THE PEOPLE'S REPUBLIC OF BANGLADESH

DETAILS DESIGN REPORT
ON
THE TELEVISION STUDIO CONSTRUCTION PROJECT

VOLUME V

MARCH 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

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CALCULATION SHEET

INDEX

1. Calculation Sheet of Structure

STRUCTURAL ANALYSIS
ON
CONSTRUCTION PROJECT
OF B.T.V. HALL IN DACCA

CONTENTS

(TOTAL-161 P)

I - GENERAL

GENERAL NOTE

NAME OF BUILDING : B. T. V. HALL

LOCATION : DACCA , BANGLADESH

USE : AUDITORIUM

SCALE : 4F

TOTAL FLOOR AREA 3,925 m^2
(EXTENSION PART 2,360 m^2)

STRUCTURE : REINFORCED CONCRETE CONSTRUCTION

& STEEL CONSTRUCTION FOR PROCENIUM FRAME

MATERIAL : CONCRETE PILE Fc 210 (3,000 P.S.I.)

GENERAL Fc 180 (2,600 P.S.I.)

: REINFORCEMENT

Ms Bar (1/4" ~ 1")
J.I.S. SD30 (D10.13)
J.I.S. SD35 (D16 ~ 25)

: STEEL M/S Steel
SM50A
SS41

: HITENSION BOLT F10T

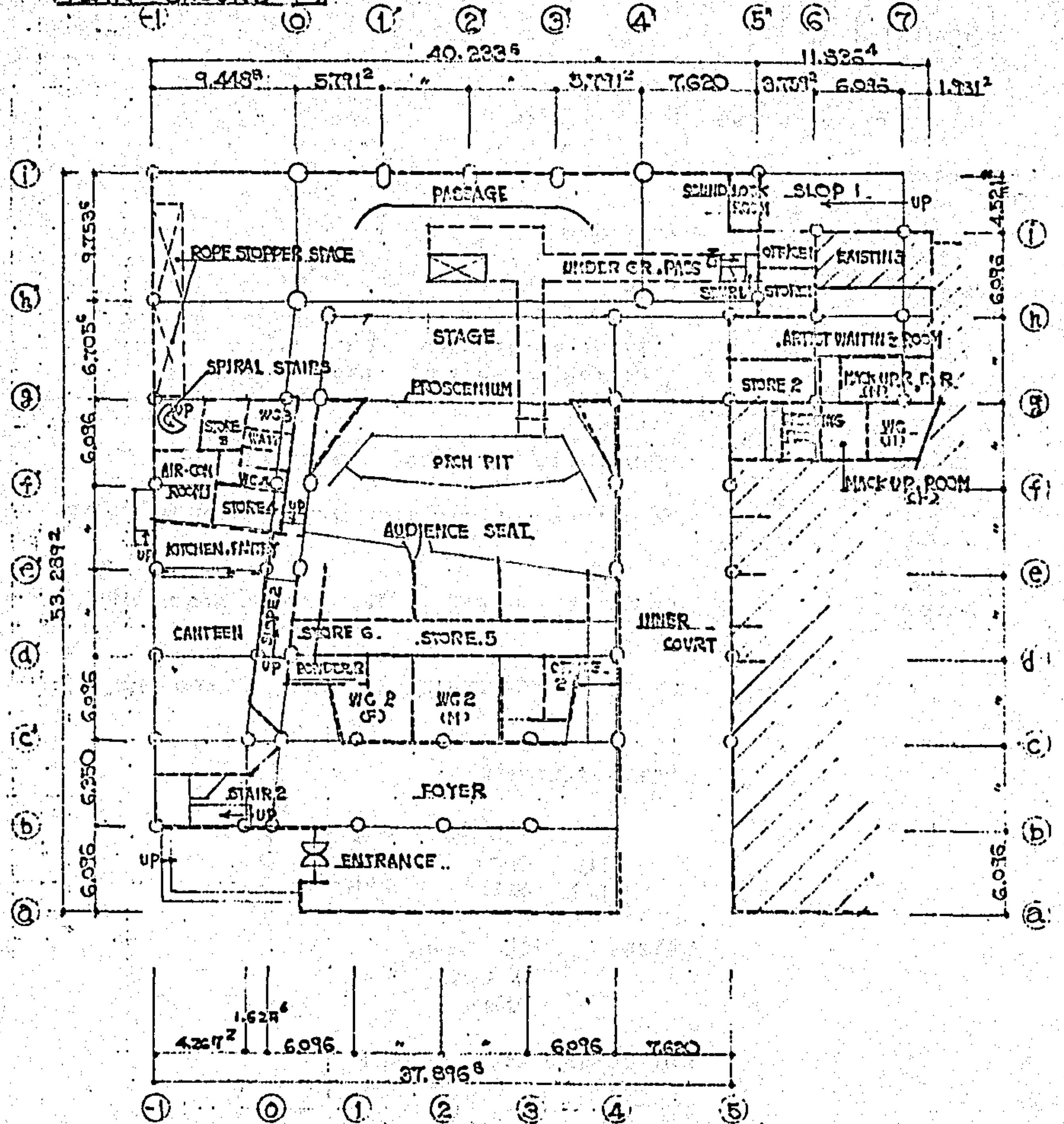
FOUNDATION : CAST IN SITU ----- INDEPENDENT FOOTING

*

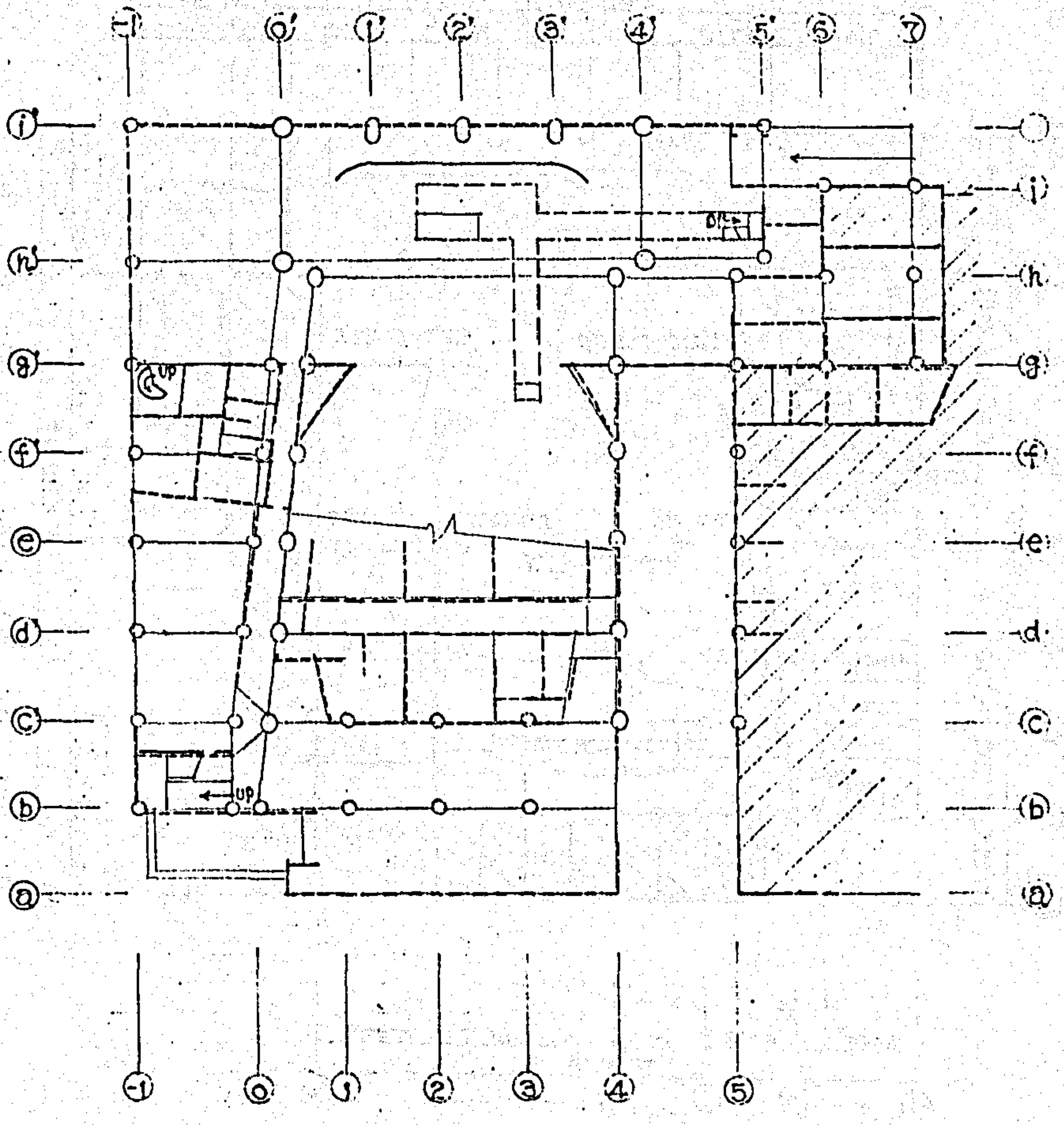
FOUNDATION IS DESIGNED BY M/S. BEAM, SUB BEAM, CANTILEVER & UNDER GROUND STRUCTURES ARE DESIGNED BY D-BAR. FOUNDATION BEAM, COLUMN, SLAB, WALL AND PROCENIUM FRAME ARE DESIGNED IN 2 CASES,

FRAME MEMBERS $Q_T = Q_L + 1.5 Q_E$ (Shear in Seismic Loading.)

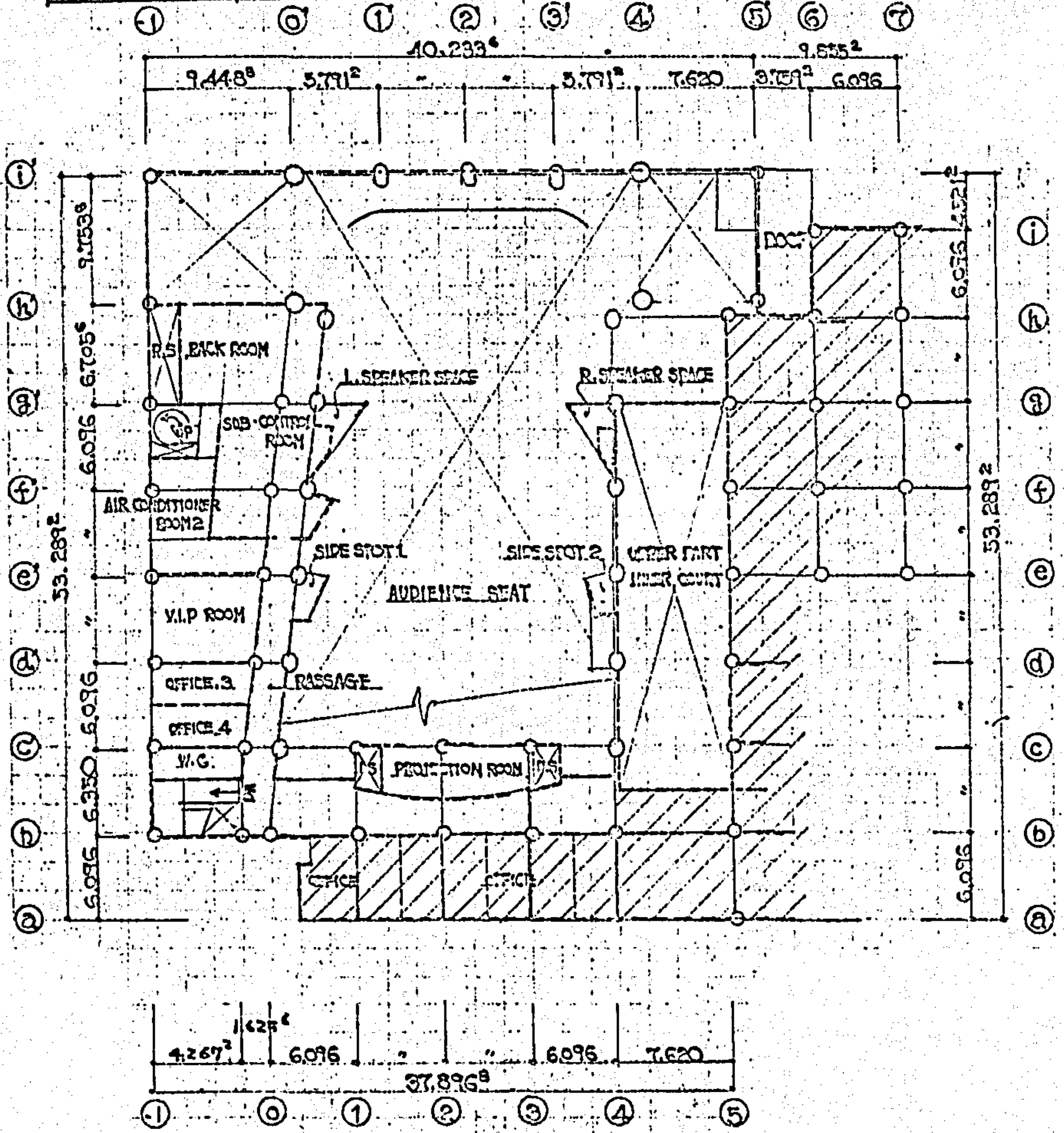
PLAN GROUND F.



KEY PLAN GROUND F.

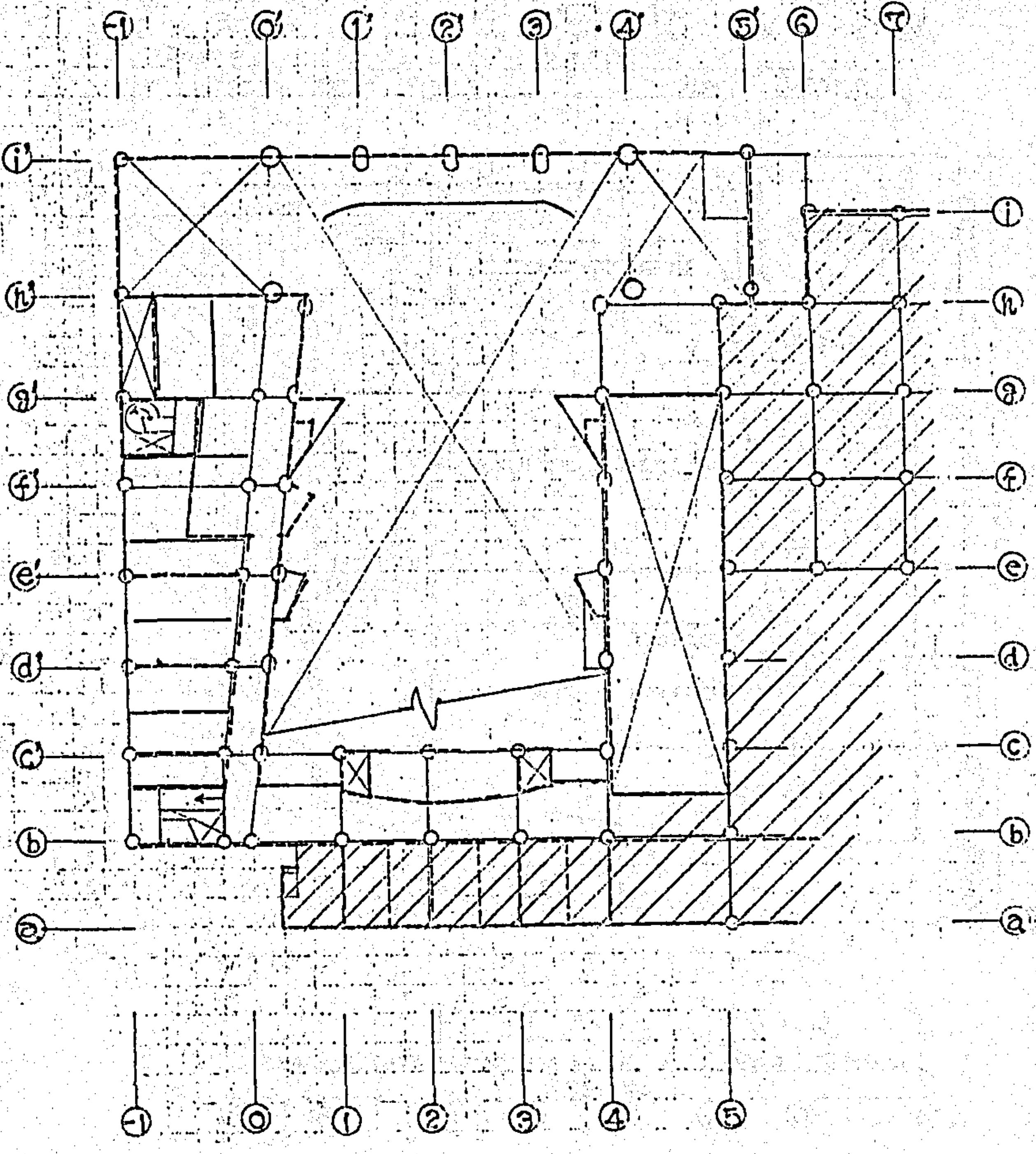


PLAN · FIRST F.

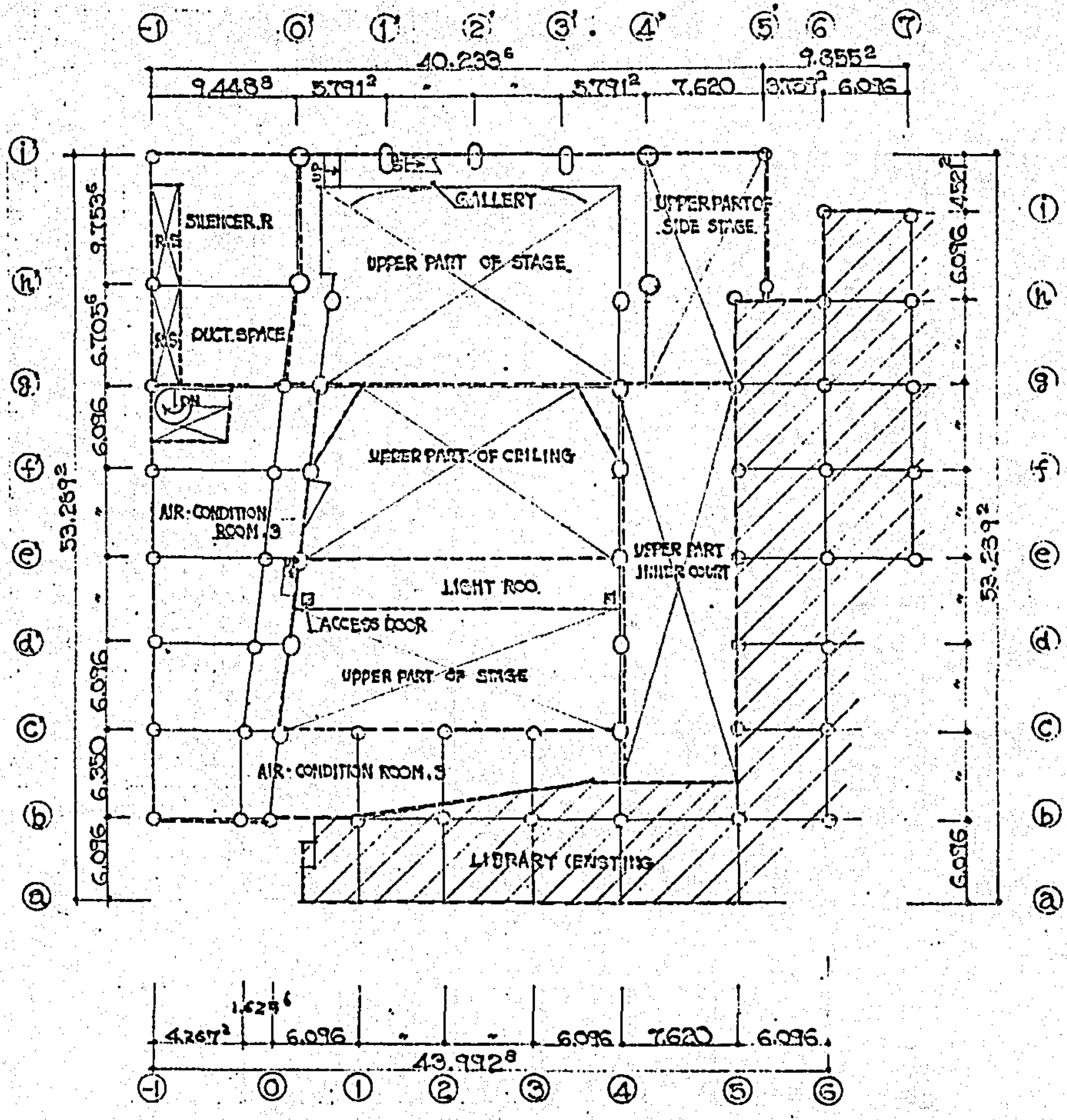


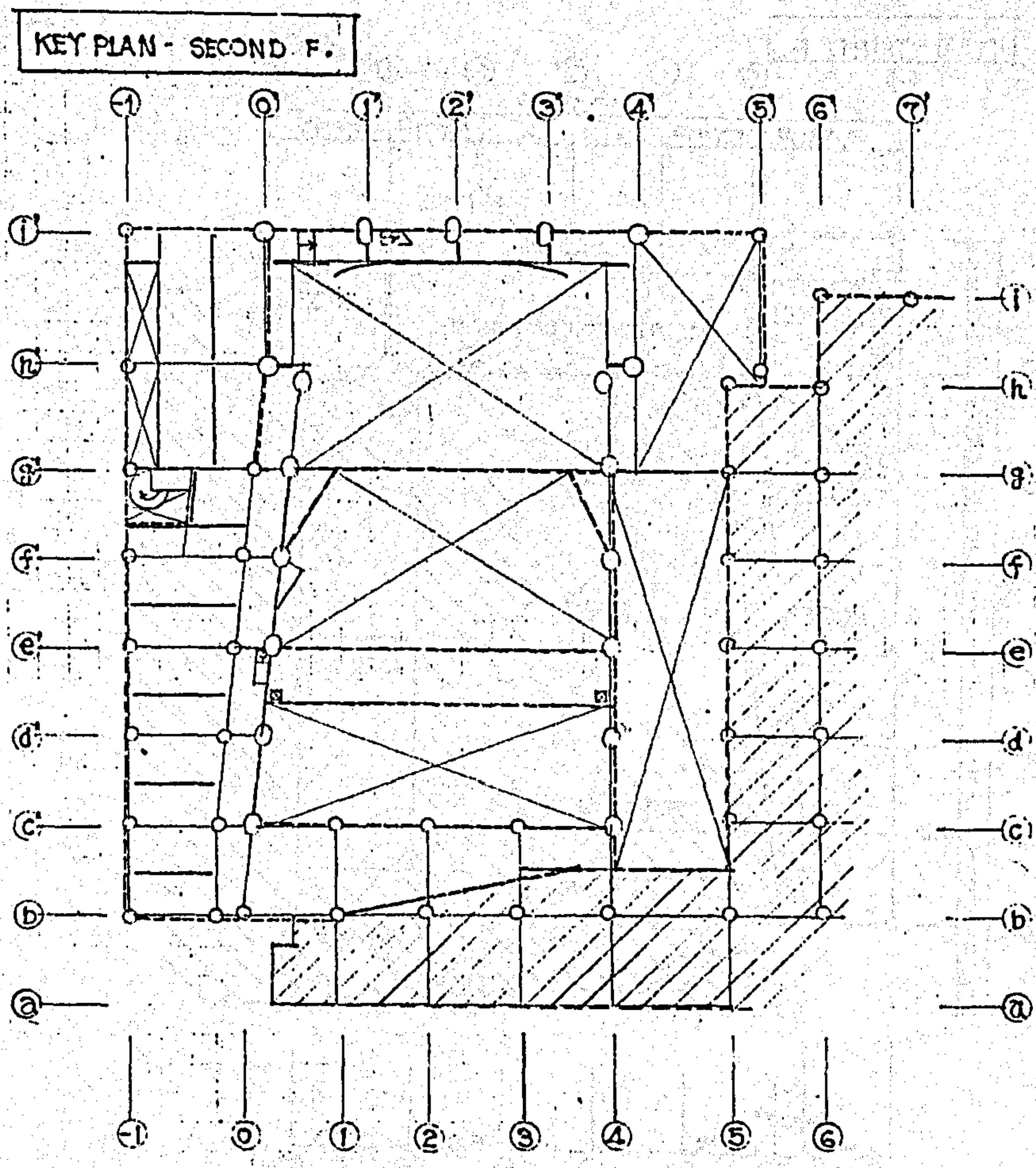
40.233
9.855
9.448
5.791
5.791
7.620
6.096
R.S
BACK ROOM
L.SPEAKER SPACE
R.SPEAKER SPACE
DOCT
UP
SUB-CONTROL ROOM
AIR CONDITIONER ROOM 2
SIDE STOT.1
SIDE STOT.2
AUDIENCE SEAT
INNER COURT
V.I.P ROOM
OFFICE.3
PASSAGE
OFFICE.4
W.C.
PROJECTION ROOM
OFFICE
OFFICE
53.289
53.289
6.096
6.350
6.096
4.267
6.096
6.096
7.620
37.896

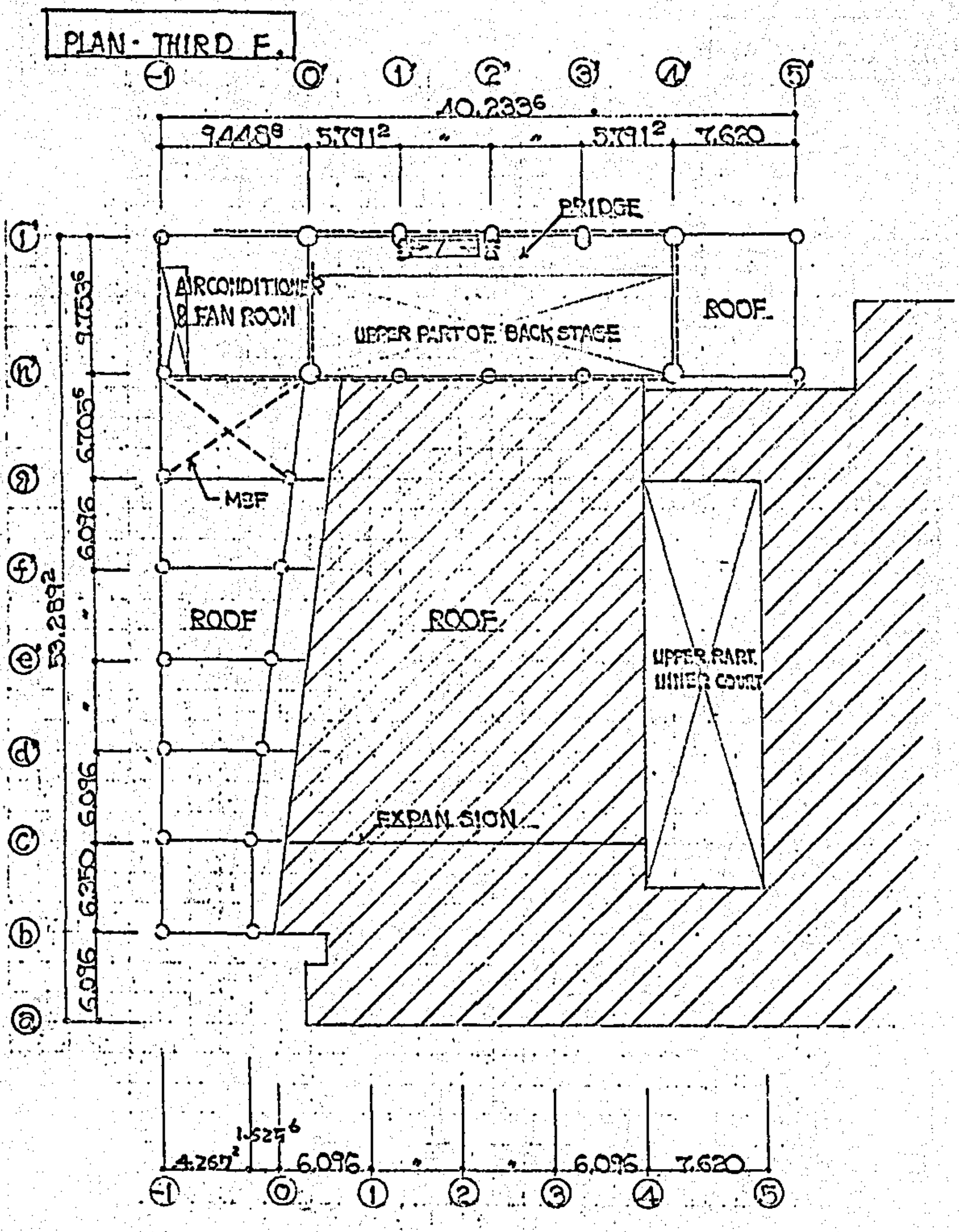
KEY PLAN : FIRST F.

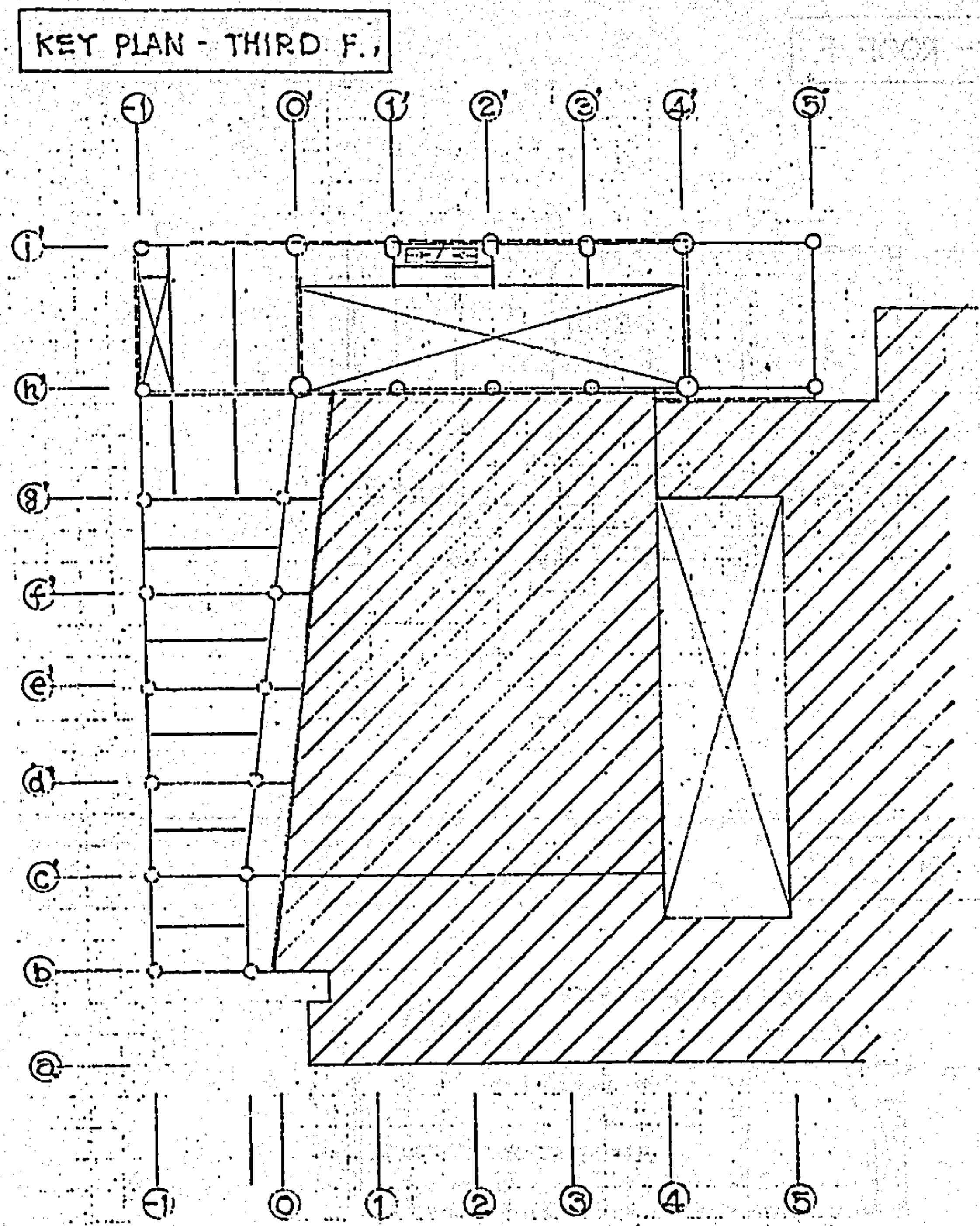


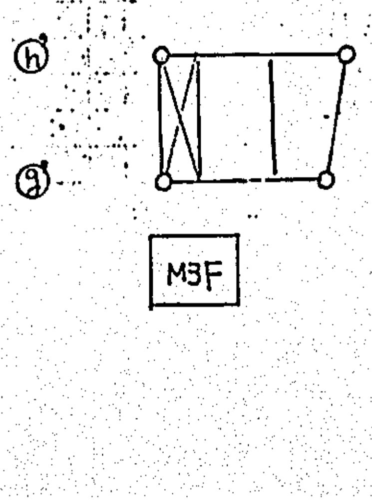
PLAN SECOND. F.



