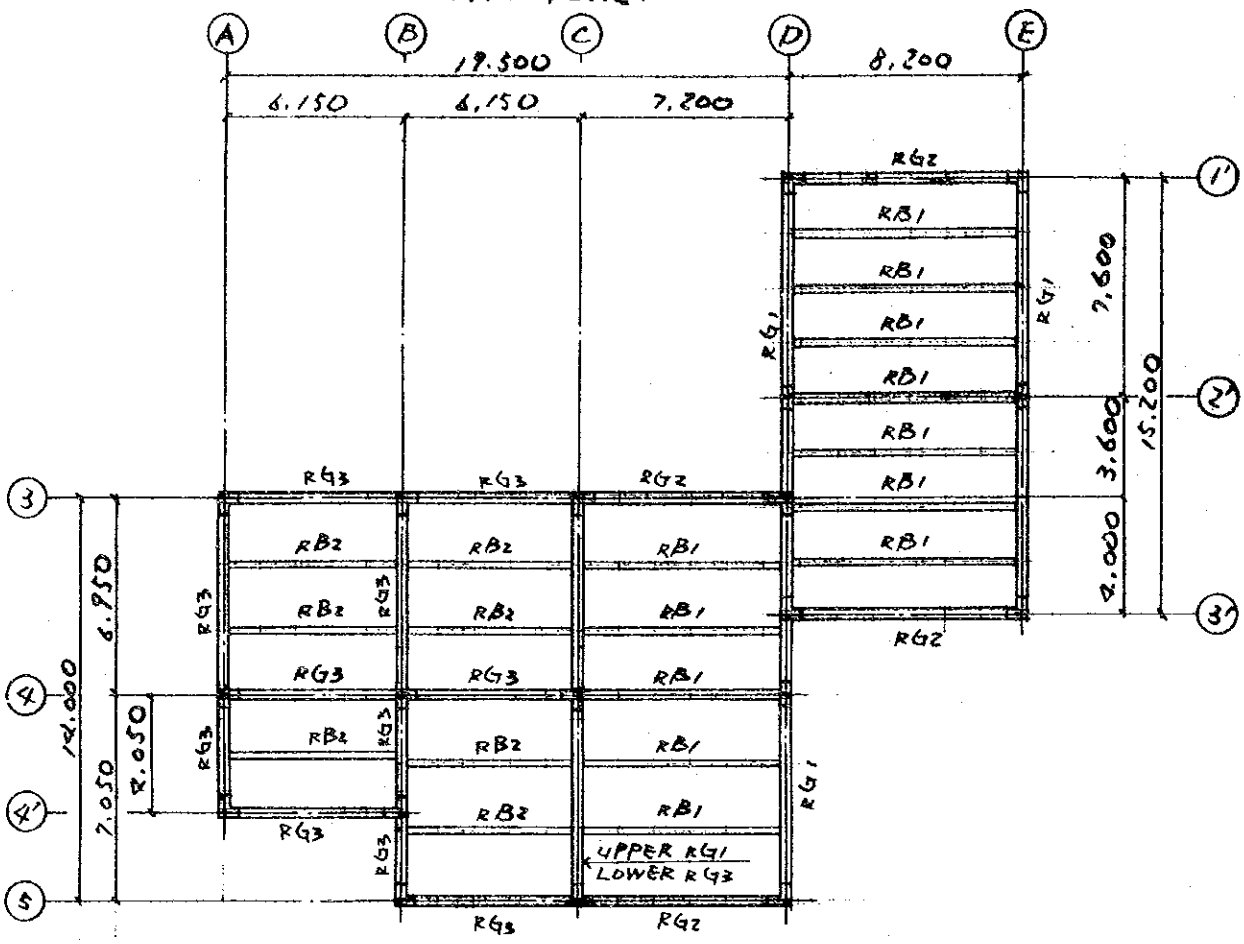
b) Concrete (For Foundation) ; Grade 20, $f_{cu} = 20 N/mm^2$

c) Reinforcing Bar ; $F_y = 410 N/mm^2$

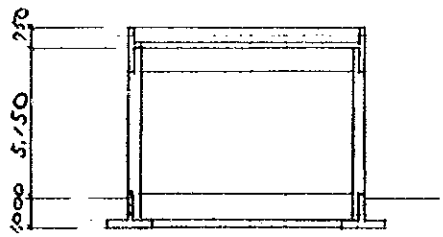
1-4 Soil Bearing Capacity

$10 t/m^2$ (Long Term)

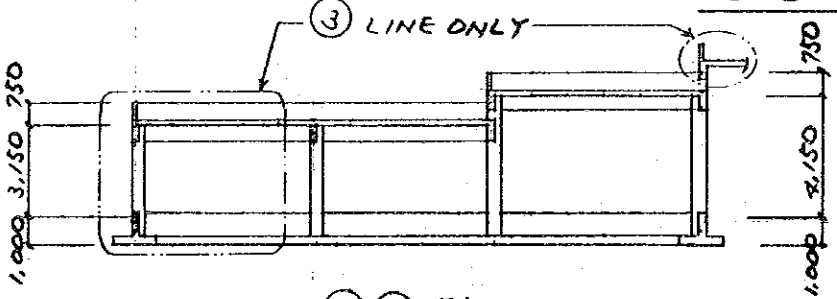
SC-2. OUTLINE OF STRUCTURE.



ROOF PLAN



①,③ FRAME



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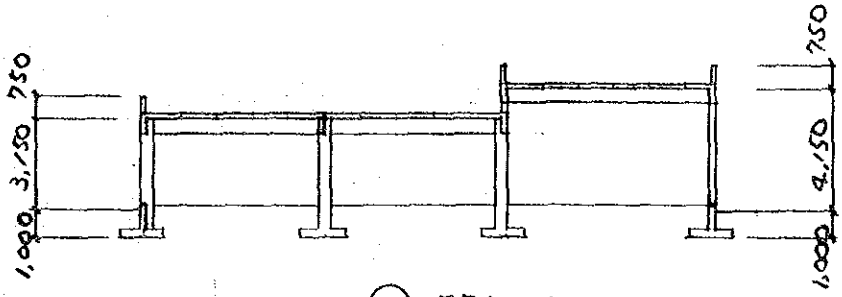

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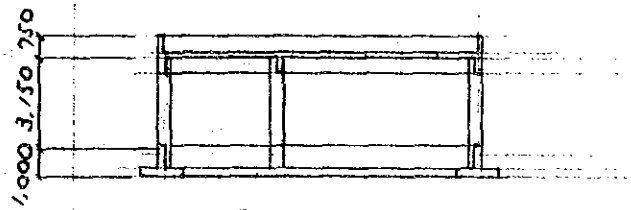

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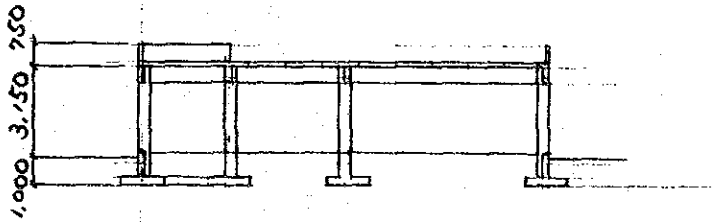
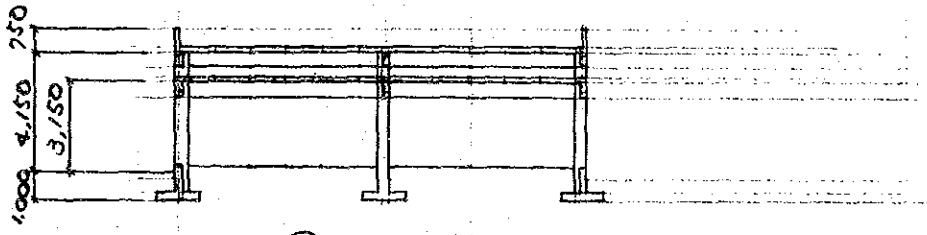


Ⓑ FRAME



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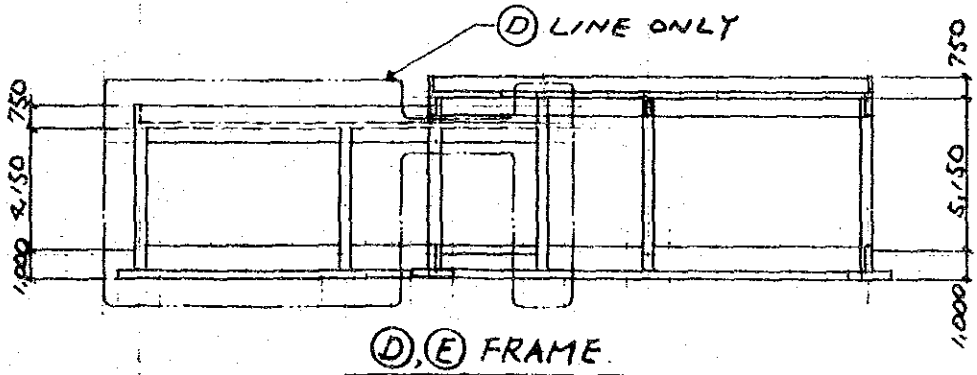
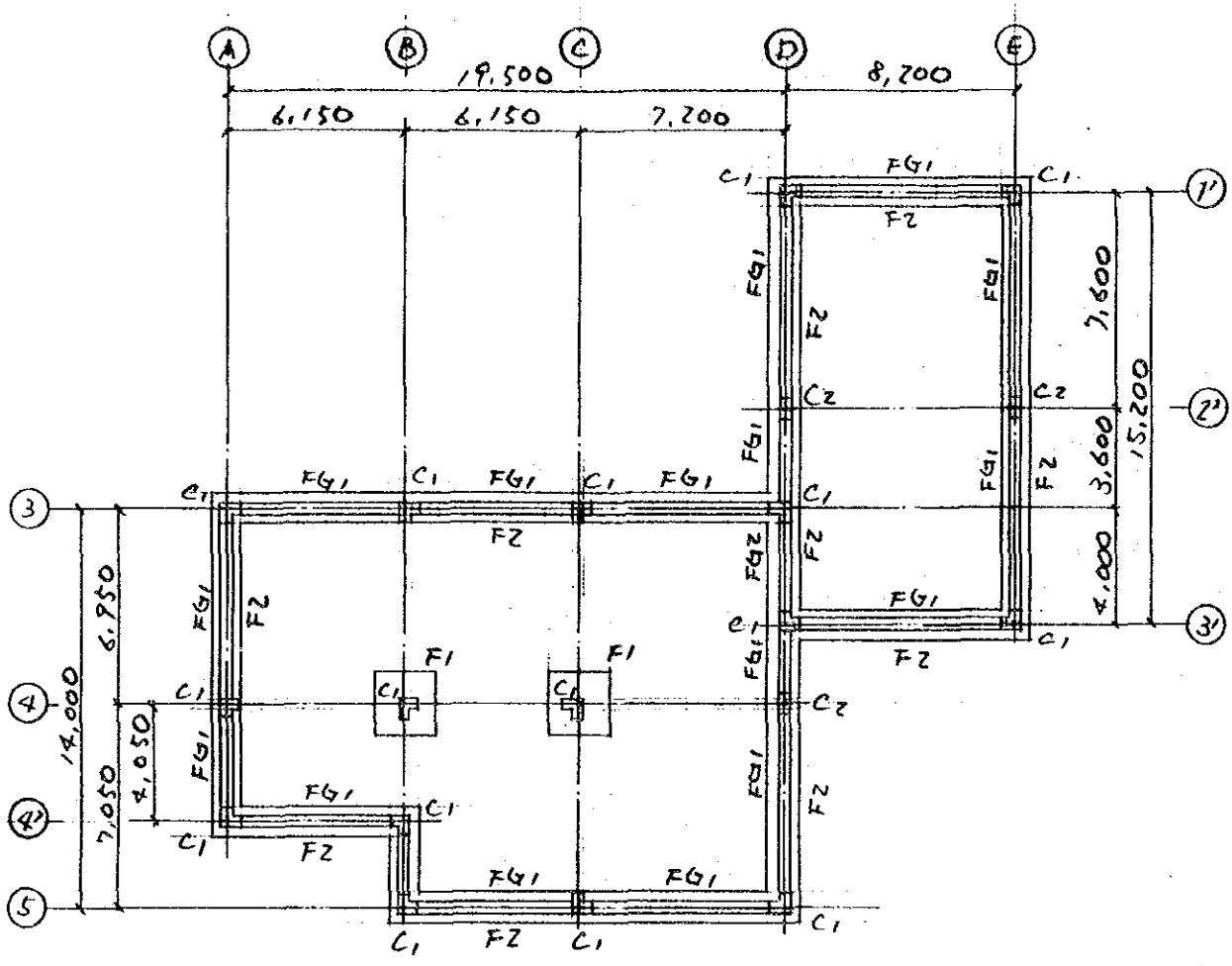


Ⓓ, Ⓔ FRAME



FOUNDATION PLAN

SC-3. LOAD ASSUMPTION

1) Dead Load (D.L)

a) Roof

Concrete Slab	(t=120)	288 kg/m²	
Insulation & Water proof	(t=40)	10 kg/m²	→ 400 kg/m²
Light weight Conc.	(t=60)	102 kg/m²	

b) Wall.

Block Wall	(t=200)	365 kg/m²	→ 445 ↓ 450 kg/m²
Finish	(t=20 Both Face)	80 kg/m²	

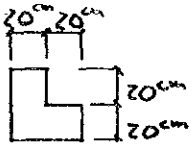
c) Parapet. (h=550)

Concrete	(t=200)	264 kg/m	→ 286 ↓ 290 kg/m
Finish	(t=20)	22 kg/m	

d) Structural Member

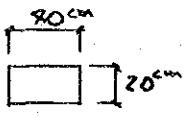
i) Column

C1



Conc.	288 kg/m	→ 352 ↓ 360 kg/m
Finish	64 kg/m	

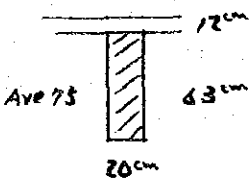
C2



Conc.	192 kg/m	→ 240 kg/m
Finish	48 kg/m	

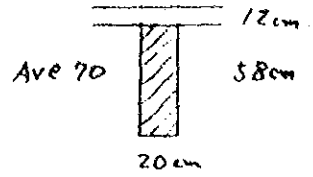
ii) Girder

RG1



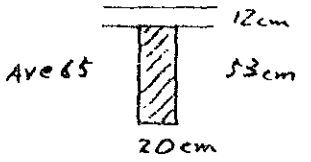
Conc.	302 kg/m	→ 360 kg/m
Finish	58 kg/m	

RG2



Conc. 278 kg/m
Finish 54 kg/m
→ 332 → 340 kg/m

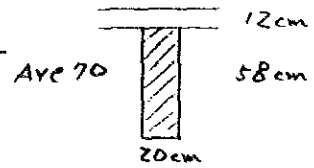
RG3



Conc. 254 kg/m
Finish 50 kg/m
→ 304 → 310 kg/m

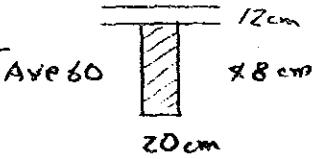
iii) Beam

RB1



Conc. 278 kg/m → 280 kg/m

RB2



Conc. 230 kg/m

2) LIVE LOAD.

Roof (No Access) 77 kg/m²

3) WIND LOAD.

a) Basic Wind Speed. Vs = 100 MPH ≒ 44.7 M/sec

b) Wind Presure

$q = 0.0625 \times 44.7^2 = 123 \text{ kg/m}^2$

$S_2 = 1.0$ ($h < 10m$) cP3 Table 3

$C_p = 0.7$ (Windward Wall)

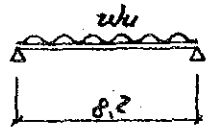
$= -0.3$ (Leeward Wall)

Total Wind Pressure

$P = 1.0 \times (0.7 + 0.3) \times 123 = 123 \text{ kg/m}^2$

SC-4. DESIGN OF SECONDARY MEMBERS

RB1

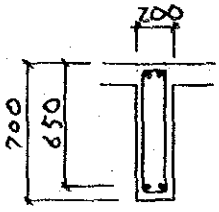


$w_u = (1.4 \times 0.4^{\text{Slab (D.L.)}} + 1.6 \times 0.077^{\text{(L.L.)}}) \times 1.9^{m} + 1.4 \times 0.28^{\text{Beam}} = 1.69\ t/m$

$M_u = 1/8 \times 1.69 \times 8.2^2 = 14.20\ t.m$

$V = 1/2 \times 1.69 \times 8.2 = 6.93\ ton$

$$\frac{M_u}{b \cdot d^2} = \frac{14.20 \times 9.8 \times 10^6}{200 \times 650^2} = 1.65 \longrightarrow \frac{100\,A_s}{b \cdot d} = 0.48$$



$A_s = 0.48 \times 200 \times 650 / 100 = 624\ mm^2$

Use 2-D22 ($A_s = 774\ mm^2$)

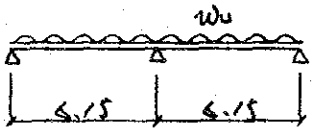
$$\frac{100\,A_s}{b \cdot d} = \frac{100 \times 774}{200 \times 650} = 0.60 \longrightarrow v_c = 0.53\ N/mm^2$$

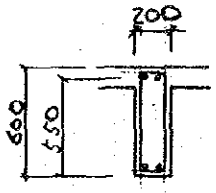
Top 2-D16
Bot. 2-D22
St. D10@250

$$v = \frac{V}{b \cdot d} = \frac{6.93 \times 9.8 \times 10^3}{200 \times 650} = 0.52 \underset{N/mm^2}{<} 0.53\ N/mm^2$$

Use stirrup D10 @250

RB2





Top & Bot. 2-D19
St. D10@250

$w_u = (1.4 \times 0.4^{\text{(D.L.)}} + 1.6 \times 0.077^{\text{(L.L.)}}) \times 2.35 + 1.4 \times 0.23^{\text{Beam}} = 1.93\ t/m$

$M_{u1} = 1/8 \times 1.93 \times 6.15^2 = 9.12\ t.m$

$M_{u2} = 9/128 \times 1.93 \times 6.15^2 = 5.13\ t.m$

$V = 5/8 \times 1.93 \times 6.15 = 7.42\ ton$

$$\frac{M_{u1}}{b \cdot d} = \frac{9.12 \times 9.8 \times 10^6}{200 \times 550^2} = 1.48 \longrightarrow \frac{100\,A_s}{b \cdot d} = 0.43$$

$A_s = 0.43 \times 200 \times 550 / 100 = 473\ mm^2$

Use 2-D19 ($A_s = 578\ cm^2$) Top & Bot.

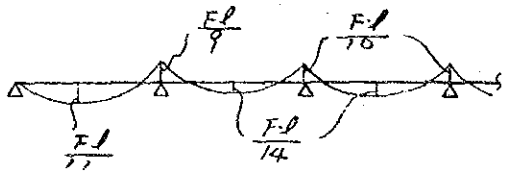
$$\frac{100\,A_s}{b \cdot d} = \frac{100 \times 578}{200 \times 550} = 0.52 \longrightarrow v_c = 0.51$$

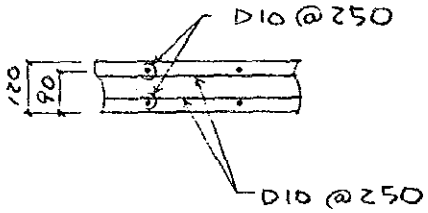
$$v = \frac{V}{b \cdot d} = \frac{7.42 \times 9.8 \times 10^3}{200 \times 550} = 0.66 \underset{N/mm^2}{>} v_c = 0.51\ N/mm^2\ \text{NG}$$

D10 ($A_{sv} = 143\ mm^2$) $S_v = \dfrac{0.87 f_{y.v} A_{sv}}{b(v - v_c)} = \dfrac{0.87 \times 240 \times 143}{200(0.66 - 0.51)} = 1700\ mm$

Use Stirrup D10 @250

Roof Slab





$F = (1.2 \times 0.80^{t/m^2} + 1.6 \times 0.077^{t/m^2}) \times 2.35^{m}$

$= 1.61\ t/m$

$M_{u(TOP)} = 1.61 \times 2.35/9 = 0.42\ t\cdot m/m$

$M_{u(BOT)} = 1.61 \times 2.35/11 = 0.34\ t\cdot m/m$

$V_{max} = 0.6F = 0.6 \times 1.61 = 0.97\ t/m$

$\frac{M_{u(TOP)}}{b\cdot d^2} = \frac{0.42 \times 9.8 \times 10^6}{1000 \times 90^2} = 0.51 \longrightarrow \frac{100 A_s}{b\cdot d} = 0.17$

$A_s = 0.17 \times 1000 \times 90/100 = 153\ mm^2/m$

$M_{u(BOT)} = 0.34\ t\cdot m/m < M_{u(TOP)} = 0.42\ t\cdot m/m$

Use D10 @250 ($A_s = 285\ mm^2/m$) Top & Bot.