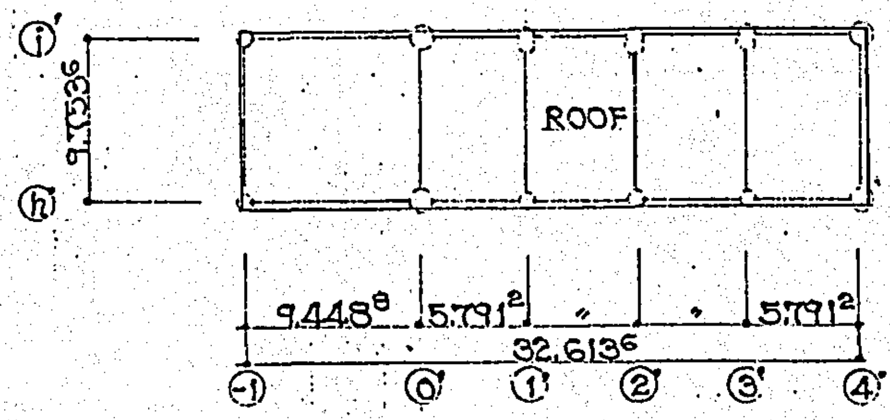

KEY PLAN - SECOND F.
-1
0
1'
2'
3'
4'
5'
6'
7'
i'
h'
g'
f'
e'
d'
c'
b
a
i
h
g
f
e
d
c
b
a
-1
0
1
2
3
4
5
6


PLAN - THIRD F.
40,2336
9448[8]
5791[2]
5791[2]
7,620
BRIDGE
AIRCONDITIONER & FAN ROOM
UPPER PART OF BACK STAGE
ROOF
MBF
ROOF
ROOF
UPPER PART INNER COURT
EXPANSION
53,2892
9,1536
6,7056
6,096
6,096
6,350
6,096
1,5256
4,2672
6,096
6,096
7,620

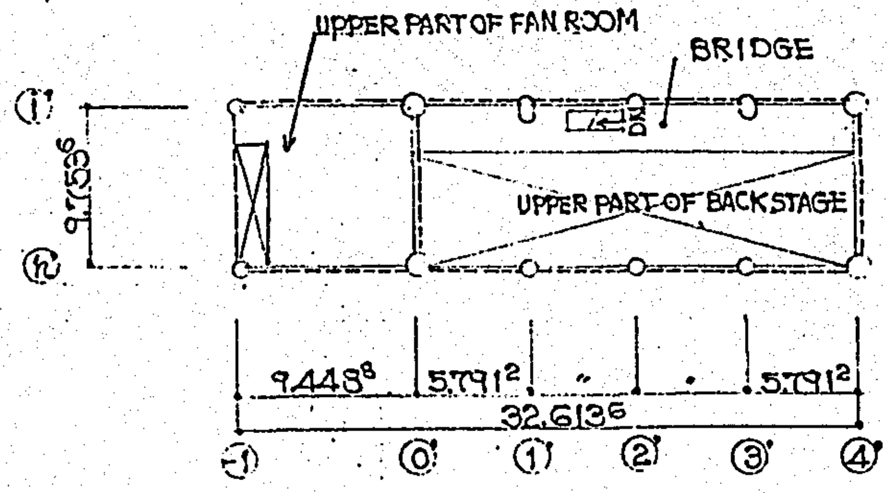

KEY PLAN - THIRD F.
-1'
0'
1'
2'
3'
4'
5'
i'
h'
g'
f'
e'
d'
c'
b
a
-1
0
1
2
3
4
5


h'
g'
M3F

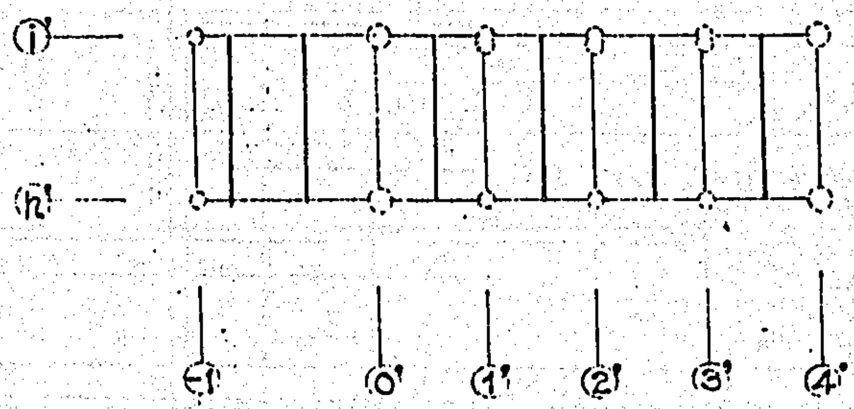
PLAN - ROOF F.



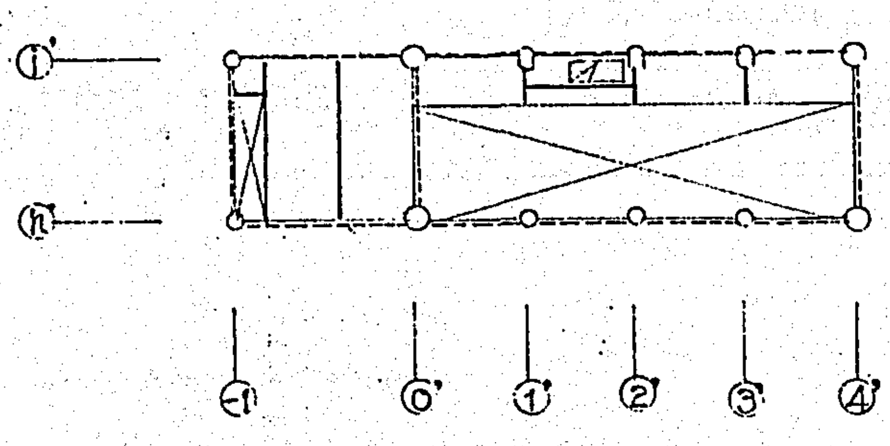
PLAN - FOURTH F.



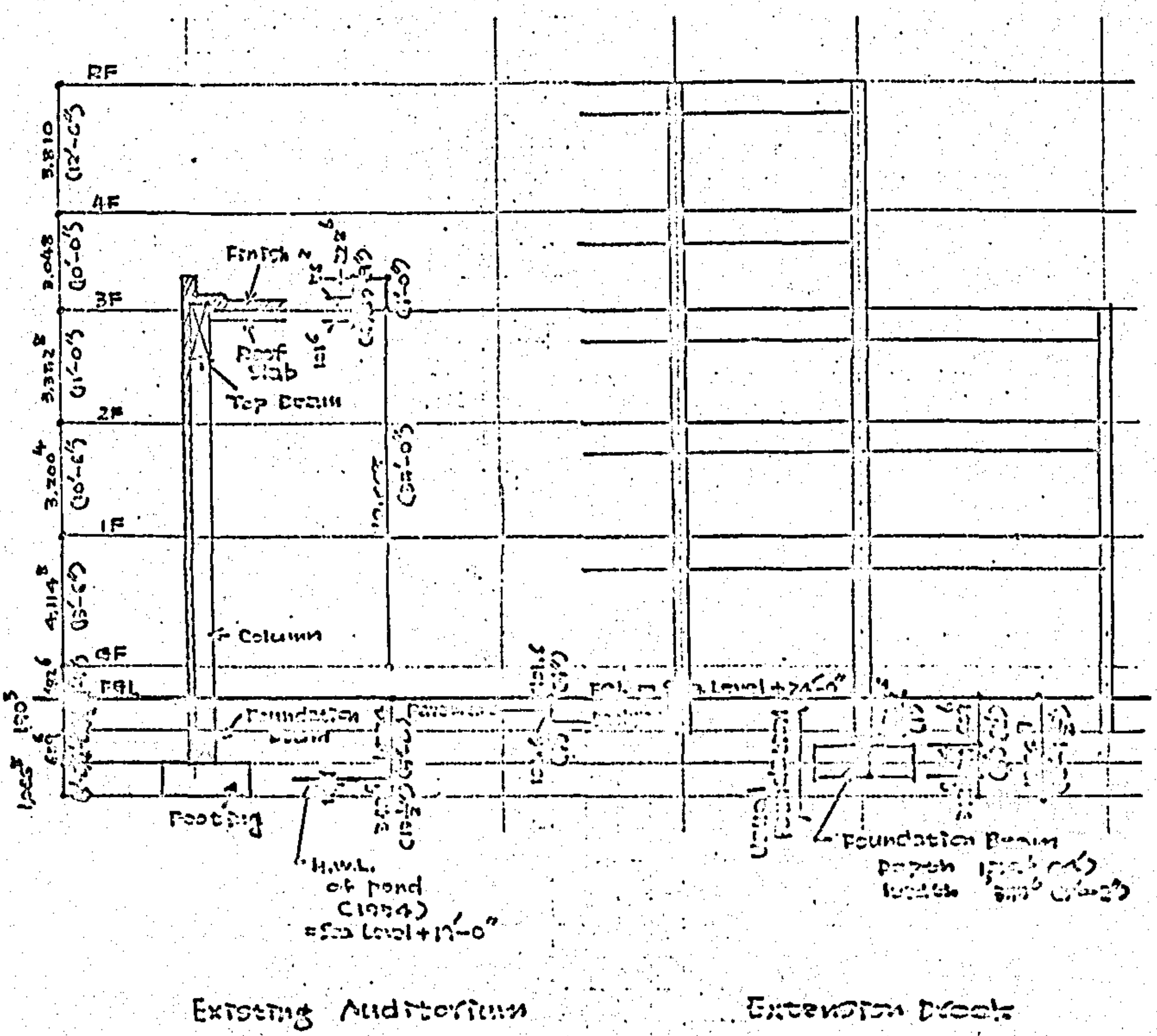
KEY PLAN - ROOF F.



KEY PLAN - FOURTH F.



Section



RF
4F
3F
2F
1F
GF
FBL
Finish
Roof Slab
Top Beam
Column
Foundation Beam
Footing
H.W.L. of pond (1954) =Sea Level+17'-0"
Foundation Beam
Existing Auditorium
Extension Block

ALLOWABLE STRESS INTENSITY

[kg/cm²]

MATERIAL \ STRESS		SUSTAINED LOADING: TENSION	COMPRESSION	SHEAR	POSITION / Fc	TOP BAR	IN GENERAL	WELDING: BUTT: IN GENERAL	WELDING: BUTT: SHEAR	WELDING: FILLET	TEMPORARY LOADING
CONCRETE	Fc 180 (2,600 PSI)	/	60	/	/	/	/	/	/	/	× 2.0
		/	/	6	/	/	/	/	/	/	× 1.5
	Fc 210 (3,000 PSI)	/	70	/	/	/	/	/	/	/	× 2.0
		/	/	7	/	/	/	/	/	/	× 1.5
REINFORCEMENT	M/S * BAR	1,265 (15 kip/in²)	1,125 (16 〃)	1,265 (18 〃)	/	/	/	/	/	/	× 1.33
		/	/	/	Fc 180	7.2	10.8	/	/	/	× 1.5
					〃 210	8.4	12.6				
	SD30	2,000	2,000	2,000	/	/	/	/	/	/	
		/	/	/	Fc 180	12.0	18.0	/	/	/	× 1.5
					〃 210	14.0	21.0				
	SD35	2,200	2,200	(2,000)	/	/	/	/	/	/	3,500 (3,000)
		/	/	/	Fc 180	12.0	18.0	/	/	/	× 1.5
					〃 210	14.0	21.0				
STEEL	M/S ** STEEL	1,265 (13 kip/in²)	1,125 (16 〃)	844 (12 〃)	/	/	/	/	/	800 (11.4 kip/in²)	× 1.33
	SS41	1,600	1,600	900	/	/	/	1,400	800	800	×1.5
	SM50A	2,200	2,200	1,300	/	/	/	2,200	1,300	1,300	×1.5

* Reinforcing No 1 grade

** 圧 = "SANJUKTA" 圧 (weldable Quality)

[1 psi = 0.001 kip/in² = 0.0703 kg/cm²]

M/S BAR'S DATA

Dia	φ cm	at cm²	φ cm	MAX LENGTH m (′)	UNIT WEIGHT kg/m
1/4″	0.635	0.317	1.995		0.249
(5/16″)	(0.794)	(0.495)	(2.494)		
3/8″	0.953	0.713	2.992	12.192 (40′)	0,559
1/2″	1.270	1.267	3.990	〃	0.994
5/8″	1.588	1.979	4.987	10.668 (35′)	1.554
3/4″	1.905	2.850	5.985	〃	2.237
7/8″	2.223	3.879	6.982	8.839 (29′)	3.045
1″	2.540	5.067	7.980	〃	3.978
1 1/4″	3.175	7.917	9.975	〃	6.215

M/S STEEL'S DATA

L

MAX LENGTH
26' = 7924.8

"	M/M	A cm²	W kg/m
3/4"×3/4"×1/8"	19 × 19 × 3		≒ 0.80
1"×1"×1/8"	25 × 25 × 3	1.548	1.22
1 1/2"×1 1/2"×1/8"	38 × 38 × 3		≒ 1.80
× 3/16"	× 5	3.419	2.68
× 1/4"	× 6	4.452	3.49
2"×2"×1/4"	51 × 51 × 6	6.065	4.76
2 1/2"×2 1/2"×1/4"	64 × 64 × 6	7.613	5.98
3"×3"×3/8"	76 × 76 × 10	13.484	10.58

M/S 板

UNIT
8'×4' = 2438.4×1219.2

"	M/M	W kg/m²
1/8	3.18	24.9
3/16	4.76	37.4
1/4	6.35	49.8
3/8	9.53	74.8
1/2	12.70	99.7
3/4	19.05	149.5
1	25.4	199.3

FB (FLAT IRON BAR)

MAX LENGTH
30' = 9144.0

"	M/M	A cm²	W kg/m
3/4"×1/8"	19 × 3	0.60	0.47
× 3/16	× 5	0.91	0.71
× 1/4"	× 6	1.21	0.95
1"×1/8"	25 × 3	0.81	0.63
× 3/16"	× 5	1.21	0.95
× 1/4"	× 6	1.61	1.27
1 1/2"×3/16"	38 × 5	1.81	1.42
× 1/4"	× 6	2.42	1.90
2"×1/4"	51 × 6	3.23	2.53

2—STRESS ANALISIS

Stiffness Ratio

(IN FINAL REPORT, SOME MEMBER'S SIZE CHANGED TO 9M UNIT ROUND NUMBER SIZE)

Column

	J (×10⁴)	Story	4'	3	2	1	G
		Height	289.56	393.24	338.28	320.04	512.70
2' × 2'	115.08		0.40	0.29	0.34	0.36	0.22
						0.14	
3' × 2'	388.39		1.34	0.99	1.15	1.21	0.75
						0.46	
2' × 3'	172.62		0.60	0.44	0.51	0.54	0.33
3' × 3'	582.59		201	1.52	1.72	1.82	1.13
						0.70	

Beam

	J (×10⁴)	φ	φJ	Span 426.72	528.32	629.92	731.52	833.12	944.48	[731.64] 572.12	762.00	635.00	609.60	670.56	975.36
1'-6" × 1'-2"	28,3	1.5n 1.5s	43.87 52.39	0.10 0.12	0.10	0.08						0.07 0.08	0.07 0.09	0.07 0.08	
2' × 1'-2"	67.13	(1.0) 1.5 1.8	(67.13) 100,69 120.83	0.24 0.26	0.19 0.23	0.16 0.19	0.14 0.17	0.12 0.15	(0.07) 0.11 0.13	[0.12] 0.17 0.21	(0.09) 0.13 0.16	0.16 0.19	0.17 0.20	0.15 0.18	(0.07) 0.10 0.12
2'-6" × 1'-2"	131,11	1.5 1.8	196,67 236,00	0,46 0,55	0,37 0,45	0,31 0,37	0,27 0.32	0,24 0,28	0,21 0,25	0.34 0.41	0,26 0.31	0,31 0,37	0.32 0.39	0,29 0,35	0.20 0,24
3' × 1'-2"	226,56	(1.0) 1,4 1.7	226,56 312,19 385,16	0,74 0,90	0,60 0,73	0.50 0,61	0,43 0,53	0,38 0,46	0.34 0,41	[0,14] 0,55 0,67	(0.30) 0,42 0,51	0,50 0,61	0,52 0.63	0.47 0,57	(0.24) 0,33 0,39
2' × 1'-2"	67.13	1.0	67.13						0,07	[0,03] 0.12	0,09				0,07
5' × 1'-2"	1048,90	1.0	1048,90							[0.45] 1.81					
4' × 1'-2"	537,04	1,0	537,04	1,26	1,02	0.85	0,73	0,64	0,57	0,93	0,70	0,85	0,88	0,80	0,55

Coefficient for T-Section's Geometrical Moment of Inertia

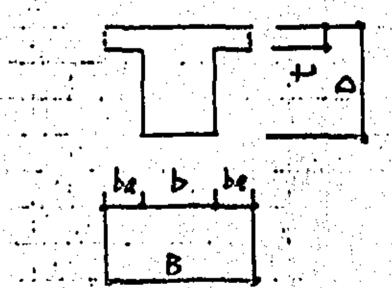
b	D	Type	t	t/D	ba =0.18	B	B/b	φ								
35.56 (1'-2")	45.72 (1'-6")	T	12.7 (5")	0.28	60.96	96.52	2.71	1.58								
		T	〃	〃	〃	157.48	4.43	1.75								
35.56 (1'-2")	60.96 (2'-0")	T	〃	0.21	〃	96.52	2.71	1.5								
		T	〃	〃	〃	157.48	4.43	1.8								
〃	76.20 (2'-6")	T	〃	0.17	〃	96.52	2.71	1.5								
		T	〃	〃	〃	157.48	4.43	1.8								
〃	914.4 (3'-0")	T	〃	0.14	〃	96.52	2.71	1.4								
		T	〃	〃	〃	157.48	4.43	1.7								

J : Geometrical Moment of T-Section (T)

J_0 : 〃 of Usual Section (▯)

$$J = \phi I_0 = \phi \frac{bD^3}{12}$$

$$\phi = 4\alpha - 3\frac{\beta^2}{\gamma}$$



$$\alpha = 1 + (b_1 - 1)t_1^3$$

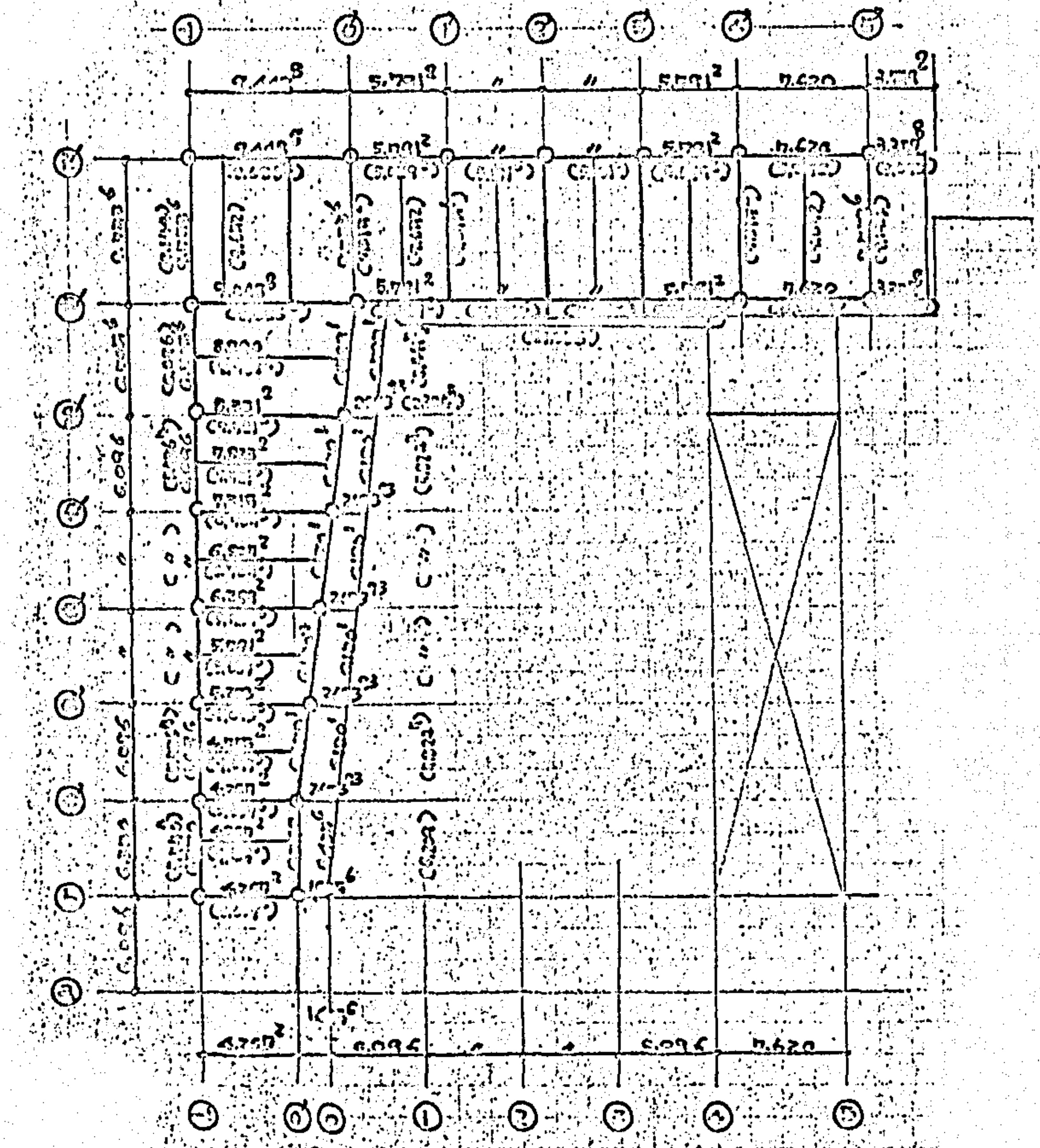
$$\beta = 1 + (b_1 - 1)t_1^2$$

$$\gamma = 1 + (b_1 - 1)t_1$$

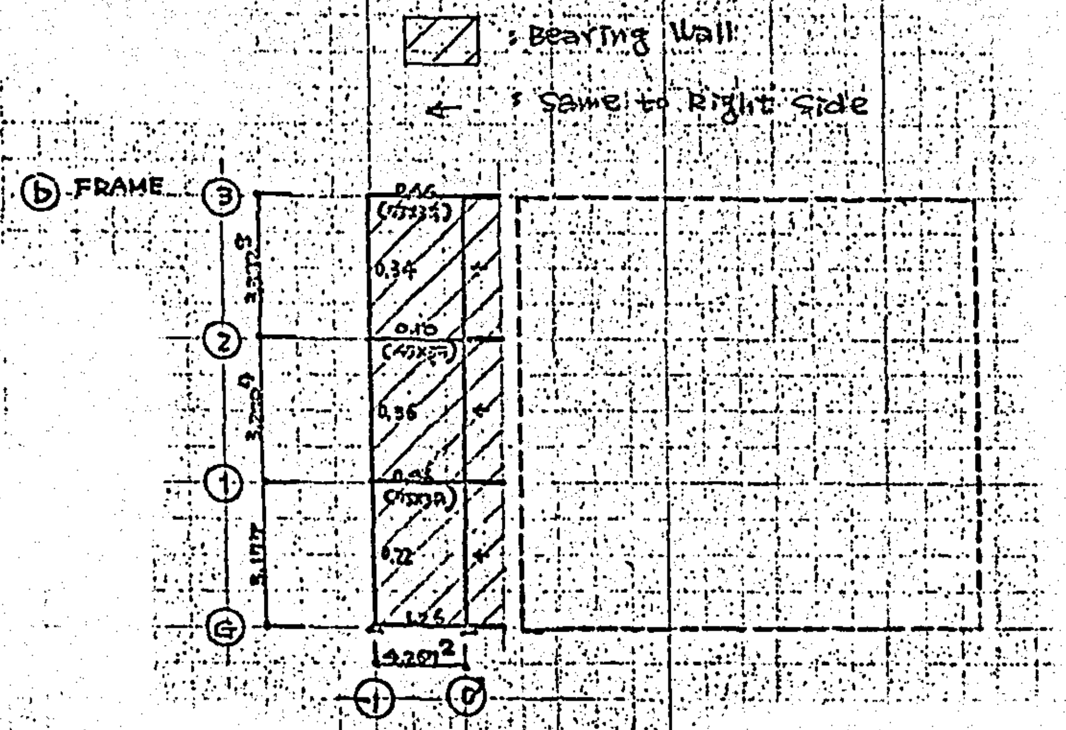
$$b_1 = \frac{B}{b}$$

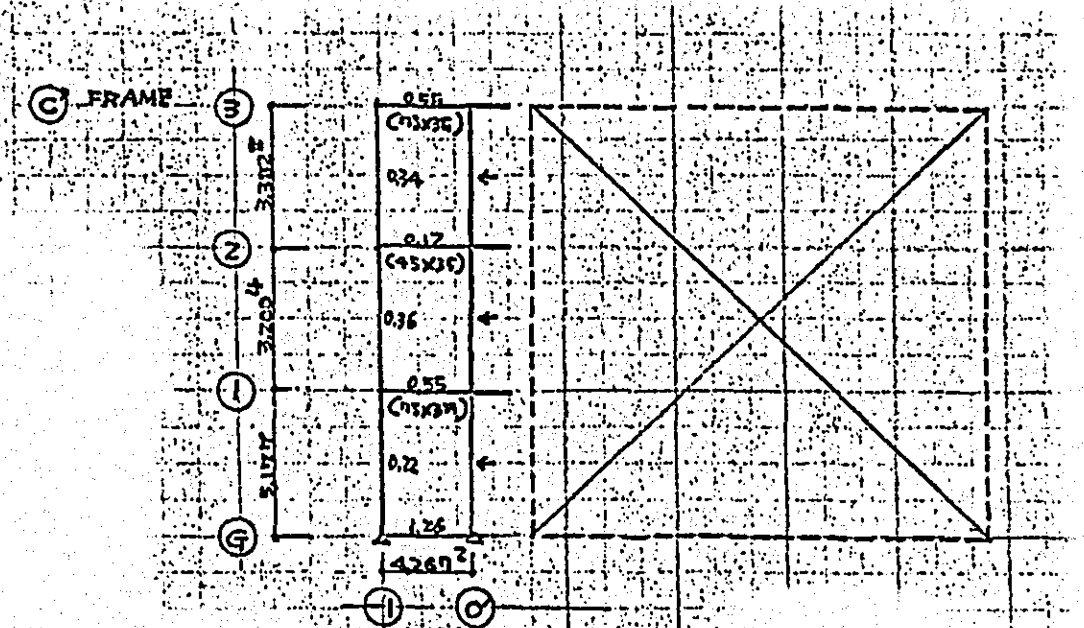
$$t_1 = \frac{t}{D}$$

Span Length — MM (Clear Span)

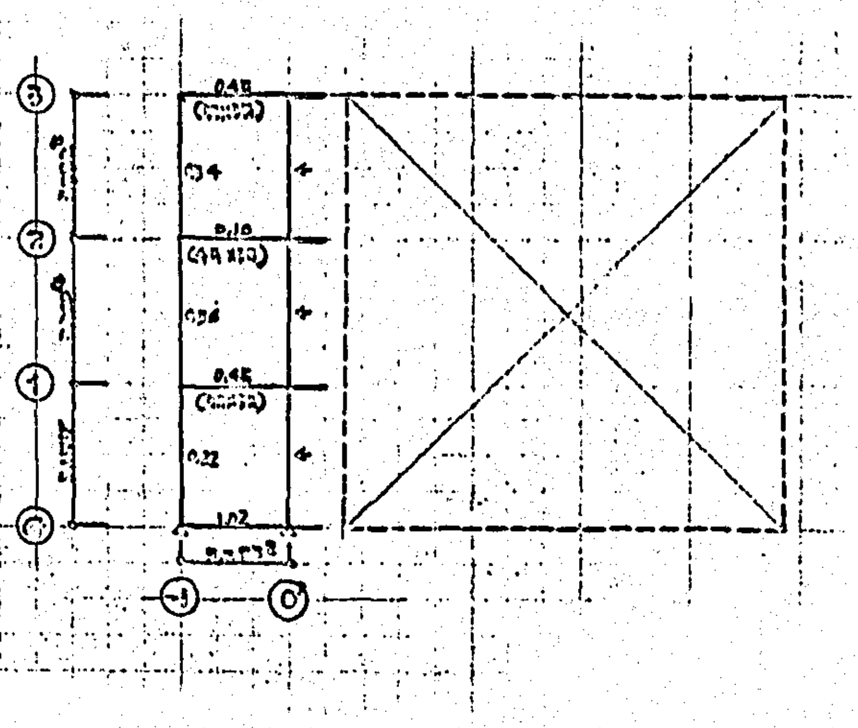


Stiffness Ratio Chart

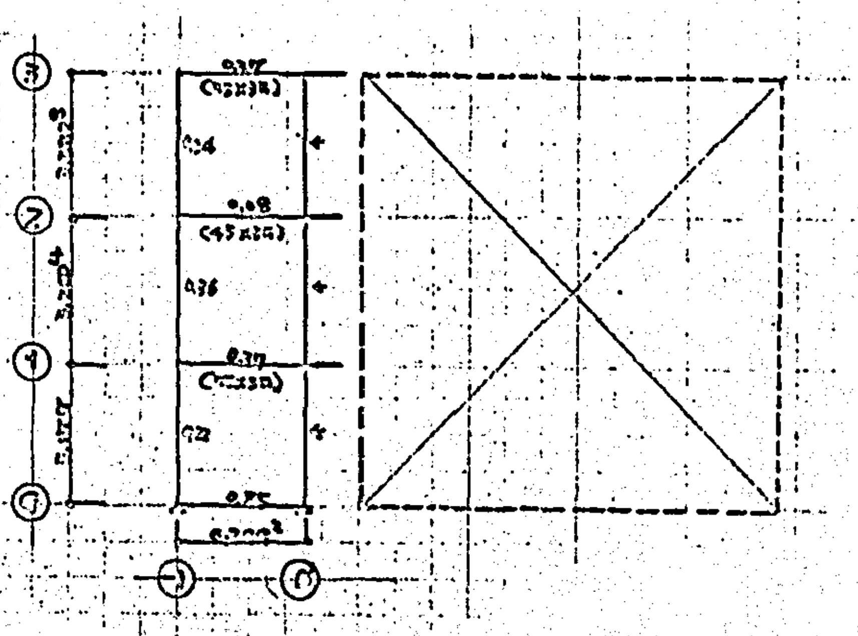


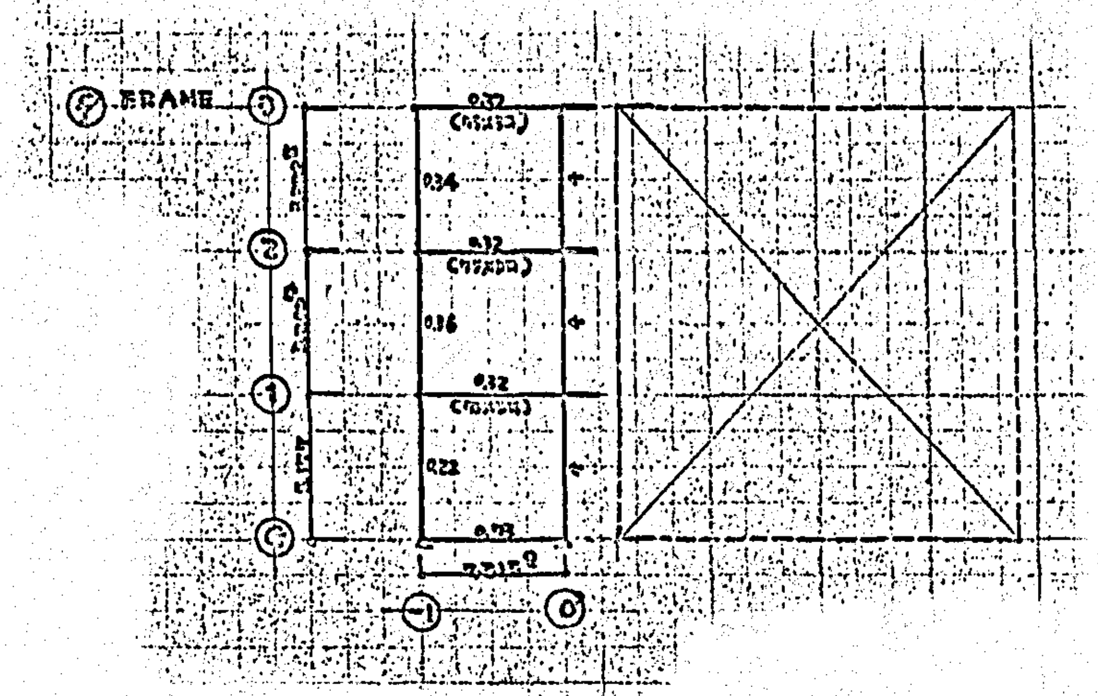


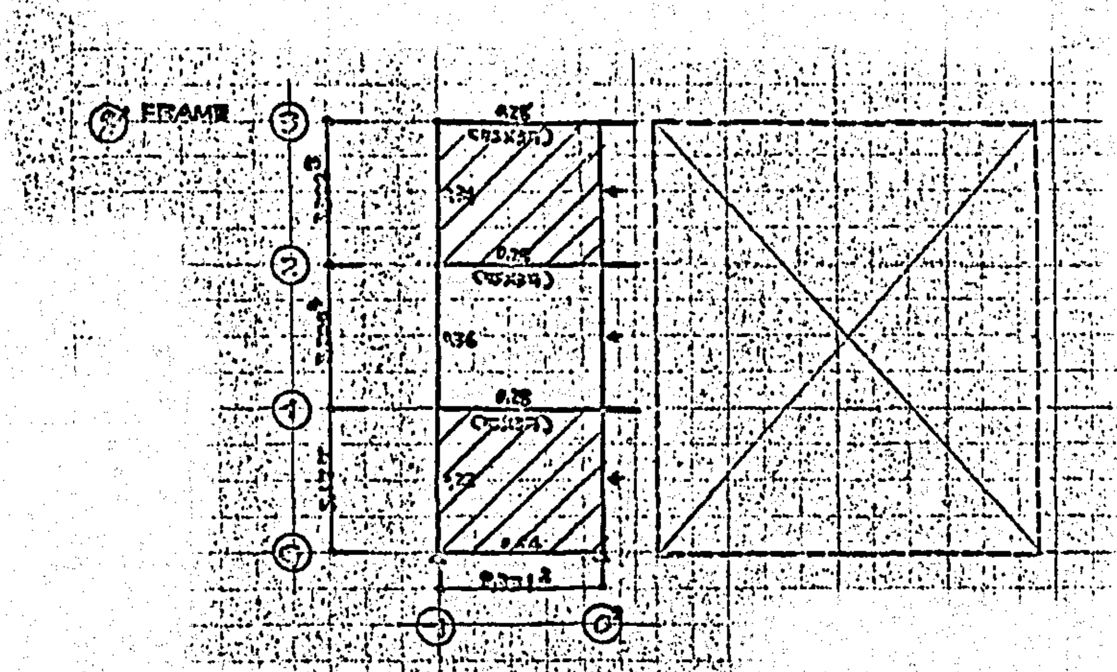
(d') FRAME

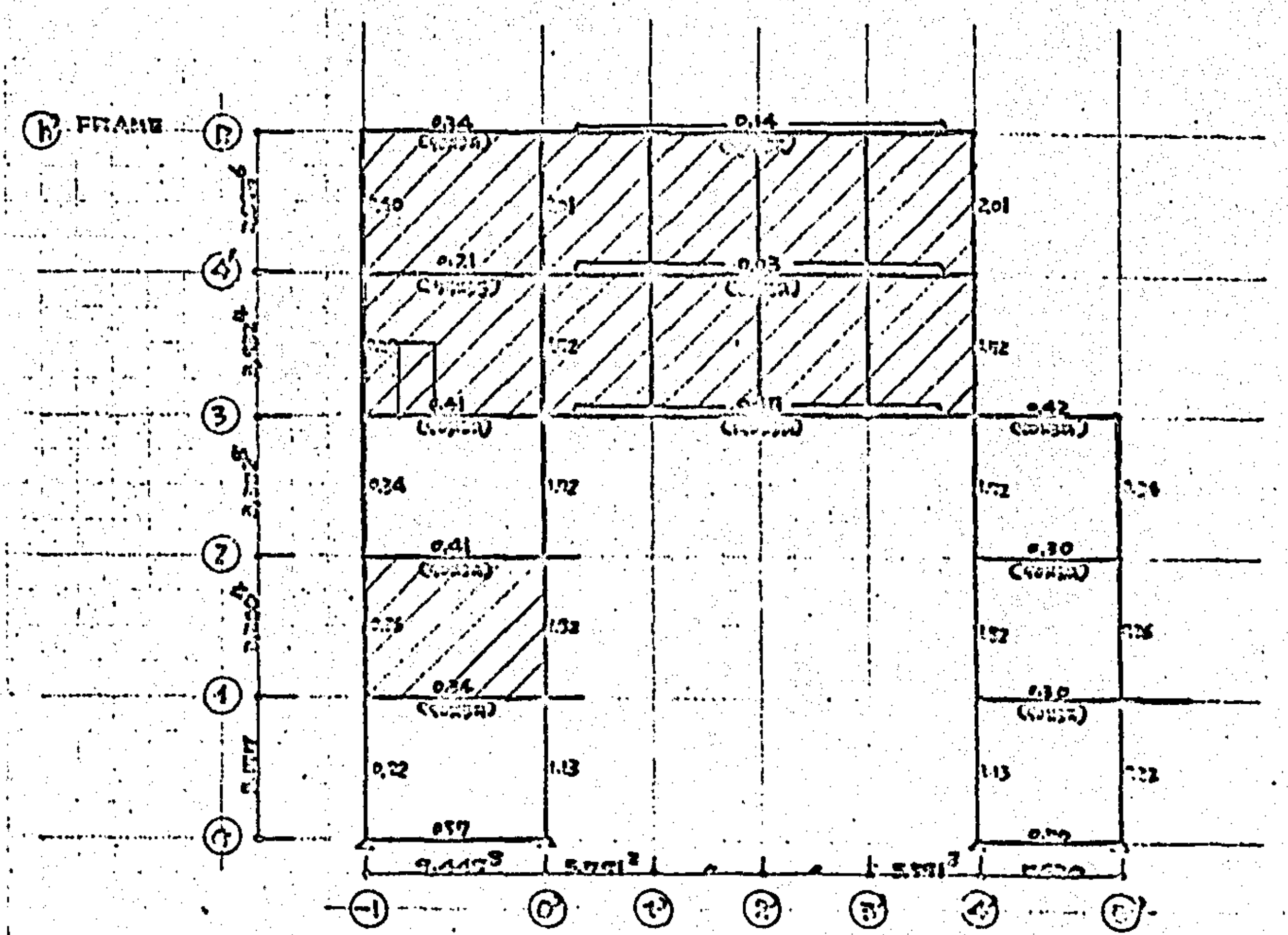


(e) FRAME




FRAME
0.32
0.34
0.32
0.36
0.32
0.22


FRAME
0.36
0.28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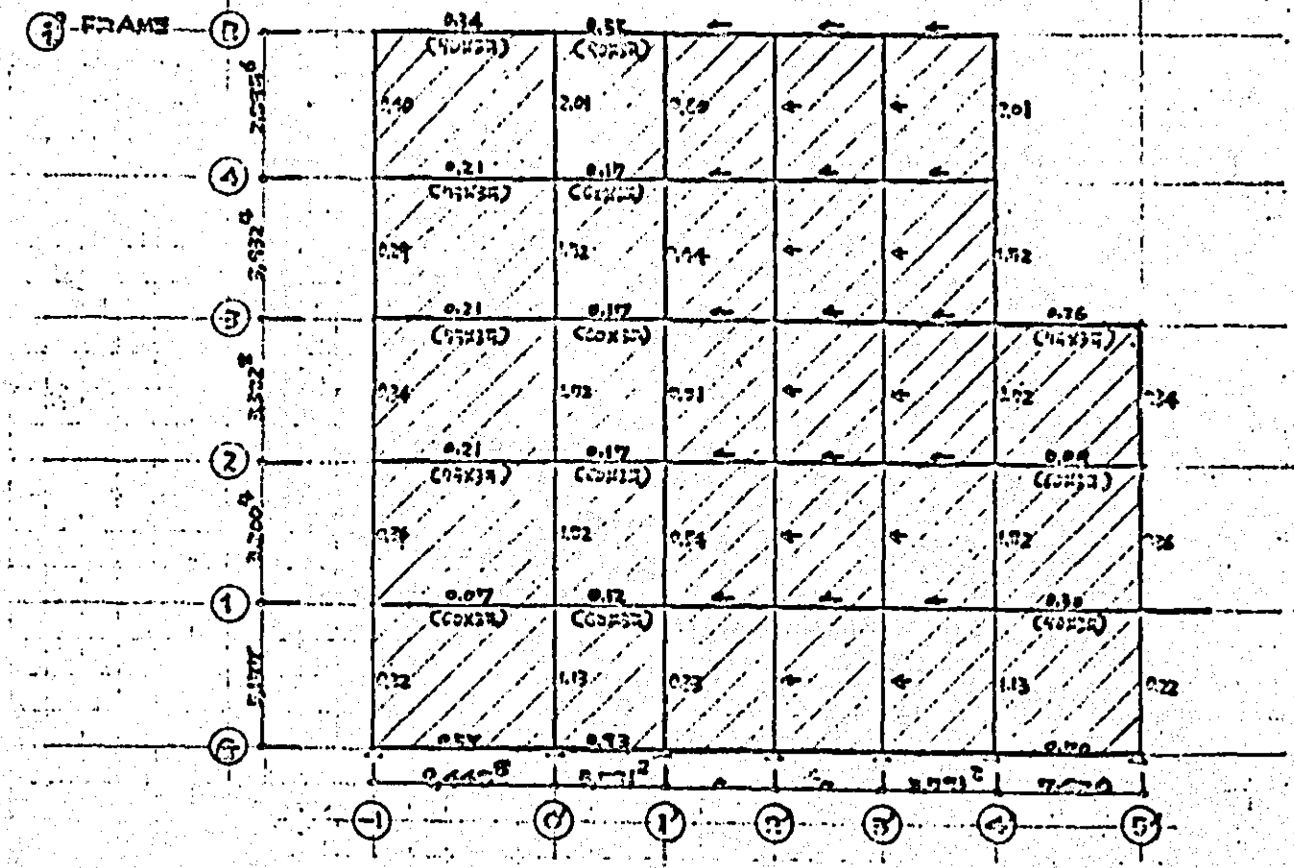
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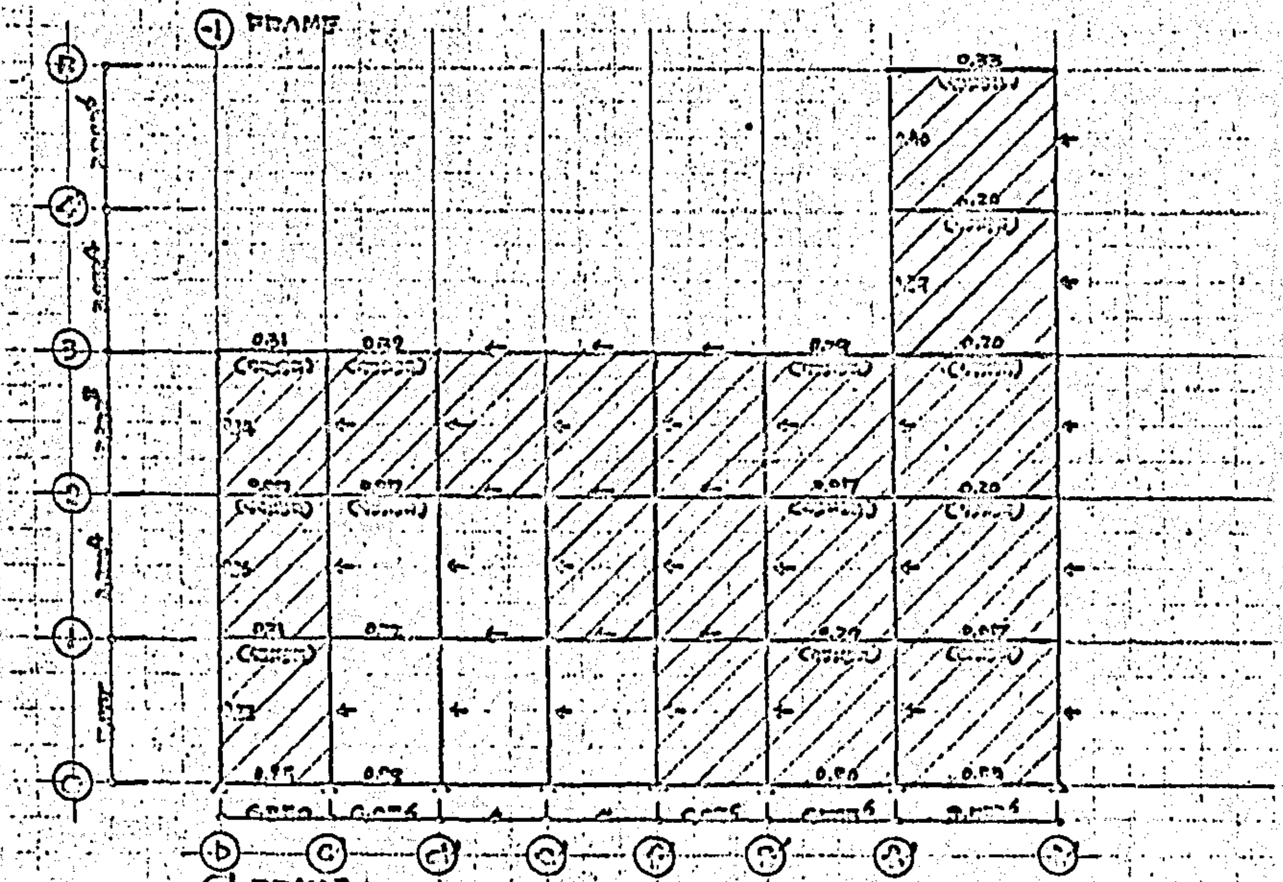
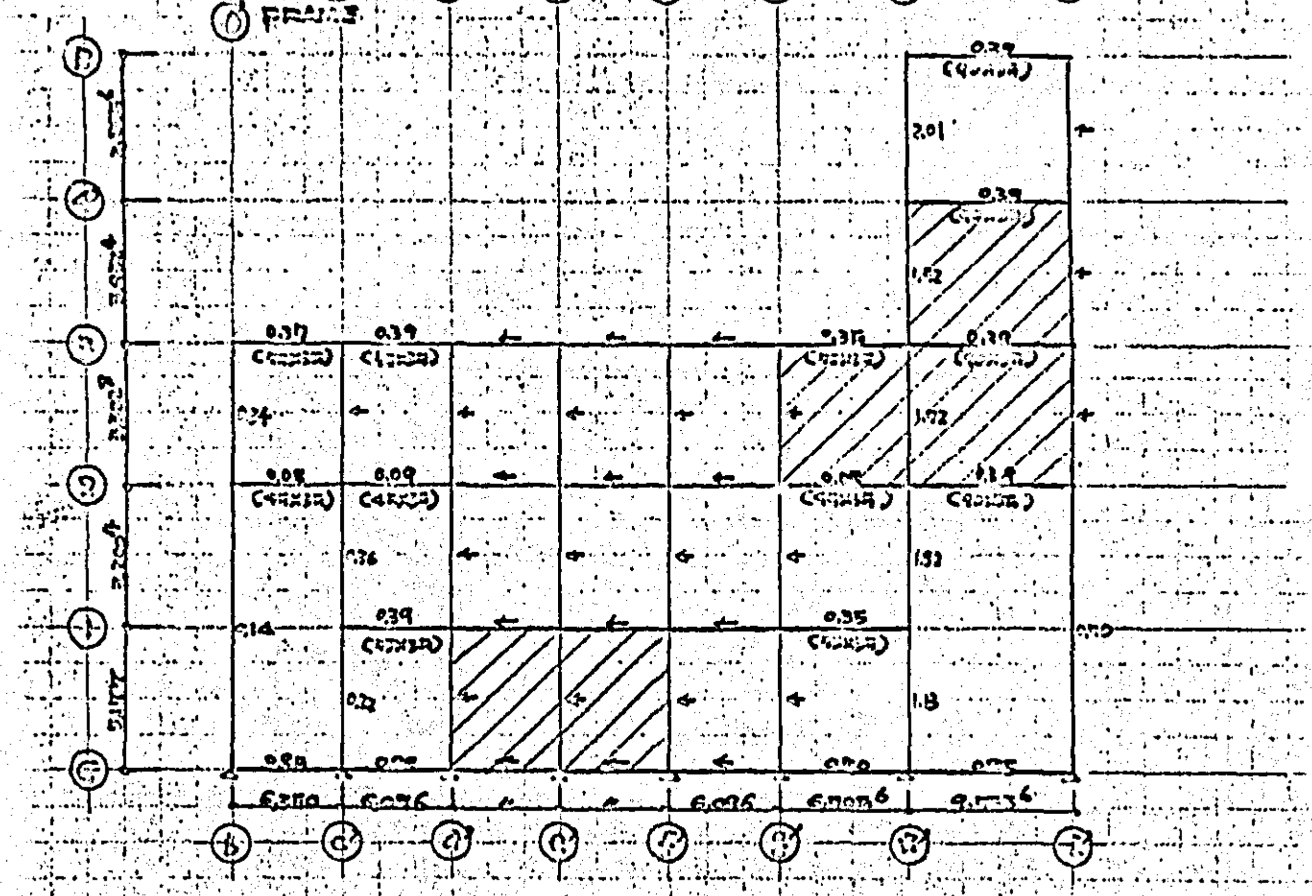

FRAME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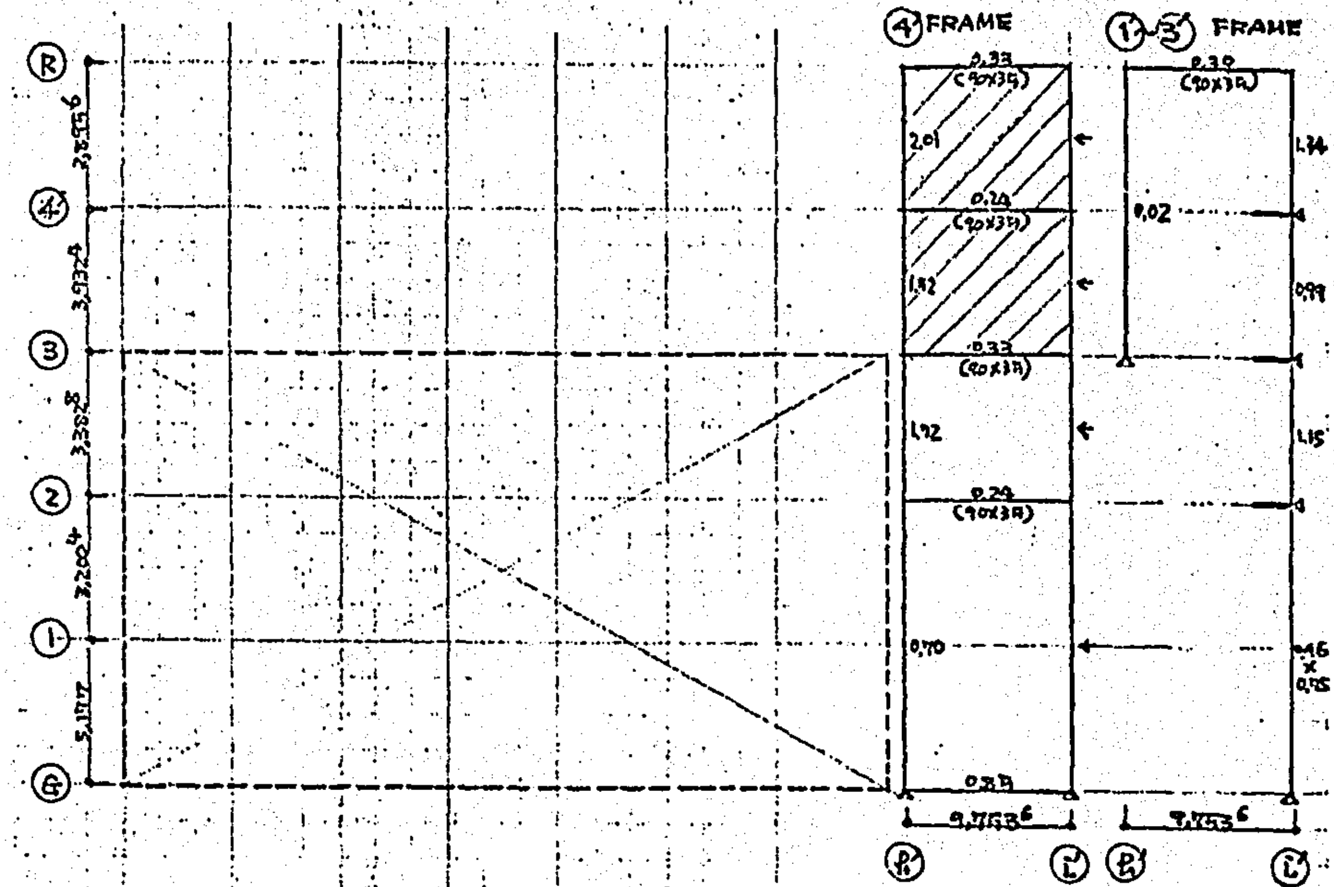
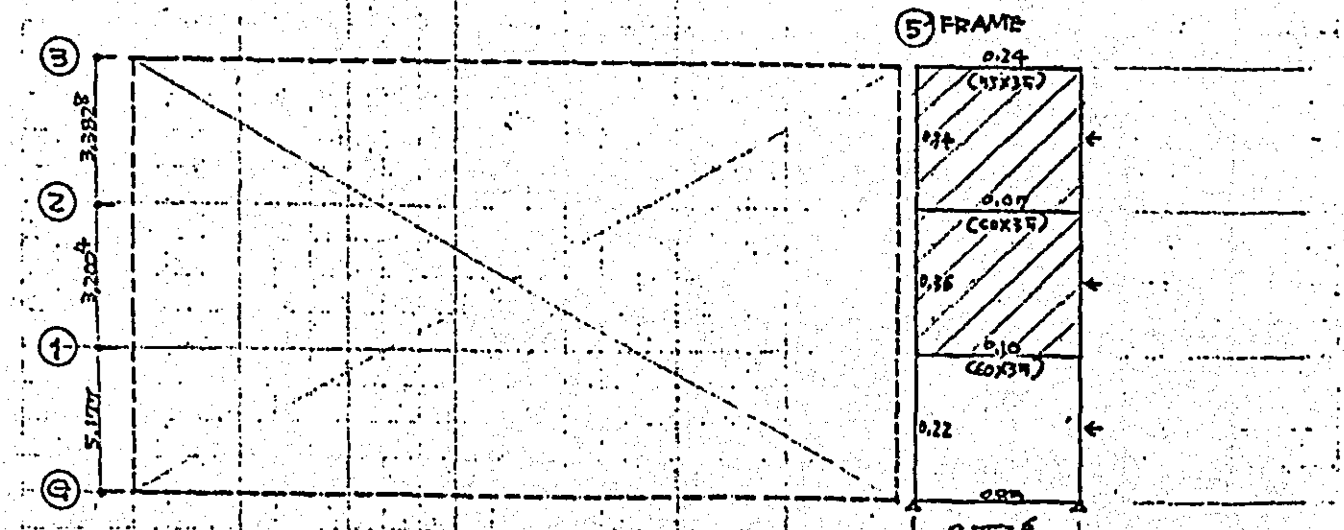
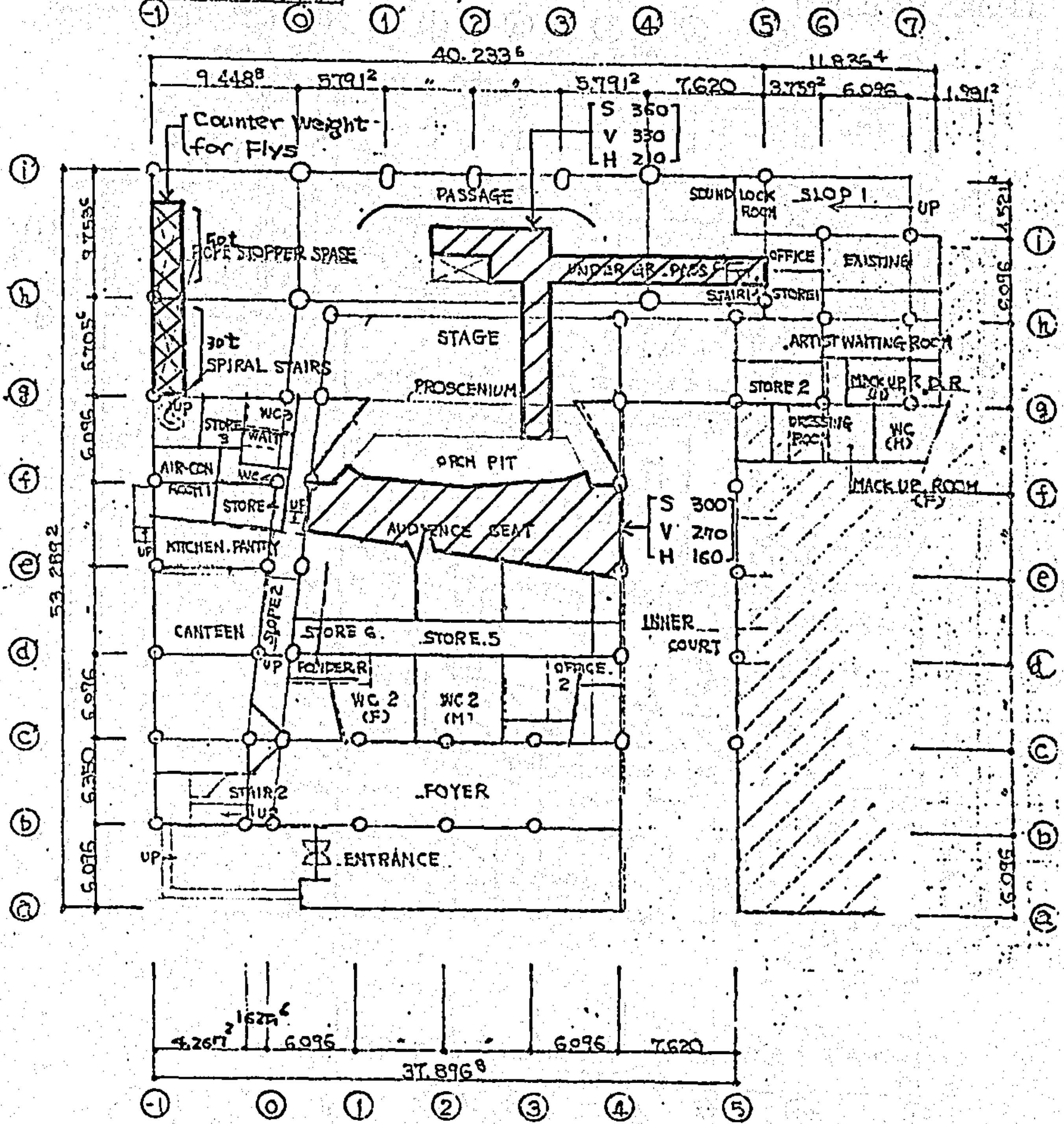

④' FRAME
①'~③' FRAME
(90x35)
(90x37)


⑤' FRAME
(60x35)
(60x37)

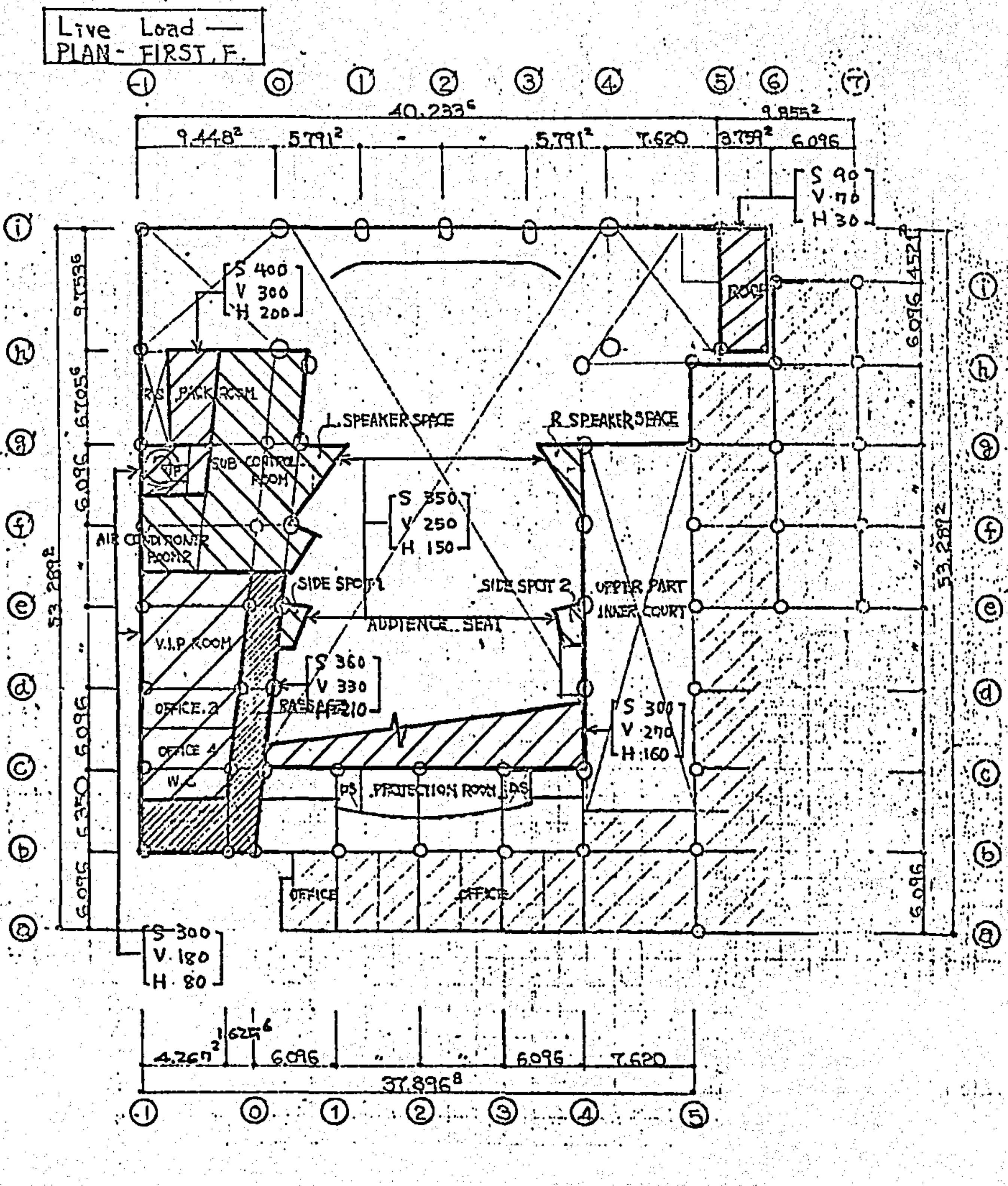
Live Load ——
PLAN GROUND F.