$\frac{100 A_s}{b\cdot d} = \frac{100 \times 285}{1000 \times 90} = 0.32 \longrightarrow v_c = 0.39\ N/mm^2$

$v = \frac{V}{b\cdot d} = \frac{0.97 \times 9.8 \times 10^3}{1000 \times 90} = 0.11\ N/mm^2 < v_c = 0.39\ N/mm^2$

O.K

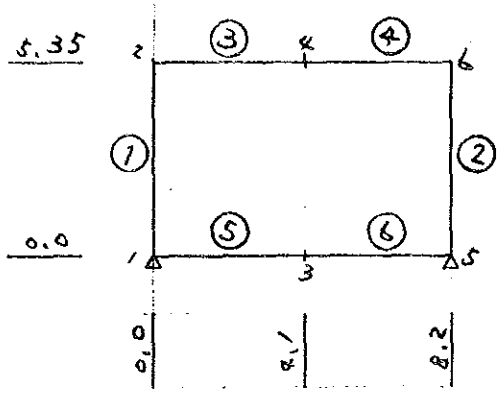
SC-5. AXIAL FORCE OF COLUMN.

Col. No.	Load	Member	Calculation	P (ton)	ΣP (ton)
B-4	D.L	Roof	$0.40^{t/m^2} \times 6.15^{m} \times (6.95+4.05)/2$	13.53	
		Girder	$0.31^{t/m} \times (6.15 \times 2 + 6.95 + 4.05)/2$	3.61	
		Beam	$0.23^{t/m} \times (6.15/2 + 6.15)$	2.12	19.26
		Column	$0.36^{t/m} \times 4.15^{m}$	1.49	20.75
	L.L	Roof	$0.077^{t/m^2} \times 6.15 \times (6.95+4.05)/2$	2.60	(2.60)
C-4	D.L	Roof	$0.40^{t/m^2} \times 14.0 \times (6.15+7.2)/4$	18.69	
		Parapet	$0.29^{t/m} \times 14.0/2$	2.03	
		Girder	$(0.31^{t/m} + 0.36^{t/m}) \times 14.0/2 + 0.31^{t/m} \times 6.15/2$	5.64	
		Beam	$0.28^{t/m} \times 7.2 + 0.23^{t/m} \times 6.15$	3.43	29.79
		Column	$0.36^{t/m} \times 4.15 + 0.24^{t/m} \times 1.0$	1.73	31.52
	L.L	Roof	$0.077^{t/m^2} \times 14.0 \times (6.15+7.2)/4$	3.60	(3.60)
E-1'	D.L	Roof	$0.40^{t/m^2} \times 7.6 \times 8.2/4$	6.23	
		Parapet	$0.29^{t/m} \times (7.6+8.2)/2$	2.29	
		Girder	$0.36^{t/m} \times 7.6/2 + 0.34^{t/m} \times 8.2/2$	2.76	
		Beam	$0.28^{t/m} \times 8.2^{m} \times 3/4$	1.72	13.0
		Column	$0.36^{t/m} \times 6.15$	2.21	15.21
	L.L	Roof	$0.077^{t/m^2} \times 7.6 \times 8.2/4$	1.20	(1.20)
E-2'	D.L	Roof	$0.40^{t/m^2} \times 7.6 \times 8.2/2$	12.46	
		Parapet	$0.29^{t/m} \times 7.6$	2.20	
		Girder	$0.34^{t/m} \times 7.6$	2.58	
		Beam	$0.28^{t/m} \times 8.2 \times (3+1/2)/2$	4.02	21.26
		Column	$0.24^{t/m} \times 6.15$	1.48	22.74
	L.L	Roof	$0.077^{t/m^2} \times 7.6 \times 8.2/2$	2.40	(2.40)

SC-6. STRESS ANALYSIS

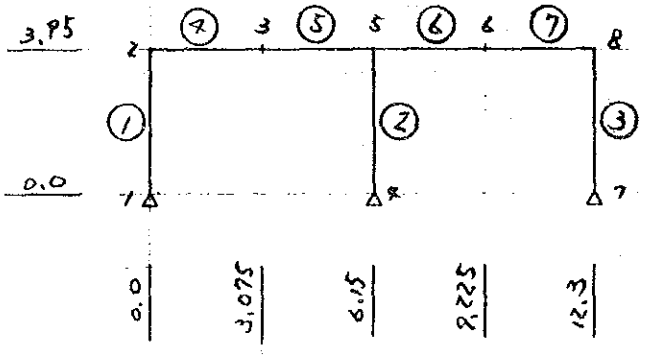
6-1 JOINT COODINATES AND MEMBER PROPERTIES

① FRAME



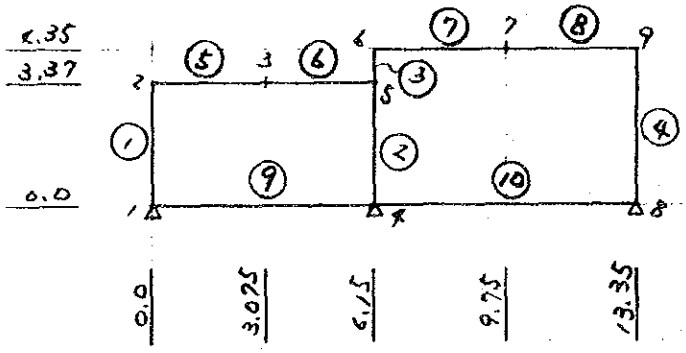
MEM. NO.	SECT.	$A_{(m^2)}$	$I_{(m^4)}$
①, ②	0.4 × 0.2	0.08	1.07×10^{-3}
③, ④	0.2 × 0.7	0.14	5.72×10^{-3}
⑤, ⑥	0.2 × 1.15	0.23	25.3×10^{-3}

④ FRAME



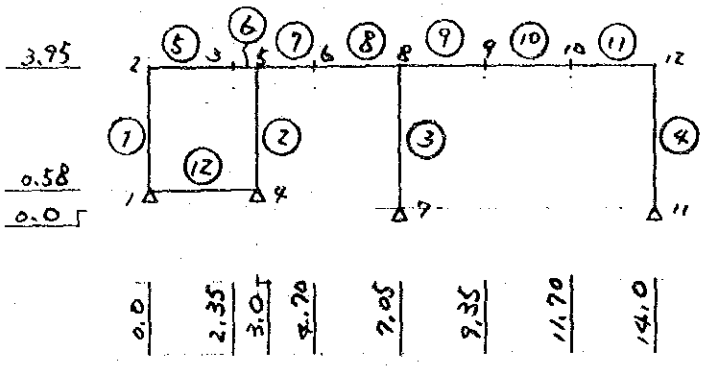
MEM. NO.	SECT.	$A_{(m^2)}$	$I_{(m^4)}$
① ~ ③	0.4 × 0.2	0.08	1.07×10^{-3}
④ ~ ⑦	0.65 × 0.2	0.13	4.58×10^{-3}

⑤ FRAME



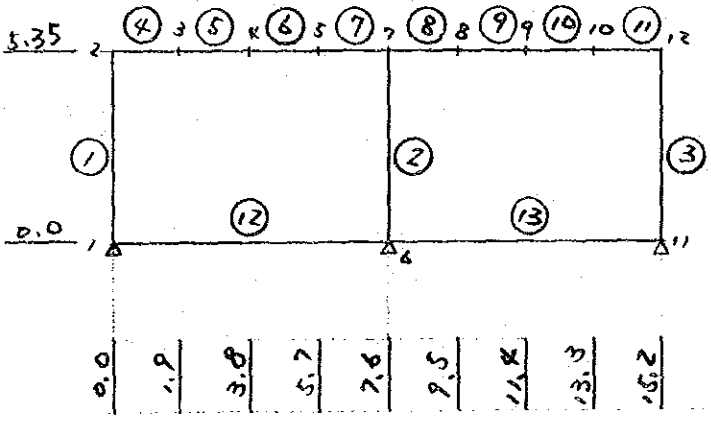
MEM. NO.	SECT.	$A_{(m^2)}$	$I_{(m^4)}$
① ~ ④	0.4 × 0.2	0.08	1.07×10^{-3}
⑤, ⑥	0.2 × 0.7	0.14	5.72×10^{-3}
⑦, ⑧	0.2 × 0.65	0.13	4.58×10^{-3}
⑨, ⑩	0.2 × 1.15	0.23	25.3×10^{-3}

(B) FRAME



MEM. NO.	SECT.	A (m^2)	I (m^4)
① ~ ④	0.4 × 0.2	0.08	1.07×10^{-3}
⑤ ~ ⑪	0.2 × 0.65	0.13	4.58×10^{-3}
⑫	0.2 × 1.15	0.23	25.3×10^{-3}

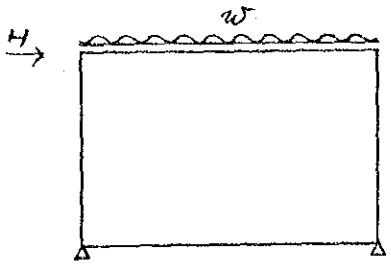
(E) FRAME



MEM. NO.	SECT.	A (m^2)	I (m^4)
① ~ ③	0.4 × 0.2	0.08	1.07×10^{-3}
④ ~ ⑪	0.2 × 0.75	0.15	7.03×10^{-3}
⑫, ⑬	0.2 × 1.15	0.23	25.3×10^{-3}

6-2 LOADING DIAGRAM

① FRAME



i) Dead Load (D.L)

$w = 0.80^{\text{Roof}}\ t/m^2 \times 1.8/2^{m} + 0.29^{\text{Parapet}} + 0.34^{\text{Girder}} = 1.01\ t/m$

ii) Live Load (L.L)

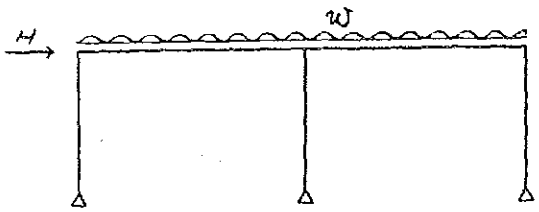
$w = 0.077^{\text{Roof}} \times 1.8/2 = 0.07\ t/m$

iii) Wind Load (W.L)

$H = 0.123\ t/m^2 \times 7.6 \times (5.15/2 + 0.75)$

$= 3.11$ ton.

④ FRAME



i) Dead Load (D.L)

$w = 0.80^{\text{Roof}} \times 2.35^{m} + 0.31^{\text{Girder}} = 1.25\ t/m$

ii) Live Load (L.L)

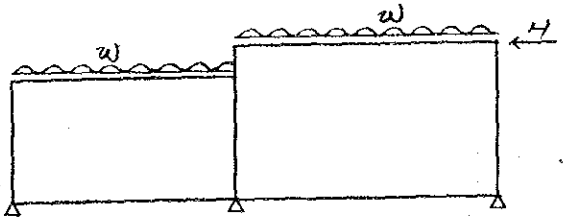
$w = 0.077 \times 2.35 = 0.18\ t/m$

iii) Wind Load (W.L)

$H = 0.123 \times 7.0 \times (3.15/2 + 0.75)$

$= 2.00$ ton

⑤ FRAME



i) Dead Load (D.L)

$w = 0.80^{\text{Roof}} \times 2.35/2 + 0.29^{\text{Parapet}} + 0.31^{\text{Girder}} = 1.07\ t/m$

ii) Live Load (L.L)

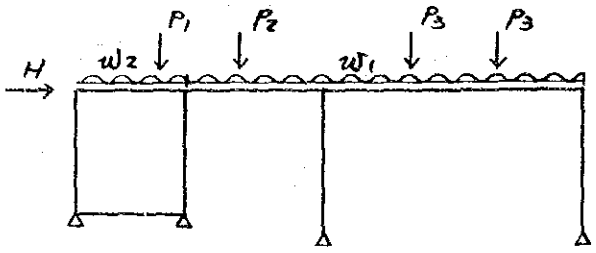
$w = 0.077 \times 2.35/2 = 0.09\ t/m$

iii) Wind Load (W.L)

$H = 0.123 \times 7.0 \times (4.15/2 + 0.75)$

$= 2.83$ ton.

(B) FRAME



i) Dead Load (D.L)

$P_1 = (0.40 \times 2.35 + 0.23) \times 6.15/2$ (Roof, Beam)

$= 3.60$ ton

$P_2 = 3.60 + (0.40 \times 4.05/2 + 0.23) \times 6.15/2$

$= 6.80$ ton

$P_3 = 3.60 \times 2 = 7.20$ ton

$w_1 = 0.31$ t/m

$w_2 = 0.31 + 0.29 = 0.60$ t/m

ii) Live Load (L.L)

$P_1 = 0.077 \times 2.35 \times 6.15/2 = 0.56$ ton

$P_2 = 0.56 + 0.077 \times 4.05/2 \times 6.15/2$

$= 1.04$ ton

$P_3 = 0.56 \times 2 = 1.12$ ton

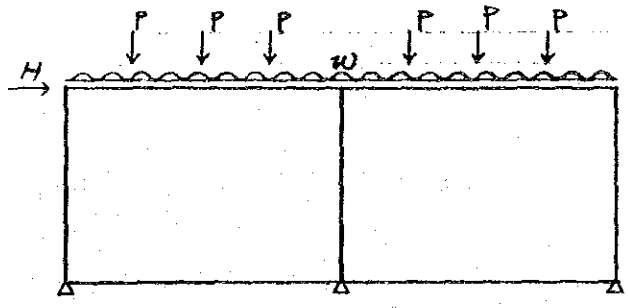
$w_1 = w_2 = 0$

iii) Wind Load (W.L)

$H = 0.123 \times 6.15 \times (3.15/2 + 0.75)$

$= 1.76$ ton

(E) FRAME



i) Dead Load (D.L)

$P = (0.80 \times 1.9 + 0.28) \times 8.2/2 = 4.26$ ton (Roof, Beam)

$w = 0.29 + 0.36 = 0.65$ t/m (Parapet, Girder)

ii) Live Load (L.L)

$P = 0.077 \times 1.9 \times 8.2/2 = 0.60$ ton

$w = 0$

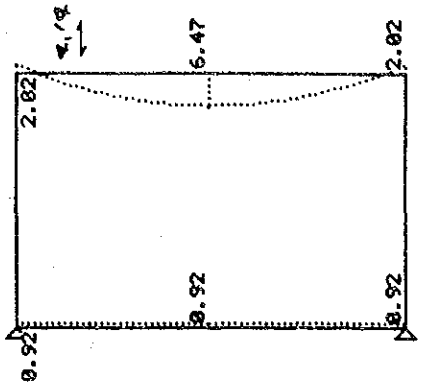
iii) Wind Load (W.L)

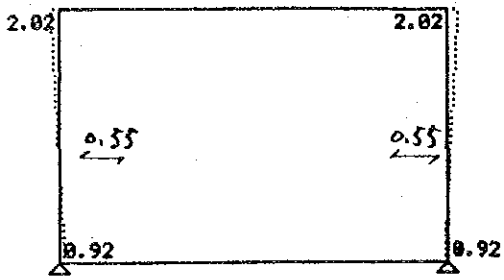
$H = 0.123 \times 8.2/2 \times (5.15/2 + 0.75)$

$= 1.68$ ton

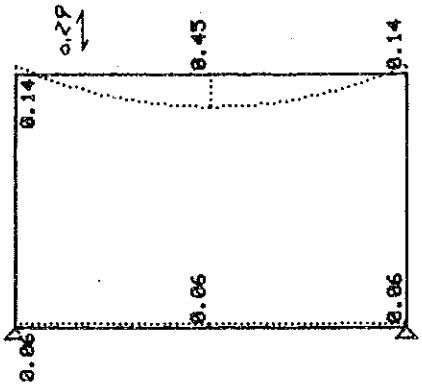
6-3. STRESS DIAGRAM

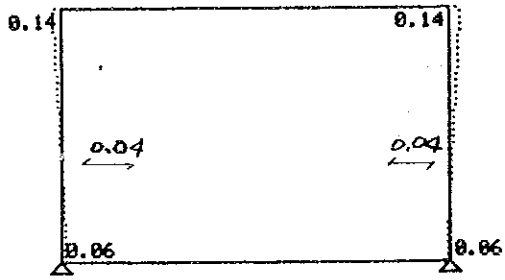
① FRAME



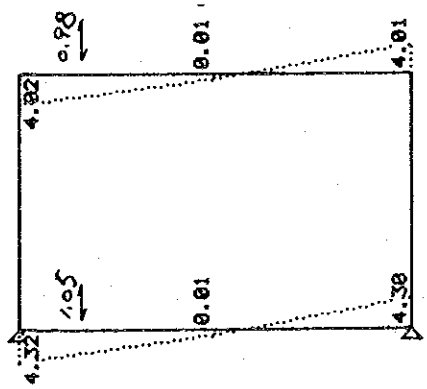


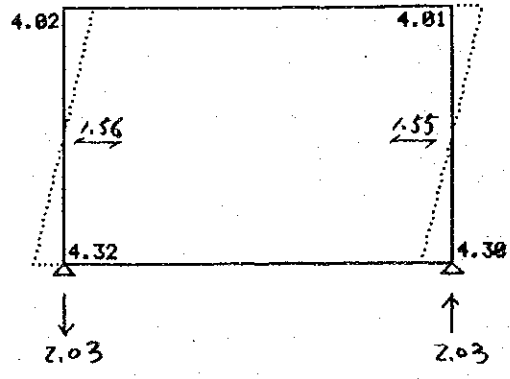
D.L





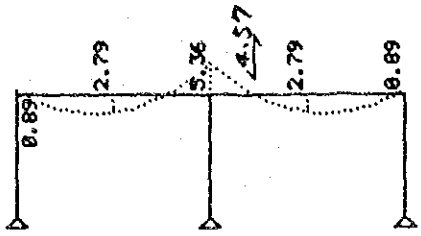
L.L

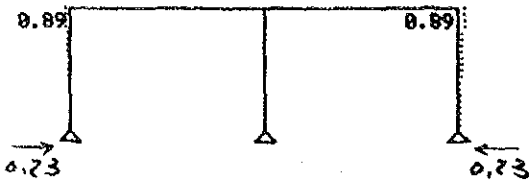




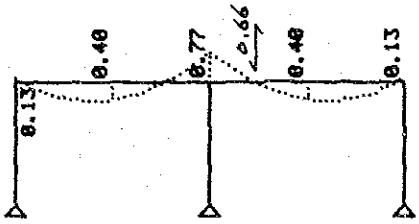
W.L

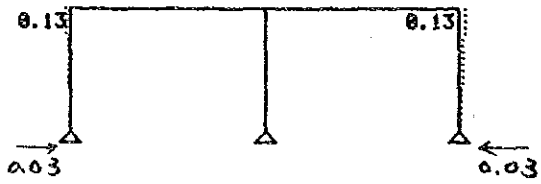
④ FRAME.