Index Kg/m²

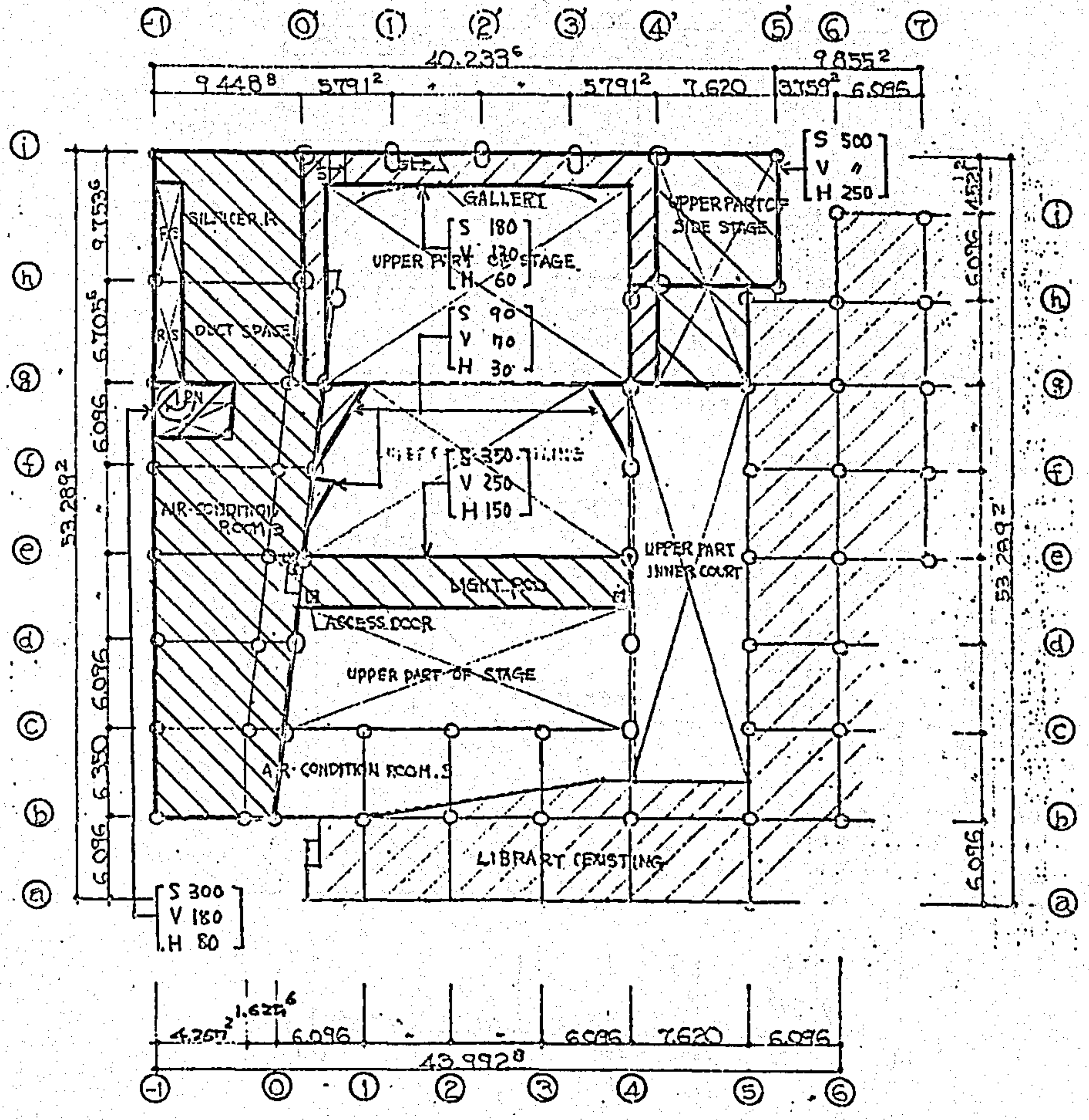
S : Live Load for Slab and Subbeam.
V : 〃 Vertical Load
H : 〃 Seismic Force

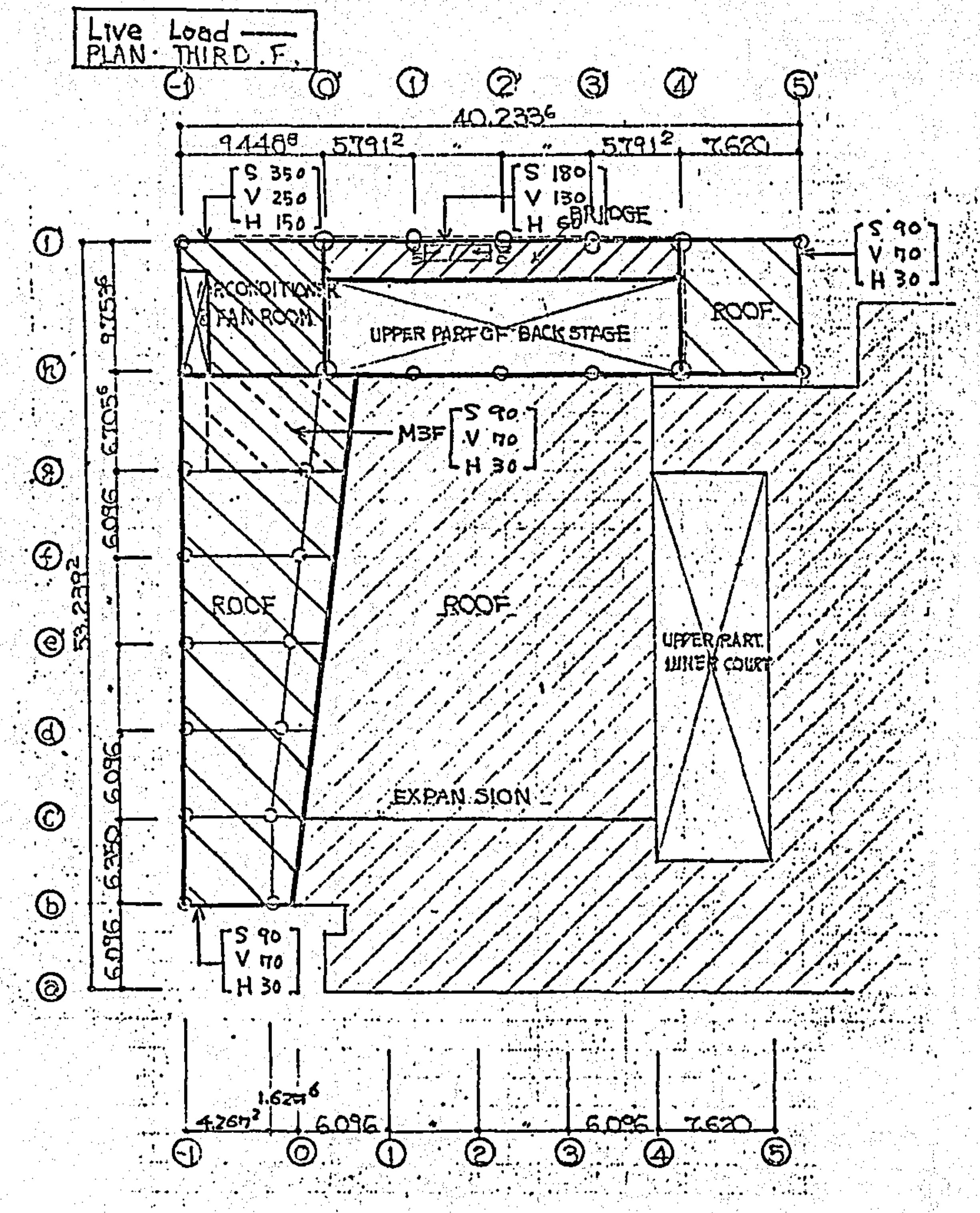
(1 P.S.f. = 4.88266 Kg/m²
0.20481 P.S.f = 1 Kg/m²)



Live Load —
PLAN - FIRST. F.
40.233⁶
9.855²
9.448²
5.791²
5.791²
7.620
3.759²
6.096
S 90
V 170
H 30
S 400
V 300
H 200
ROOF
PACK ROOM
L.SPEAKER SPACE
R.SPEAKER SPACE
SUB CONTROL ROOM
S 350
V 250
H 150
AIR CONDITIONER ROOM 2
SIDE SPOT 1
SIDE SPOT 2
UPPER PART INNER COURT
AUDIENCE SEAT
V.I.P ROOM
S 360
V 330
H 210
OFFICE 2
PASSAGE
OFFICE 4
W.C
S 300
V 270
H 160
PS
PROJECTION ROOM
PS
OFFICE
OFFICE
S 300
V 180
H 80
53.282
4.267²
1.625⁶
6.096
6.096
7.620
37.896⁸

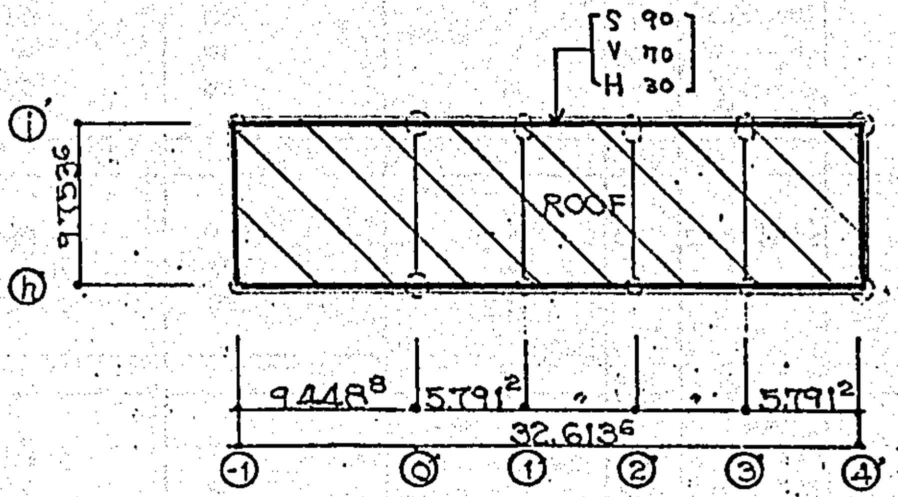
Live Load ——
PLAN SECOND F.



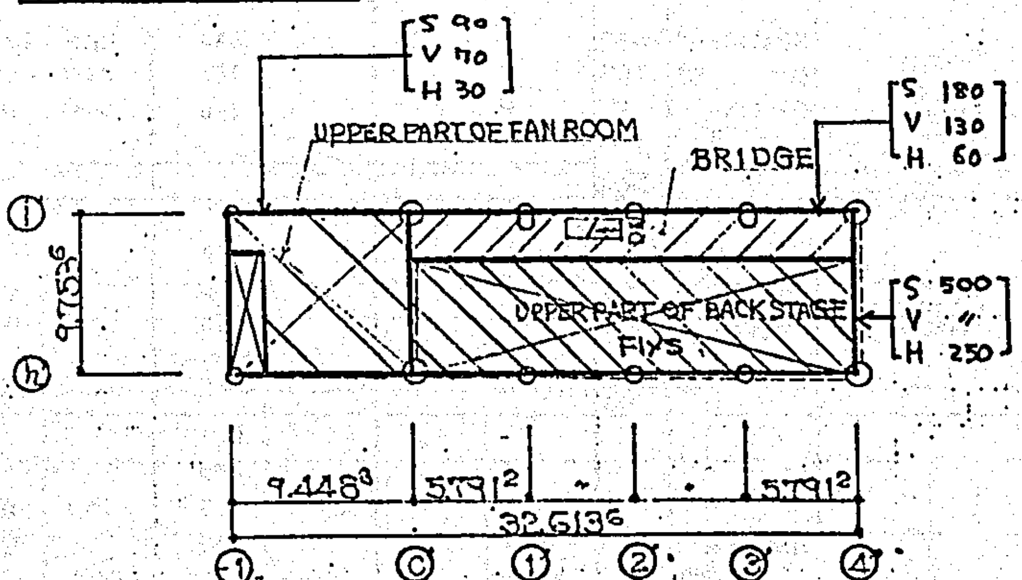


Live Load ——
PLAN · THIRD F.
40.233⁶
9.448⁸
5.791²
5.791²
7.620
S 350
V 250
H 150
S 180
V 130
H 60
BRIDGE
S 90
V 170
H 30
AIRCONDITIONER FAN ROOM
UPPER PART OF BACK STAGE
ROOF
M3F
S 90
V 170
H 30
53.239²
ROOF
ROOF
UPPER PART INNER COURT
EXPANSION
S 90
V 170
H 30
4.267²
1.627⁶
6.096
6.096
7.620

Live Load —
PLAN - ROOF F



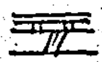
Live Load —
PLAN - FOURTH F



Unit Load

Floor	Dead Load		Live Load		Total Load
					kg/m2
Roof	Water Roof	300	S	90	740
	RC 5"	305	V	70	720
	Ceiling	35	H	30	680
		650			
Flys	Steel Frame	100	S	500	600
			V	500	600
			H	250	350
		100			
Gallery · Ropping Space	Finish	60	S	180	590
	RC 5"	305	V	130	540
	Ceiling	45	H	60	470
		410			
Mezzanine Roof		〃	S	90	500
			V	70	480
			H	30	440
		410			
Air , Sub Con Con -Room 3-2F ~ 1F	Finish 6"	65~365	S	350	760 1060
	RC 5"	305	V	250	660 ~ 960
	Ceiling	50	H	150	560 860
		410~710			
Lighting Room	Finish	60	S	350	550
	Steel Frame	100	V	250	450
	Ceiling	40	H	150	350
		200			
Rack Room	same to 1F Air con -Room		S	400	1110
			V	300	1010
			H	200	910
		710			
Office	Same to gallery		S	300	710
			V	180	590
			H	80	490
		410			

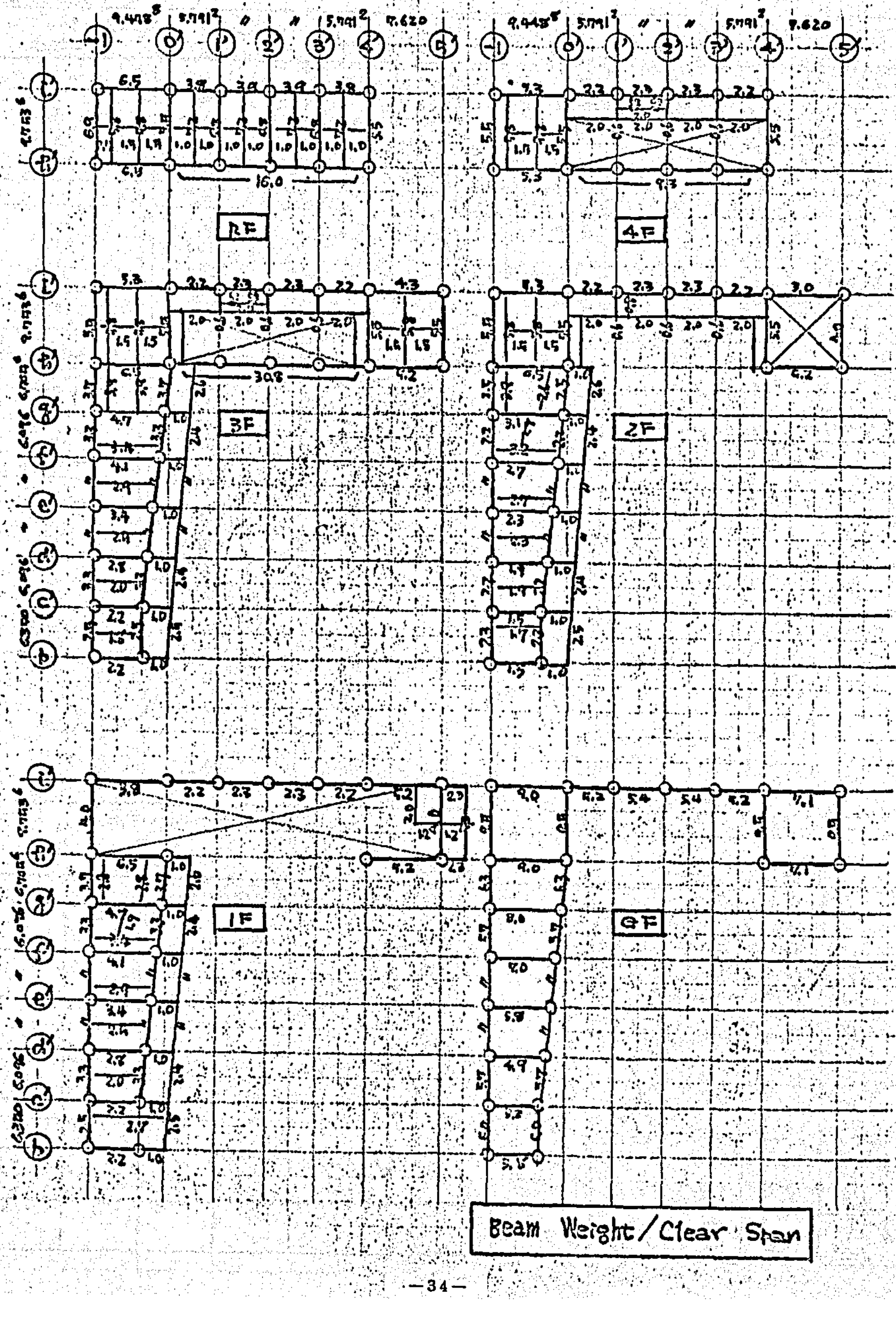
kg/m2

	Dead	Load		Live	Load	Total Load
Corridor		Same to Gallery		S V H	360 330 210	770 740 620
			410			
Staire case		410×2		S V H	360 330 210	1180 1150 1030
			820			
Toilet		Finish RC 5" ceiling	200 305 45	S V H	360 330 210	910 880 760
			550			
Stage		Finish RC 5"	65 305	S V H	360 330 210	730 700 580
			370			

(IN FINAL REPORT, SOME BEAM AND COLUMN SIZE CHANGED.)

Beam

	t/m			t/clear span							
	Skeleton	Finish	Σ								
1'6" ⊥ 1'-2"	0.390	0.016	0.406								
2' ⊥ 1'-2"	0.412	0.024	0.436								
2'-6" ⊥ 1'-2"	0.542	0.064	0.606	See FOLLOWING P.							
3' ⊥ 1'-2"	0.672	0.079	0.751								
5' ⊥ 1'-2"	1.293	0.152	1.445								
4' □ 1'-2"	1.041	—	1.041								



Beam Weight/Clear Span

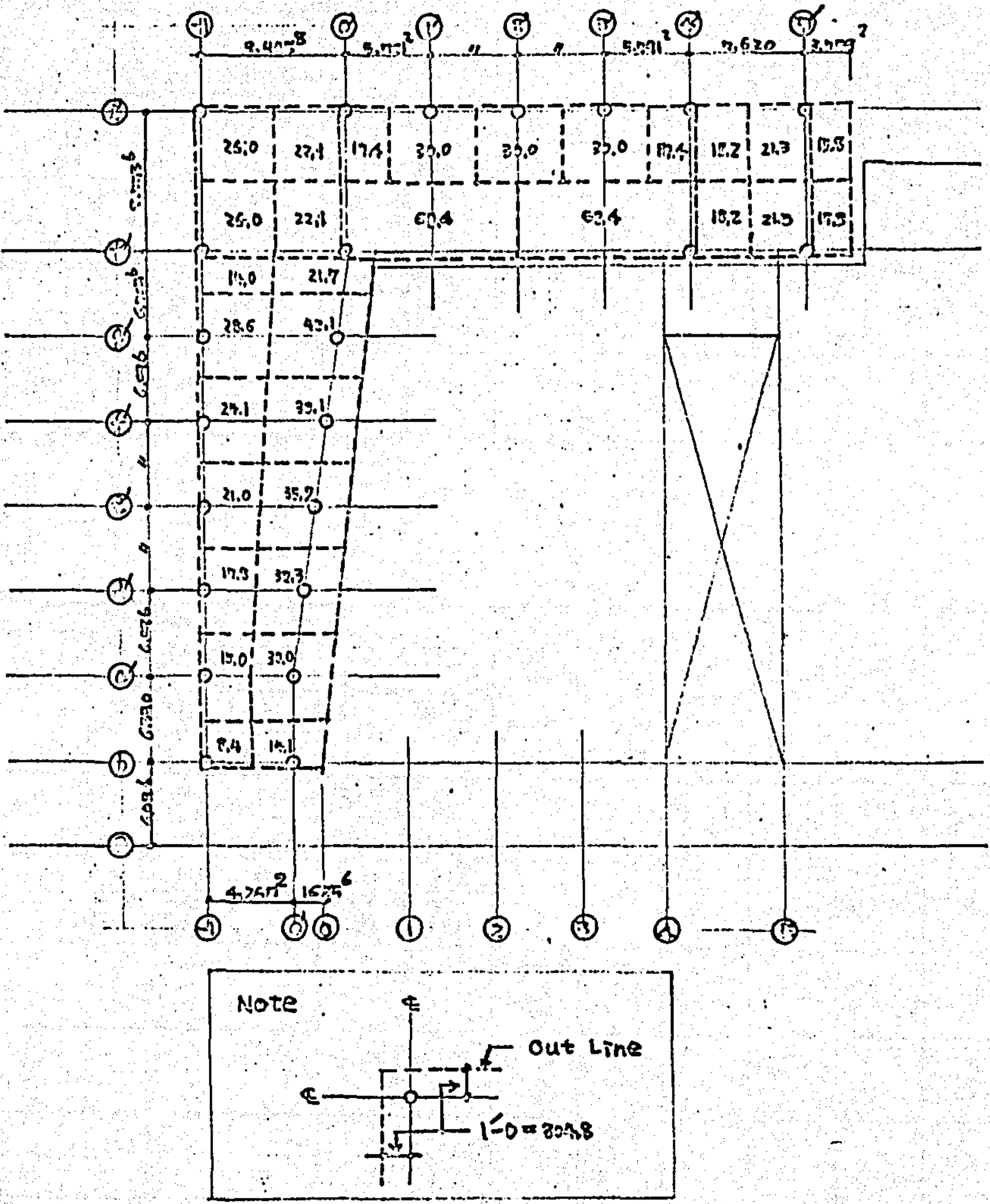
Column

	t/m			t/story						
	Skeleton	Finish	Σ	Story	4F	3F	2F	1F	GF	
				Height	3,518	3,048	3,352	3,200	6,121	
3' □ 3'	2.006	0.153	2.159		8.3	6.7	7.3	7.0	[illegible]	
				4.7	5.3	6.8	7.2	10.8	5.0	
3' □ 2'	1,338	0,152	1,540		5.9	4.7	5.2	4.9	5.4	
				5.0	5.3	5.0	5.1	7.4	4.7	
2' □ 2'	0,592	0.051	0.643		2.6	2.9	3.2	3.0	5.5	
				1.3	2.3	2.1	3.1	4.8	2.9	

Wall.

	t/m²				t/clear height m					
	Skeleton	Finish	Σ		Story	4F	3F	2F	1F	GF
					Height	2,898	3,962[4]	3,352[7]	3,200[4]	4,902[2]
				Net Height	Under beam ~ Under slab	2,205[4] ~ 2,768	3,352[8] ~ 3,835[4]	2,743[2] ~ 3,229[5]	2,590[6] ~ 3,073[4]	4,272[6] ~ 4,521[2]
5" + 6"	0,203 + 0,366	0,050	0,619			1.43 ~ 1.71	2.08 ~ 2.37	1.70 ~ 2.00	1.60 ~ 1.90	2.65 ~ 2.80
6"	0.356	0,100	0,456			1.05 ~ 1.25	1.76 ~ 1.79	1.25 ~ 1.50	1.21 ~ 1.43	2.00 ~ 2.11
					Parapet 0,50					

Unit Area — M^2



25.0
22.1
17.4
30.0
30.0
30.0
17.4
15.2
21.3
15.5
25.0
22.1
60.4
62.4
15.2
21.5
17.5
15.0
21.7
28.6
43.1
24.1
39.1
21.0
35.7
17.3
32.3
15.0
30.0
8.4
15.1
Note
Out Line

Detail of Vertical Load for Column (t)

Floor		(b) (−1)		(b) (c')		(c') (−1)		(c') (c')	
4	S								
	B								
	C								
	W								
	Σ								
3	S								
	B								
	C								
	W								
	Σ								
2	S	0.96 × 8.4	8.1	× 14.1	13.5	× 15.0	14.4	× 30.0	28.8
	B	1.1 + 0.4	1.5	1.1 + 1.0	2.1	1.1 + 0.9	2.0	1.1 + 1.9	3.0
		1.8	1.8	1.8 + 1.3	3.1	3.4	3.4	3.4 + 2.6	6.0
	C		1.6		1.6		1.6		1.6
	W								
	Σ	13.0	13.0	20.3	20.3	21.4	21.4	39.4	39.4
1	S	0.96 × 8.4	8.1	× 14.1	13.5	× 15.0	14.4	× 30.0	28.8
	B	1.1 + 0.4	1.5	1.1 + 1.0	2.1	1.1 + 0.9	2.0	1.1 + 1.9	3.0
		1.8	1.8	1.8 + 1.3	3.1	3.4	3.4	3.4 + 2.6	6.0
	C		3.1		3.1		3.1		3.1
	W	1.85 × 4.7	8.7	× 3.2	5.9	× 5.6	10.4	—	
		1.50 —		—		—		—	
	Σ	36.2	23.2	48.0	27.7	54.7	33.3	50.3	40.9
G	S	1.15 × 8.4	9.7	× 8.4	9.7	0.59 × 15.0	8.9	× 15.0	9.0
				0.74 × 5.7	4.3			× 15.0	11.1
	B	1.1 + 0.4	1.5	1.1 + 1.0	2.1	1.1 + 0.9	2.0	1.1 + 1.9	3.0
		1.8	1.8	1.8	1.8	3.4	3.4	3.4 + 2.6	6.0
	C		4.4		4.4		4.4		4.4
	W	1.76 × 4.7	8.3	× 3.2	5.6	× 7.7	13.6	× 2.1	3.7
		1.43 —		—		1.43 × 3.0	4.3	× 9.8	14.0
	Σ	61.9	25.7	55.9	27.9	91.3	35.5	131.5	51.2
F	S								
	B	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
		2.3	2.3	2.3	2.3	4.4	4.4	4.4	4.4
	C		2.9		2.9		2.9		2.9
	W	2.60 × 4.7	12.2	× 3.2	8.3	× 7.7	20.0	× 2.1	5.5
		2.11 —		—		—		2.11 × 6.2	13.1
	Σ	80.7	18.8	90.8	14.9	120.0	28.7	150.8	27.3

		⊘ ⊖		⊘ ⊘		⊘ ⊖		⊘ ⊘	
4	S								
	D								
	C								
	W								
	Σ								
B	S								
	D								
	C								
	W								
	Σ								
Z	S	0.96 × 17.8	17.1	× 22.3	21.0	× 21.0	20.2	× 27.2	27.8
	D	1.4 + 1.1	2.5	1.4 + 2.1	3.5	1.7 + 1.3	3.0	1.7 + 2.3	4.0
		3.3	3.3	3.3 + 2.6	5.9	3.3	3.3	3.3 + 2.6	5.9
	C		1.6		1.6		1.6		1.6
	W								
	Σ	23.5	24.5	42.0	42.0	28.1	28.1	45.3	45.3
1	S	0.96 × 17.8	17.1	× 22.3	21.0	× 21.0	20.2	× 27.2	27.8
	D	1.4 + 1.1	2.5	1.4 + 2.1	3.5	1.7 + 1.3	3.0	1.7 + 2.3	4.0
		3.3	3.3	3.3 + 2.6	5.9	3.3	3.3	3.3 + 2.6	5.9
	C		3.1		3.1		3.1		3.1
	W	1.95 × 5.5	10.2	—		× 5.5	10.2	—	
		1.50 —		—		—		—	
	Σ	60.7	35.2	87.5	43.5	67.9	39.8	92.1	46.8
G	S	0.59 × 17.8	10.5	× 17.8	10.5	× 21.0	12.4	× 21.0	12.4
				0.74 × 14.5	10.7			× 14.2	10.5
	D	1.4 + 1.1	2.5	1.4 + 2.1	3.5	1.7 + 1.3	3.0	1.7 + 2.3	4.0
		3.3	3.3	3.3 + 2.6	5.9	3.3	3.3	3.3 + 2.6	5.9
	C		4.4		4.4		4.4		4.4
	W	1.75 × 5.5	9.7	—		× 5.5	9.7	—	
		1.43 × 2.8	3.3	× 8.2	11.7	× 2.8	4.0	× 8.2	11.7
	Σ	58.4	33.7	132.2	45.7	103.7	35.8	141.0	43.9
F	S								
	B	1.3	1.3	1.3	1.3	2.2	2.2	2.2	2.2
		4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
	C		2.9		2.9		2.9		2.9
	W	2.50 × 5.5	13.3	—		× 5.5	13.3	—	
		2.11 —		× 5.9	12.4	× 4.5	9.5	× 9.9	20.9
	Σ	117.7	23.3	155.6	21.4	157.9	23.2	151.3	22.3