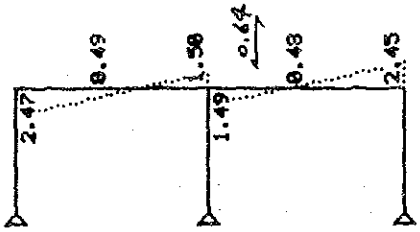


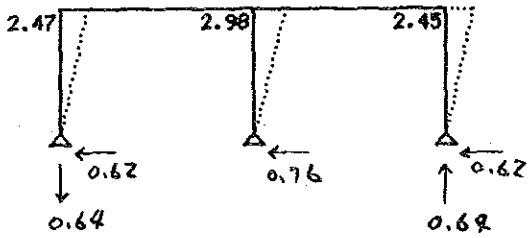
D.L





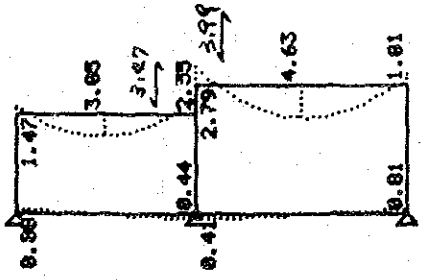
L.L

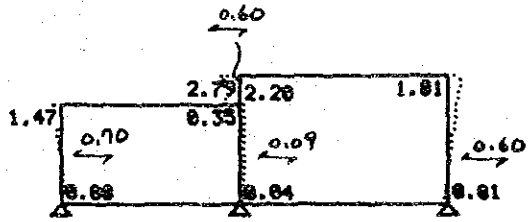




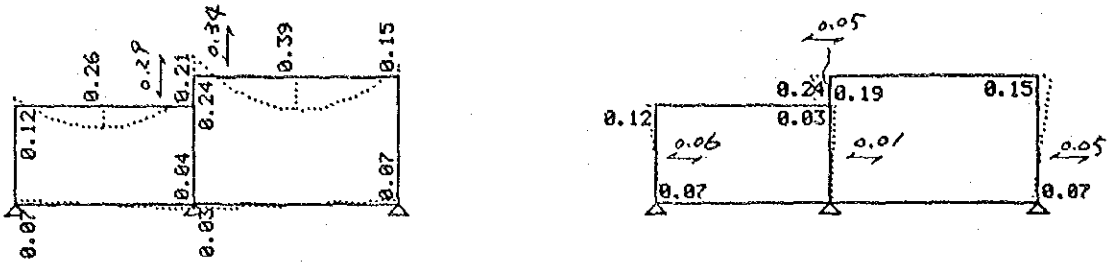
W.L

⑤ FRAME.

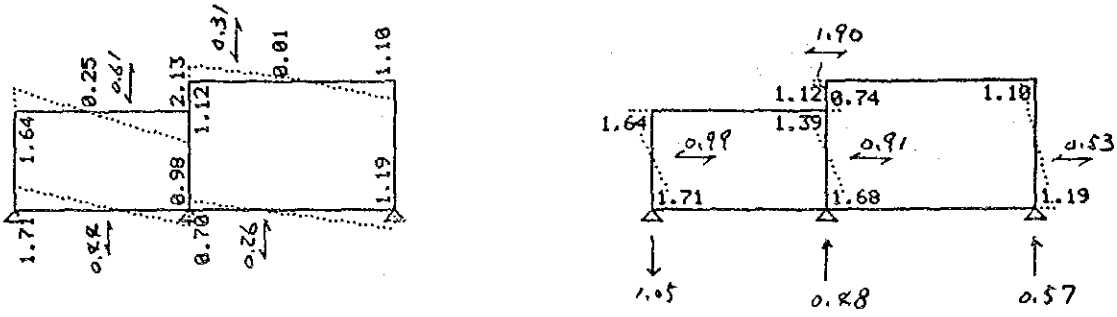




D.L

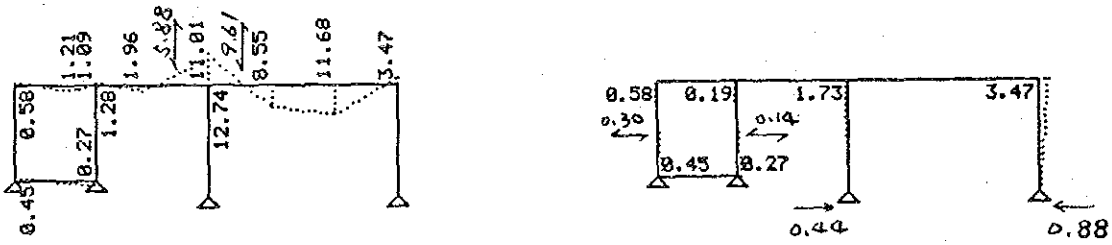


L.L

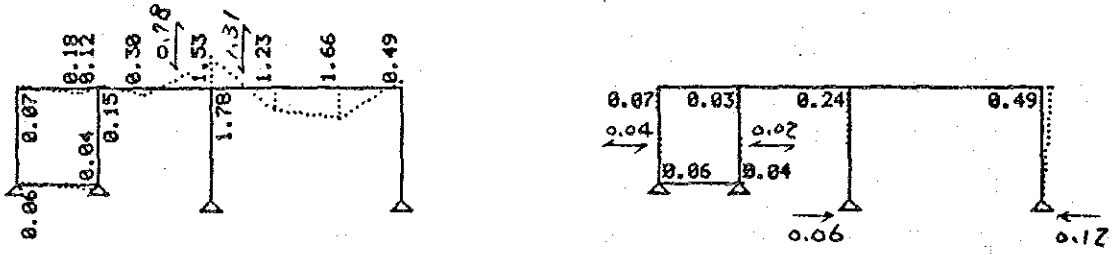


W.L

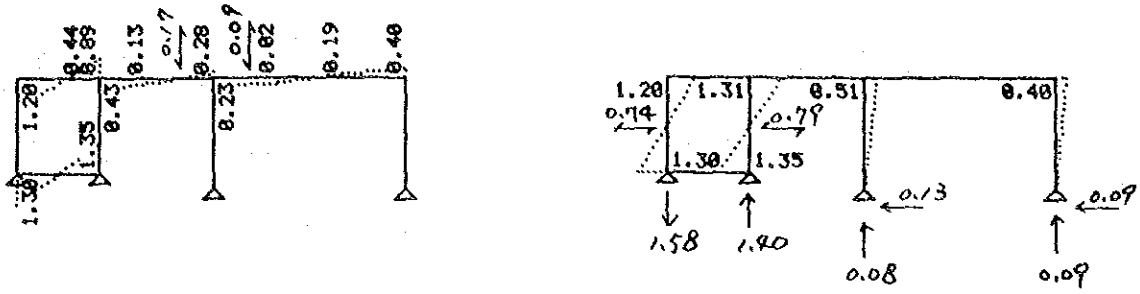
(B) FRAME



D.L

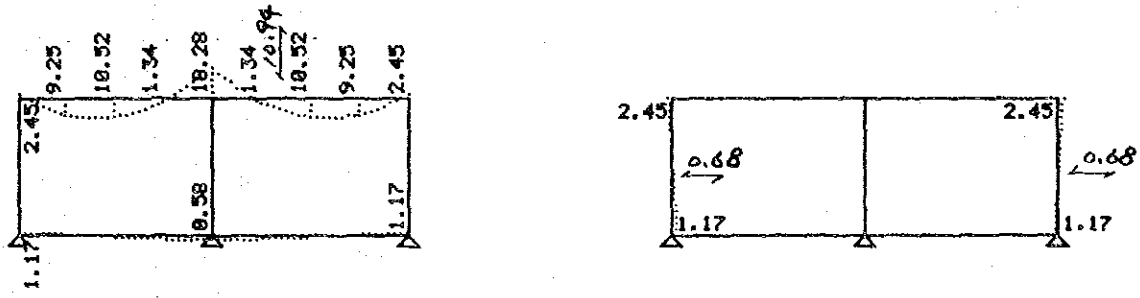


L.L

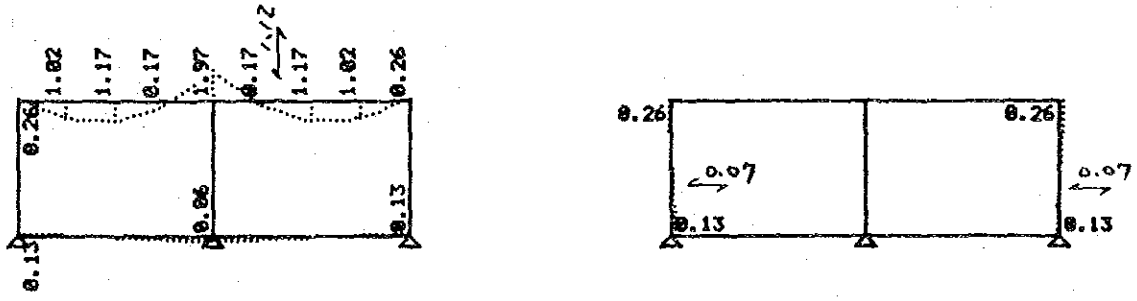


W.L

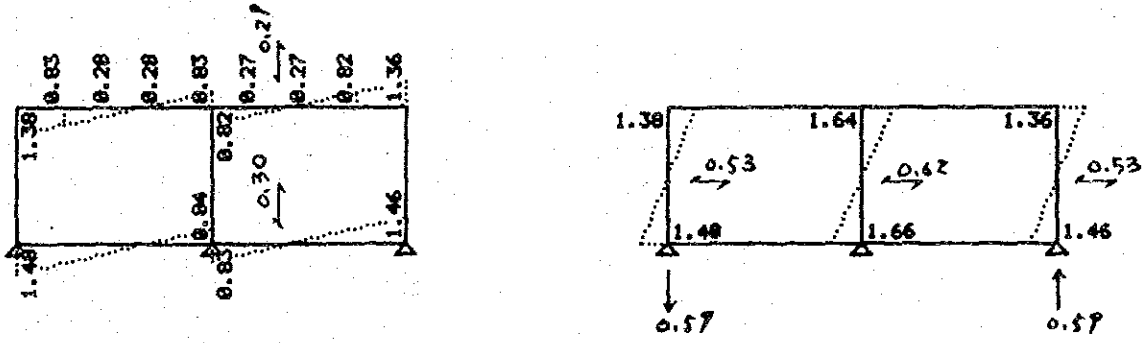
Ⓔ FRAME



D.L



L.L



W.L

SC-7. DESIGN OF MEMBERS

7-1 Ultimate Stress

$U1 = 1.4\,D.L + 1.6\,L.L$

$U2 = 0.9\,D.L + 1.4\,W.L$

$U3 = 1.2\,D.L + 1.2\,L.L + 1.2\,W.L$

1) Column

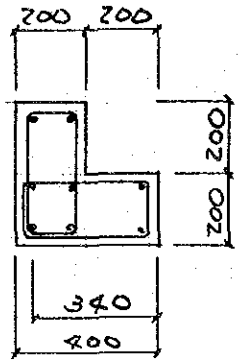
Col. No.	Stress	D.L	L.L	W.L	U1	U2	U3
C1	M	2.02	0.18	4.02	3.05	7.45	7.42
	P	13.00	1.20	0.98	20.12	13.07	18.22
	V	0.55	0.08	1.56	0.83	2.68	2.58
C2	M	0	0	1.68		2.30	
	P	21.26	2.80	0		19.13	
	V	0	0	0.62		0.87	

2) Girder

Girder No.	Stress	D.L	L.L	W.L	U1	U2	U3
G1	M(TOP)	18.28	1.97	0.83	28.74	17.61	25.30
	M(BOT.)	10.25	1.17	0.28	16.22	9.62	14.05
	V	10.94	1.12	0.29	17.11	10.25	14.82
G2	M(TOP)	2.02	0.18	4.02	3.05	7.45	7.42
	M(BOT.)	6.47	0.45	0	9.78	—	—
	V	4.14	0.29	0.98	6.26	5.10	6.49
G3	M(TOP)	12.78	1.78	0.23	20.68	11.79	17.70
	M(BOT.)	11.68	1.66	0.19	19.01	10.78	16.24
	V	9.61	1.31	0.09	15.55	8.78	13.21

7-2 Design of Column.

C1



$$\frac{Mu}{b\cdot d^2} = \frac{7.95\times 9.8\times 10^6}{200\times 340^2} = 3.16$$

$$\frac{Pu}{b\cdot d} = \frac{13.07\times 9.8\times 10^3}{200\times 340 + 200\times 140} = 1.33$$

$$\rightarrow \frac{100\,Asc}{b\cdot d} = 2$$

$Asc = 2\times 200\times 340/100 = 1360\ mm^2$

Use 4(8) - D22 ($Asc = 1548\ mm^2$)

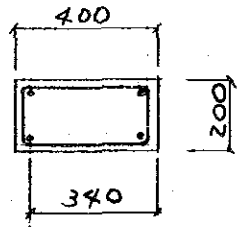
$$\frac{100\,As}{b\cdot d} = \frac{100\times 1548}{200\times 340\times 2} = 1.14 \longrightarrow v_c = 0.68\ N/mm^2$$

$$v = \frac{V}{b\cdot d} = \frac{2.68\times 9.8\times 10^3}{200\times 340} = 0.39\ N/mm^2 < v_c = 0.68\ N/mm^2$$

o.k

Use Stirrup D10 @ 250

C2



$$\frac{Mu}{b\cdot d^2} = \frac{2.30\times 9.8\times 10^6}{200\times 340^2} = 0.97$$

$$\frac{Pu}{b\cdot d} = \frac{19.13\times 9.8\times 10^3}{200\times 340} = 2.76$$

$$\rightarrow \frac{100\,Asc}{b\cdot d} = 0.$$

$Asc(min) = 0.01\times 200\times 340 = 680\ mm^2$

Use 4 - D22 ($Asc = 1548\ mm^2$)

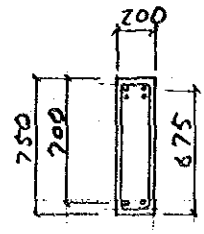
$$v = \frac{V}{b\cdot d} = \frac{0.87\times 9.8\times 10^3}{200\times 340} = 0.13\ N/mm^2 < v_c = 0.68\ N/mm^2$$

ok

Use Stirrup D10 @250

7-2 Design of Girder

G1



$\frac{Mu(TOP)}{b \cdot d^2} = \frac{28.74 \times 9.8 \times 10^6}{200 \times 675^2} = 3.09 \longrightarrow \frac{100As}{bd} = 0.93$

$As(TOP) = 0.93 \times 200 \times 675 / 100 = 1255.5\ mm^2$

$\frac{Mu(BOT.)}{b \cdot d^2} = \frac{16.22 \times 9.8 \times 10^6}{200 \times 700^2} = 1.62 \longrightarrow \frac{100As}{b \cdot d} = 0.87$

$As(BOT.) = 0.87 \times 200 \times 700 / 100 = 658\ mm^2$

Use TOP 4-D22 ($As = 1548\ mm^2$)
Use BOT. 2-D22 ($As = 774\ mm^2$)

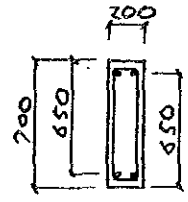
$\frac{100As}{b \cdot d} = \frac{100 \times 1548}{200 \times 675} = 1.15 \longrightarrow v_c = 0.68\ N/mm^2$

$v = \frac{Vu}{b \cdot d} = \frac{17.11 \times 9.8 \times 10^3}{200 \times 675} = 1.24\ N/mm^2 > v_c = 0.68\ N/mm^2$

D10 ($Asv = 143\ mm^2$) $S_v = \frac{0.87 \cdot f_{yv} \cdot Asv}{b(v - v_c)} = \frac{0.87 \times 410 \times 143}{200 \times (1.24 - 0.68)} = 455\ mm$

Use Stirrup D10 @250

G2



$\frac{Mu(TOP)}{b \cdot d^2} = \frac{7.85 \times 9.8 \times 10^6}{200 \times 650^2} = 0.86 \longrightarrow \frac{100As}{b \cdot d} = 0.25$

$As(TOP) = 0.25 \times 200 \times 650 / 100 = 325\ mm^2$

$\frac{Mu(BOT.)}{b \cdot d^2} = \frac{8.78 \times 9.8 \times 10^6}{200 \times 650^2} = 1.13 \longrightarrow \frac{100As}{b \cdot d} = 0.31$

$As(BOT.) = 0.31 \times 200 \times 650 / 100 = 403\ mm^2$

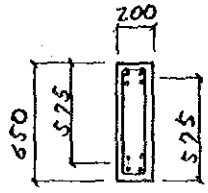
Use 2-D19 ($As = 574\ mm^2$) TOP & BOT.

$\frac{100As}{b \cdot d} = \frac{100 \times 574}{200 \times 650} = 0.44 \longrightarrow v_c = 0.48\ N/mm^2$

$v = \frac{Vu}{b \cdot d} = \frac{6.49 \times 9.8 \times 10^3}{200 \times 650} = 0.49\ N/mm^2 > v_c = 0.48\ N/mm^2$

Use Stirrup D10 @250

G3



$$\frac{Mu(TOP)}{b\cdot d^2} = \frac{20.68\times 9.8\times 10^6}{200\times 575^2} = 3.06 \longrightarrow \frac{100As}{b\cdot d} = 0.93$$

$$As(TOP) = 0.93\times 200\times 575/100 = 1069.5\ mm^2$$

$$\frac{Mu(BOT.)}{b\cdot d^2} = \frac{18.01\times 9.8\times 10^6}{200\times 575^2} = 2.82 \longrightarrow \frac{100As}{b\cdot d} = 0.83$$

$$As(BOT.) = 0.83\times 200\times 575/100 = 954.5\ mm^2$$

Use 4-D19 ($As = 1148\ mm^2$) TOP & BOT.

$$\frac{100As}{b\cdot d} = \frac{100\times 1148}{200\times 575} = 1.0 \longrightarrow v_c = 0.65\ N/mm^2$$

$$v = \frac{Vu}{b\cdot d} = \frac{15.55\times 9.8\times 10^3}{200\times 575} = 1.33\ N/mm^2 > v_c = 0.65\ N/mm^2$$

D10 ($Asv = 143\ mm^2$) $$S_v = \frac{0.87\cdot f_{sv}\cdot Asv}{b(v-v_c)} = \frac{0.87\times 410\times 143}{200\times(1.33-0.65)} = 375\ mm^2$$

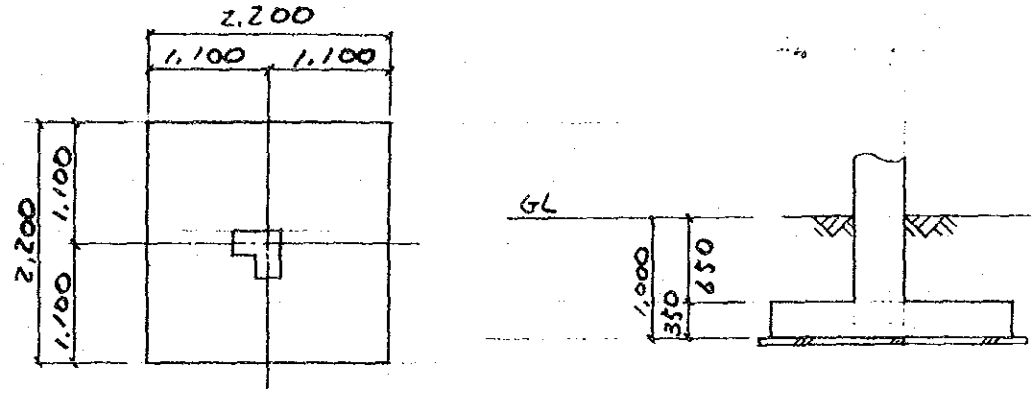
Use Stirrup D10@250

SC-8. DESIGN OF FOUNDATION

8-1. DESIGN OF FOOTING.

F1 (C-4)

a) Plan & Elevation.



b) Foundation Weight

Footing	$2.4 \times 0.35 \times 2.2^2$	= 4.07 t
Soil	$1.8 \times 0.65 \times (2.2^2 - 0.4^2 + 0.2^2)$	= 5.52 t
Total		9.59 t

c) Check of Contact Pressure

i) Total Vertical Load.

D.L + L.L	(31.52+9.59) + 3.60	= 44.71 t.
D.L + L.L + W.L	44.71 + 0.64	= 45.35 t

ii) Check of Contact Pressure

D.L + L.L $\sigma = \frac{44.71}{2.2^2} = 9.24\ t/m^2 < 10\ t/m^2$ o.k

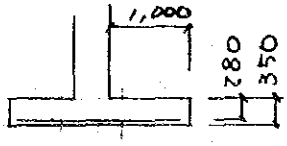
d) Contact Pressure for Ultimate Load.

Ultimate Vertical Load.

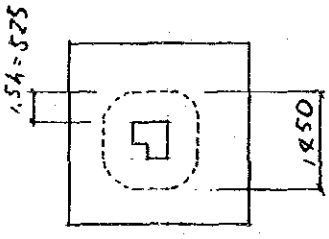
$U = 1.4 \times 31.52 + 1.6 \times 3.60 = 49.89$ t.