		[illegible]		[illegible]		[illegible]		[illegible]	
4	S								
	D								
	C								
	W								
	Σ								
3	S								
	D								
	C								
	W								
	Σ								
2	S	0.96 × 24.1	23.1	× 25.1	25.5	× 25.6	27.5	× 43.1	41.4
						0.43 × 15.3	6.9	× 22.3	19.4
	D	2.1 + 1.5	3.6	2.1 + 2.5	3.6	4.7 + 2.7	7.4	4.7 + 5.5	10.2
		3.3	3.3	3.3 + 2.6	5.9	5.4	5.4	5.4 + 2.7	8.1
	C		1.6		1.6		1.6		1.6
	W								
	Σ	31.5	31.6	47.7	47.7	43.3	43.3	50.7	50.7
1	S	0.96 × 24.1	23.1	× 25.1	25.6	× 14.3	13.7	× 25.9	24.5
						1.15 × 14.3	16.4	0.55 × 7.2	3.9
	D	2.1 + 1.5	3.6	2.1 + 2.5	4.6	2.4 + 1.8	4.2	2.4 + 2.3	5.2
		3.3	3.3	3.3 + 2.6	5.9	2.5	2.5	2.5 + 2.7	6.2
	C		3.1		3.1		3.1		3.1
	W	1.85 × 5.5	10.2	—		× 5.5	10.2	—	
		1.50 × 7.0	10.5	× 3.1	4.7	× 7.3	11.7	—	
	Σ	55.4	53.8	102.6	54.9	111.6	62.8	123.4	57.9
G	S	0.96 × 24.1	23.1	× 53.1	50.6	1.01 × 14.3	14.4	0.96 × 43.1	41.4
						1.15 × 14.3	16.4		
	D	2.1 + 1.5	3.6	2.1 + 2.5	4.6	2.4 + 1.8	4.2	2.4 + 1.8	4.2
		3.3	3.3	3.3 + 2.6	5.9	2.5	2.5	2.5 + 2.7	6.2
	C		4.4		4.4		4.4		4.4
	W	1.76 × 5.5	9.7	—		× 5.5	9.7	—	
		1.43 × 7.0	10.0	× 4.5	6.9	× 7.8	11.2	× 1.6	2.3
	Σ	129.5	54.1	161.0	93.4	175.4	63.3	157.1	57.5
F	S					15.0	15.0		
	D	2.6	2.6	2.6	2.6	3.0	3.0	3.0	3.0
		4.3	4.3	4.3	4.3	3.6	3.5	3.6	3.6
	C		2.9		2.9		2.9		2.9
	W	2.60 × 5.5	14.3	—		× 5.5	14.3	—	
		2.11 × 10.4	21.9	× 13.7	29.9	× 5.6	11.9	× 12.5	26.4
	Σ	125.5	45.0	197.7	39.7	226.0	50.5	219.0	55.9

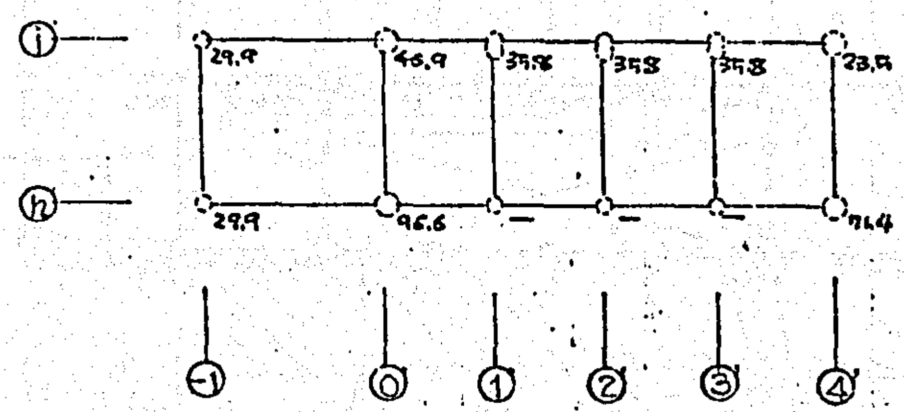
		[illegible]		[illegible]		[illegible]		[illegible]	
4	S	0.72 × 24.5	17.6	× 65.5	63.5	× 61.6	44.4		
	B	3.3	3.3	11.3	11.3	5.5	5.5		
		5.5 + 3.7	9.2	8.3 + 11.0	19.3	8.8 + 5.5	14.3		
	C		1.3		4.2		4.2		
	W								
	Σ	29.9	29.9	95.6	95.6	71.4	71.4		
3	S	0.43 × 24.5	11.5	× 22.9	11.0				
				0.60 × 61.6	37.0	× 61.6	37.0		
	B	3.3	3.3	10.2	10.2	6.9	6.9		
		3.5 + 3.7	7.2	3.5 + 3.7	7.2	2.8	2.8		
	C		3.3		5.5		5.5		
	W	2.11 × 9.0	19.0	× 15.7	33.1	× 15.8	33.3		
		1.92 —		× 4.6	8.9	—			
	Σ	94.5	44.6	210.5	113.9	155.9	87.5		
2	S	0.96 × 14.0	13.4	× 21.7	20.8	0.72 × 18.2	13.1	× 21.3	15.3
		0.43 × 14.0	6.0	× 21.7	10.4				
		0.95 × 24.5	23.5	× 23.9	22.0				
	B	6.0 + 1.9	7.9	10.2 + 1.9	12.1	7.5	7.5	2.7	2.7
		7.2 + 3.7	10.9	7.2 + 17.7	24.9	3.5 + 14.4	17.9	3.5 + 1.7	5.2
	C		3.1		6.5		6.5		1.6
	W	1.68 × 9.0	15.1	× 15.7	26.4	× 15.8	26.5		
		1.76 —		× 4.6		—			
	Σ	159.1	80.6	323.6	113.1	232.4	73.5	23.9	24.8
1	S	0.96 × 38.5	37.0	× 38.5	37.0	0.60 × 18.2	10.9	× 21.3	12.8
				0.54 × 16.5	8.9	× 10.4	5.6		
	B	3.3 + 0.9	4.2	13.3 + 0.9	4.2	—		—	
		5.3 + 3.7	9.0	5.3 + 3.7	9.0	—		—	
	C		3.1		5.2		5.2		3.1
	W	1.85 × 7.6	14.1	—		—		× 4.6	8.5
		1.50 × 8.2	12.3	× 7.6	11.4	—		—	
	Σ	228.3	89.7	401.3	77.7	255.1	23.7	49.2	24.4
G	S	1.01 × 14.0	14.1	0.96 × 21.7	20.8	—		0.72 × 15.8	11.4
	B	2.7 + 0.9	3.6	2.7 + 1.9	4.6	—		2.3	2.3
		4.6	4.6	1.9 + 1.4	3.3	—		3.5 + 3.7	7.2
	C		4.4		10.5		10.5		4.4
	W	1.76 × 7.6	13.4	—		—		× 4.6	8.1
		1.43 × 7.8	11.2	× 6.7	9.6	—		—	
	Σ	285.1	51.3	450.1	48.8	266.6	10.5	82.6	33.4
F	S	40.0	40.0						
	B	3.5	3.5	12.3	12.3	11.6	11.6	2.8	2.8
		6.0	6.0	6.0	6.0	3.6	3.6	3.6	3.6
	C		2.9		7.0		7.0		2.9
	W	2.60 × 7.6	20.0	—		—		× 4.6	12.0
		2.11 —		—		—		—	
	Σ	353.5	72.4	475.4	25.3	288.8	22.2	103.9	21.3

		[illegible]		[illegible]		[illegible]		[illegible]	
4	S	0.92 × 23.5	19.6	× 20.5	23.4	× 30.0	21.6	× 10.6	12.0
	D	3.3	3.3	5.3	5.3	3.9	3.9	2.0	2.0
		3.5 ÷ 3.7	9.2	3.5 ÷ 5.5	9.0	3.6 ÷ 3.7	9.3	3.5 ÷ 1.7	5.3
	C		1.3		9.2		3.0		0.2
	W								
	Σ	22.9	22.9	46.9	46.9	35.8	36.9	23.5	23.5
3	S	0.47 × 23.5	11.0	× 23.9	11.0				
				0.84 × 5.5 0.69 × 9.1	4.1 6.3	× 13.5 × 13.11	5.3 4.7	× 5.3 × 9.1	4.1 6.3
	D	3.3	3.3	4.9 +1.3	6.2	3.1 +2.5	5.6	1.6 +1.3	2.9
		3.5 ÷ 3.7	9.2	2.5 ÷ 3.7	6.2	0.3	0.3	2.3	2.3
	C		3.3		5.5		5.3		9.5
	W	2.11 × 9.0	19.0	× 5.0	15.3	× 5.2	11.0	× 5.2	15.2
		1.92 —		× 4.6	5.9	—		—	
	Σ	93.5	43.6	110.1	63.2	55.7	39.9	61.5	30.0
2	S	0.95 × 24.5	23.5	× 23.9	22.0			0.52 × 12.2	13.1
				0.54 × 5.5	4.1	× 13.5	5.3	× 5.3	4.1
	D	3.3	3.3	4.9 +1.3	6.2	3.1 +2.5	5.6	4.2 +1.3	5.5
		3.5 ÷ 3.7	9.2	3.5 ÷ 3.7	9.2	0.3	0.3	3.5 ÷ 1.7	9.2
	C		3.1		6.5		5.0		6.5
	W	1.63 × 9.0	15.1	× 9.0	11.3	× 5.2	2.7	× 5.2	12.1
		1.25 —		× 4.6	0.3	—		—	
	Σ	125.7	53.2	155.2	65.1	103.1	27.4	109.9	45.5
1	S	0.95 × 23.5	23.5	× 23.9	22.0			0.60 × 12.2	13.9
				0.84 × 13.2	9.1	× 13.5	5.3	× 13.3	5.3
	D	3.3	3.3	4.9 +1.3	6.2	3.1 +2.5	5.6	3.7 +1.3	5.0
		3.5 ÷ 3.7	9.2	3.5 ÷ 3.7	9.2	0.3	0.3	2.3	2.3
	C		3.1		9.2		5.1		9.2
	W	1.55 × 9.0	15.7	× 9.0	13.0	× 5.2	9.6	× 6.1	11.3
		1.59 × 4.9	9.4	× 4.6	6.9	—		—	
	Σ	155.9	61.2	205.1	63.6	135.5	23.4	153.5	43.9
G	S	—							
	D	2.7	2.7	4.3 +	4.3	3.1	3.1	3.7	3.7
		2.3	2.3						12.5
	C		4.4		10.5		9.4		
	W	1.56 × 9.0	15.3	× 9.0	12.3	× 5.2	9.2	× 6.1	10.7
		1.43 —		—		—		—	
	Σ	212.6	25.7	291.2	27.1	151.2	19.7	159.4	23.9
F	S	25.0	25.0						
	D	3.5	3.5	5.5	5.5	4.0	4.0	4.3	4.8
		3.6	3.6	3.6	3.6			3.6	3.6
	C		2.7		7.0		4.7		7.0
	W	2.60 × 9.0	23.4	× 7.0	13.2	× 5.2	13.5	× 6.1	15.9
		2.11 —		—		—		—	
	Σ	291.0	55.4	315.3	24.3	173.4	22.2	208.7	21.3

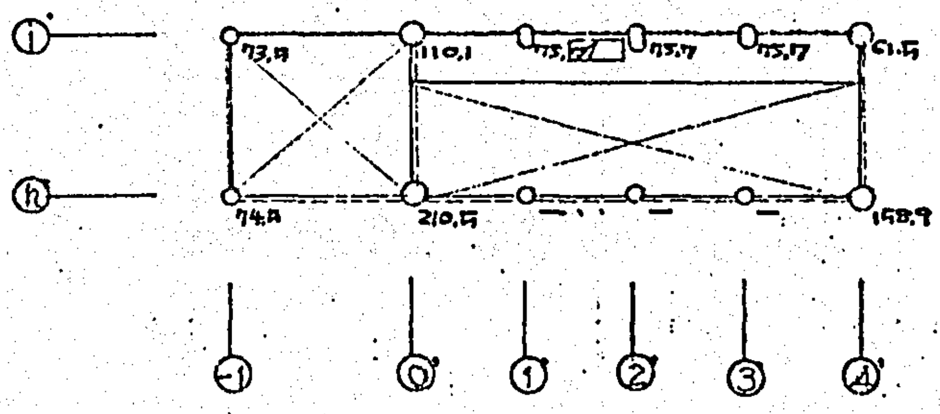
		(L') (5')		○ ○		○ ○		○ ○	
4	S								
	B								
	C								
	W								
	Σ								
3	S								
	B								
	C								
	W								
	Σ								
2	S	0.72 × 21.3	15.3						
	B	2.7 3.5 + 1.7	2.7 5.2						
	C		1.6						
	W								
	Σ	24.8	24.8						
1	S	0.60 × 21.3	12.8						
	B	2.1 2.8	2.1 2.8						
	C		3.1						
	W	1.85 × 8.1 1.50 –	15.0						
	Σ	63.6	35.8						
G	S	0.72 × 15.8	11.4						
	B	2.1 + 2.3 3.5 + 3.7	4.4 7.2						
	C		4.4						
	W	1.76 × 8.1 1.43 –	14.3						
	Σ	105.3	41.7						
F	S								
	B	2.8 3.6	2.8 3.6						
	C		2.9						
	W	2.60 × 8.1 2.11 × 7.0	54.8 14.8						
	Σ	184.2	78.9						

(NOTE)
SOME SMALL DIFFERENCE
ARE IN THE CONTENTS
OF COLUMN AXIAL FORCE
LIST WITH ACTURAL
FINAL PLAN.

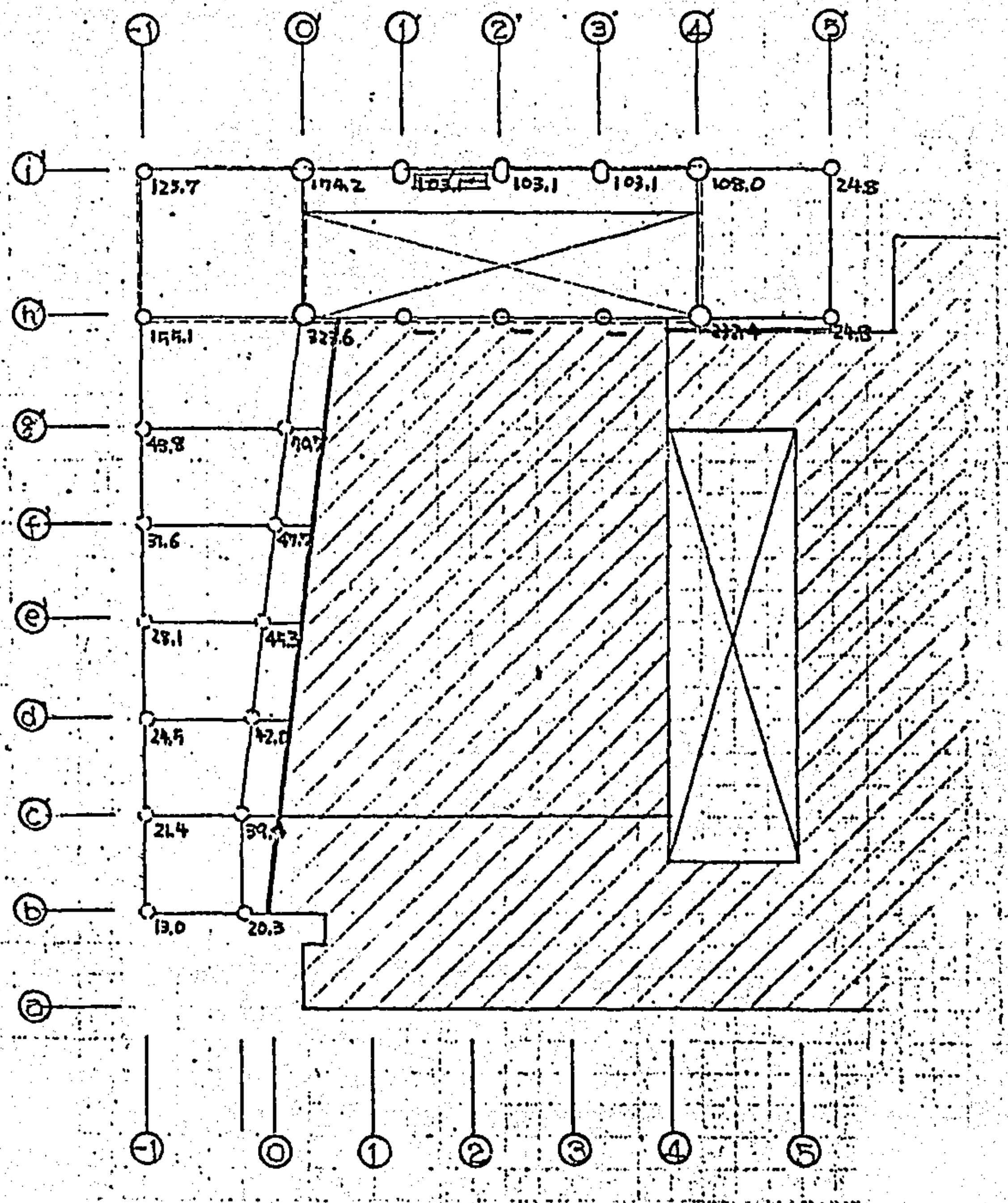
VERTICAL LOAD
KEY PLAN - ROOF. F = FOURTH F. COLUMN (t)



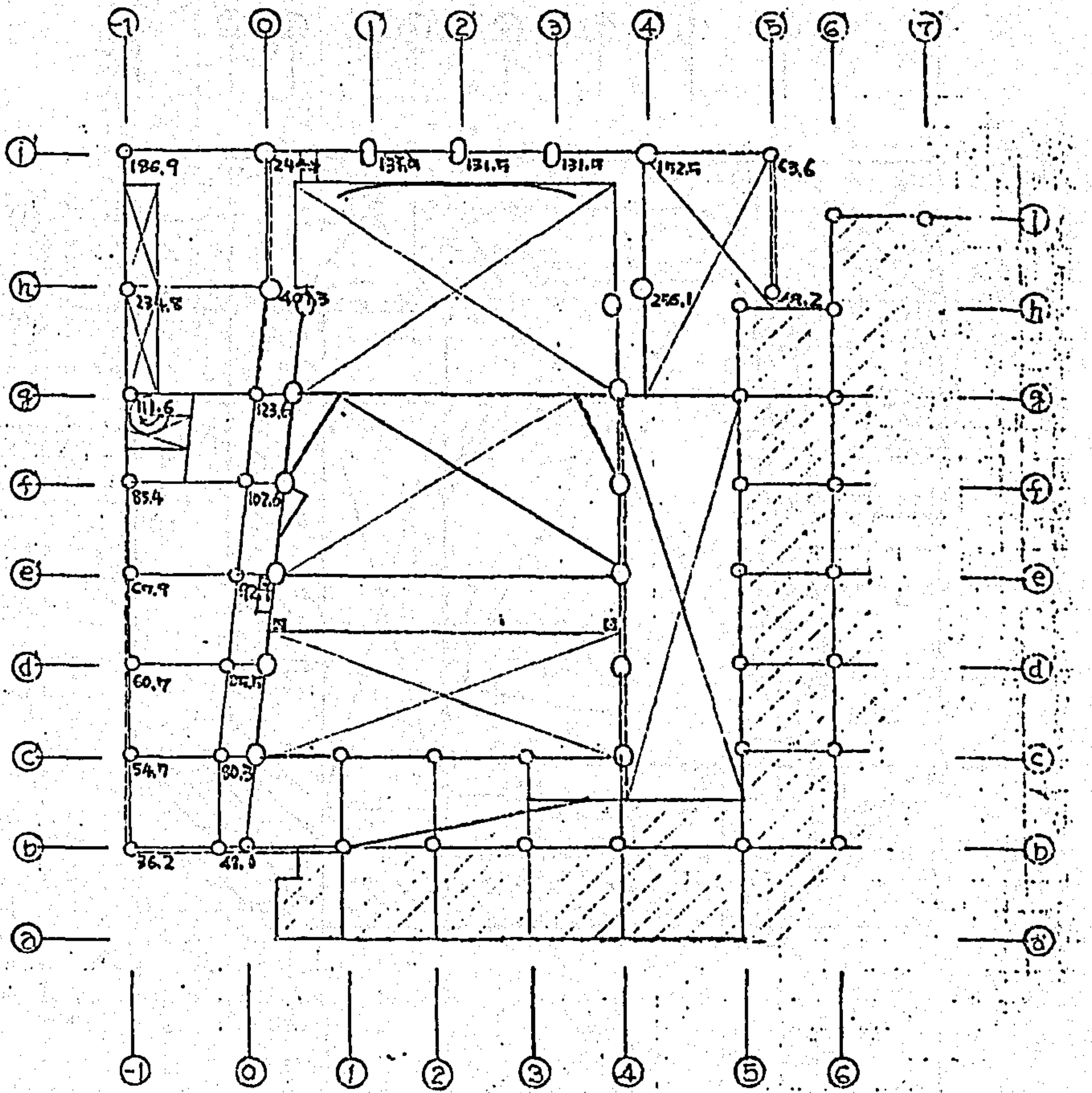
VERTICAL LOAD
KEY PLAN - FOURTH , F = THIRD F. COLUMN (t)



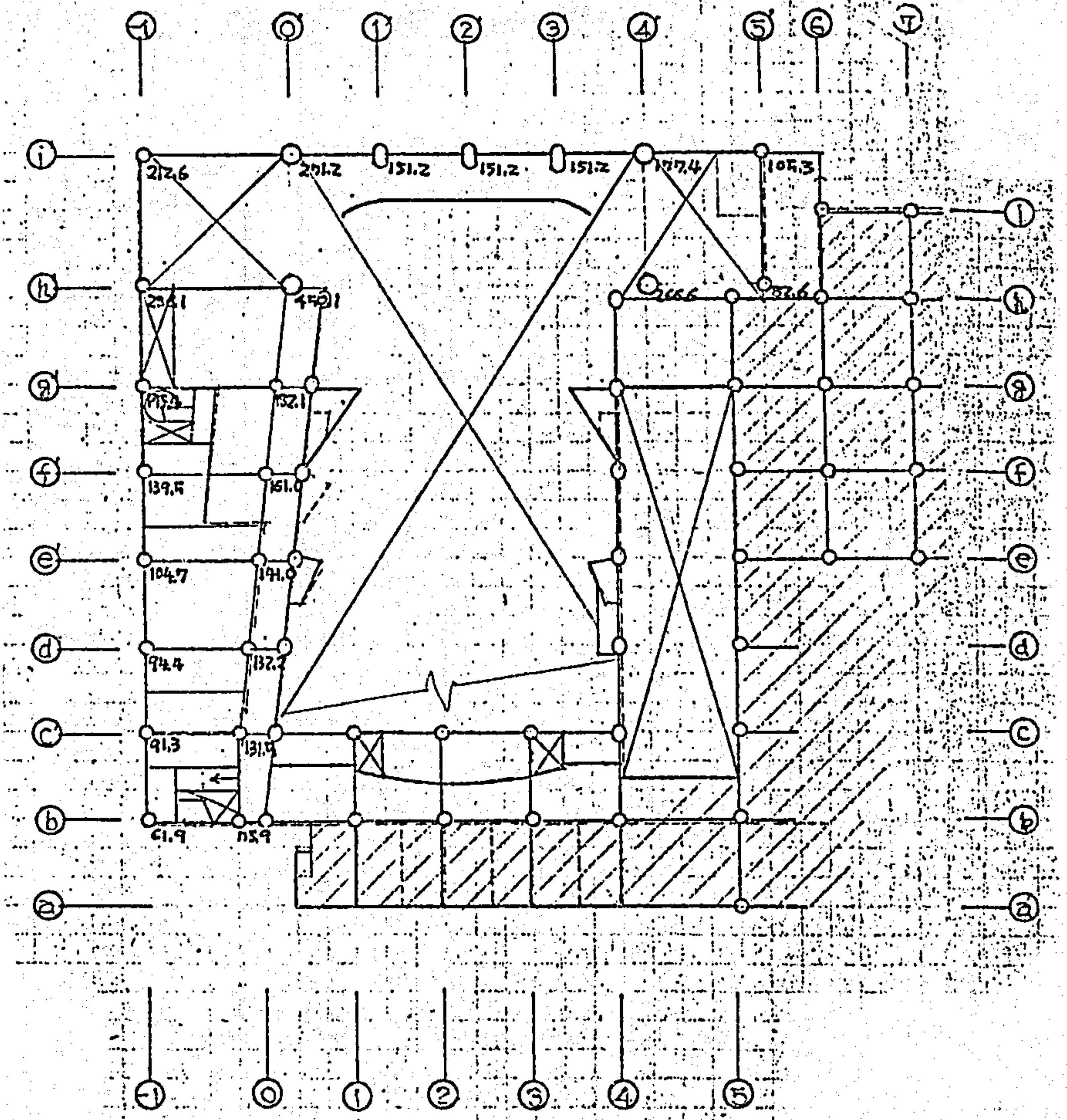
VERTICAL LOAD
KEY PLAN - THIRD.F, - SECOND F. COLUMN (t)



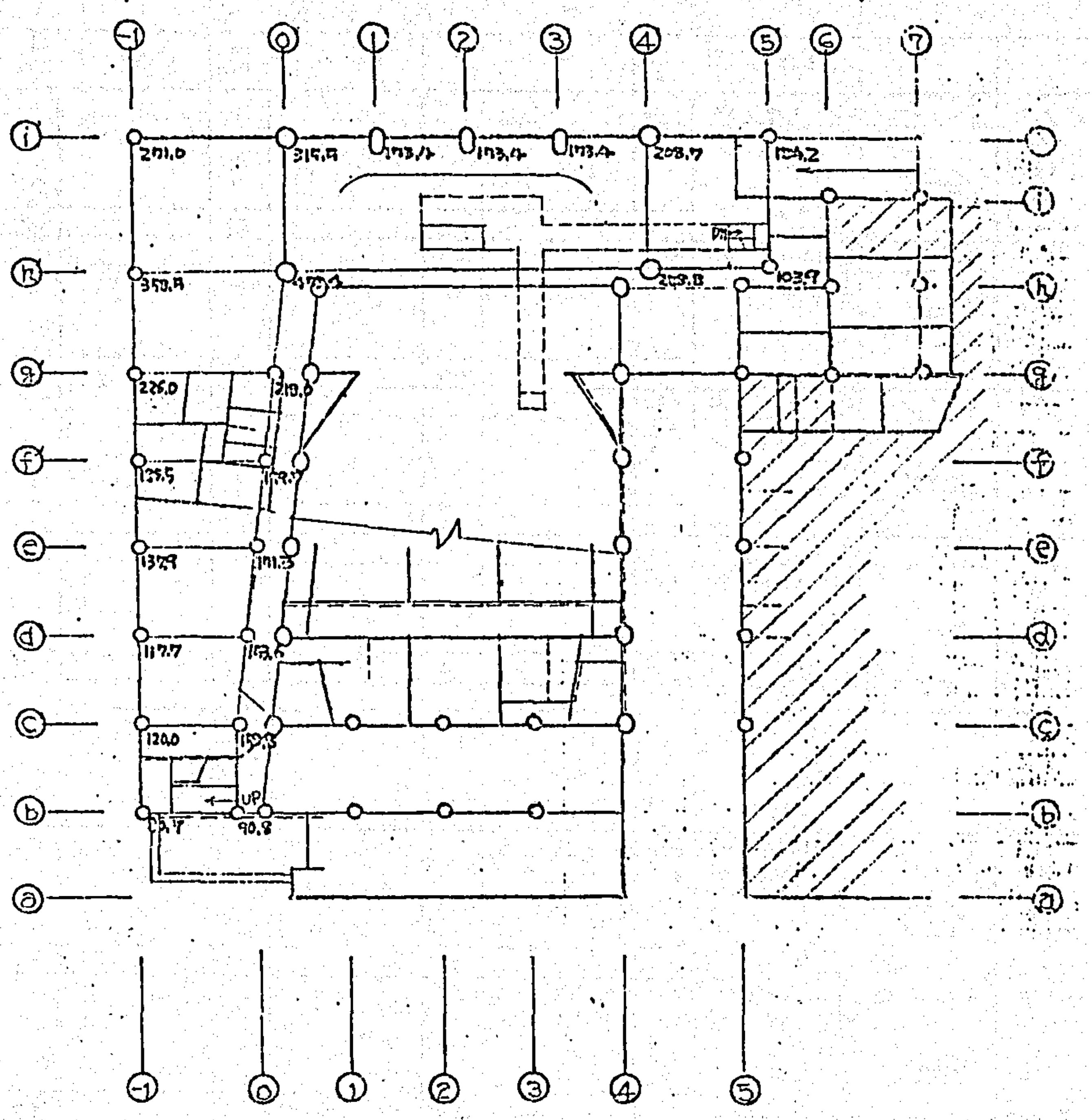
VERTICAL LOAD
KEY PLAN - SECOND. F. =FIRST F. COLUMN (t)



VERTICAL LOAD
KEY PLAN · FIRST . F = GROUND F. COLUMN (t)



VERTICAL-LOAD
KEY PLAN GROUND.F. — FOUNDATION (+)



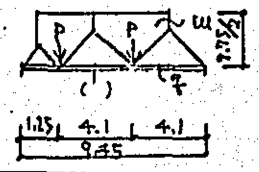
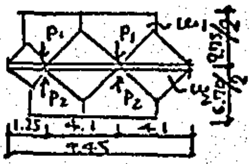
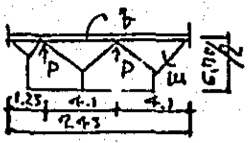
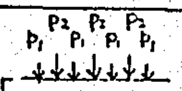
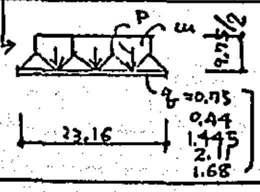
CMoQ OF BEAM

(Calculated by Computer)

[tm] [t]

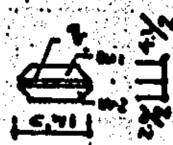
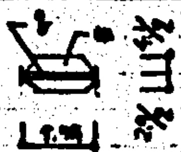
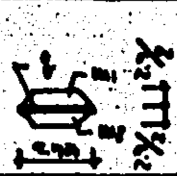
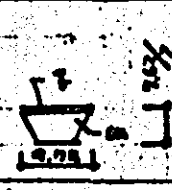
	LOAD		C	M_0	Q
3 G d' −1 ~ 0	lx 3.05 ly 5.28 w l 5.28 q	0.72 0.61	5.8	8.9	5.7
2 G d' −1 ~ 0	lx 3.05 ly 5.28 w l 5.28 q	0.66 0.61	5.4	8.4	5.4
1 G d' −1 ~ 0	lx 3.05 ly 5.28 w l 5.28 q	0.59 0.61	5.0	7.7	5.0
9 G d' −1 ~ 0	l 5.28 q	1.04	2.4	3.6	2.7
G					
3 G e' −1 ~ 0	lx 3.05 ly 6.30 w l 6.30 q	0.72 0.61	8.5	13.1	7.2
2 G e' −1 ~ 0	lx 3.05 ly 6.30 w l 6.30 q	0.66 0.61	8.0	12.2	6.7
1 G e' −1 ~ 0	lx 3.05 ly 6.30 w l 6.30 q	0.59 0.61	7.4	11.3	6.2
G G e' −1 ~ 0	l 6.30 q	1.04	3.4	5.2	3.3

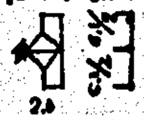
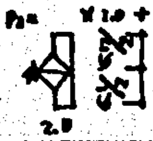
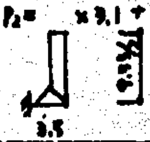
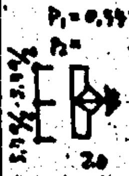
	LOAD			C		M_0		Q
3 G' −1 ~ 0	Lx 3.03 Ly 7.32 ω l 7.32 γ	0.72 0.61						
				11.8		17.9		10.6
2 G' −1 ~ 0	Lx 3.03 Ly 7.32 ω l 7.32 γ	0.65 0.61						
				11.2		16.8		9.1
1 G' −1 ~ 0	Lx 3.03 Ly 7.32 ω l 7.32 γ l 3.05 P	0.96 0.61 1.95		15.3 4.7		22.6 9.8		10.7 2.7
				19.7		32.4		13.4
G G' −1 ~ 0	l 7.32 γ l 3.05 P	1.06 [illegible]		4.6 7.1		7.0 14.3		3.8 3.7
				11.7		21.3		7.7
G								
3 G'	ω_1 ω_2 γ P	0.72 0.72 0.61 0.64	15.7	14.0 13.5	(20.5)	26.3 21.1	16.3	8.0 8.4
			27.3	27.5		46.4	17.0	16.4
2 G'	ω_1 ω_2 γ P	0.66 0.65 0.61 0.44	14.6	13.0 12.7	(18.6)	22.6 19.7	9.7	7.4 7.7
			27.3	25.7		42.3	17.9	15.3
1 G'	ω_1 ω_2 γ P	0.96 0.96 0.61 [illegible]	30.7	27.3 16.3	(26.0)	33.0 26.3	21.0	14.6 10.3
			47.3	42.6		64.3	31.3	24.9
G G'	l 3.35 γ l 3.05 P	1.04 [illegible]	16.4	6.0 12.3	(14.8)	9.1 23.8	11.8	4.3 6.7
		(0.91)	22.4	18.3		32.9	16.1	11.0