$\sigma = \frac{49.89}{2.2^2} = 10.31$ t/m²

e) Stress of Footing Slab.



$M_u = 1/2 \times 10.31 \times 1.0^2 = 5.16$ t·m/m



$l = 400 \times 4 + 1050 \times 3.14 = 4897$ mm

$v = \frac{49.89 \times 9.8 \times 10^3}{280 \times 4897} = 0.36$ N/mm²

f) Design of Section

$\frac{M_u}{b \cdot d^2} = \frac{5.16 \times 9.8 \times 10^6}{1000 \times 280^2} = 0.65 \longrightarrow \frac{100 A_s}{b \cdot d} = 0.20$

$A_s = 0.20 \times 1000 \times 280 / 100 = 560$ mm²/m

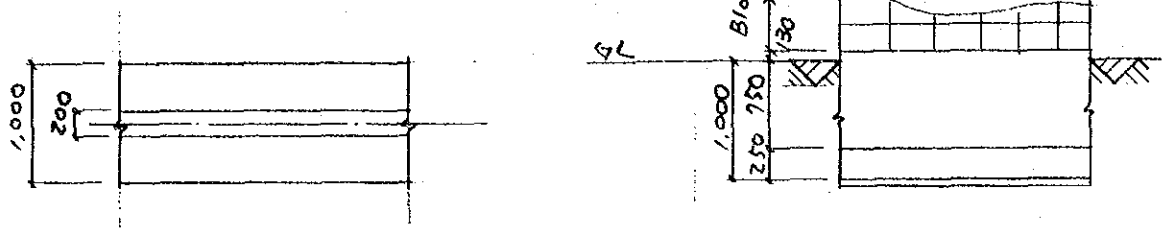
Use D19@250 ($A_s = 1148$ mm²/m) Each Way

$\frac{100 A_s}{b \cdot d} = \frac{100 \times 1148}{1000 \times 280} = 0.41 \longrightarrow v_c = 0.41$ N/mm² (Grade 20)

$v = 0.36$ N/mm² < $v_c = 0.41$ N/mm² O.K

F2 (Ⓔ LINE)

a) Plan & Elevation



b) Foundation Weight.

Footing & Grade Beam	$2.4 \times (0.25 \times 1.0 + 0.2 \times 0.88)$	= 1.02 t/m
Soil	$1.8 \times 0.75 \times (1.0 - 0.2)$	= 1.08 t/m
Block (t=150)	$0.45^{t/m^2} \times 4.4$	= 1.98 t/m
Total		4.08 t/m

c) Check of Contact Pressure

i) Total Vertical Load

D.L+L.L $\{(15.21 + 1.20) \times 2 + (22.74 + 2.4)\} / 15.2^m$

$+ 4.08^{t/m} = 7.89\ t/m$

ii) Check of Contact Pressure

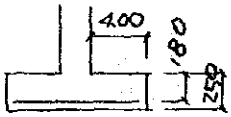
D.L+L.L $\sigma = \frac{7.89}{1.0} = 7.89\ t/m^2 < 10\ t/m^2$ o.k

d) Contact Pressure for Ultimate Load.

$$U = 1.4 \times (15.21 \times 2 + 22.74) / 15.2^{m} + 1.6 \times (1.2 \times 2 + 2.4) / 15.2^{m} = 5.40 \ t/m$$

$$uq = \frac{5.40}{1.0} = 5.40 \ t/m^2$$

e) Stress of Footing Slab



$$Mu = 1/2 \times 5.40 \times 0.4^2 = 0.43 \ t\cdot m/m$$

$$v = \frac{5.40 \times 9.8 \times 10^3}{1000 \times 180 \times 2} = 0.15 \ N/mm^2$$

f) Design of Section

$$\frac{Mu}{b \cdot d^2} = \frac{0.43 \times 9.8 \times 10^6}{1000 \times 180^2} = 0.13 \longrightarrow \frac{100As}{b \cdot d} = 0.05$$

$$As = 0.05 \times 1000 \times 180 / 100 = 90 \ mm^2/m$$

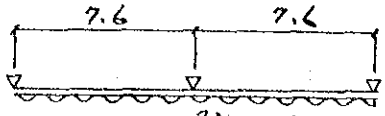
Use D13 @250 ($As = 508 \ mm^2/m$)

$$\frac{100As}{b \cdot d} = \frac{100 \times 508}{1000 \times 180} = 0.28 \longrightarrow v_c = 0.36 \ N/mm^2 \ (\text{Grade } 20)$$

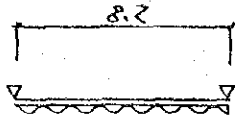
$v = 0.15 \ N/mm^2 < v_c = 0.36 \ N/mm^2$ ok

8-2. DESIGN OF GRADE BEAM.

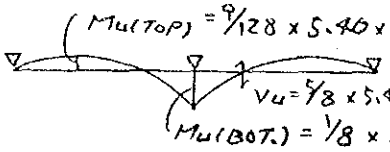
FG1



W_u = 5.40 t/m
See P.



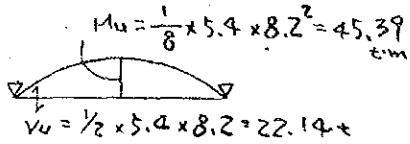
W_u = 5.40 t/m



$M_{u(TOP)} = \frac{9}{128} \times 5.40 \times 7.6^2 = 21.93$ t·m

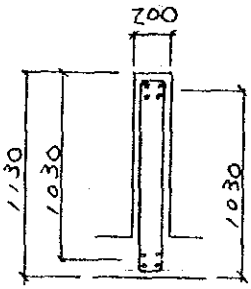
$V_u = \frac{5}{8} \times 5.4 \times 7.6 = 25.65$ t

$M_{u(BOT.)} = \frac{1}{8} \times 5.40 \times 7.6^2 = 38.99$ t·m



$M_u = \frac{1}{8} \times 5.4 \times 8.2^2 = 45.39$ t·m

$V_u = \frac{1}{2} \times 5.4 \times 8.2 = 22.14$ t



$$\frac{M_{u(TOP)}}{b \cdot d^2} = \frac{45.39 \times 9.8 \times 10^6}{200 \times 1030^2} = 2.10 \longrightarrow \frac{100 A_s}{b \cdot d} = 0.6$$

$$A_s = 0.6 \times 200 \times 1030 / 100 = 1236\ mm^2$$

$$\frac{M_{u(BOT.)}}{b \cdot d^2} = \frac{38.99 \times 9.8 \times 10^6}{200 \times 1030^2} = 1.80 \longrightarrow \frac{100 A_s}{b \cdot d} = 0.51$$

$$A_s = 0.51 \times 200 \times 1030 / 100 = 1050.6\ mm^2$$

Use TOP 4-D22 ($A_s = 1548\ mm^2$)
BOT. 4-D19 ($A_s = 1148\ mm^2$)

$$\frac{100 A_s}{b \cdot d} = \frac{100 \times 1148}{200 \times 1030} = 0.56 \longrightarrow v_c = 0.52\ N/mm^2$$

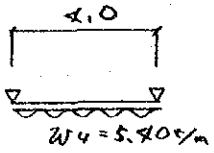
$$v = \frac{V_u}{b \cdot d} = \frac{25.65 \times 9.8 \times 10^3}{200 \times 1030} = 1.22\ N/mm^2 > v_c = 0.52\ N/mm^2$$

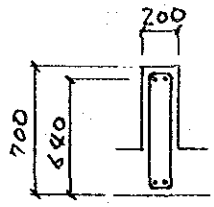
N.G

D10 ($A_{sv} = 143\ mm^2$) $S_v = \frac{0.87 \cdot f_{yv} \cdot A_{sv}}{b(v - v_c)} = \frac{0.87 \times 410 \times 143}{200 \times (1.22 - 0.52)} = 364$ mm

Use Stirrup D10 @250

FG2





$Mu = 1/8 \times 5.40 \times 4.0^2 = 10.80\ t\cdot m$

$Vu = 1/2 \times 5.40 \times 4.0 = 10.80\ t.$

$\frac{Mu}{b\cdot d^2} = \frac{10.80 \times 9.8 \times 10^6}{200 \times 640^2} = 1.2\ P \longrightarrow \frac{100\,As}{b\cdot d} = 0.40$

$As = 0.40 \times 200 \times 640 / 100 = 512\ mm^2$

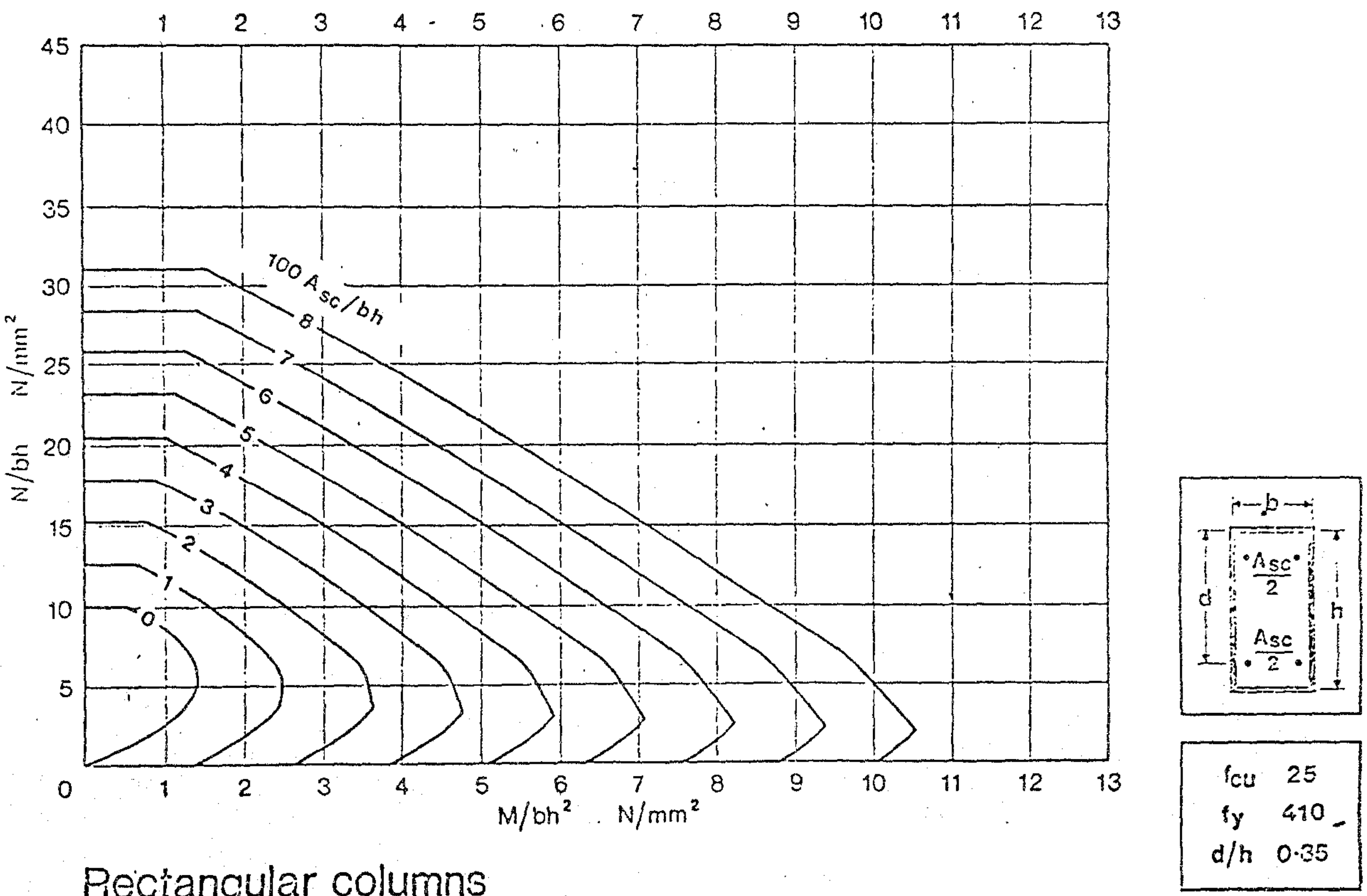
use 2-D19 ($As = 574\ mm^2$) Top & Bot.

$\frac{100\,As}{b\cdot d} = \frac{100 \times 574}{200 \times 640} = 0.45 \longrightarrow v_c = 0.47\ N/mm^2$

$v = \frac{Vu}{b\cdot d} = \frac{10.8 \times 9.8 \times 10^3}{200 \times 640} = 0.83\ N/mm^2 > v_c = 0.47\ N/mm^2$

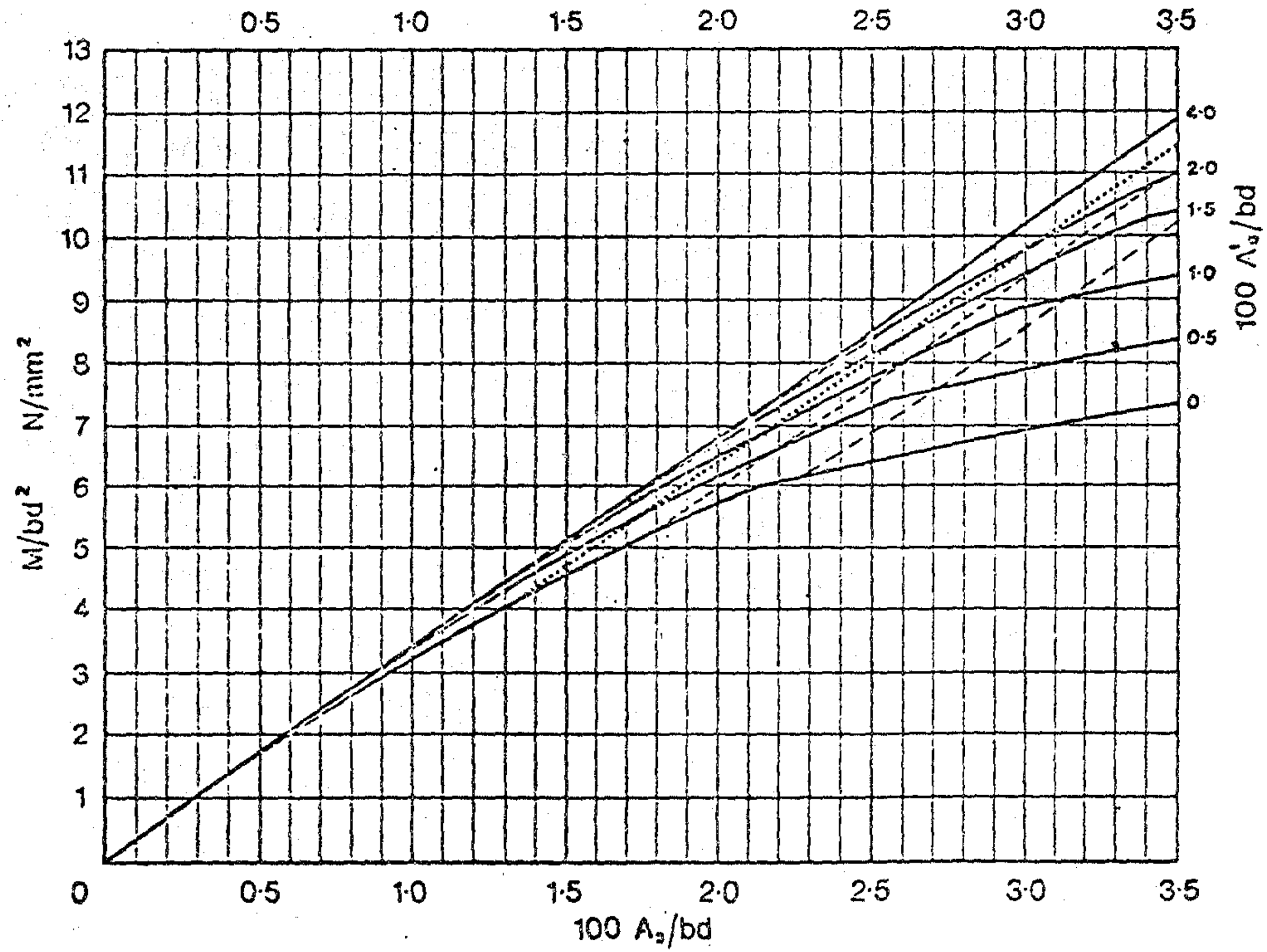
D10 ($Asv = 143\ mm^2$) $Sv = \frac{0.87 \cdot f_{yv} \cdot Asv}{b(v - v_c)} = \frac{0.87 \times 410 \times 143}{200 \times (0.83 - 0.47)} = 708\ mm$

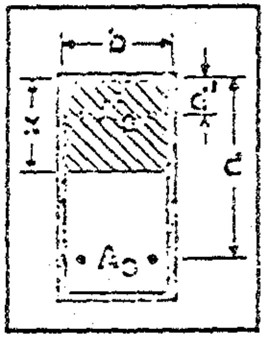
Use Stirrup D10 @250



Rectangular columns

x/d = 0·3 ············
x/d = 0·4 - - - - - -
x/d = 0·5 — — — —



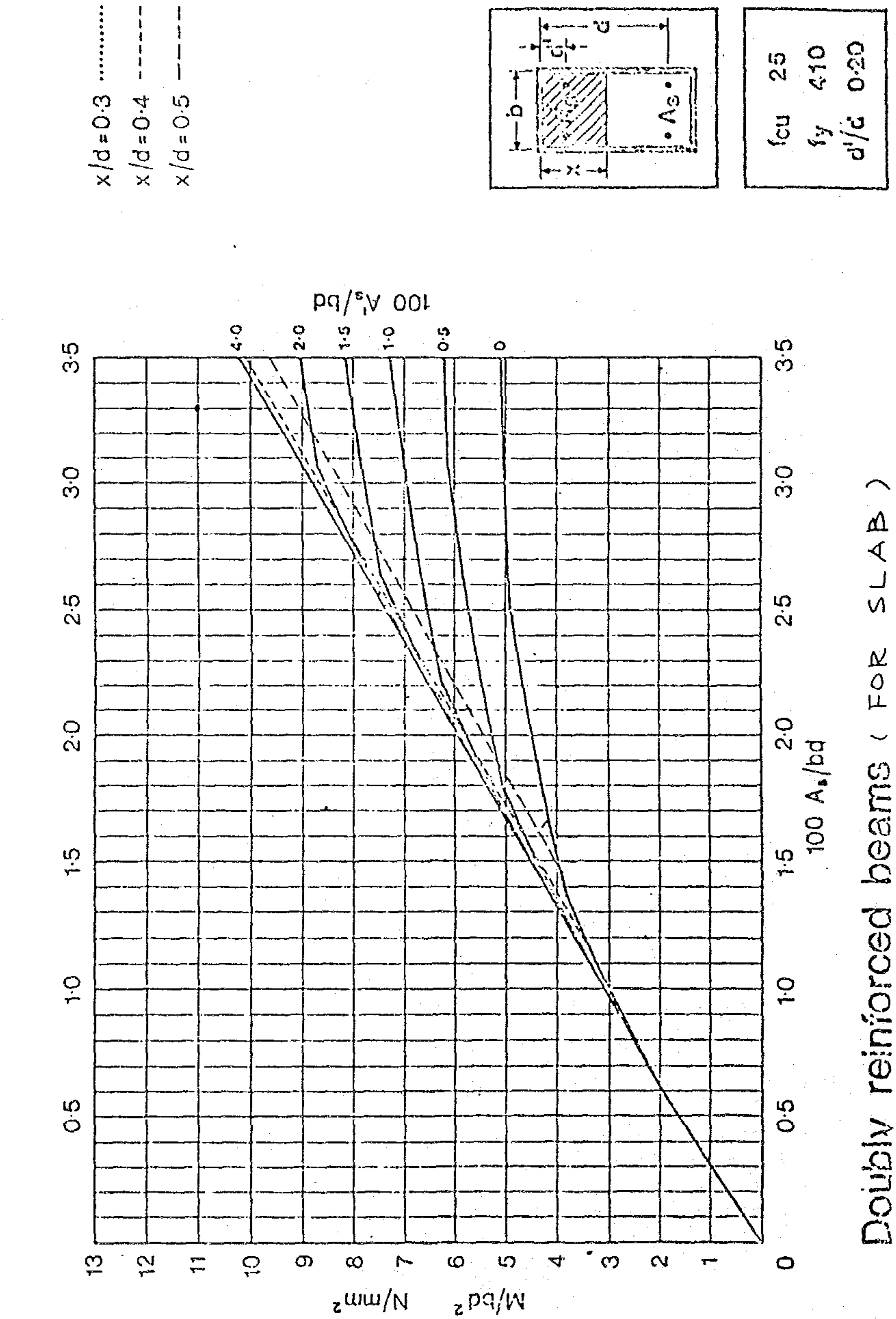


f_{cu}	40
f_y	410
d'/d	0·05

Doubly reinforced beams (FOR GIRDER & BEAM)

2P

3%/30



Doubly reinforced beams (FOR SLAB)

CHECK OF 2nd FLOOR

AT LABORATORY BUILDING.

SC-1. GENERAL.

1-1. Application Codes, Specification ect.

a) Reinforced Concrete Structure ; BS. CP110

b) Live Load ; BS. CP3

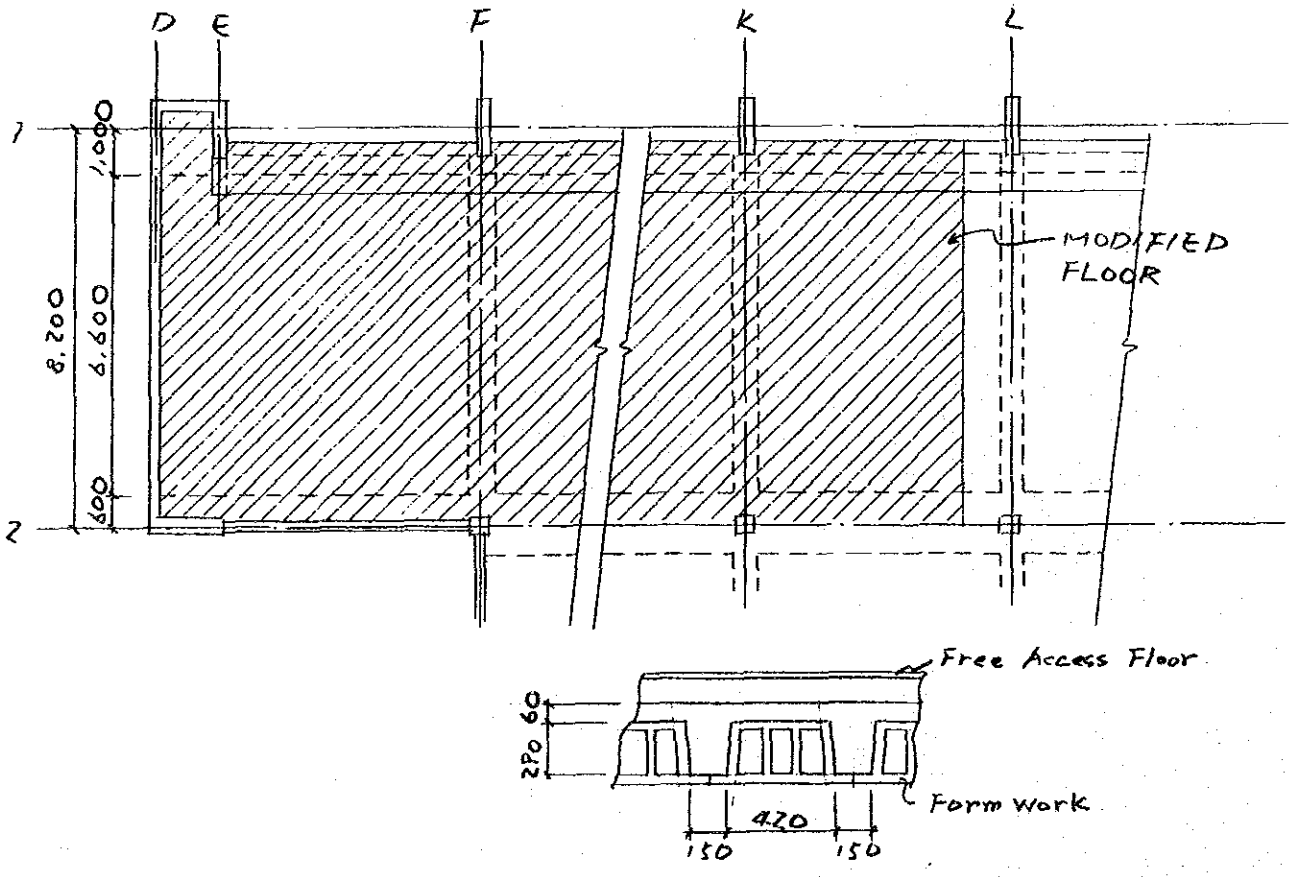
1-2. Materials

a) Concrete ; Grade 25 $f_{cu} = 25\ N/mm^2$

b) Reinforcing Bar ; $F_y = 410\ N/mm^2$ (#)

$F_y = 250\ N/mm^2$ (Φ)

SC-2 OUTLINE.



SC-3. LOAD ASSUMPTION.

3-1 Dead Load (D.L)

a) Floor

Free Access Floor	42 kg/m²	326 kg/m²
Concrete Slab (t=60)	144 kg/m²	
Finish (t=70)	140 kg/m²	

b) Beam

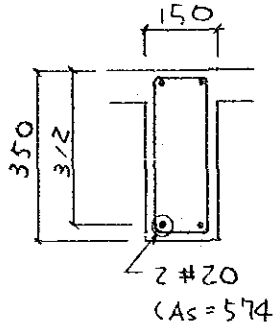
Conc.	105 kg/m	272 kg/m
Form work	167 kg/m	

3-2. Live Load.

Laboratories, including equipment 306 kg/m².

SC-4 CHECK OF MEMBER.

4-1. Beam.

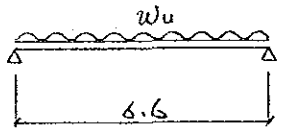


$$Wu = 1.4 \times (0.326^{t/m^2} \times 0.57^{m} + 0.272^{t/m}) + 1.6 \times 0.306^{t/m^2} \times 0.57^{m}$$

$$= 0.92\ t/m$$

$$Mu = 1/8 \times 0.92 \times 6.6^2 = 5.01\ t\cdot m$$

$$Vu = 1/2 \times 0.92 \times 6.6 = 3.04\ t.$$



$$\frac{Mu}{b\cdot d^2} = \frac{5.01 \times 9.8 \times 10^6}{150 \times 312^2} = 3.36 \rightarrow \frac{100As}{b\cdot d} = 1.07$$

$$As = 1.07 \times 150 \times 312/100 = 500.76\ mm^2 < 574\ mm^2$$

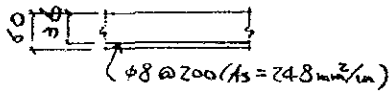
o.k.

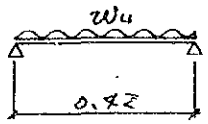
$$\frac{100As}{b\cdot d} = \frac{100 \times 574}{150 \times 312} = 1.23 \longrightarrow v_c = 0.70\ N/mm^2$$

$$v = \frac{Vu}{b\cdot d} = \frac{3.04 \times 9.8 \times 10^3}{150 \times 312} = 0.64\ N/mm^2 < v_c = 0.70\ N/mm^2$$

o.k.

4-2. Slab.





$$Wu = 1.4 \times 0.326^{t/m^2} + 1.6 \times 0.306^{t/m^2} = 0.95\ t/m^2$$

$$Mu = 1/8 \times 0.95 \times 0.42^2 = 0.021\ t\cdot m/m$$

$$Vu = 1/2 \times 0.95 \times 0.42 = 0.20\ t/m$$

$$\frac{Mu}{b\cdot d^2} = \frac{0.021 \times 9.8 \times 10^6}{1000 \times 36^2} = 0.16 \longrightarrow \frac{100As}{b\cdot d} = 0.08$$

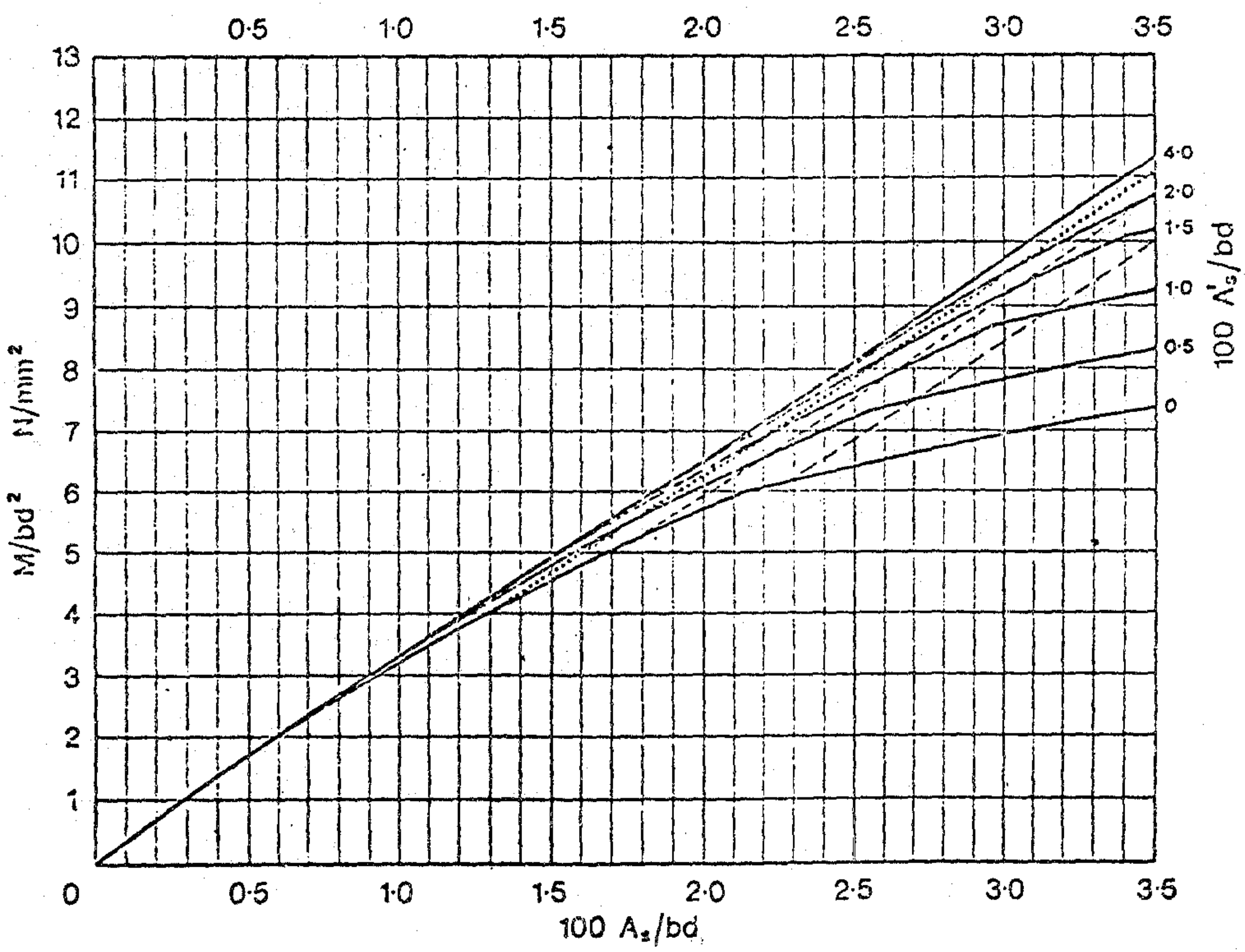
$$As = 0.08 \times 1000 \times 36/100 = 28.8\ mm^2/m < 248\ mm^2/m$$

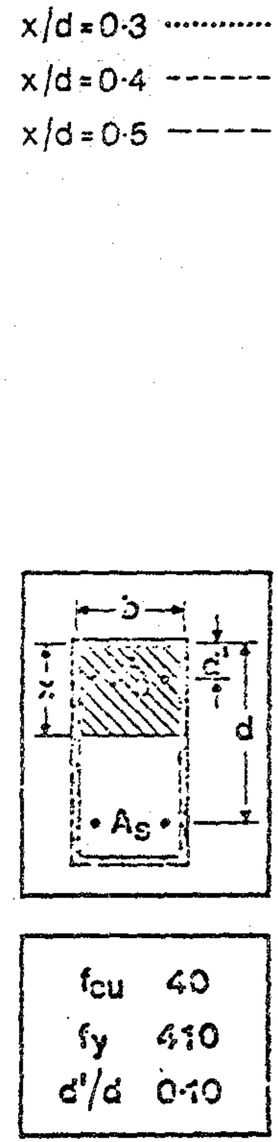
o.k

$$\frac{100As}{b\cdot d} = \frac{100 \times 248}{1000 \times 36} = 0.69 \longrightarrow v_c = 0.53\ N/mm^2$$

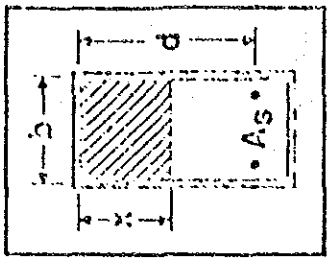
$$v = \frac{Vu}{b\cdot d} = \frac{0.20 \times 9.8 \times 10^3}{1000 \times 36} = 0.05\ N/mm^2 < v_c = 0.53\ N/mm^2$$

o.k

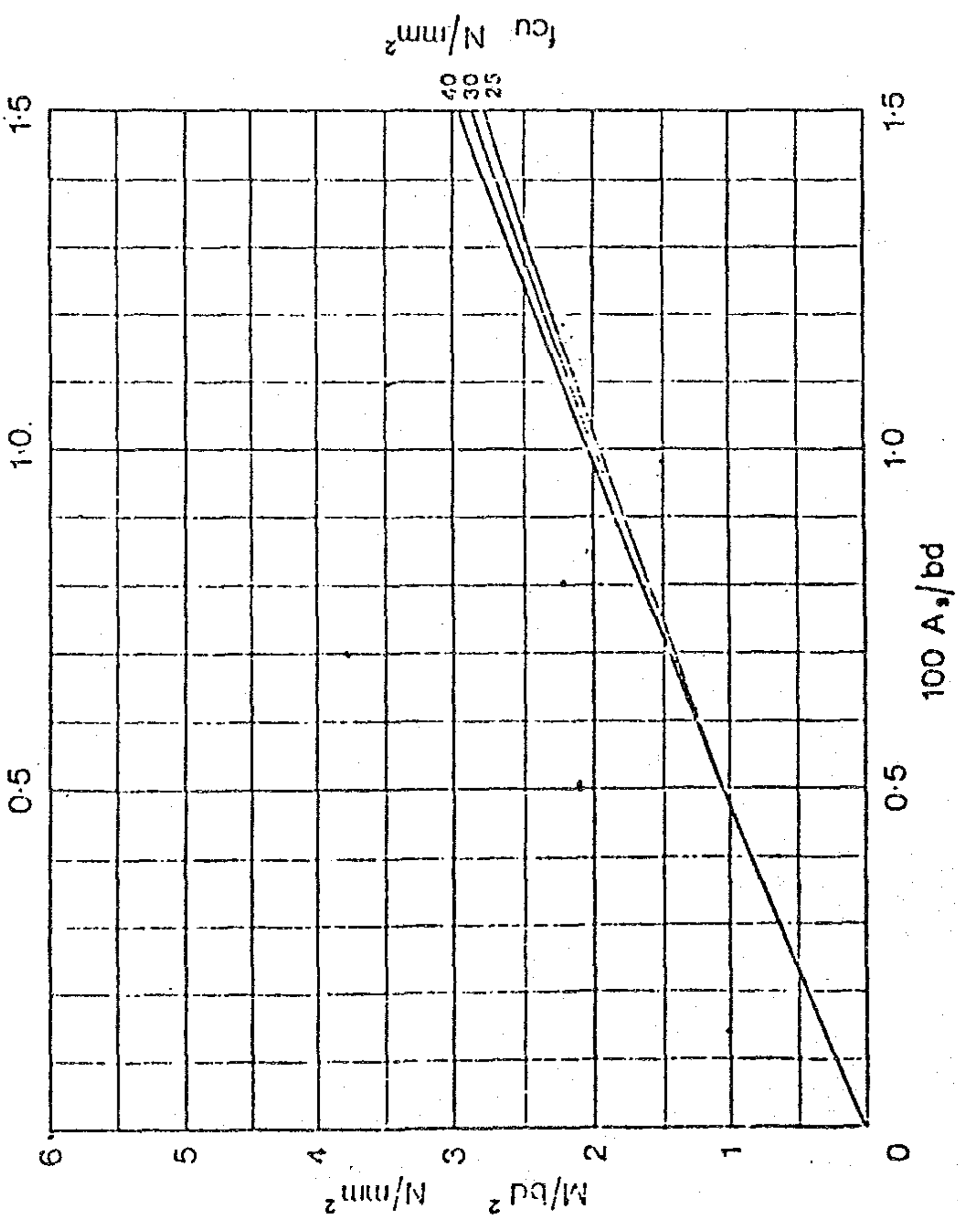




 Doubly reinforced beams (*For Beam*)



f_y 250

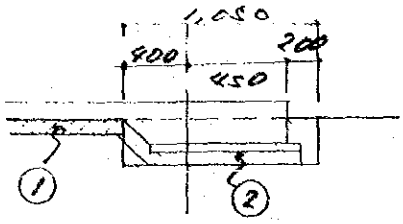


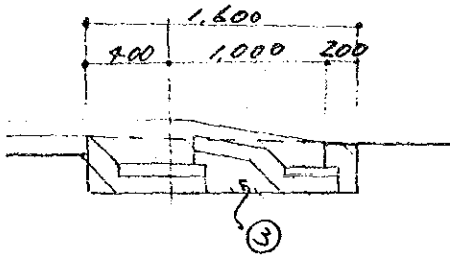
Singly reinforced beams (For Slab)

MATERIAL TAKE OFF

LABORATORY BUILDING

1. EXCAVATION.





	①	$(1.8 - 0.4) \times (2.8 - 0.4 \times 2) \times 0.1$	$= 0.28$ m³	
FOR APRON	②	$1.05 \times (1.8 + 0.45 + 0.2) \times 0.3 \times 2$	$= 1.54$ m³	
		$1.05 \times 0.05 \times 0.3 \times 2$	$= 0.03$ m³	
FOR STOOP	③	$1.6 \times 1.9 \times 0.3$	$= 0.91$ m³	2.76 m³

2. COBBLESTONE.

$(1.8 - 0.25) \times (2.8 - 0.25 \times 2) \times 0.15$	$= 0.53$	m³
$0.8 \times (1.8 + 0.25 + 0.1) \times 0.15 \times 2$	$= 0.56$	m³
$0.8 \times 0.4 \times 0.15 \times 2$	$= 0.1$	m³
$0.25 \times 1.5 \times 0.15$	$= 0.1$	m³
$0.8 \times 1.7 \times 0.15$	$= 0.08$	m³
$1.7 \times 0.7 \times 0.15$	$= 0.18$	m³ 1.55 m³

3 LEVELING CONCRETE.

FOR APRON	$0.8 \times (1.8 + 0.25 + 0.1) \times 0.05 \times 2$	$= 0.19$	m³
	$0.8 \times 0.4 \times 0.05 \times 2$	$= 0.03$	m³
	$0.25 \times 1.5 \times 0.05$	$= 0.03$	m³
FOR STOOP	$0.3 \times 1.7 \times 0.05$	$= 0.03$	m³ 0.28 m³

4. DISPOSAL SOIL

$0.875 \times (1.8 + 0.25) \times 0.5 \times 2$	$= 0.59\ m^3$	
$0.875 \times 0.325 \times 0.15 \times 2$	$= 0.09\ m^3$	
$0.425 \times 1.5 \times 0.15$	$= 0.1\ m^3$	
$0.2 \times 1.5 \times 0.15$	$= 0.05\ m^3$	
$0.62 \times 0.105 \times 1/2 \times 1.5$	$= 0.05\ m^3$	
DISPOSAL SOIL	$= 1.35\ m^3$	
LEVELING CONCRETE.	$= 0.28\ m^3$	$2.71\ m^3$