	LOAD			C.		M_i		Q	
R G h' −1 ∼ 0		w q P	0.72 0.75 0.75	t_E	t_D			t_E	t_D
				36.7	32.8	(46.1)	57.2	22.8	17.0
4' G h' −1 ∼ 0	〃	w q P	0.54 0.75 0.75						
				30.7	27.3	(38.6)	47.6	19.2	14.3
3 G h' −1 ∼ 0		w_1	0.66	34.7	30.9	(43.6)	54.0	21.6	16.1
		w_2	0.72	19.6	17.7	(24.8	30.7	11.9	9.0
		q P_1 P_2	0.75 0.75 0.44						
				54.3	48.6	(68.4)	84.7	33.5	25.1
2 G h' −1 ∼ 0	〃	w_1	0.66	34.7	30.9	(43.6)	54.0	21.6	16.1
		w_2	0.66	18.2	16.4	(23.0)	28.5	11.1	8.3
		q P_1 P_2	0.75 0.75 0.44						
				52.9	47.3	(66.6)	82.5	32.7	24.4
1 G h' −1 ∼ 0		w q P	0.99 0.75 .76+0.44 = 2.20						
				42.9	37.6	(53.7)	65.7	26.9	19.6
G G h' −1 ∼ 0	l 9.45	q	1.04						
					7.7		11.6		4.9
G									
G	 ←	P_1 = {1.32×(8.38+19.86)} + {6.43×5.77} + {0.75} = 75.3 [t] P_2 = {1.32×4.19} + {6.43×2.90} = 24.2 [t]							
R G h' 0' ∼ 4'		w (0.72+0.60) q P	1.32 6.43 0.75						
					590.2		904.9		141.4

	LOAD			C		M		Q
G[3] b' ④~⑧'	lx 3.81 ly 4.75 w l 4.62 q l 4.75/2 P	0.92 0.98 0.25						
				20.9		37.9		12.7
G[2] b' ④'~⑧'	l 4.62 q	0.98						
				3.6		1.4		2.9
G[1] b' ④~⑧'	l 4.62 q	0.98						
				3.6		5.4		2.9
G[0] b' ④~⑧'	l 4.62 q	1.04						
				4.0		7.5		4.0
G								
G[3] 0 b~c'	6.38 4.75/2 w1 w2 q P	0.92 0.92 0.61 0.44		5.2 4.4		9.2 6.6		3.8 3.9
				9.6		15.8		7.7
G[2] 0 b~c'	w1 w2 q P	0.66 0.66 0.39 0.39		4.8 3.4		8.4 5.2		3.5 3.0
				8.2		13.6		6.5
G								
G[9] 0 b~c'	6.38 q	1.04						
				3.5		5.2		3.3

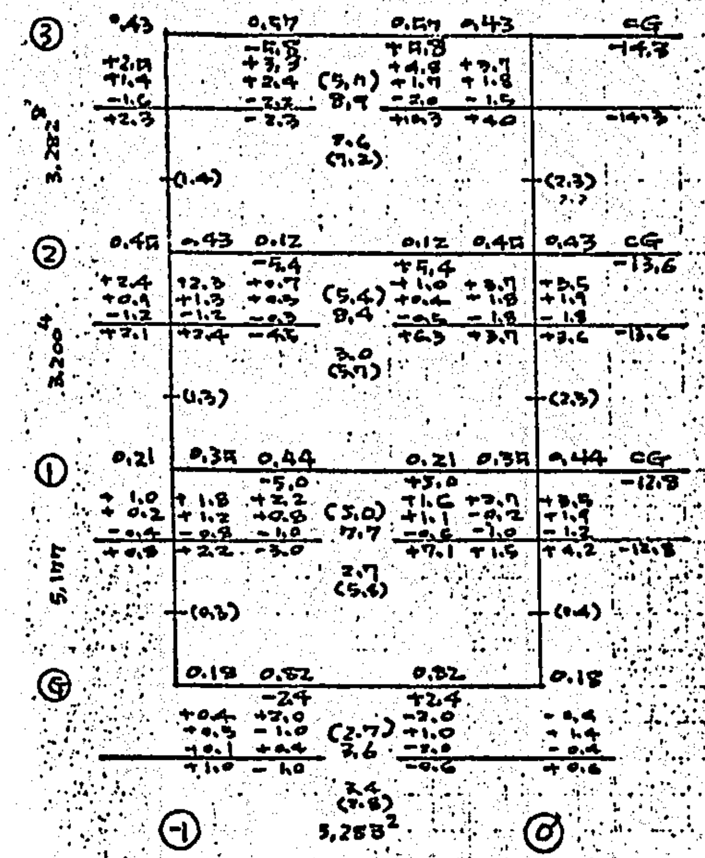
	LOAD			C	M_0	Q
G_0^3 c' ~ d'	6.10	w1 w2 q P	0.72 0.72 0.61 0.44	5.3 4.0	4.6 6.1	4.0 3.7
				9.3	15.7	7.7
G_0^2 c' ~ d'	〃	w1 w2 q P	0.66 0.66 0.39 0.39	4.9 3.2	8.8 4.8	3.6 2.9
				8.1	13.6	6.5
G_0^1 c' ~ d'	〃	w1 w2 q P	0.59 0.59 0.61 0.44	4.5 3.6	8.2 5.5	3.4 3.4
				8.1	13.7	6.8
G_0^6 c' ~ d'	6.10	q	1.04			
				3.2	4.8	3.2
G						
G_0^3 f' ~ g'	6.10	w1 w2 q P	0.92 0.92 0.61 0.44	8.4 4.0	15.7 6.1	6.0 3.7
				12.4	21.8	9.7
G_0^2 f' ~ g'	〃	w1 w2 q P	0.66 0.66 0.39 0.39	7.7 3.2	14.3 4.8	5.5 2.9
				10.9	19.1	8.4
G_0^1 f' ~ g'	〃	w1 w2 q P	0.96 0.96 0.61 0.44	10.8 4.7	20.1 7.1	7.7 4.3
				15.5	27.2	12.0
G_0^9 f' ~ g'	6.10	q	1.04			
				3.2	4.8	3.2

	LOAD			C	M.	Q
$^{3}G_{0}$ g'~h'	0.72 + 0.60 = 1.32  [6.71]	w_1 w_2 q	1.32 1.32 0.61	15.6	24.0	12.1
$^{2}G_{0}$ g'~h'	〃	w_1 w_2 q	0.66 0.66 0.39	8.1	12.5	6.3
$^{1}G_{0}$ g'~h'	〃	w_1 w_2 q	0.96 0.96 0.61	12.0	18.6	9.4
$^{4}G_{0}$ g'~h'	[6.71]	q	1.04	3.9	5.9	3.5
R~2 G0 h'~i'	 [4.95]	w_{max} q	0.92 0.95	7.5 11.4 5.9 24.8	12.1 17.4 8.9 38.4	7.9 6.0 2.7 17.6
$^{R}G_{1'}$ h'~i'	 [4.95]	w_1 w_2 q	0.92 0.91 0.95	21.7	32.8	12.3
$^{2}G_{4'}$ h'~i'	 [4.95]	w q	0.60 0.78+(0.2×4×1.4) =1.91 0.7... × 1.6	29.6	39.5	14.1
$^{6}G_{4'}$ h'~i'	[4.95]	q	1.04	8.2	12.4	5.1

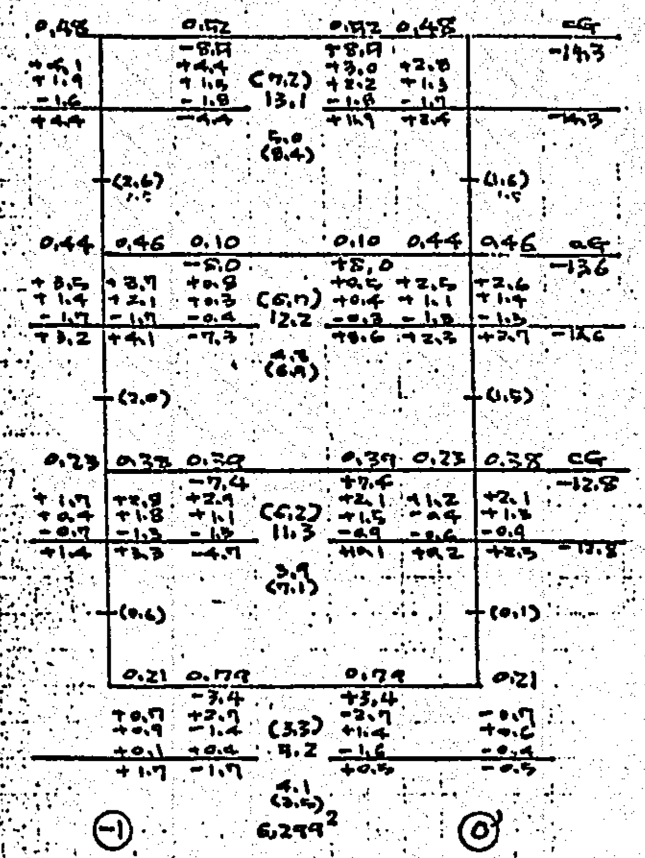
	LOAD			C		Mo		Q
3 CG c' o'~	P_1 = 0.72×5.1 + 0.39×6.1 =	6.05	× 2.0	12.1			× 1.0	6.1
	P_2 = 0.72×2.0 + 0.39×2.0 =	2.22	× 1.0	2.2			× 1.0	2.2
				14.3				8.3
2 CG c' o'~	P_1 = 0.66×5.1 + 0.39×6.1 =	5.75	× 2.0	11.5			× 1.0	5.8
	P_2 = ×2.0 + ×2.0 =	2.10	× 1.0	2.1			× 1.0	2.1
				13.6				7.9
1 CG c' o'~	P_1 = 0.59×5.1 + 0.39×6.1 =	5.39	× 2.0	10.8			× 1.0	5.4
	P_2 = ×2.0 + ×2.0 =	1.96	× 1.0	2.0			× 1.0	2.0
				12.8				7.4
3 CG 3' o'~	P_1 = 0.72×5.4 + 0.39×6.4 =	6.38	× 2.0	12.8			× 1.0	6.4
	P_2 = ×2.0 + ×2.0 =	2.22	× 1.0	2.2			× 1.0	2.2
				15.0				8.6
2 CG 3' o'~	P_1 = 0.66×5.4 + 0.39×6.4 =	6.06	× 2.0	12.1			× 1.0	6.1
	P_2 = ×2.0 + ×2.0 =	2.30	× 1.0	2.3			× 1.0	2.3
				14.4				8.4
1 CG 3' o'~	P_1 = 0.96×5.4 + 0.39×6.4 =	7.68	× 2.0	15.4			× 1.0	7.7
	P_2 = ×2.0 + ×2.0 =	2.70	× 1.0	2.7			× 1.0	2.7
				18.1				10.4
1 CG h 4'~	P_1 = 0.72×7.0 + 0.75×4.9 =	8.72	× 3.5	30.5			× 1.0	8.7
	P_2 = ×3.1 + ×3.5 =	4.86	× 1.75	8.5			× 1.0	4.9
				39.0				13.6
4'~2 CG 4'~2 ~i'	P_1 = 0.54×4.8 + 0.39×5.8 =	4.85	× 2.0	9.7			× 1.0	4.9
	P_2 = ×2.0 + ×2.0 =	1.86	× 1.0	1.9			× 1.0	1.9
				11.6				6.8
CG								

VERTICAL LOAD — STRESS

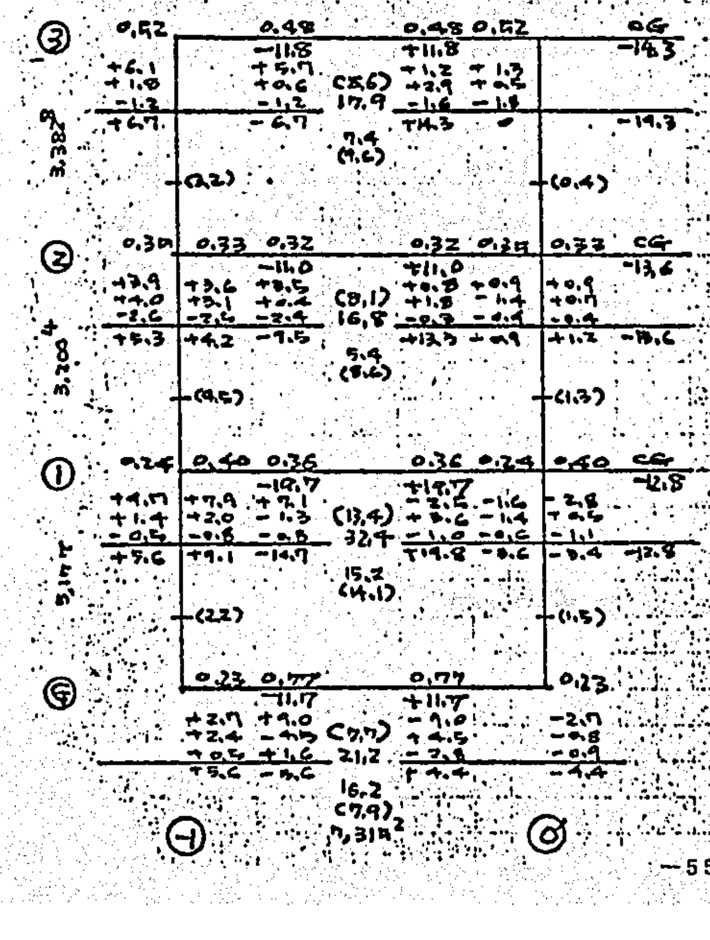
(d) FRAME



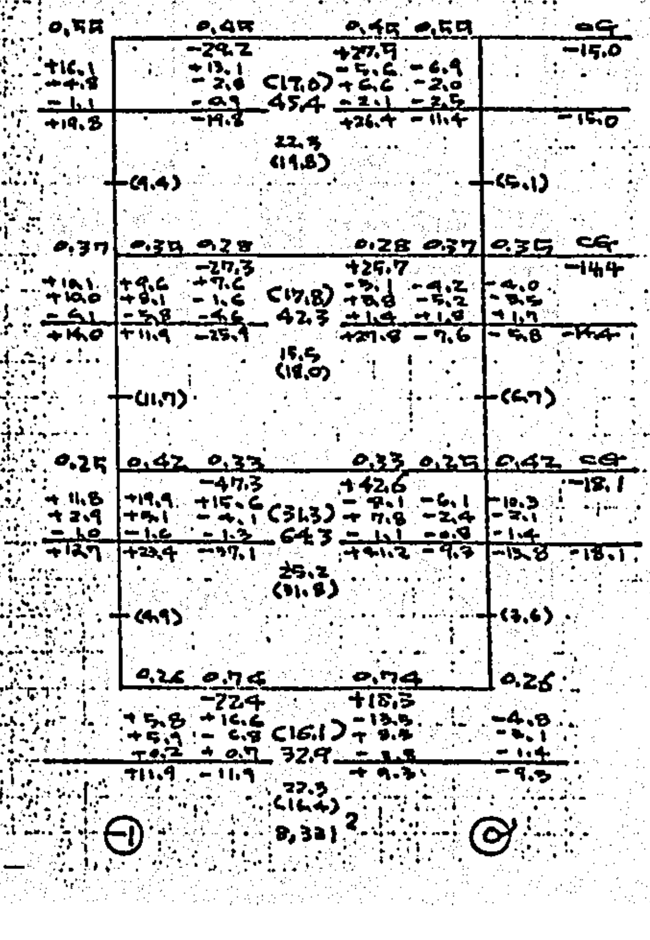
(e) FRAME



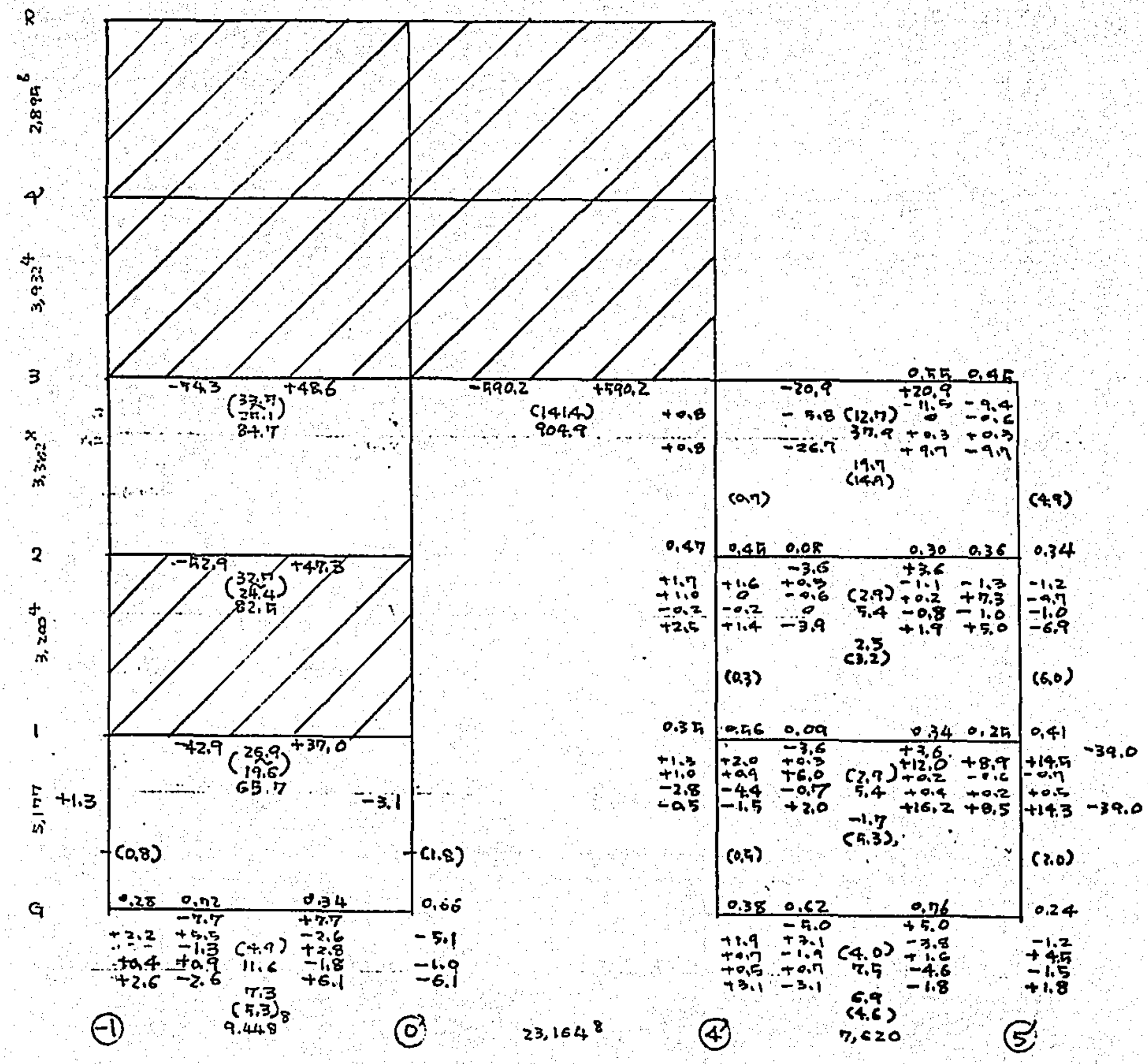
(f) FRAME

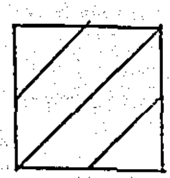


(g) FRAME



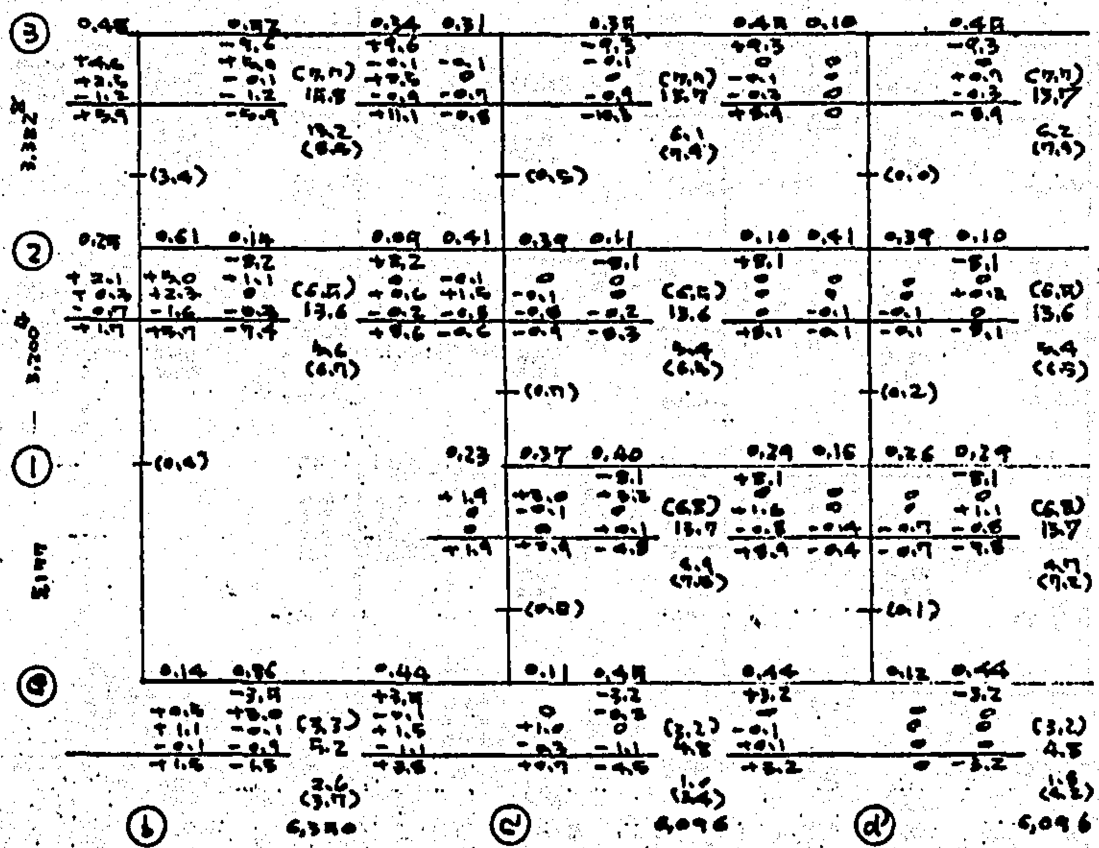
(P1) FRAME



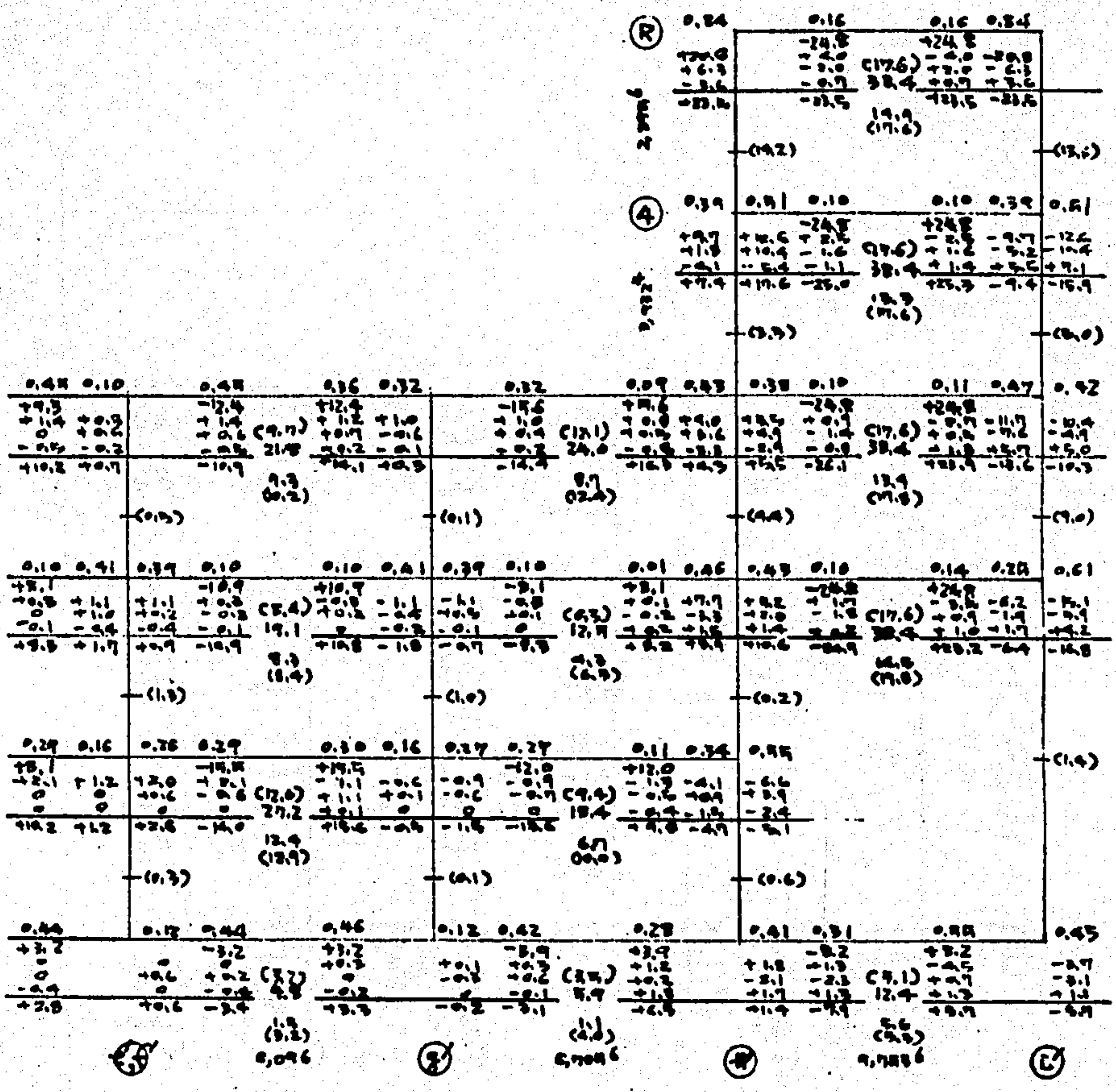


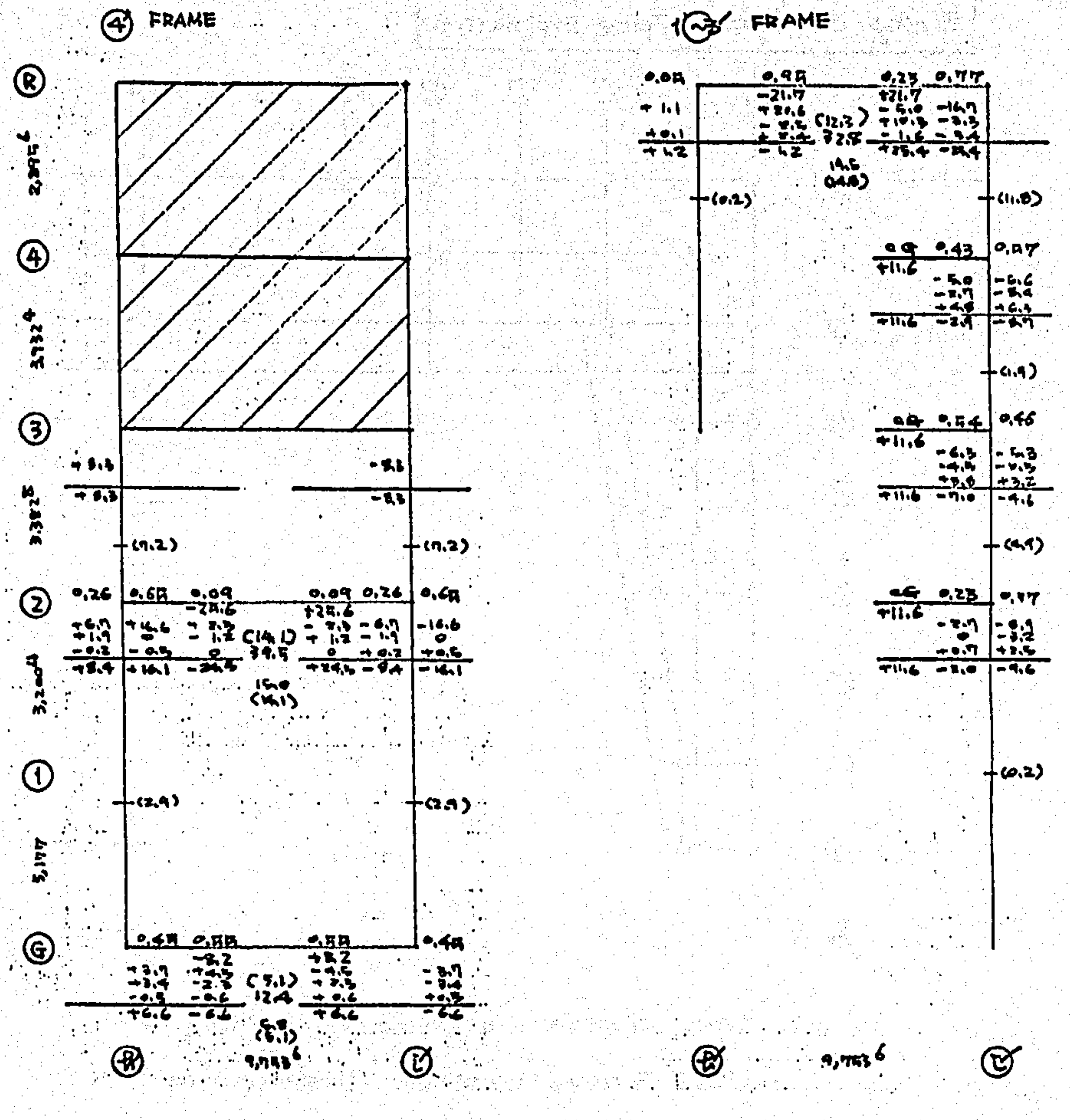
= Bearing wall
(Not to be removed in future)

FRAME : (1)



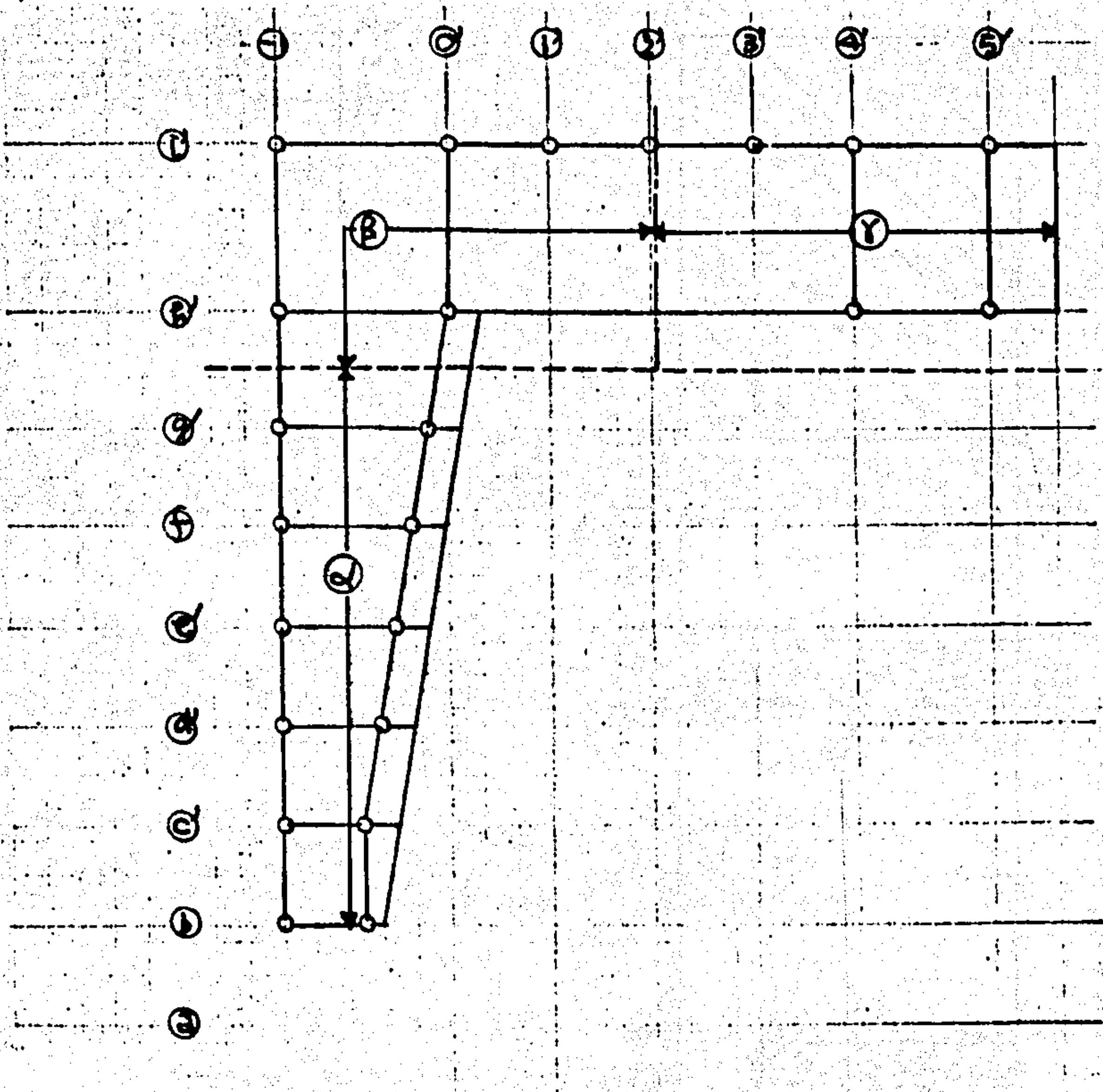
Ⓒ FRAME (2)





FRAME
FRAME

Zoning of Seismic Force Estimation



Seismic Forces are estimated according to devided 3 zones which are illustrated in above fig. Existence of big opening of stage requires such device.