5. BACK FILLING.

$2.76\ m^3 - 2.71\ m^3$	$= 0.05\ m^3$	$0.05\ m^3$

6. CONCRETE FOR GRAND SLAB.

SLAB	$(1.8 \times 0.1) \times (2.8 + 0.1 \times 2) \times 0.5$	$= 0.86\ m^3$	
	$0.425 \times (1.8 + 0.1) \times 0.5 \times 2$	$= 0.22\ m^3$	
	$0.425 \times 2.15 \times 0.15$	$= 0.14\ m^3$	
APRON	$0.45 \times (1.8 + 0.25) \times 0.3 \times 2$	$= 0.27\ m^3$	
	$0.35 \times 0.25 \times 0.3 \times 2$	$= 0.16\ m^3$	
STOP	$0.2 \times 1.5 \times 0.15$	$= 0.05\ m^3$	
	$0.71 \times 1.5 \times 0.12$	$= 0.13\ m^3$	$2.05\ m^3$

7 CONCRETE FOR SUPER STRUCTURE.

B 2	$(0.2 + 0.5) \times 1/2 \times (1.8 + 0.1) \times 0.2 \times 2$	$= 0.28\ m^3$	
B 1	$0.2 \times (2.8 - 0.1 \times 2) \times 0.2$	$= 0.21\ m^3$	
ROOF SLAB	$(1.8 - 0.1) \times (2.8 - 0.1 \times 2) \times 0.12$	$= 0.54\ m^3$	
	$0.35 \times (1.8 + 0.25) \times 0.12 \times 2$	$= 0.19\ m^3$	
	$0.35 \times (2.8 + 0.1 \times 2) \times 0.12$	$= 0.13\ m^3$	$1.4\ m^3$

8. FORMWORK FOR STOUP

$0.4 \times (1.8 + 0.25) \times 2$	=	$1.22\ m^2$
$0.3 \times 1.1 \times 2$	=	$0.66\ m^2$
0.15×1.5	=	$0.23\ m^2$
$0.2 \times 0.5 \times 2$	=	$0.06\ m^2$
$0.355 \times 0.12 \times 2$	=	$0.09\ m^2$
		$2.39\ m^2$

9. FAIR FACED FORMWORK

B2	$(0.28 + 0.38) \times 1/2 \times (1.8 + 0.1) \times 2$	=	$1.25\ m^2$
	$(0.28 + 0.38) \times 1/2 \times (1.8 - 0.1) \times 2$	=	$1.12\ m^2$
B1	$0.28 \times [(2.8 - 0.1 \times 2) + (2.8 + 0.1 \times 2)]$	=	$1.57\ m^2$
ROOF SCAB.	$(1.8 + 0.25) \times (2.8 + 0.25 \times 2)$	=	$8.33\ m^2$
	$(1.8 + 0.25) \times 0.12 \times 2$	=	$0.52\ m^2$
	$(2.8 + 0.25 \times 2) \times 0.12$	=	$0.42\ m^2$
			$13.22\ m^2$

10. REINFORCED BAR.

D10	B2	$\{(1.8 + 0.1) \times 2 \times 0.56^{kg/m}\} \times 2$	=	$8.26\ kg$
	B1	$(2.8 + 0.2) \times 2 \times 0.56^{kg/m}$	=	$5.36\ kg$
	ROOF SCAB	$(1.8 + 0.25) \times 17 \times 0.56^{kg/m}$	=	$21.42\ kg$
		$(2.8 + 0.25 \times 2) \times 11 \times 0.56^{kg/m}$	=	$22.99\ kg$
	STIRRUP B2	$\{(0.25 + 0.2) \times 2 \times 8 \times 0.56^{kg/m}\} \times 2$	=	$11.65\ kg$
	B1	$(0.4 + 0.2) \times 2 \times 11 \times 0.56^{kg/m}$	=	$7.39\ kg$ $\quad 90.87\ kg$
D13	B2	$\{(1.8 + 0.1) \times 2 \times 0.995^{kg/m}\} \times 2$	=	$7.56\ kg$
	B1	$(2.8 + 0.2) \times 2 \times 0.995^{kg/m}$	=	$5.97\ kg$ $\quad 13.53\ kg$

$0.08\ ton$

11. WELDED WIRE FABRIC.

$(1.8 + 0.25) \times (2.8 + 0.25 \times 2) = 8.34 \ m^2$

$1.5 \times (1.0 - 0.25) = 0.82 \ m^2$ — $9.16 \ m^2$

12. CONCRETE BROCK, 200 MM THK.

$1.8 \times (1.8 \times 2 + 2.8 - 1.2) = 9.36 \ m^2$ — $9.36 \ m^2$

8. FINISH WORK

8A FLOOR

a) VINYL TILE

R-06, R-12.	12.2ft	x	4.4	= 53.9
R-05, R-07 R-08, R-09, R-10	30.0	x	6.8	= 204.0
	Δ 3.4	x	2.5	= Δ 8.5
R-11	12.4ft	x	6.8	= 82.66

TOTAL 332.06 M²

b) FLOATING FLOOR

R-03, R-04	32.8	x	7.8	= 255.84
	Δ 2.1	x	11.0	= Δ 23.1

TOTAL 232.74 M²

c) VINYL COVE BASE

R-06.	(6.7ft	+	4.4)	x 2 = 22.3
R-12	(5.5	+	4.2)	x 2 = 19.8
R-04, 07 08, 09 10.	30.0	x	2	= 60.0
	6.8	x	8	= 54.4
	4.3	x	4	= 17.2
	2.8	x	2	= 5.6
R-11.	(12.4ft	+	6.8)	x 2 = 38.5
	4.2	x	6	= 25.2
	Δ 1.0	x	12 + 1.2	x 9 + 1.8 = Δ 24.6
R-03. R-04	32.8	x	2	= 65.6
	7.8	x	4	= 31.2

TOTAL 315.2 M

d) CONCRETE STEEL TROWEL

2.25 x 3.7 = 8.33

0.55 x 1.5 = 0.83

TOTAL 9.16 M²

8C. WALL

a) PLASTER BOARD

11.0 x 2.7 x 2 = 59.4

4.4 x 2.7 x 2 = 23.76

5.5 x 2.7 x 2 x 2 = 59.4

Δ 1.2 x 2.1 x 6 = Δ 15.12

Δ 1.8 x 2.1 = Δ 3.78

TOTAL 123.66 M²

b) CEMENT PLASTER

0.3 x 2.7 x 6 = 8.86

TOTAL 8.86 M²

c) LITHING SPRAT

1.9 x 2.2 x 2 = 8.36

3.0 x 2.2 = 6.6

Δ 1.8 x 1.2 = Δ 2.16

TOTAL 12.8 M²

8D. WALL

a) CONCRETE BLOCK w/PLASTER

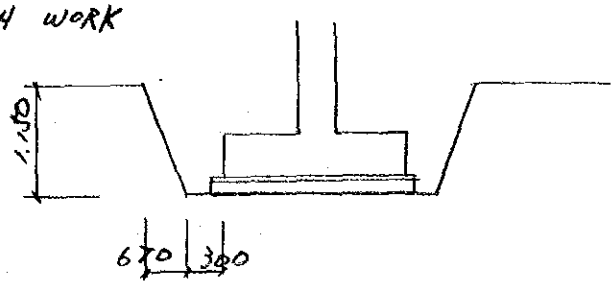
2.7 x 7.8 x 2 = 42.12

2.7 x 5.4 x 2 = 29.16

TOTAL 71.28 M²

TEST PLANT BUILDING

1 EARTH WORK



a) EXCAVATION

F1 $(2.2 + 0.6 + 0.67) \times (2.2 + 0.6 + 0.67) \times 1.15 \times 2 = 27.69$

F2 Ⓐ LINE $(1.0 + 0.6 + 0.67) \times (12.0 + 0.6 + 0.67) \times 1.15 = 34.64$

Ⓑ " $(1.0 + 0.6 + 0.67) \times (4.0 + 0.6 + 0.67) \times 1.15 = 13.76$

Ⓓ " $(1.0 + 0.6 + 0.67) \times (26.2 + 0.6 + 0.67) \times 1.15 = 71.71$

Ⓔ " $(1.0 + 0.6 + 0.67) \times (16.4 + 0.6 + 0.67) \times 1.15 = 46.13$

①, ③ " $(1.0 + 0.6 + 0.67) \times 6.53 \times 2 = 29.65$

② " $(1.0 + 0.6 + 0.67) \times 17.23 = 39.34$

④ " $(1.0 + 0.6 + 0.67) \times 3.88 = 8.81$

⑤ " $(1.0 + 0.6 + 0.67) \times 11.08 = 25.15$

TOTAL $296.88\ M^3$

b) DISPOSAL SOIL

F1 COBBLESTONE $2.4 \times 2.4 \times 0.1 \times 2 = 1.15$

LEVELING CONC. $2.4 \times 2.4 \times 0.05 \times 2 = 0.58$

FOUND. CONC. $2.2 \times 2.2 \times 0.35 \times 2 = 3.39$

COLUMN $0.2 \times 0.6 \times 0.65 \times 2 = 0.16$

SUB $5.28\ M^3$

F2 COBBLESTONE

A. LINE	$12.^2 \times 1.^2 \times 0.^1$	$= 1.46$
B "	$4.^2 \times 1.^2 \times 0.^1$	$= 0.5$
D "	$26.^{44} \times 1.^2 \times 0.^1$	$= 3.17$
E "	$16.^6 \times 1.^2 \times 0.^1$	$= 1.99$
1', 3' "	$7.^0 \times 1.^2 \times 0.^1 \times 2$	$= 1.68$
3 "	$18.^3 \times 1.^2 \times 0.^1$	$= 2.^2$
4' "	$4.^{95} \times 1.^2 \times 0.^1$	$= 0.59$
5 "	$12.^{15} \times 1.^2 \times 0.^1$	$= 1.46$

SUB $13.^{05}$ M³

LEVELING CONC.

A. LINE	$12.^2 \times 1.^2 \times 0.^{05}$	$= 0.^{73}$
B "	$4.^2 \times 1.^2 \times 0.^{05}$	$= 0.^{25}$
D "	$26.^{44} \times 1.^2 \times 0.^{05}$	$= 1.58$
E "	$16.^6 \times 1.^2 \times 0.^{05}$	$= 1.^0$
1', 3' "	$7.^0 \times 1.^2 \times 0.^{05} \times 2$	$= 0.84$
3 "	$18.^3 \times 1.^2 \times 0.^{05}$	$= 1.^1$
4' "	$4.^{95} \times 1.^2 \times 0.^{05}$	$= 0.^3$
5 "	$12.^{15} \times 1.^2 \times 0.^{05}$	$= 0.73$

SUB $6.^{53}$ M³

FOUND. CONC. , FG1 , FG2

A. CINE.	$12.0 \times 1.0 \times 0.25$		$= 3.03$
FG1	$11.2 \times 0.75 \times 0.2$		$= 1.68$
	$0.2 \times 0.75 \times 0.2$		$= 0.03$
B "	$4.0 \times 1.0 \times 0.25$		$= 1.0$
FG1.	$3.2 \times 0.75 \times 0.2$		$= 0.48$
	$0.2 \times 0.75 \times 0.2$		$= 0.03$
D "	$26.2 \times 1.0 \times 0.25$		$= 6.55$
FG1.	$11.5 \times 0.75 \times 0.2$		$= 1.73$
"	$10.3 \times 0.75 \times 0.2$		$= 1.55$
FG2	$3.4 \times 0.45 \times 0.2$		$= 0.31$
E "	$16.4 \times 1.0 \times 0.25$		$= 4.1$
FG1	$15.4 \times 0.75 \times 0.2$		$= 2.31$
1', 3' "	$7.2 \times 1.0 \times 0.25$	$\times 2$	$= 3.6$
FG1	$8.0 \times 0.75 \times 0.2$	$\times 2$	$= 2.4$
3 "	$18.5 \times 1.0 \times 0.25$		$= 4.63$
FG1	$19.3 \times 0.75 \times 0.2$		$= 2.9$
	$0.2 \times 0.75 \times 0.2$	$\times 2$	$= 0.06$
4' "	$5.25 \times 1.0 \times 0.25$		$= 1.29$
FG1	$5.95 \times 0.75 \times 0.2$		$= 0.89$
5 "	$12.25 \times 1.0 \times 0.25$		$= 3.09$
FG1	$13.25 \times 0.75 \times 0.2$		$= 1.97$

SUB $43.63\ M^3$

TOTAL $68.49\ M^3$

c) BACKFILLING w/COMPACTION TO GL w/EXCAVATION SOIL

$296.88\ M^3 - 68.49\ M^3 = 228.39$

TOTAL $228.39\ M^3$

d) CUTTING. $\bar{z} = 100 \sim 300$

SLAB ON GRADE	8.0×15.0		$= 120.0$
	10.8×19.3		$= 208.44$
	3.0×13.15		$= 39.45$
STOOP	$2.4 \times 1.3 \times 3$		$= 9.36$
	1.5×1.3		$= 1.95$
	3.6×1.9		$= 6.84$

TOTAL $386.04\ M^2$

e) COBBLESTONE

F1			$= 1.15$
F2			$= 13.05$
SLAB ON GRADE	$8.0 \times 15.0 \times 0.1$		$= 12.0$
	$10.8 \times 19.3 \times 0.1$		$= 20.84$
	$3.0 \times 13.15 \times 0.1$		$= 3.95$
STOOP	$2.6 \times 1.4 \times 0.1 \times 3$		$= 1.09$
	$1.7 \times 1.4 \times 0.1$		$= 0.24$
	$3.8 \times 2.0 \times 0.1$		$= 0.76$

TOTAL $53.08\ M^3$

f) VAPOR BARRIER

$8.0 \times 15.0 + 10.8 \times 19.3 + 3.0 \times 13.15 =$

TOTAL $367.89\ M^2$

2. CONCRETE WORK.

a) LEVELING CONC.

F1.		= 0.58
F2		= 6.58
STOOP.	2.6 × 0.3 × 0.05 × 3	= 0.12
	1.7 × 0.3 × 0.05	= 0.03
	3.8 × 0.3 × 0.05	= 0.06

TOTAL 7.32 M³

b) CONCRETE FOR UNDERGROUND, GRAND SLAB & STOOP (210 KG/CM²)

F1.	2.2 × 2.2 × 0.35 × 2	= 3.39
COLUMN,	0.6 × 0.78 × 0.2 × 2	= 0.19
F2, FG1. FG.2		
A LINE	12.0 × 1.0 × 0.25	= 3.0
	11.2 × 0.75 × 0.2	= 1.68
	0.2 × 0.75 × 0.2	= 0.03
B LINE	4.0 × 1.0 × 0.25	= 1.0
	3.2 × 0.75 × 0.2	= 0.48
	0.2 × 0.75 × 0.2	= 0.03
D LINE	26.2 × 1.0 × 0.25	= 6.55
	11.5 × 0.75 × 0.2	= 1.73
	10.3 × 0.75 × 0.2	= 1.55
	3.4 × 0.45 × 0.2	= 0.31
E LINE	16.4 × 1.0 × 0.25	= 4.1
	15.4 × 0.75 × 0.2	= 2.31
1', 3' LINE	7.2 × 1.0 × 0.25 × 2	= 3.6
	8.0 × 0.75 × 0.2 × 2	= 2.4

3 LINE	$18.5 \times 1.0 \times 0.25$	$= 4.63$
	$19.3 \times 0.75 \times 0.2$	$= 2.9$
	$0.2 \times 0.75 \times 0.2 \times 2$	$= 0.06$
4' LINE	$5.15 \times 1.0 \times 0.25$	$= 1.29$
	$5.95 \times 0.75 \times 0.2$	$= 0.89$
5 LINE	$10.35 \times 1.0 \times 0.25$	$= 3.09$
	$13.15 \times 0.75 \times 0.2$	$= 1.97$
STOOP	$2.4 \times 1.3 \times 0.12 \times 4$	$= 1.12$
	$2.4 \times 0.25 \times 0.08 \times 3$	$= 0.14$
	$1.5 \times 1.3 \times 0.12$	$= 0.23$
	$1.5 \times 0.25 \times 0.08$	$= 0.03$
	$3.6 \times 1.9 \times 0.12$	$= 0.82$
	$3.6 \times 0.25 \times 0.08$	$= 0.07$
GROUND SLAB	$8.2 \times 15.2 \times 0.15$	$= 18.7$
	$13.35 \times 14.0 \times 0.15$	$= 28.04$
	$6.15 \times 11.0 \times 0.15$	$= 10.15$
EQUIP FOUND	$2.87 \times 1.25 \times 0.6$	$= 2.14$

TOTAL $108.62 M^3$

C) CONCRETE FOR SUPER STRUCTURE (210kg/cm²)

COLUMN

5 LINE.	0.6	× 0.2	× 3.14			=	0.38
	0.6	× 0.2	× 4.14	× 2		=	0.99
4' "	0.6	× 0.2	× 3.2	× 2		=	0.77
4 "	0.6	× 0.2	× 3.081	× 2		=	0.79
	0.6	× 0.2	× 4.281			=	0.51
	0.4	× 0.2	× 4.281			=	0.34
3 "	0.6	× 0.2	× 3.42	× 2		=	0.82
	0.6	× 0.2	× 4.42			=	0.53
E "	0.6	× 0.2	× 5.14	× 2		=	1.23
	0.4	× 0.2	× 5.14			=	0.41
D "	0.6	× 0.2	× 5.304	× 3		=	1.91
	0.4	× 0.2	× 5.304			=	0.42

GIRDER

5 LINE	0.53	× 0.2	× 5.75			=	0.61
	0.58	× 0.2	× 6.6			=	0.77
4' "	0.53	× 0.2	× 5.55			=	0.59
4 "	0.53	× 0.2	× 5.75			=	0.61
	0.53	× 0.2	× 5.55			=	0.59
3 "	0.53	× 0.2	× 5.75	× 2		=	1.22
	0.58	× 0.2	× 6.6			=	0.77
1',3' "	0.58	× 0.2	× 7.6	× 2		=	1.76
A "	0.53	× 0.2	× 10.0			=	1.06
B "	0.53	× 0.2	× 12.6			=	1.34

8/47

C LINE	$1.52 \times 0.2 \times 13.0$	$= 3.98$
D "	$0.63 \times 0.2 \times 9.2$	$= 1.16$
	$1.514 \times 0.2 \times 3.4$	$= 1.03$
	$0.63 \times 0.2 \times 10.4$	$= 1.31$
E "	$0.63 \times 0.2 \times 14.2$	$= 1.79$
RB2	$0.48 \times 0.2 \times 5.95 \times 7$	$= 4.0$
RB1	$0.58 \times 0.2 \times 7.0 \times 5$	$= 4.06$
	$0.58 \times 0.2 \times 8.0 \times 7$	$= 6.5$
SLAB	$8.4 \times 15.4 \times 0.12$	$= 15.52$
	$7.4 \times 14.2 \times 0.12$	$= 12.61$
	$5.95 \times 6.85 \times 0.12$	$= 4.9$
	$6.05 \times 7.15 \times 0.12$	$= 5.19$
	$6.25 \times 11.2 \times 0.12$	$= 8.4$
PARAPET	$0.52 \times 0.12 \times 19.7$	$= 1.23$
	$0.24 \times 0.12 \times 19.5$	$= 0.56$
	$0.38 \times 0.12 \times 14.0 \times 2$	$= 1.28$
	$0.38 \times 0.12 \times 9.8$	$= 0.45$
	$0.52 \times 0.12 \times 15.4$	$= 0.96$
	$0.356 \times 0.12 \times 15.4$	$= 0.66$
	$0.438 \times 0.12 \times 8.1 \times 2$	$= 0.85$
	$(0.07 + 0.05) \times 0.07 \times 1/2 \times 14.0$	$= 0.06$
	$(0.07 + 0.05) \times 0.07 \times 1/2 \times 4.0$	$= 0.02$
GARGOYLE	$0.2 \times 0.1 \times 0.2 \times 3$	$= 0.01$
	$(0.3 + 0.2) \times 0.2 \times 1/2 \times 2 \times 3$	$= 0.3$

76.83

DROP WALL

$0.3 \times 0.2 \times 2.82$	=	0.2
$0.2 \times 0.2 \times 2.04$	=	0.08
$0.21 \times 0.2 \times 0.72$	=	0.03
$0.21 \times 0.2 \times 2.04$	=	0.09
$0.63 \times 0.2 \times 4.87$	=	0.61
$0.3 \times 0.2 \times 1.64$	=	0.11
$0.3 \times 0.2 \times 1.62$	=	0.11
$0.514 \times 0.2 \times 3.42$	=	0.35
$0.15 \times 0.2 \times 2.64$	=	0.08
$0.15 \times 0.2 \times 2.04$	=	0.06

TOTAL 96.99 M^3

3. FORM WORK

a) FORM WORK FOR UNDERGROUND.

F1. $2.^2 \times 4 \times 0.3\text{ft} \times 2 = 6.16$

COLUMN. $(0.^4 \times 2 + 0.^2 \times 2) \times 0.78 \times 2 = 1.87$

F2, FG1. FG2.

A. LINE	$(12.^0 + 10.^0) \times 0.^2\text{ft}$	= 5.5
	$11.^2 \times 0.^7\text{ft} \times 2$	= 16.8
	$0.^2 \times 0.^7\text{ft} \times 2$	= 0.3
B LINE	$3.^0 \times 0.^2\text{ft} \times 2$	= 1.5
	$3.^2 \times 0.^7\text{ft} \times 2$	= 4.8
	$0.^2 \times 0.^7\text{ft} \times 2$	= 0.3
D LINE	$24.^2 \times 0.^2\text{ft} \times 2$	= 12.1
	$11.^5\text{ft} \times 0.^7\text{ft} \times 2$	= 17.25
	$10.^3 \times 0.^7\text{ft} \times 2$	= 15.45
	$3.^4 \times 0.^4\text{ft} \times 2$	= 3.06
E LINE	$(16.^4 + 14.^4) \times 0.^2\text{ft}$	= 7.7
	$15.^4 \times 0.^7\text{ft} \times 2$	= 23.1
1', 3' LINE	$(7.^2 + 6.^2) \times 0.^2\text{ft} \times 2$	= 6.7
	$8.^0 \times 0.^7\text{ft} \times 2 \times 2$	= 24.0
3 LINE	$18.^5\text{ft} \times 0.^2\text{ft} \times 2$	= 9.25
	$19.^3 \times 0.^7\text{ft} \times 2$	= 28.95
	$0.^2 \times 0.^7\text{ft} \times 2 \times 2$	= 0.6
4' LINE	$5.^1\text{ft} \times 0.^2\text{ft} \times 2$	= 2.58
	$5.^9\text{ft} \times 0.^7\text{ft} \times 2$	= 8.93
5 LINE	$12.^3\text{ft} \times 0.^2\text{ft} \times 2$	= 6.18
	$13.^1\text{ft} \times 0.^7\text{ft} \times 2$	= 19.13

TOTAL 222.81 M²

b) FORM WORK FOR STOOP

$1.3 \times 0.12 \times 2 \times 3$	=	0.94
$2.4 \times 0.2 \times 3$	=	1.44
$1.3 \times 0.12 \times 2$	=	0.31
1.5×0.2	=	0.3
$1.9 \times 0.12 \times 2$	=	0.46
3.6×0.2	=	0.72

TOTAL 4.17 M^2

C) FORM WORK FOR ABOVE GROUND.

COLUMN

5 LINE	$(0.4 \times 2 + 0.2 \times 4) \times 3.14$	=	5.02
	$(0.4 \times 2 + 0.2 \times 4) \times 4.14 \times 2$	=	13.25
4' "	$(0.4 \times 2 + 0.2 \times 4) \times 3.2 \times 2$	=	10.24
4 "	$(0.4 \times 2 + 0.2 \times 4) \times 3.281 \times 2$	=	10.5
	$(0.4 \times 2 + 0.2 \times 4) \times 4.281$	=	6.85
	$0.6 \times 2 \times 4.281$	=	5.14
3 "	$(0.4 \times 2 + 0.2 \times 4) \times 3.82$	=	5.87
	$(0.4 \times 2 + 0.2 \times 4) \times 4.82$	=	7.07
E "	$(0.4 \times 2 + 0.2 \times 4) \times 5.14$	=	8.22
	$0.6 \times 2 \times 5.14$	=	6.17
D "	$(0.4 \times 2 + 0.2 \times 4) \times 5.304 \times 3$	=	25.46
	$0.6 \times 2 \times 5.304$	=	6.36

GIRDER SLINE	$(0.53 + 0.65) \times 5.75$	= 6.79
	$(0.58 + 0.7) \times 6.6$	= 8.45
X' "	$(0.53 + 0.65) \times 5.55$	= 6.55
4 "	$0.53 \times 2 \times 5.75$	= 6.1
	$0.53 \times 2 \times 5.55$	= 5.88
3 "	$(0.53 + 0.65) \times 5.75 \times 2$	= 13.57
	$(0.58 + 0.7) \times 6.6$	= 8.45
1, 3' "	$(0.58 + 0.7) \times 7.6 \times 2$	= 19.46
A "	$(0.53 + 0.65) \times 10.0$	= 11.8
B "	$0.53 \times 2 \times 12.6$	= 13.36
C "	$1.53 \times 2 \times 13.0$	= 39.78
D "	$(0.63 + 0.75) \times 9.2$	= 12.7
	$1.514 \times 2 \times 3.4$	= 10.3
	$(0.63 + 0.75) \times 10.4$	= 14.35
E "	$(0.63 + 0.75) \times 14.2$	= 19.6
RB2.	$0.48 \times 2 \times 5.95 \times 5$	= 28.56
SCAB	6.05×7.15	= 43.26
	6.25×11.2	= 70.0
PARAPET	0.52×19.7	= 10.24
	0.24×19.5	= 4.68
	$0.38 \times 14.0 \times 2$	= 10.64
	0.38×9.8	= 3.72
	0.52×15.4	= 8.01
	0.356×15.4	= 5.48
	$0.438 \times 8.1 \times 2$	= 7.1

388.83 ≠ 88.58

PROP WALL

0.35	× 2.82	× 2	=	1.97
0.2	× 2.04	× 2	=	0.82
0.21	× 0.72	× 2	=	0.3
0.21	× 2.04	× 2	=	0.86
0.63	× 4.87	× 2	=	6.14
0.35	× 1.64	× 2	=	1.15
0.35	× 1.62	× 2	=	1.13
0.514	× 3.42	× 2	=	3.52
0.15	× 2.65	× 2	=	0.8
0.15	× 2.04	× 2	=	0.61

TOTAL 15.88 M^2

d) FAIR FACED FORM WORK

RB2	$0.48 \times 2 \times 5.75 \times 2$	$= 11.52$
RB1	$0.58 \times 2 \times 7.0 \times 5$	$= 40.6$
	$0.58 \times 2 \times 8.0 \times 7$	$= 64.96$
SLAB	8.4×15.4	$= 129.36$
	7.4×14.2	$= 105.08$
	5.75×6.85	$= 39.36$
PARAPET	0.52×19.7	$= 10.24$
	0.24×19.5	$= 4.68$
	$0.38 \times 14.0 \times 2$	$= 10.64$
	0.38×9.8	$= 3.72$
	0.52×15.4	$= 8.01$
	0.336×15.4	$= 5.18$
	$0.438 \times 8.1 \times 2$	$= 7.1$
	$0.07 \times 14.0 + 0.07 \times 4.0$	$= 1.26$
GARGOYLE	$0.35 \times 0.2 \times 3$	$= 0.21$
	$(0.3 + 0.2) \times 0.2 \times 1/2 \times 2 \times 3$	$= 0.3$
	$(0.2 + 0.1) \times 0.2 \times 1/2 \times 2 \times 3$	$= 0.18$

TOTAL 444.0 M^2

4. REINFORCED WORK

a) REINFORCED BAR (FY = 410 N/mm²)

F1 D19 (2.25 kg/m)

2.2 × 10 × 2 × 2 × 2.25 kg/m = 198.0

F2 D13 (0.995 kg/m)

1.0 × 49 × 0.995 kg/m = 48.76
1.0 × 17 × 0.995 kg/m = 16.92
1.0 × 106 × 0.995 kg/m = 105.47
1.0 × 67 × 0.995 kg/m = 66.67
1.0 × 30 × 0.995 kg/m × 2 = 59.7
1.0 × 75 × 0.995 kg/m = 74.63
1.0 × 22 × 0.995 kg/m = 21.89
1.0 × 51 × 0.995 kg/m = 50.75

D10 (0.56 kg/m)

12.0 × 5 × 0.56 kg/m = 33.6
4.0 × 5 × 0.56 kg/m = 11.2
26.2 × 5 × 0.56 kg/m = 73.36
16.4 × 5 × 0.56 kg/m = 45.92
8.0 × 5 × 0.56 kg/m × 2 = 22.4
19.3 × 5 × 0.56 kg/m = 54.02
5.95 × 5 × 0.56 kg/m = 16.66
13.15 × 5 × 0.56 kg/m = 36.82

FG1. D22 (3.04 kg/m)

12.76 × 4 × 3.04 kg/m = 155.16

D19 (2.25 kg/m)

12.52 × 4 × 2.25 kg/m = 112.68

D10 (0.56 kg/m)

(2.66 × 15 + 11.0 × 4 + 0.25 × 2 × 12) × 0.56 kg/m = 95.03

D22

4.76 × 4 × 3.04 kg/m = 57.88

D19.

4.52 × 4 × 2.25 kg/m = 40.68

D10

(2.66 × 13 + 3.0 × 4 + 0.25 × 2 × 4) × 0.56 kg/m = 27.2

D22

12.96 × 4 × 3.04 kg/m = 157.59

11.76 × 4 × 3.04 kg/m = 143.0

D19

12.72 × 4 × 2.25 kg/m = 114.48

11.52 × 4 × 2.25 kg/m = 103.68

5.52 × 4 × 2.25 kg/m = 49.68

D10

(2.66 × 86 + 21.2 × 4 + 0.25 × 2 × 22) × 0.56 kg/m = 181.75

(1.8 × 17 + 4.0 × 2 + 0.25 × 5) × 0.56 kg/m = 22.32

D22

16.96 × 4 × 3.04 kg/m = 206.23

D19

16.72 × 4 × 2.25 kg/m = 150.48

D10

(2.66 × 62 + 15.2 × 4 + 0.25 × 2 × 16) × 0.56 kg/m = 130.88

D22

9.96 × 4 × 3.04 kg/m = 121.11

D19

9.72 × 4 × 2.25 kg/m = 87.48

D10

(2.66 × 34 + 8.2 × 4 + 0.25 × 2 × 9) × 0.56 kg/m × 2 = 143.07

D22

$21.26 \times 4 \times 3.04\,kg/m = 258.52$

D19

$21.02 \times 4 \times 2.23\,kg/m = 187.18$

D10

$(2.66 \times 79 + 19.5 \times 4 + 0.28 \times 2 \times 20) \times 0.56\,kg/m = 166.96$

D22

$7.91 \times 4 \times 3.04\,kg/m = 96.19$

D19

$7.67 \times 4 \times 2.23\,kg/m = 69.03$

D10

$(2.66 \times 26 + 6.54 \times 4 + 0.28 \times 2 \times 7) \times 0.56\,kg/m = 52.65$

D22

$15.11 \times 4 \times 3.04\,kg/m = 183.74$

D19

$14.87 \times 4 \times 2.23\,kg/m = 133.83$

D10

$(2.66 \times 55 + 13.34 \times 4 + 0.28 \times 2 \times 14) \times 0.56\,kg/m = 115.75$

COLUMN

D22 (3.04 kg/m)

4.42 × 8 × 3.04 kg/m = 107.89

5.42 × 8 × 3.04 kg/m × 2 = 263.63

D10 (0.56 kg/m)

2.4 × 18 × 0.56 kg/m = 24.19

2.4 × 22 × 0.56 kg/m = 29.57

D22

4.48 × 8 × 3.04 kg/m × 2 = 217.91

D10

2.4 × 18 × 0.56 kg/m × 2 = 48.38

D22

4.561 × 8 × 3.04 kg/m × 2 = 221.85

5.561 × 4 × 3.04 kg/m × 2 = 135.24

D10

2.4 × 18 × 0.56 kg/m × 2 = 48.38

1.2 × 22 × 0.56 kg/m × 2 = 29.57

D22

4.7 × 8 × 3.04 kg/m × 2 = 228.61

5.7 × 8 × 3.04 kg/m × 2 = 277.25

D10

2.4 × 19 × 0.56 kg/m × 2 = 51.07

2.4 × 23 × 0.56 kg/m × 2 = 61.82

1744.96

D22

$6.42 \times 8 \times 3.04 \text{kg/m} \times 2 = 312.27$

$6.42 \times 4 \times 3.04 \text{kg/m} = 78.07$

D10

$2.4 \times 26 \times 0.56 \text{kg/m} \times 2 = 69.89$

$1.2 \times 26 \times 0.56 \text{kg/m} = 17.47$

D22

$6.584 \times 8 \times 3.04 \text{kg/m} \times 2 = 320.25$

$6.584 \times 4 \times 3.04 \text{kg/m} = 80.06$

D10

$2.4 \times 26 \times 0.56 \text{kg/m} \times 2 = 69.89$

$1.2 \times 26 \times 0.56 \text{kg/m} = 17.47$

GIRDER

RG3 D19 (2.25 kg/m)

$7.67 \times 8 \times 2.25 \text{kg/m} \times 6 = 828.36$

D10 (0.56 kg/m)

$(1.7 \times 25 + 6.15 \times 2 + 0.25 \times 7) \times 0.56 \text{kg/m} \times 6 = 190.01$

RG2 D19

$8.72 \times 8 \times 2.25 \text{kg/m} \times 2 = 313.92$

D10

$(1.8 \times 29 + 7.2 \times 2 + 0.25 \times 7) \times 0.56 \text{kg/m} \times 2 = 76.55$

RG3 D19

$12.52 \times 8 \times 2.25 \text{kg/m} = 225.36$

D10

$(1.7 \times 45 + 11.0 \times 2 + 0.25 \times 11) \times 0.56 \text{kg/m} = 56.7$

D19

$15.52 \times 8 \times 2.25 kg/m \times 2 = 558.72$

D10

$(1.7 \times 56 + 14.0 \times 2 + 0.25 \times 14) \times 0.56 kg/m \times 2 = 141.9$

RG1 D22

$15.76 \times 6 \times 3.04 kg/m \times 2 = 574.92$

D10

$(1.9 \times 56 + 14.0 \times 2 + 0.25 \times 14) \times 0.56 kg/m \times 2 = 154.25$

D22

$16.96 \times 6 \times 3.04 kg/m \times 2 = 618.7$

D10

$(1.9 \times 61 + 15.2 \times 2 + 0.25 \times 16) \times 0.56 kg/m \times 2 = 168.32$

RG2 D19

$9.72 \times 4 \times 2.25 kg/m \times 2 = 174.96$

D10

$(1.8 \times 33 + 8.2 \times 2 + 0.25 \times 8) \times 0.56 kg/m \times 2 = 87.14$

RB1 D22

$9.96 \times 2 \times 3.04 kg/m \times 7 = 423.9$

D16 (1.56 kg/m)

$9.48 \times 2 \times 1.56 kg/m \times 7 = 207.05$

D10

$(1.8 \times 33 + 8.2 \times 2 + 0.25 \times 8) \times 0.56 kg/m \times 7 = 304.98$

D22

$8.96 \times 2 \times 3.04 \text{ kg/m} \times 5 = 272.38$

D16

$8.48 \times 2 \times 1.56 \text{ kg/m} \times 5 = 132.29$

D10

$(1.8 \times 29 + 7.2 \times 2 + 0.25 \times 7) \times 0.56 \text{ kg/m} \times 5 = 191.38$

RB2 D19

$7.67 \times 4 \times 2.25 \text{ kg/m} \times 7 = 483.21$

D10

$(1.6 \times 25 + 6.15 \times 2 + 0.25 \times 6) \times 0.56 \text{ kg/m} \times 7 = 210.9$

ROOF D10

$(8.2 \times 15.2 + 6.15 \times 11.0 + 13.35 \times 14.0) \times 8.96 \text{ kg/m}^2 = 3397.54$

PARAPET D13 (0.995 kg/m)

$(15.2 + 8.2 + 8.2 + 25.2 + 14.0 + 14.0 + 19.5 + 19.5) \times 0.995 \text{ kg/m} = 123.18$

D10

$123.8 \times 3 \times 0.56 \text{ kg/m} = 207.98$

$0.92 \times 620 \times 0.56 \text{ kg/m} = 319.42$

GARGOYLE D10:

$(0.6 \times 5 + 0.9 \times 2.) \times 0.56 \text{ kg/m} \times 3 = 8.06$

DROP WALL

D10

$(1.0 \times 12 + 3.32 \times 4) \times 0.56 \text{ kg/m} = 18.16$

$(0.9 \times 9 + 2.04 \times 2) \times 0.56 \text{ kg/m} = 6.82$

$(0.86 \times 11 + 3.16 \times 2) \times 0.56 \text{ kg/m} = 8.84$

$(1.28 \times 20 + 5.37 \times 4) \times 0.56 \text{ kg/m} = 26.14$

P10

$(1.0 \times 13 + 3.66 \times 4) \times 0.56 kg/m$	$= 15.28$
$(1.264 \times 14 + 3.84 \times 4) \times 0.56 kg/m$	$= 18.51$
$(0.9 \times 18 + 5.39 \times 2) \times 0.56 kg/m$	$= 15.11$
$1.05 \times 52 \times 2 \times 0.56 kg/m$	$= 61.15$
$0.934 \times 16 \times 2 \times 0.56 kg/m$	$= 16.74$

TOTAL 176485 kg.

b) WELDED WIRE FABRIC Φ6 x 150 x 150

$8.2 \times 15.2 + 6.15 \times 11.0 + 13.35 \times 14.0$	$= 379.19$
$2.4 \times 1.3 \times 3$	$= 9.36$
1.5×1.3	$= 1.95$
3.6×1.9	$= 6.84$

TOTAL $397.34 m^2$

5. MASONRY WORK

a) CONC. BLOCK 200THK.

1', 3' LINE	7.6 x 4.44 x 2	=	67.49
	Δ 7.0 x 0.9 x 2	= Δ	12.6
	Δ 3.0 x 2.0	= Δ	6.0
	Δ 0.375 x 0.375 x 4	= Δ	0.5
3 LINE.	5.75 x 2.77 x 2	=	31.86
	Δ 1.8 x 2.1	= Δ	3.78
	Δ 0.9 x 2.1	= Δ	1.89
	Δ 2.0 x 0.9	= Δ	1.8
	6.6 x 3.72	=	24.55
	Δ 1.8 x 2.1	= Δ	3.78
	Δ 0.25 x 0.25	= Δ	0.06
4' LINE	5.55 x 2.55	=	14.15
	Δ 2.0 x 0.5	= Δ	1.0
	Δ 2.04 x 0.21	= Δ	0.43
5 LINE	5.75 x 2.49	=	14.32
	6.6 x 3.44	=	22.70
	Δ 2.0 x 0.9	= Δ	1.8
	Δ 2.0 x 2.0	= Δ	4.0
	Δ 0.35 x 2.82	= Δ	0.99
	Δ 0.2 x 2.04	= Δ	0.41
E LINE	7.1 x 4.39 x 2	=	62.34
	Δ 3.0 x 2.0 x 2	= Δ	12.0
	Δ 0.375 x 0.375	= Δ	0.13

237.41 − 51.17

D LINE	7.1	×	4.55		= 32.33
	3.3	×	4.55		= 15.03
	6.55	×	3.39		= 22.2
	2.65	×	3.39		= 8.98
	3.4	×	3.39		= 11.53
	Δ 3.0	×	4.0		= Δ 12.0
	Δ 1.8	×	2.1		= Δ 3.78
	Δ 2.0	×	2.0	× 2	= Δ 8.0
	Δ 0.3	×	0.3		= Δ 0.09
	Δ 0.345	×	0.345		= Δ 0.13
	Δ 3.42	×	0.514		= Δ 1.76
	Δ 2.65	×	0.15		= Δ 0.50
	Δ 2.04	×	0.15		= Δ 0.31
C LINE	6.55	×	2.77		= 18.14
	6.45	×	2.77		= 17.87
	Δ 1.2	×	2.1		= Δ 2.52
	Δ 1.6	×	2.1		= Δ 3.36
	Δ 1.62	×	0.35		= Δ 0.57
	Δ 1.64	×	0.35		= Δ 0.57
B LINE	4.95	×	2.77		= 13.71
	3.45	×	2.77		= 9.56
	2.6	×	2.77		= 7.2

156.11 Δ 33.49

25/37

A. LINE	6.55	× 2.77	=	18.14
	3.45	× 2.77	=	9.56
	Δ 2.0	× 0.9	= Δ	1.8
	Δ 1.8	× 2.1	= Δ	3.78
	Δ 0.25	× 0.25	= Δ	0.06
4 LINE	5.55	× 2.631	=	14.6
	Δ 0.8	× 2.1	= Δ	1.68

TOTAL 344.28 M²

b) CONC. BLOCK 100 THK.