α —zone

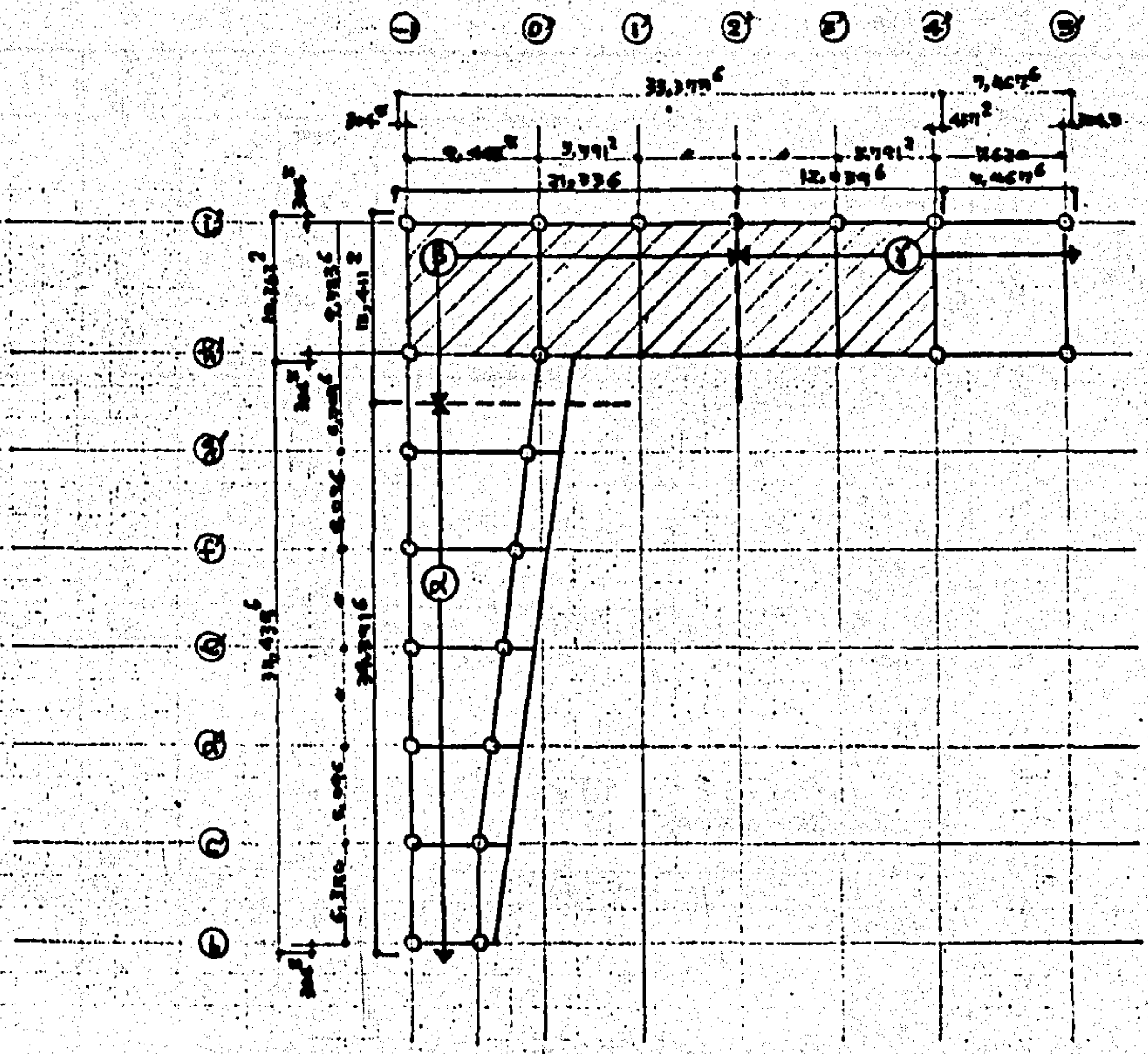
				W	K / KW	Q
R_F	S					
	G					
	B					
	C					
	W					
	Σ					
4_F	S					
	G					
	B					
	C					
	W					
	Σ					
3_F	S	(0.68×307.7)	209.2			
	G	19.4+32.6	52.0			
	B	18.6+17.3	35.9			
	C	(3.2 × 12)/ 2	19.2			
	W	(0.50×40.4)+{(1.90×35.9)+(1.28×24.3)+(0.16×26.9)} /2	67.3		0.05	
	Σ	$\bar{w}$ = 383.6/ 307.7 = 1.25 t/m²		383.6	19.2	20.0
2_F	S	(0.44×34.9)+(0.56×307.7)	188.1			
	G	13.0+24.7	37.7			
	B	17.8+16.7	34.5			
	C	(3.0× 12)/2	18.0			
	W	{(1.60×29.7)+(1.21×62.0)} /2	61.3			
		19.2+47.1	66.3		〃	
	Σ	$\bar{w}$ = 395.9/ 307.7 = 1.29 t/m²		395.9	19.8	40.0
1_F	S	(0.91×14.3)+(1.03×22.7)+(0.86×133.4)+(0.62×50.5) +(0.49×82.5)+(0.76×4.3)	226.1			
	G	19.4+32.6	52.0			
	B	19.5+16.2	35.7			
	C	(5.8× 12) /2	34.8			
	W	{(2.66×29.0)+(2.00×62.0)} /2	100.6			
		18.0+61.3	79.3		〃	
	Σ	$\bar{w}$ = 528.5/ 307.7 = 1.72 t/m²		528.5	26.4	67.0
G_F	S					
	G	33.3+63.9	97.2			
	B					
	C					
	W	34.8+100.6	135.4		〃	
	Σ			232.6	11.6	79.0

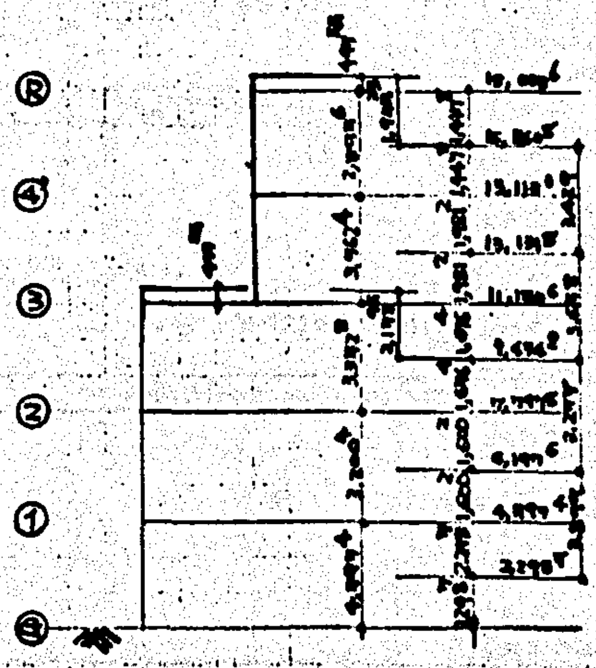
β —— zone

				W	K KW	Q
RF	S	(0.68×221.1)	150.3			
	G	28.7+22.6	51.3			
	B	7.4+26.0	33.4			
	C	{(8.3×2)+(5.9×1.5)+(3.6×2)}/2	16.3			
	W	(0.50×53.0)+{(1.43×47.4)}/2	60.4			
					0.05	
	Σ	$\bar{w}$ = 311.7 / 221.1 = 1.41 t/m2		311.7	15.9	16.0
4F	S	(0.47×125.3)+(0.41×95.8)	97.4			
	G	19.5+11.0	30.5			
	B	9.0+12.5	21.5			
	C	{(6.7×2)+(4.7×1.5)+(2.9×2)}/2	13.1			
	W	{(2.08×44.4)+(1.56×21.5)}/2	62.9			
		16.3+33.9	50.2		〃	
	Σ	$\bar{w}$ = 270.9 / 221.1 = 1.23 t/m2		270.9	13.5	30.0
3F	S	(0.47×41.1)+(0.46×96.2)+(0.88×35.9)	97.5			
	G	31.7+14.7	46.4			
	B	9.0+19.3	28.3			
	C	{(7.3×2)+(5.2×1.5)+(3.2×2)}/2	14.4			
	W	(0.50×6.8)+{(1.90×31.1)+(1.28×33.0)}/2	51.0			
		13.1+62.9	76.0		0.05	
	Σ	$\bar{w}$ = 313.6 / 256.8 = 1.22 t/m2		313.6	15.7	40.0
2F	S	(0.47×41.1)+(0.56×131.9)+(0.94×35.7)	108.9			
	G	16.3+13.5	29.8			
	B	8.0+17.0	25.0			
	C	{(7.0×2)+(4.9×1.5)+(3.0×2)}/2	13.8			
	W	{(1.60×31.1)+(1.21×17.5)}/2	35.5			
		14.4+47.6	62.0		〃	
	Σ	$\bar{w}$ = 275.0 / 256.8 = 1.07 t/m2		275.0	13.8	60.0
1F	S	(0.91×14.0)+(0.86×21.7)	31.4			
	G	14.8+7.7	22.5			
	B	1.0+4.1	5.1			
	C	{(14.0×2)+(9.4×1.5)+(9.9×2)}/2	26.9			
	W	{(2.66×31.1)}/2	41.4			
		13.8+35.5	49.3		〃	
	Σ	$\bar{w}$ = 176.6 / 256.8 = 0.69 t/m2		176.6	8.8	69.0
GF	S					
	G	28.6+25.3	53.9			
	B					
	C					
	W					
		26.9+41.4	68.3		〃	
	Σ			122.2	6.1	76.0

γ — Zone

				W	K / KW	Q
RF	S	(0.68×124.8)	84.9			
	G	15.7 + 15.7	31.4			
	B	4.0 + 14.4	18.4			
	C	{(8.3×2)+(5.9×1.5)} /2	12.7			
	W	(0.90×[illegible])+{(1.40×29.1)} /2	37.9		0.05	
	Σ	$\bar{w}$ = 185.3 / 123.2 = 1.50 t/m2		185.3	9.3	10.0
4F	S	(0.47×27.0)+(0.35×98.3)	47.2			
	G	9.2 + 5.5	14.7			
	B	4.0 + 0.9	4.9			
	C	{(6.7×2)+(4.7×1.5)} /2	10.2			
	W	{(2.08×29.1)} /2	30.3			
	L	12.7 + 20.8	33.5		〃	
	Σ	$\bar{w}$ = 140.8 / 123.2 = 1.14 t/m2		140.8	7.1	18.0
3F	S	(0.47×41.1)+(0.68×79.0)	73.0			
	G	29.4 + 11.0	40.4			
	B	7.0 + 6.7	13.7			
	C	{(7.3×2)+(8.7×1.8)+(3.2×2)} /2	14.4			
	W	(0.50×12.0)+{(1.90×26.2)} /2	31.2			
	L	10.2 + 30.3	40.5		0.05	
	Σ	$\bar{w}$ = 213.2 / 202.2 = 1.05 t/m2		213.2	10.7	29.0
2F	S	(0.47×39.6)	18.7			
	G	12.7 + 9.5	22.2			
	B	4.0 + 0.9	4.9			
	C	{(7.0×2)+(4.9×1.5)+(3.0×2)} /2	13.8			
	W	{(1.60×26.2)} /2	21.0			
	L	14.4 + 22.3	36.7		〃	
	Σ	$\bar{w}$ = 116.3 / 202.2 = 0.58 t/m2		116.3	5.8	38.0
1F	S	(0.68×32.6)+(0.44×12.0)	27.4			
	G	14.9 + 4.0	18.9			
	B	5.8 + 9.3	15.1			
	C	{(14.0×2)+(9.4×1.5)+(5.5×2)} /2	26.9			
	W	(0.50×16.9)+{(2.66×21.3)+(2.00×9.0)} /2	45.5			
	L	13.8 + 21.0	34.8		〃	
	Σ	$\bar{w}$ = 168.6 / 241.2 = 0.70 t/m2		168.6	8.4	44.0
GF	S					
	G	24.8 + 19.0	43.8			
	B					
	C					
	W	26.9 + 37.2	64.1		〃	
	Σ			107.9	5.4	50.0





Wind Velocity in Dacca by Cylone

: $V = 120$ [miles/hour]

$= 120 \times 1{,}609.34 / 3{,}600$

$= 53.64$

Velocity Pressure

: $P = \frac{1}{2} \rho V^2$

(ρ : Density of Air $= \frac{1}{8}$ kg·sec²/m⁻⁴)

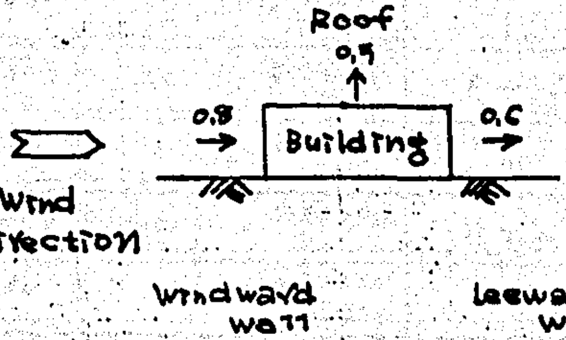
$\sim P = \frac{1}{2} \times \frac{1}{8} \times 53.64^2$

$= 180$ [kg/m²]

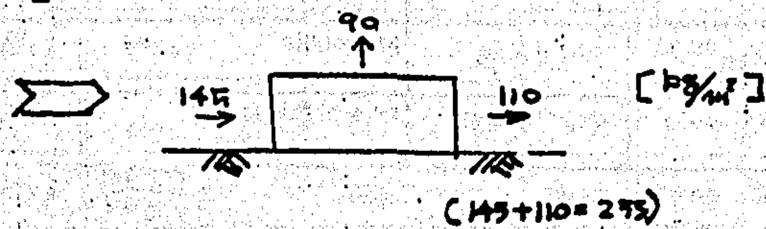
In this design above value (225 [kg/m²]) is applied as the constant wind pressure for wall surface.

coefficient of wind force

: C = 0.8 0.6



C × q

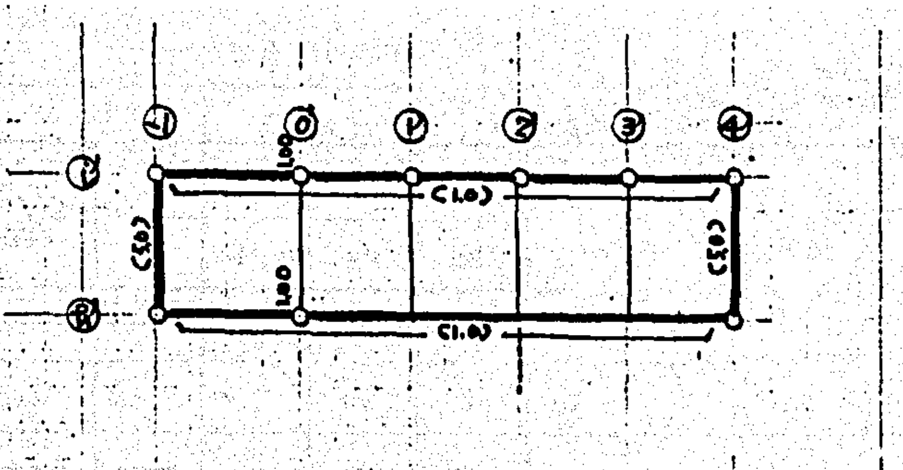


Wind Force

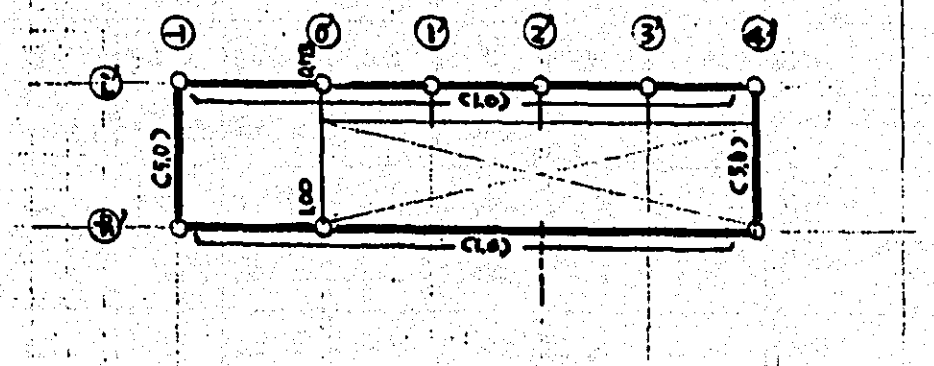
Wind Direction	Level	Zone	Surface Area		H	Q
↔	RF	α				
		β + γ	10.36 × 1.95	20.2	× 0.255 5.2	5.2
	4F	α				
		β + γ	10.36 × 3.43	35.5	× 0.255 9.1	14.3
	3F	α	34.39 × 2.17	74.6	× 0.145 10.8	10.8
		β + γ	10.36 × 1.48 13.41 × 2.17	44.4	× 0.145 6.4	20.7
	2F	α	34.39 × 3.28	112.8	× 0.145 16.4	27.2
		β + γ	13.41 × 3.28	44.0	× 0.145 6.4	27.1
	1F	α	34.39 × 3.90	134.1	× 0.145 19.4	46.6
		β + γ	13.41 × 3.90	52.3	× 0.145 7.6	34.7
↕	RF	α + β	21.34 × 1.95	41.6	× 0.255 10.6	10.6
		γ	12.04 × 1.95	23.5	× 0.145 3.4	3.4
	4F	α + β	21.34 × 3.43	73.2	× 0.255 18.6	29.2
		γ	12.04 × 3.43	41.3	× 0.145 6.0	9.4
	3F	α + β	21.34 × 3.66	78.1	× 0.255 19.9	49.1
		γ	12.04 × 1.48 7.47 × 2.17	34.0	× 0.145 4.9	14.3
	2F	α + β	21.34 × 3.28	70.0	× 0.255 17.9	67.0
		γ	19.51 × 3.28	64.0	× 0.145 9.3	23.6
	1F	α + β	21.34 × 3.90	83.2	× 0.255 21.2	88.2
		γ	19.51 × 3.90	76.1	× 0.145 11.0	34.6

Generally
Seismic Force
> Wind Force

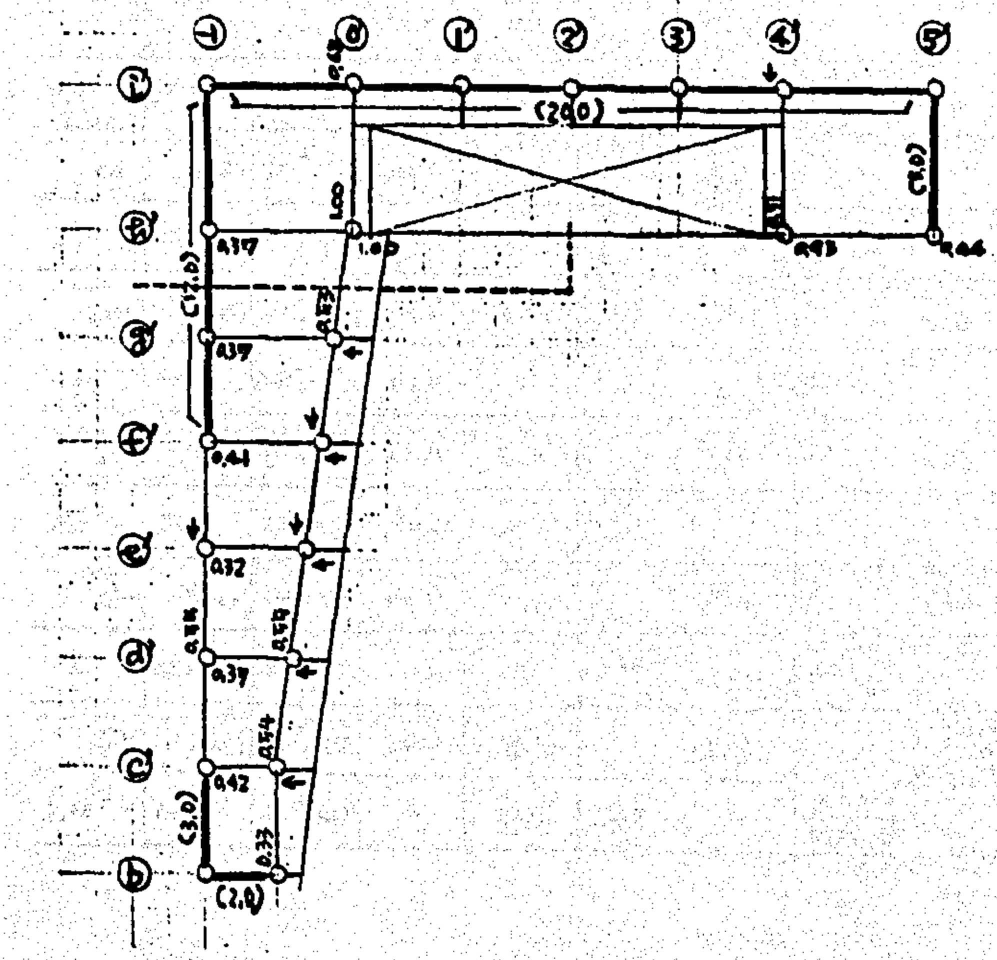
Direction	Level	Zone	Seismic Force	Wind Force	D: Dc	D: Dw	D: Dc : Dw	D: Σ	Q/ΣD
↔	R_F	α	/	/	—	—	—	—	—
		β+γ	26.0	5.2	0	2.00	0 : 100	2.00	13.0
	4_F	α	/	/	—	—	—	—	—
		β+γ	48.0	14.3	0	2.00	0 : 100	2.00	24.0
	3_F	α	20.0	10.8	3.88	2.00	65 : 35	5.88	3.6
		β+γ	77.0	20.7	2.74	20.00	12 : 88	22.74	13.3
	2_F	α	40.0	29.2	6.00	2.00	75 : 25	8.00	5.0
		β+γ	95.0	29.1	3.16	20.00	14 : 86	23.16	4.1
	1_F	α	67.0	46.6	5.82	2.00	77 : 23	7.82	7.6
		β+γ	113.0	34.7	3.29	20.00	14 : 86	23.29	4.9
↕	R_F	α+β	16.0	10.6	2.00	5.00	29 : 71	7.00	2.3
		γ	10.0	3.4	0	5.00	0 : 100	5.00	2.0
	4_F	α+β	34.0	29.2	1.93	5.00	26 : 74	6.93	4.5
		γ	18.0	9.4	0	5.00	0 : 100	5.00	3.6
	3_F	α+β	66.0	44.1	5.83	15.00	28 : 72	20.83	3.2
		γ	29.0	14.3	1.02	5.00	17 : 83	6.02	4.8
	2_F	α+β	100.0	68.0	7.15	15.00	32 : 68	22.15	4.5
		γ	35.0	23.6	1.24	5.00	20 : 80	6.24	5.6
	1_F	α+β	136.0 → 131.5	58.2	4.26	10.00	22 : 78	14.26	6.8
		γ	44.0 → 57.0	34.6	0.66	0	100 : 0	0.66	86.1



D-Value 4th.F.

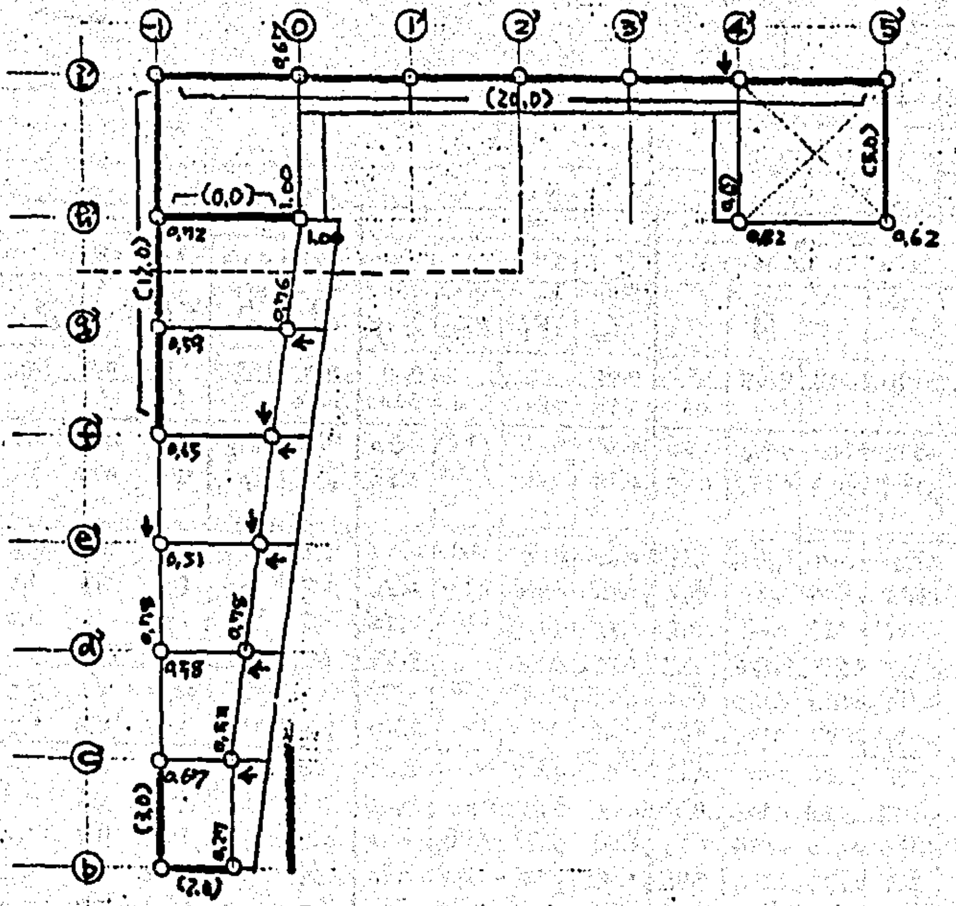


D-Value 3rd.F.

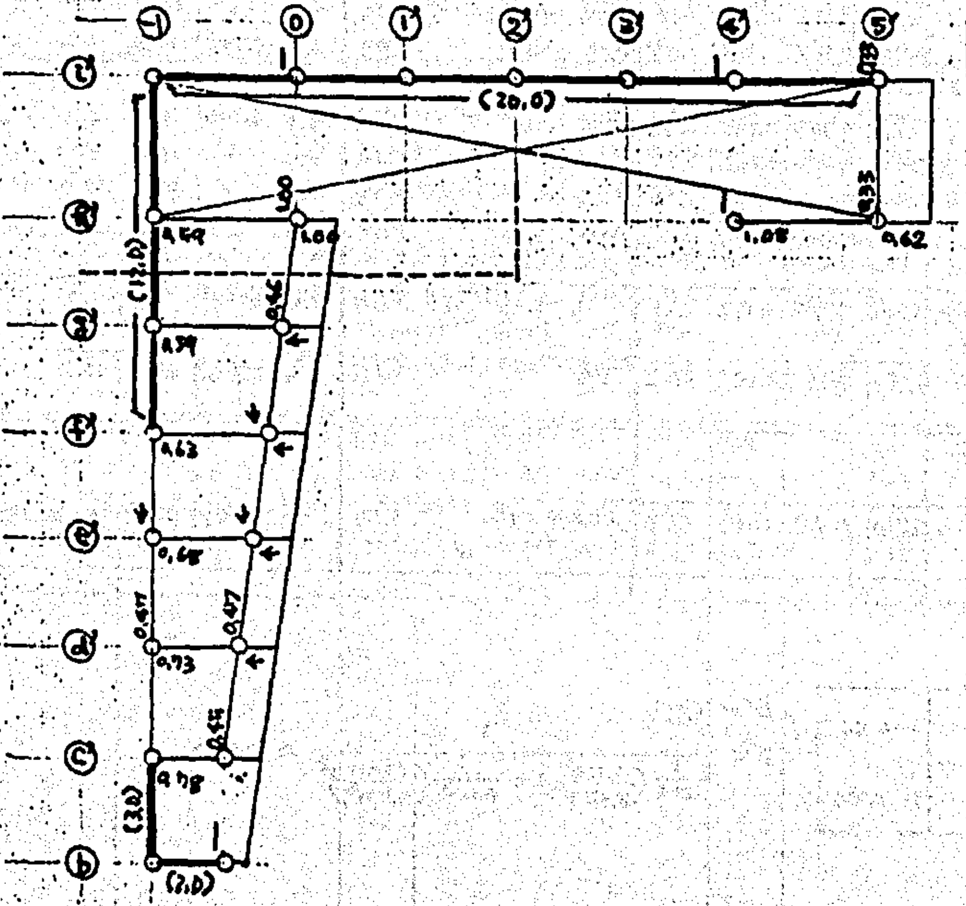


D-Value 2nd.F.

D-Value 1st. F.

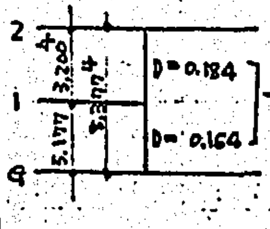


D-Value G F.