LOCKER RM.	5.75	× 2.631	=	15.13
	Δ 0.8	× 2.1	= Δ	1.68
MEETING. RM.	(4.25 + 4.3)	× 3.16	=	27.33
	Δ 0.8	× 2.1	= Δ	1.68
TOILET.	(3.6 + 4.3)	× 3.16	=	24.96
	(3.6 + 0.7)	× 3.16	=	13.59
	Δ 0.65	× 2.1	= Δ	1.37
	Δ 0.8	× 2.1	= Δ	1.68
PIPE SPACE	3.45	× 1.8	=	6.21
	2.1	× 1.1	=	2.31
	1.9	× 1.1	=	2.09
	3.85	× 2.1	=	8.09
	1.1	× 1.1	=	1.21

TOTAL 99.51 M²

100.72

6. WATER PROOF WORK.

6A. WATER PROOFING.

a) LIGHT WEIGHT CONCRETE $t = 60$

$8.2 \times 15.2 = 124.64$

$13.35 \times 14.0 = 186.9$

$6.15 \times 11.0 = 67.65$

TOTAL $379.19\ M^2$

b) WATER TIGHTNESS PVC SHEET. $t = 1$

$8.2 \times 15.2 = 124.64$

$13.35 \times 14.0 = 186.9$

$6.15 \times 11.0 = 67.65$

$15.2 \times 0.45 = 6.84$

$15.2 \times 0.276 = 4.2$

$8.2 \times 0.358 \times 2 = 5.87$

$19.5 \times 0.45 = 8.58$

$19.5 \times 0.16 = 3.12$

$14.0 \times 0.3 \times 4 = 16.8$

TOTAL $424.45\ M^2$

C) THERMAL INSULATION $t = 40$

$8.2 \times 15.2 + 13.35 \times 14.0 + 6.15 \times 11.0 = 379.19$

TOTAL $379.19\ M^2$

d). PVC VAPOR TIGHTNESS MEMBRANE PVC -200 MICRON.

$8.2 \times 15.2 + 13.35 \times 14.0 + 6.15 \times 11.0 = 379.19$

TOTAL $379.19\ M^2$

6B. SEALING.

a). COMPRESSIVE FILLER

$8.2 \times 2 + 19.5 \times 2$	$= 55.4$
$14.0 + 15.2 + 25.2$	$= 54.4$
$2.87 \times 2 + 1.245 \times 2$	$= 8.23$

TOTAL 118.03 M

b) SEALING FOR ROOF

8.2×2	$= 16.4$
15.2×2	$= 30.4$
19.5×2	$= 39.0$
14.0×4	$= 56.0$
$0.6 \times 4 \times 3$	$= 7.2$

TOTAL 149.0 M

C) SEALING FOR EXTERIOR DOOR, WINDOW & VENTILATOR.

$4.0 \times 2 + 3.0$	$= 11.0$
$(2.1 \times 2 + 1.8) \times 3$	$= 18.0$
$2.1 \times 2 + 0.9$	$= 5.1$
$(3.0 + 2.0) \times 2 \times 3$	$= 30.0$
$2.0 \times 4 \times 3$	$= 24.0$
$(2.9 + 0.9) \times 2 \times 3$	$= 17.4$
$(7.0 + 0.9) \times 2 \times 2$	$= 31.6$
$(2.0 + 0.5) \times 2$	$= 5.0$
$0.4 \times 4 \times 6$	$= 9.6$
0.35×4	$= 1.4$
$0.9 \times 4 \times 2$	$= 2.4$

TOTAL 155.5 M

7. DOOR & WINDOW

8. FINISH WORK

8A INTERIOR

a) MORTAR STEEL TROWEL $t=20$.

STORAGE.	$5.9'$	x	$6.8'$	=	$\times 0.76$
MACHINE SHOP	7.0	x	13.8	=	96.6
MODULE TEST	8.0	x	15.0	=	120.0

TOTAL $257.36\ M^2$

b) VINYL TILE w/MORTAR BED $t=20$

MEETING.	4.2	x	$5.15'$	=	21.63
TEA RM.	2.1	x	$3.\times'$	=	7.25
	$\Delta\ 0.7$	x	$0.9'$	$= \Delta$	0.67
CORRIDOR	2.4	x	$6.7'$	=	16.2
	$1.6'$	x	$6.7'$	=	11.14
	$8.0'$	x	$1.5'$	=	12.08
LOCKER.	$5.9'$	x	$3.9'$	=	23.5
	$\Delta\ 1.8$	x	3.0	$= \Delta$	5.4

TOTAL $85.73\ M^2$

c) CERAMIC TILE w/MORTAR BED $t=3'$

SHOWER.	0.8	x	3.0	=	2.4
TOILET.	$2.9'$	x	$3.\times'$	=	10.18
	0.7	x	$0.8'$	=	0.6

TOTAL $13.18\ M^2$

d). MORTAR STEEL TROWEL BASE H=100

STORAGE	$(5.95 + 6.85) \times 2$	$= 25.6$
	$\Delta\ 0.8 + 1.6$	$= \Delta\ 2.4$
MACHINE	$(7.0 + 13.8) \times 2$	$= 41.6$
	$\Delta\ 1.6 + 1.2 + 1.8 + 1.8$	$= \Delta\ 6.4$
MODULE	$(8.0 + 15.0) \times 2$	$= 46.0$
	$\Delta\ 3.0 + 1.8$	$= \Delta\ 4.8$
	TOTAL	99.6 M

e) VINYL COVE BASE

MEETING.	$(4.2 + 5.15) \times 2$	$= 18.7$
		$= \Delta\ 0.9$
TEA R4	$(2.1 + 3.45) \times 2$	$= 11.1$
	$\Delta\ 0.8 + 0.65$	$= \Delta\ 0.52$
CORRIDOR	$6.75 \times 2 + 12.1 \times 2$	$= 37.7$
	5.3×2	$= 10.6$
	$\Delta\ 0.8 \times 4 + 1.8 \times 2$	$= \Delta\ 6.8$
	$\Delta\ 0.9 + 1.2$	$= \Delta\ 1.08$
LOCKER.	$(5.95 + 3.95) \times 2$	$= 19.8$
	$\Delta\ 3.0 + 1.8 + 0.8$	$= \Delta\ 5.6$
	TOTAL	83.0 M

f) CERAMIC WALL TILE

TOILET	$(2.95 + 3.45) \times 2 \times 1.6$	=	20.48
	$0.7 \times 2 \times 1.6$	=	2.24
	$\Delta\ 0.85 \times 1.6$	= Δ	1.04
SHOWER	$(3.0 + 1.8) \times 2.1$	=	10.08

g) MORTAR STEEL TROWEL (WALL) TOTAL 31.76 M^2

MODULE TEST	$(8.0 + 15.0) \times 2 \times 5.0$	=	230.0
	$\Delta\ 7.0 \times 0.9 \times 2$	= Δ	12.6
	$\Delta\ 3.0 \times 2.0 \times 3$	= Δ	18.0
	$\Delta\ 0.35 \times 0.35 \times 6$	= Δ	0.76
	$\Delta\ 3.0 \times 4.0$	= Δ	12.0
MACHINE	$(7.0 + 13.8) \times 2 \times 4.0$	=	166.4
	$\Delta\ 2.0 \times 2.0 \times 3$	= Δ	12.0
	$\Delta\ 0.3 \times 0.3$	= Δ	0.09
	$\Delta\ 1.8 \times 2.1 \times 3$	= Δ	11.34
	$\Delta\ 1.2 \times 2.1$	= Δ	2.52
	$\Delta\ 1.6 \times 2.1$	= Δ	3.36
STORAGE	$(5.95 + 6.85) \times 2 \times 3.0$	=	76.8
	$\Delta\ 2.0 \times 0.9$	= Δ	1.8
	$\Delta\ 1.6 \times 2.1$	= Δ	3.36
	$\Delta\ 0.8 \times 2.1$	= Δ	1.68

377.5

CORRIDOR	$(6.75 \times 2 + 12.1 \times 2) \times 2.4$	$= 90.48$
	$5.3 \times 2 \times 2.4$	$= 25.44$
	$\Delta\ 1.8 \times 2.1 \times 2$	$= \Delta\ 7.56$
	$\Delta\ 0.8 \times 2.1 \times 4$	$= \Delta\ 6.72$
	$\Delta\ 0.9 \times 2.1$	$= \Delta\ 1.89$
	$\Delta\ 1.2 \times 2.1$	$= \Delta\ 2.52$
	$\Delta\ 2.0 \times 0.9$	$= \Delta\ 1.8$
MEETING.	$(4.2 + 5.15) \times 2 \times 2.4$	$= 44.88$
	$\Delta\ 2.0 \times 0.9$	$= \Delta\ 1.8$
	$\Delta\ 0.8 \times 2.1$	$= \Delta\ 1.68$
TEARM.	$(2.1 + 3.45) \times 2 \times 2.4$	$= 26.64$
	$\Delta\ 0.8 \times 2.1$	$= \Delta\ 1.68$
	$\Delta\ 0.65 \times 2.1$	$= \Delta\ 1.37$
TOILET	$(2.95 + 3.45) \times 2 \times 0.8$	$= 10.24$
	$0.7 \times 2 \times 0.8$	$= 1.12$
	$\Delta\ 0.25 \times 0.25$	$= \Delta\ 0.06$
	$\Delta\ 0.65 \times 0.5$	$= \Delta\ 0.83$
SHOWER	$(5.95 + 3.95) \times 2 \times 2.4$	$= 47.52$
	$\Delta\ (3.0 + 1.8) \times 2.1$	$= \Delta\ 10.08$
	$\Delta\ 0.8 \times 2.1$	$= \Delta\ 1.68$
	$\Delta\ 2.0 \times 0.5$	$= \Delta\ 1.0$
	$\Delta\ 0.25 \times 0.25$	$= \Delta\ 0.6$

TOTAL $599.24\ m^2$

h.) ACOUSTIC FIBER BOARD CEILING

MEETING.	4.2	×	5.15	= 21.63
CORRIDOR	2.4	×	6.75	= 16.2
	1.65	×	6.75	= 11.14
	8.0	×	1.5	= 12.08

TOTAL 61.05 M²

i) GLASS FIBER CEMENT BOARD CEILING.

TOILET	2.95	×	3.45	= 10.18
TEA RM	2.1	×	3.45	= 7.25
LOCKER	5.95	×	3.95	= 23.5

TOTAL 40.93 M²

j) EXPOSED CEILING.

STORAGE	5.95	×	6.85	= 40.76
MACHINE SHOP	7.0	×	13.8	= 96.6
MODULE TEST	8.0	×	15.0	= 120.0

TOTAL 257.36 M².

EXISTING CONTROL BUILDING

a) PLASTER WALL BOARD.

	(5.32 + 3.69)	×	3.0 × 2	= 50.06
	7.32	×	3.0 × 2	= 43.92
Δ	0.8	×	2.1 × 2	= Δ 3.36
Δ	1.8	×	2.1 × 2	= Δ 7.56

TOTAL 108.9 M²

8B. EXTERIOR.

a) CEMENT MORTAR BROOM FINISH

A LINE.	11.2	×	3.64	=	40.77
	Δ 1.8	×	2.1	= Δ	3.78
	Δ 2.0	×	0.9	= Δ	1.8
	Δ 0.2ft	×	0.2ft	= Δ	0.06
B LINE.	3.0	×	3.64	=	10.92
C LINE	14.2	×	1.01	=	14.34
D LINE	10.0	×	4.64	=	46.4
	11.2	×	5.64	=	63.17
	4.2	×	1.01	=	4.24
	Δ 2.0	×	2.0	× 2 = Δ	8.0
	Δ 3.0	×	4.0	= Δ	12.0
	Δ 0.3	×	0.3	= Δ	0.09
	Δ 0.3ft	×	0.3ft	= Δ	0.18
E. LINE	15.4	×	5.64	=	86.86
	Δ 3.0	×	2.0	× 2 = Δ	12.0
	Δ 0.3ft	×	0.3ft	= Δ	0.18
F, G LINE	8.4	×	5.64	× 2 =	94.75
	Δ 7.0	×	0.9	× 2 = Δ	12.6
	Δ 3.0	×	2.0	= Δ	6.0
	Δ 0.3ft	×	0.3ft	× 2 = Δ	0.5

3,5 LINE $7.^2 \times 8.^{64} \times 2 = 66.^{92}$

$12.^3 \times 3.^{64} \times 2 = 89.^{54}$

$\Delta\ 1.^8 \times 2.^1 \times 2 = \Delta\ 7.^{56}$

$\Delta\ 0.^9 \times 2.^1 = \Delta\ 1.^{89}$

$\Delta\ 2.^0 \times 0.^9 \times 2 = \Delta\ 3.^6$

$\Delta\ 2.^0 \times 2.^0 = \Delta\ 4.^0$

$\Delta\ 2.^0 \times 0.^5 = \Delta\ 1.^0$

$\Delta\ 0.^{25} \times 0.^{25} = \Delta\ 0.^{06}$

TOTAL $942.^{61}\ M^2$

b). CEM. MORTAR STEEL TROWEL BASE

$(8.^4 \times 2 + 19.^5 \times 2) \times 0.^{15} = 8.^{37}$

$(15.^2 \times 2 + 11.^2 \times 2) \times 0.^{15} = 7.^{62}$

$\Delta(3.^6 + 2.^4 + 1.^5 + 2.^4) \times 0.^{15} = \Delta\ 1.^{89}$

TOTAL $17.^{88}\ M^2$

C). MORTAR STEEL TROWEL COPING

$(8.^2 \times 2 + 15.^2 \times 2) \times 0.^{17} = 7.^{98}$

$(19.^5 \times 2 + 14.^0 \times 3) \times 0.^{17} = 13.^{77}$

$\Delta\ 4.^0 \times 0.^{17} = \Delta\ 0.^{68}$

TOTAL $21.^{25}\ M^2$

d). MORTAR STEEL TROWEL WINDOW SILL

$3.^0 \times 3 + 2.^0 \times 7 + 7.^0 \times 2 = 37.^0$

TOTAL $37.^0\ M$

e) CONC. STEEL TROWEL FLOOR

$1.^9 \times 3.^6 + 2.^4 \times 1.^3 = 9.^{96}$

$1.^5 \times 1.^3 + 2.^0 \times 2.^4 = 6.^{75}$

$1.^0 \times 7.^0 = 7.^0$

TOTAL $23.^{71}\ M^2$

8C. PAINTING.

a). FOR STEEL DOOR

$1.8 \times 2.1 \times 4 \times 2.7$	=	40.82
$3.0 \times 4.0 \times 2.7$	=	32.4
$0.9 \times 2.1 \times 2.7$	=	5.10

b). FOR WOOD DOOR TOTAL $78.32\ M^2$

$1.2 \times 2.1 \times 2.7$	=	6.8
$1.6 \times 2.1 \times 2.7$	=	9.07
$1.8 \times 2.1 \times 2.7$	=	10.21
$0.8 \times 2.1 \times 5 \times 2.7$	=	22.68
$0.65 \times 2.1 \times 2.7$	=	3.69

TOTAL $52.45\ M^2$

9. MISC. WORK

a). TOILET & SHOWER PARTITION

$(2.45 + 1.5 + 1.5) \times 2.1$	=	13.55
$(1.8 \times 3 + 3.0 + 1.2) \times 2.1$	=	18.9

TOTAL $32.45\ M^2$

b) MISC. STEEL

LADDER $\phi 19$	$12 \times 0.4 \times 2.23\ kg/m$	=	10.7
	$8 \times 1.2 \times 2.23\ kg/m$	=	21.4
FB-100x9	$6.0 \times 2 \times 3.53\ kg/m$	=	42.36
FB-100x9	$0.32 \times 6 \times 7.06\ kg/m$	=	9.32

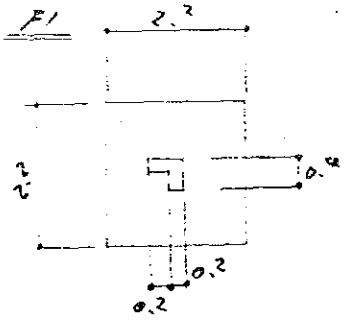
TOTAL. $83.78\ kg$

8E. COAL TAR PAINT (for CONCRETE SURFACE IN contact with soil)

3.

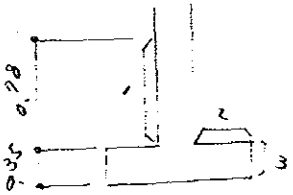
(A) LINE	$0.25^m \times (12.0^m + 10.0^m)$	= 5.5
(B) LINE	$0.25^m \times 3.0^m \times 2$	= 1.5
(C) LINE	$0.25^m \times (24.2^m + 23.7^m)$	= 11.98
(D) LINE	$0.25^m \times (18.2^m + 16.2^m)$	= 9.6
(1') LINE	$0.25^m \times (9.2^m + 7.2^m)$	= 4.1
(2) LINE	$0.25^m \times (17.5^m + 18.5^m)$	= 9.5
(3) LINE	$0.25^m \times (8.2^m + 7.2^m)$	= 3.85
(4) LINE	$0.25^m \times 6.15^m \times 2$	= 3.08
(5) LINE	$0.25^m \times (19.35^m + 12.35^m)$	= 6.68

SUB TOTAL 349.04



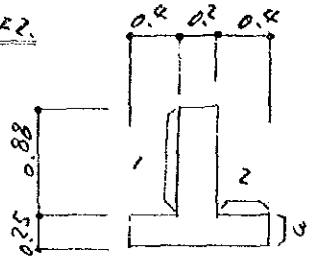
1 ———	$0.4^m \times 4 \times 0.98^m \times 2$	= 2.5
2 ———	$(2.2^m \times 2.2^m - 0.4^m \times 0.2^m - 0.2^m \times 0.2^m) \times 2$	= 9.44
3 ———	$0.35 \times 2.2^m \times \pi \times 2$	= 6.16

SUB TOTAL 18.1



Total / 367.14 m²

F2.



1.

Ⓐ LINE: $0.88^{m} \times (11.2^{m} + 10.8^{m} + 0.2^{m} \times 2)$ = 19.71

Ⓑ LINE: $0.88^{m} \times (3.2^{m} + 3.2^{m})$ = 5.63

Ⓓ LINE: $0.88^{m} \times (25.0^{m} + 25.0^{m})$ = 44.0

Ⓔ LINE: $0.88^{m} \times (15.0^{m} + 15.4^{m})$ = 26.75

Ⓘ LINE: $0.88^{m} \times (8.4^{m} + 8.0^{m})$ = 14.43

② LINE: $0.88^{m} \times (19.5^{m} + 19.3^{m} + 0.2^{m} \times 4)$ = 34.85

②' LINE: $0.88^{m} \times (8.2^{m} + 8.0^{m})$ = 14.26

④' LINE: $0.88^{m} \times 6.5^{m} \times 2$ = 10.82

⑤ LINE: $0.88^{m} \times (13.55^{m} + 13.15^{m})$ = 23.5

2.

Ⓐ LINE: $0.4^{m} \times (12.0^{m} + 11.6^{m} + 0.2^{m} \times 2)$ = 9.6

Ⓑ LINE: $0.4^{m} \times (3.8^{m} \times 2 + 0.2^{m}) + 0.2^{m} \times 0.2^{m}$ = 3.16

Ⓓ LINE: $0.4^{m} \times (26.0^{m} + 25.8^{m} + 0.2^{m} \times 2)$ = 20.08

Ⓔ LINE: $0.4^{m} \times (15.8^{m} + 16.2^{m} + 0.2^{m} \times 2)$ = 32.4

Ⓘ, ②' LINE: $0.4^{m} \times 9.2^{m} \times 4$ = 11.52

② LINE: $0.4^{m} \times 18.5^{m} \times 2$ = 14.8

$\triangle\ 0.2^{m} \times 0.2^{m} \times 2$ = $\triangle$ 0.08

④' LINE: $0.4^{m} \times 5.15^{m} \times 2$ = 4.12

⑤ LINE: $0.4^{m} \times 12.35^{m}$ = 4.94

$\triangle\ 0.2^{m} \times 0.2^{m}$ = $\triangle$ 0.04