D-Value
Inflection Point

Frame	Fl.	Col.	D: k_c	Σk_b			D		y: y_0	y_1	$y_{2,3}$	Σy	Q	h	TM	MU	ML
0'		h'	2.01	0.78	0.194	0.088	0.178	1.00	0.00	-		0.00	2.3	2.895^6	6.7	6.7	0
	3	h'	1.52	1.13	0.372	0.157	0.238	1.00	0.30			0.30	4.5	3.932^4	17.7	12.4	5.3
		i'	〃	0.78	0.257	0.114	0.173	0.73	0.25			0.25	3.3	〃	12.9	9.7	3.2
	2	b	0.34	0.45	0.662	0.249	0.085	0.33	0.30	−0.25		0.05	1.1	3.382^8	3.6	3.4	0.2
		c'	〃	0.93	1.368	0.406	0.138	0.54	0.35	−0.10		0.25	1.7	〃	5.8	4.3	1.5
		d'	〃	0.96	1.412	0.414	0.141	0.55	0.35	−0.10		0.25	1.8	〃	6.0	4.5	1.5
		g'	〃	0.91	1.338	0.401	0.136	0.53	0.35	−0.10		0.25	1.7	〃	5.7	4.3	1.4
		h'	1.72	1.21	0.392	0.150	0.257	1.00	0.40	−0.15		0.30	3.2	〃	10.8	7.6	3.2
		i'	〃	0.78	0.227	0.102	0.175	0.68	0.40			0.40	2.2	〃	8.3	5.0	3.3
	1	b	0.14	0.93	3.321	0.624	0.0817	0.27	0.55	0.10		0.65	1.2	8.377^4	10.2	3.6	6.6
		c'	0.36	0.56	0.778	0.280	0.101	0.55	0.45	0.15	−0.05	0.55	2.5	3.200^4	7.9	3.6	4.4
		d'	〃	0.96	1.333	0.400	0.144	0.78	0.45	0.10	−0.05	0.50	3.5	〃	11.2	5.6	5.6
		g'	〃	0.91	1.264	0.387	0.139	0.76	0.45	0.10	−0.05	0.50	3.4	〃	10.9	5.5	5.5
		h'	1.82	0.82	0.225	0.101	0.184	1.00	0.55	−0.15	−0.05	0.35	4.5	〃	14.4	9.4	5.0
		i'	0.70	1.24	0.886	0.307	0.215	0.67	0.65	0.10		0.75	3.0	8.377^4	25.3	6.4	18.9
	G	b	——														
		c'	0.22	2.12	4.818	0.707	0.155	0.45	0.55	0.10		0.65	3.1	5.177	15.8	5.5	10.3
		d'	〃	2.54	5.773	0.743	0.163	0.47	0.55	0.10		0.65	3.2	〃	16.5	5.7	10.8
		g'	〃	2.42	5.500	0.733	0.161	0.46	0.55	0.10		0.65	3.1	〃	16.2	5.7	10.5
		h'	1.13	2.00	0.885	0.307	0.347	1.00	0.65	0.20		0.75	6.8	〃	35.2	8.8	26.4
		i'	——														
4'	2	h'	1.72	0.57	0.166	0.077	0.132	0.51	0.55	−0.25	−0.20	0.10	2.4	3.382^8	8.1	7.3	0.8
	1	h'	0.70	1.09	0.779	0.280	0.196	0.62	0.65			0.65	3.5	8.377^4	29.3	10.2	19.1
	G	h'	——											—			
5'	G	h'	0.22	0.95	2.159	0.519	0.114	0.33	0.55	−0.20		0.35	18.5	5.177	95.8	62.3	33.5



D' = 0.320

$$D' = \frac{1}{\frac{1}{0.184}\left(\frac{3.200^4}{8.377^4}\right)^2 + \frac{1}{0.164}\left(\frac{5.177}{8.377^4}\right)^2} = 0.320$$

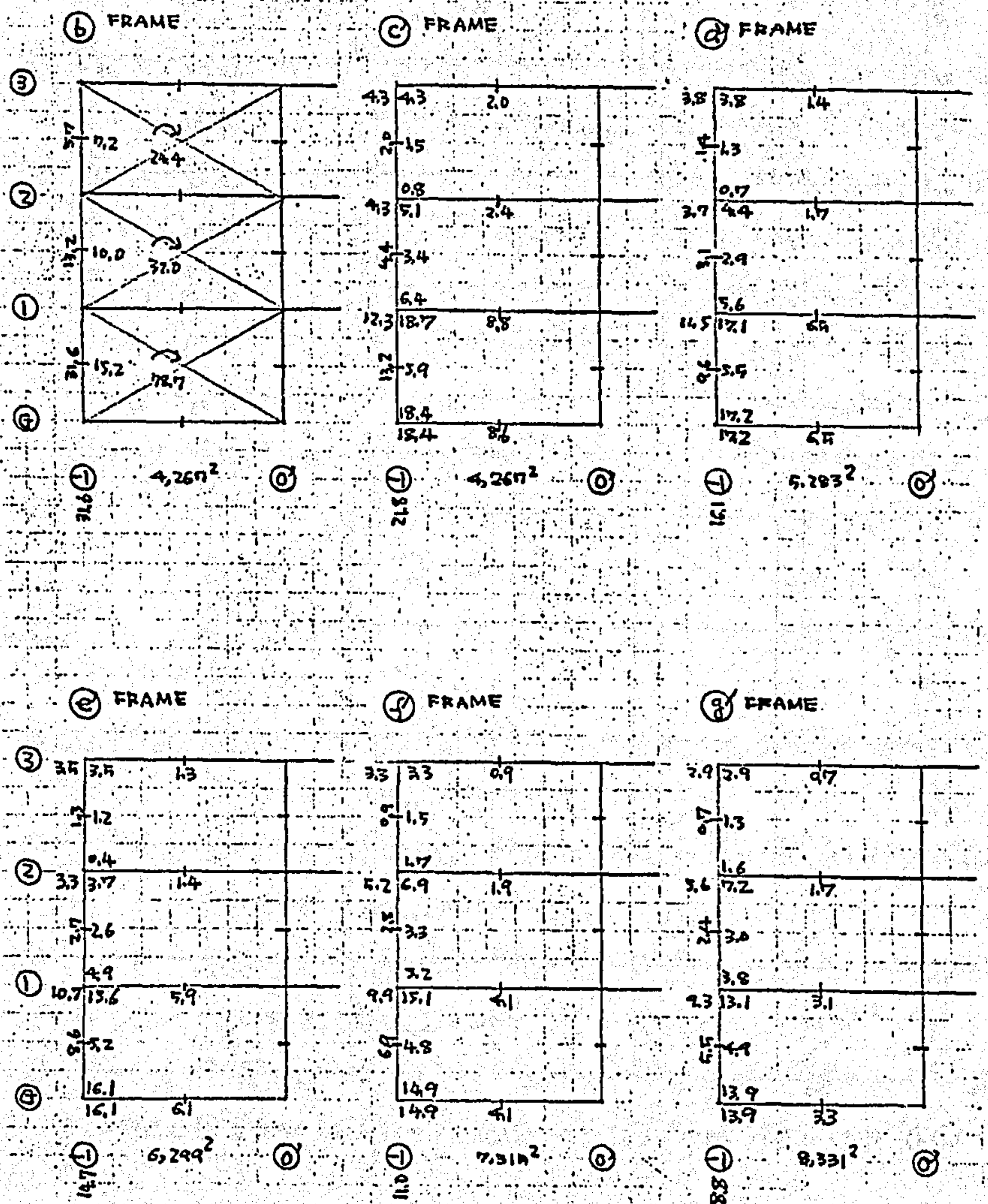
↔

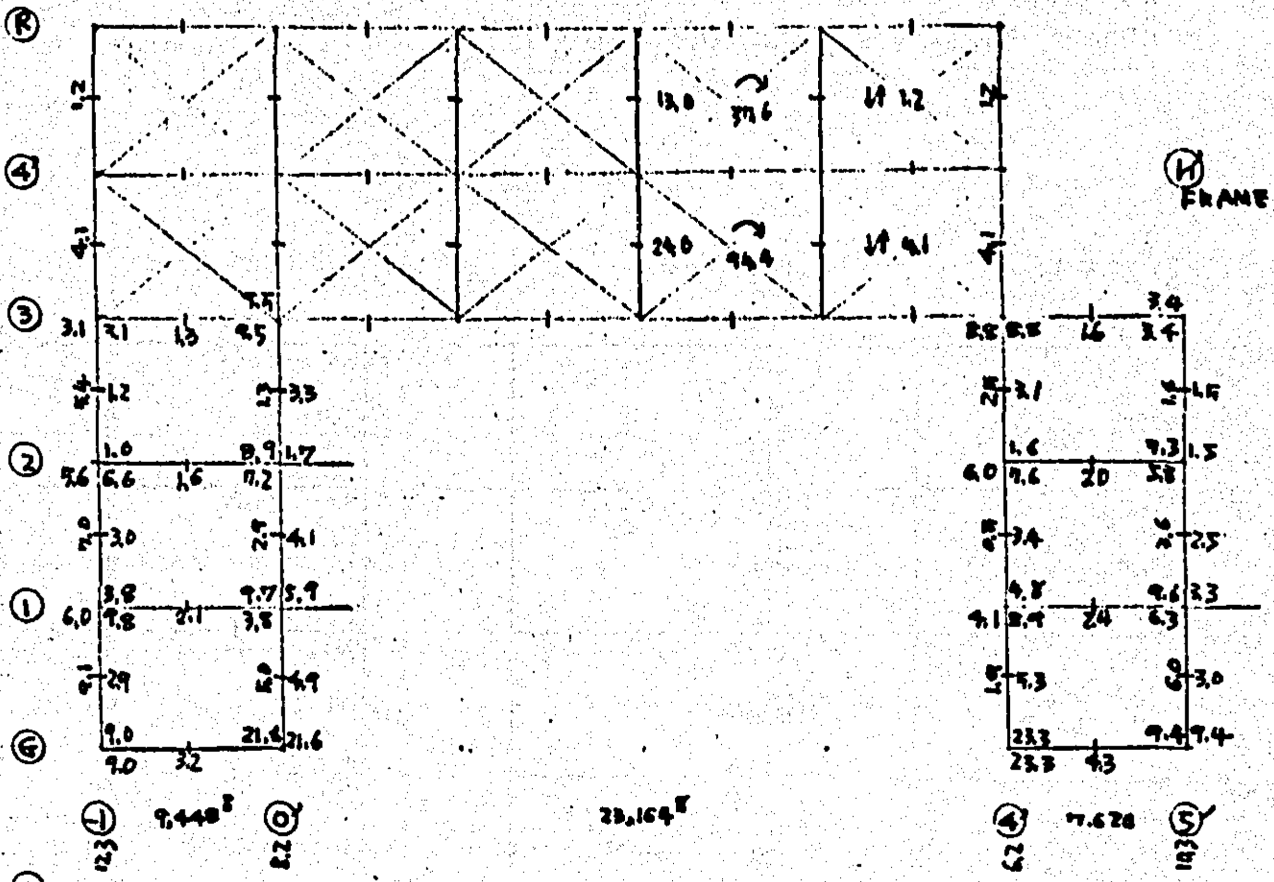
			D						y								
Frame	Ft.	Col.	k_c	Σk_b			D		y_0	y_1	y_{23}	Σy	Q	h	TM	MU	ML
c′	2	−1	0.34	0.67	0.957	0.330	0.112	0.42	0.35	−0.20		0.15	1.5	3,382^{8}	5.1	4.3	0.8
	1	〃	0.36	0.67	0.931	0.318	0.114	0.67	0.45	0.20	−0.05	0.60	3.4	3,200^{4}	10.7	4.3	6.4
	G	〃	0.72	1.81	4.114	0.673	0.148	0.78	0.55	0.05		0.60	5.9	5,177	50.7	12.3	18.4
d′	2	−1	0.34	0.55	0.809	0.288	0.098	0.37	0.35	−0.20		0.15	1.3	3,382^{8}	4.5	3.8	0.7
	1	〃	0.36	0.55	0.764	0.276	0.099	0.58	0.45	0.20	−0.05	0.60	2.9	3,200^{4}	9.3	3.7	5.6
	G	〃	0.72	1.47	3.341	0.626	0.138	0.73	0.55	0.05		0.60	5.5	5,177	28.7	11.5	17.2
e′	2	−1	0.34	0.45	0.662	0.249	0.085	0.32	0.30	−0.20		0.10	1.2	3,382^{8}	3.9	3.5	0.4
	1	〃	0.36	0.45	0.625	0.238	0.086	0.51	0.45	0.20	−0.05	0.60	2.6	3,200^{4}	8.2	3.3	4.9
	G	〃	0.72	1.22	2.773	0.581	0.125	0.68	0.55	0.05		0.60	5.2	5,177	26.8	10.7	16.1
f′	2	−1	0.34	0.64	0.941	0.320	0.109	0.41	0.35			0.35	1.5	3,382^{8}	5.0	3.3	1.7
	1	〃	0.36	0.64	0.889	0.308	0.111	0.65	0.45		−0.05	0.50	3.3	3,200^{4}	10.4	5.2	5.2
	G	〃	0.22	1.05	2.386	0.544	0.120	0.63	0.55	0.05		0.60	4.8	5,177	24.8	9.9	14.9
g′	2	−1	0.34	0.56	0.824	0.292	0.099	0.37	0.35			0.35	1.3	3,382^{8}	4.5	2.9	1.6
	1	〃	0.36	0.56	0.778	0.280	0.101	0.59	0.45		−0.05	0.40	3.0	3,200^{4}	9.4	5.6	3.8
	G	〃	0.72	0.92	2.091	0.511	0.112	0.59	0.55	0.05		0.60	4.9	5,177	23.2	9.3	13.9
h′	2	−1	0.34	0.82	1.206	0.376	0.128	0.37	0.45	−0.20		0.25	1.2	3,382^{8}	4.1	3.1	1.0
		0′	1.72	1.24	0.369	0.156	0.268	1.00	0.40	−0.25		0.15	3.3	〃	11.2	9.5	1.7
		4′	1.72	1.17	0.340	0.145	0.250	0.93	0.40	−0.25		0.15	3.1	〃	10.4	8.8	1.6
		5′	0.34	0.72	1.059	0.346	0.118	0.44	0.35	−0.05		0.30	1.5	〃	4.9	3.4	1.5
	1	−1	0.36	0.75	1.042	0.342	0.123	0.72	0.45		−0.05	0.40	3.0	3,200^{4}	9.4	5.6	3.8
		0′	1.82	〃	0.206	0.093	0.170	1.00	0.50		−0.05	0.45	4.1	〃	13.1	7.2	5.9
		4′	1.82	0.60	0.165	0.076	0.139	0.82	0.50		−0.05	0.45	3.4	〃	10.8	6.0	4.8
		5′	0.36	〃	0.833	0.294	0.106	0.62	0.45		−0.05	0.40	2.5	〃	8.1	5.8	3.3
	G	−1	0.22	0.91	2.068	0.508	0.112	0.59	0.55	0.05		0.60	2.9	5,177	15.0	6.0	9.0
		0′	1.13	〃	0.403	0.168	0.189	1.00	0.75	0.10		0.85	4.9	〃	25.4	3.8	21.6
		4′	1.13	1.00	0.442	0.181	0.205	1.08	0.75	0.10		0.85	5.3	〃	27.4	4.1	23.7
		5′	0.22	〃	2.273	0.532	0.117	0.62	0.55	0.05		0.60	3.0	〃	15.7	6.3	9.4

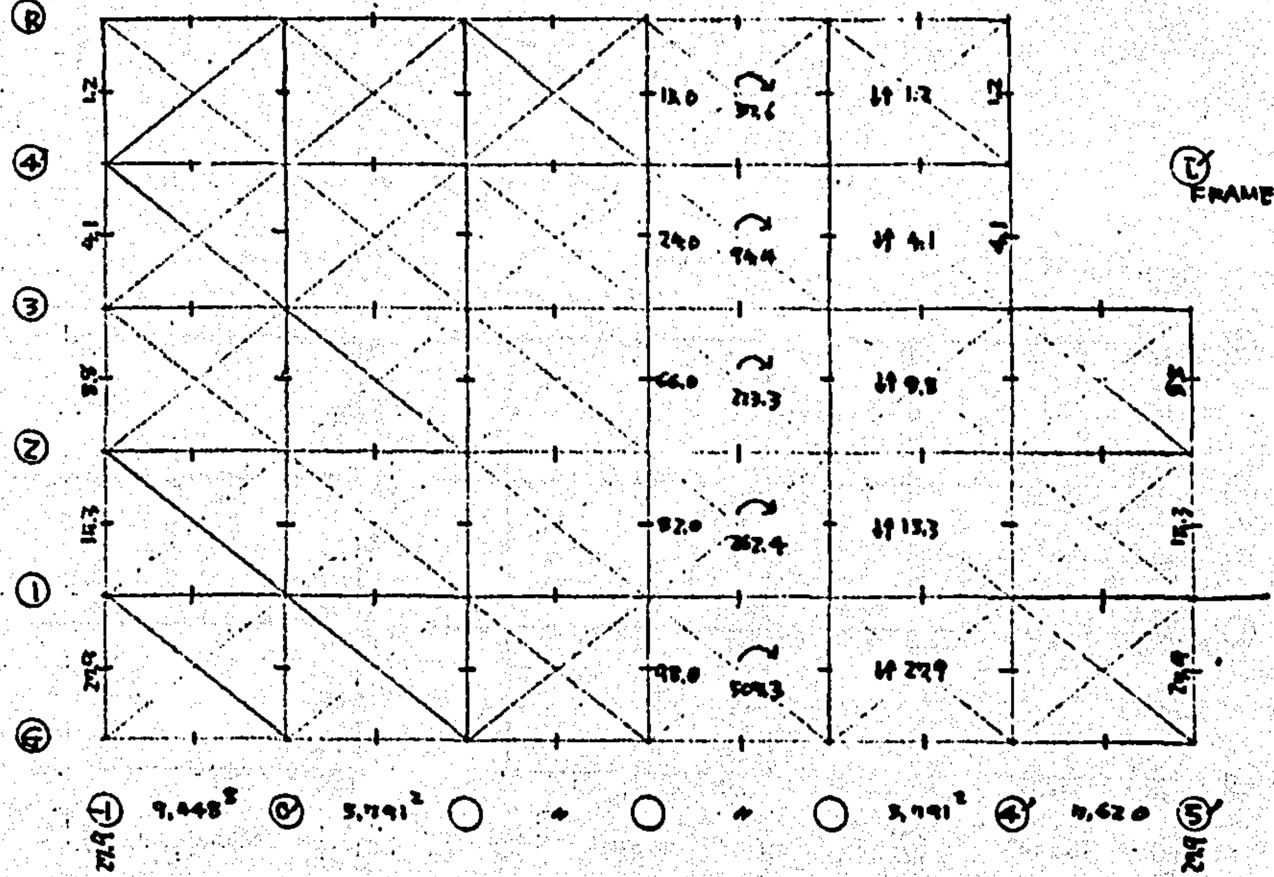
STRESS OF BEARING WALL

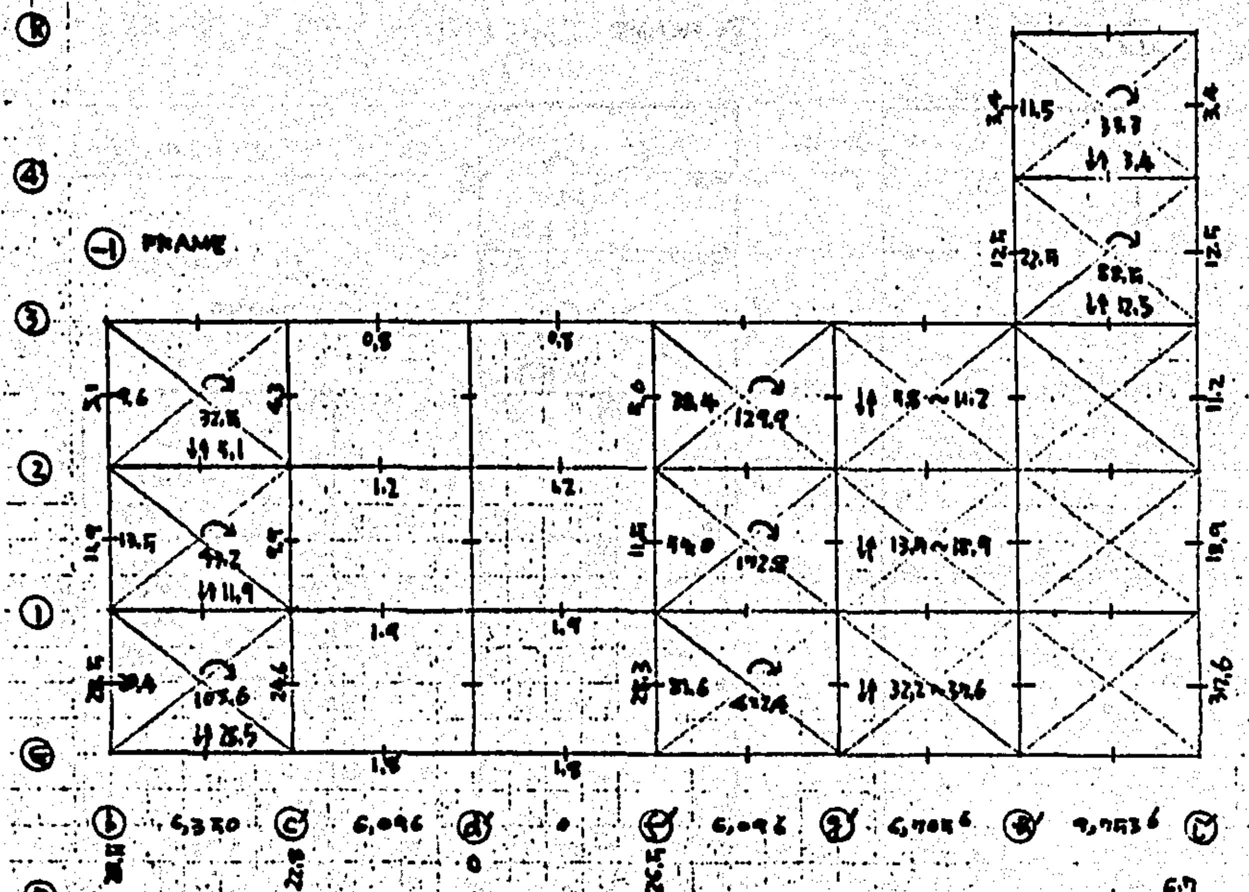
Direction	Frame	Fl.	Span	D	STRESS					
					Q	k	M	ℓ	N	ΣN
↔	i′	4′	−1 ~ 4′	1.0	13.0	2.895^{6}	37.6	32.613^{6}	1.2	1.2
		3	〃	〃	24.0	3.932^{4}	94.4	〃	2.9	4.1→33
		2	−1 ~ 5′	20.0	66.0	3.382^{8}	223.5	40.233^{6}	5.5	8.8
		1	〃	〃	82.0	3.700^{4}	262.4	〃	6.5	15.3
		G	〃	〃	98.0	5.177	507.3	〃	12.6	27.9
	b	2	−1 ~ 0′	2.0	7.2	3.382^{8}	24.4	4.261^{2}	5.7	5.7
		1	〃	〃	10.0	3.200^{4}	32.0	〃	8.5	13.2
		G	〃	〃	15.2	5.177	98.7	〃	18.4	31.6
↕	−1	2	b ~ c′	3.0	9.6	3.382^{8}	32.5	6.350	5.1	5.1
		1	〃	〃	13.8	3.200^{4}	43.2	〃	6.8	11.9
		G	〃	〃	20.4	5.177	105.6	〃	16.6	28.5
	4	4′	k′ ~ i′	5.0	11.5	2.895^{6}	33.3	9.753^{6}	3.4	3.4
		3	〃	〃	22.5	3.932^{4}	88.5	〃	9.1	12.5→5.4
		2	f′ ~ i′	12.0	38.4	3.382^{8}	129.9	22.55^{2}	5.8	5.8~11.2
		1	〃	〃	54.0	3.200^{4}	172.8	〃	7.7	13.5~18.9
		G	〃	〃	81.6	5.177	422.4	〃	18.7	32.2~37.6
	4′	4′	k′ ~ i′	5.0	10.0	2.895^{6}	29.0	9.753^{6}	3.0	3.0
		3	〃	〃	18.0	3.932^{4}	70.8	〃	7.3	10.3
	5′	2	k′ ~ i′	5.0	24.0	3.382^{8}	81.2	9.753^{6}	8.3	8.3
		1	〃	〃	28.0	3.200^{4}	89.6	〃	9.2	17.5

FRAME STRESS FOR SEISMIC FORCE




H FRAME


I FRAME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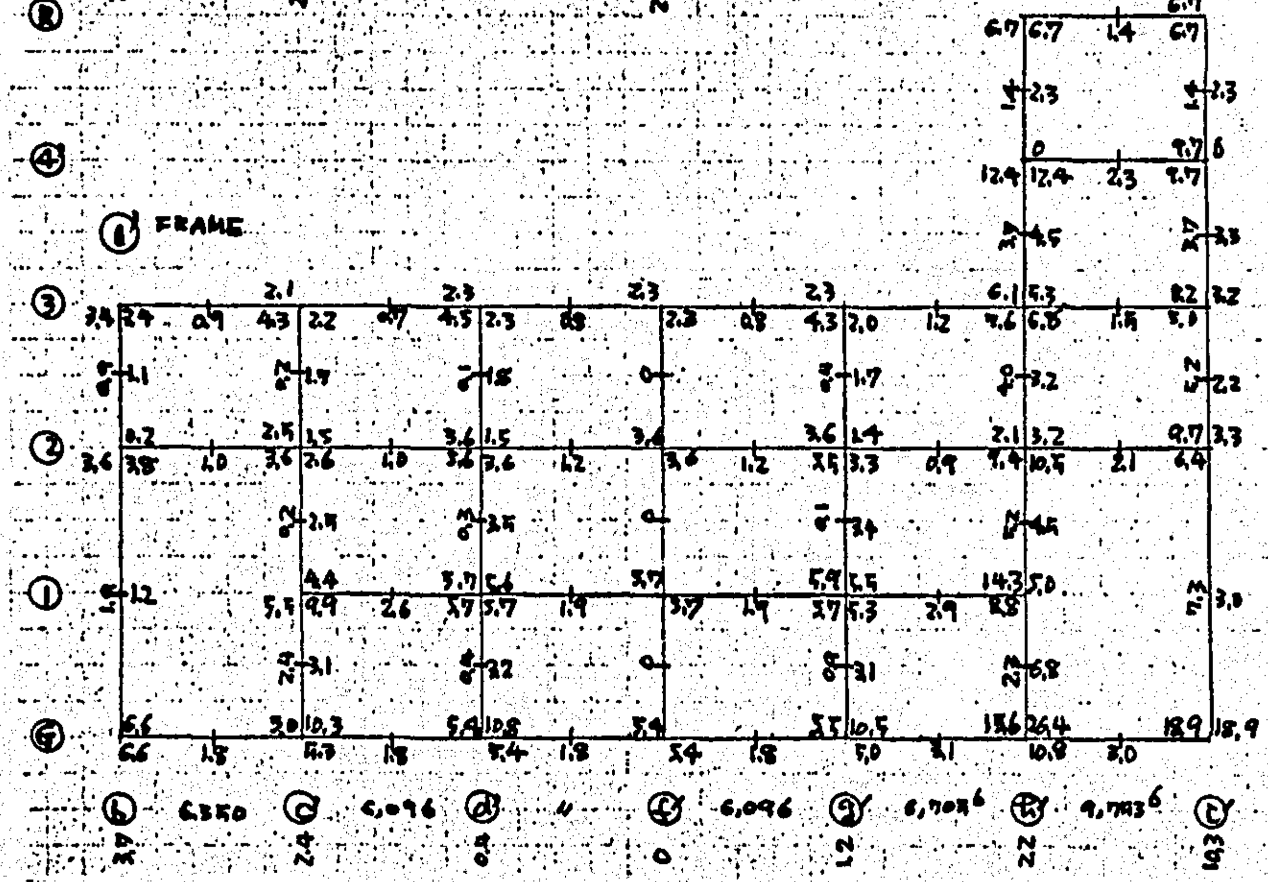
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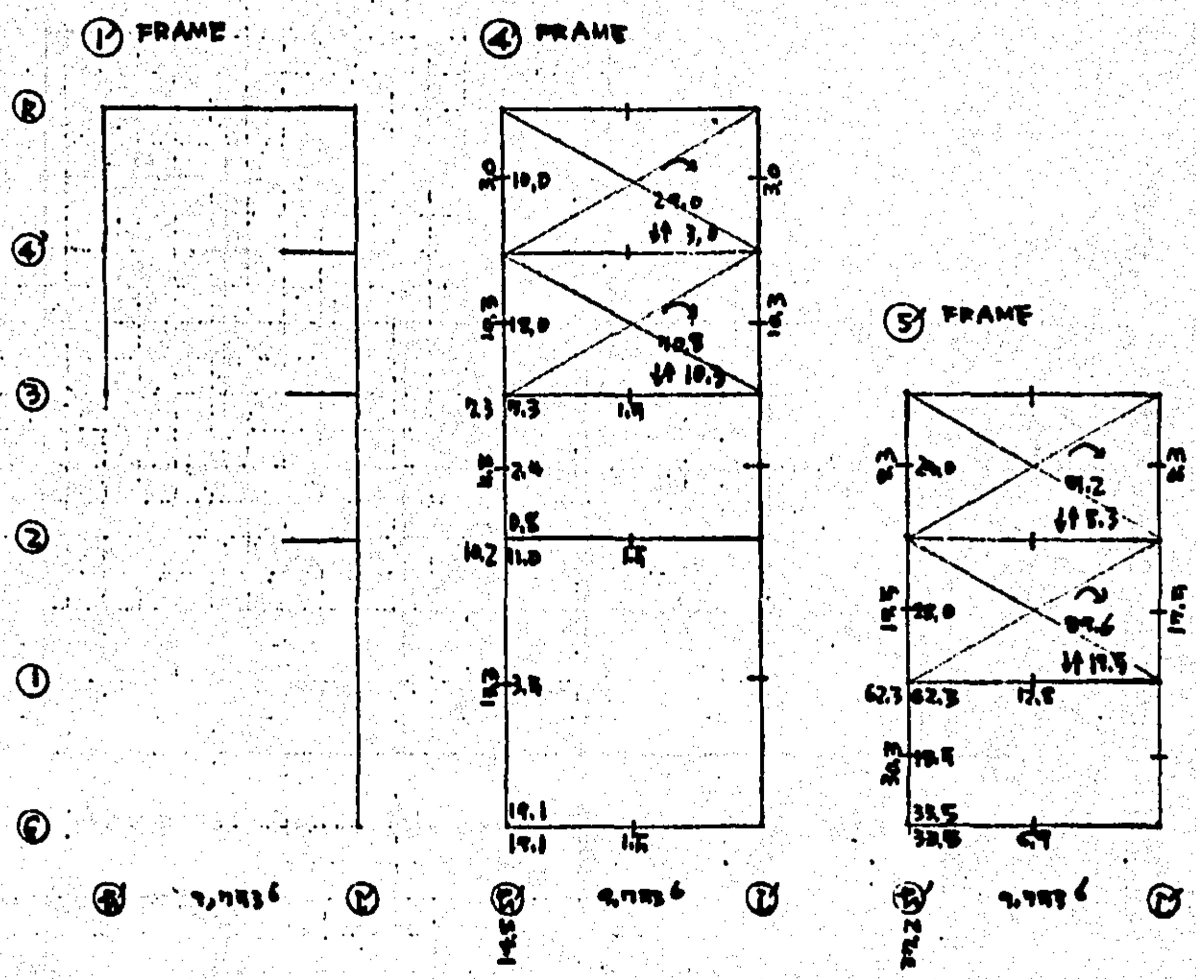

FRAME
FRAME
FRAME

3-DESIGN OF FOUNDATION

Information on Pile-Cast in situ-Works in Dacca

In this project Pile works are used for foundation.

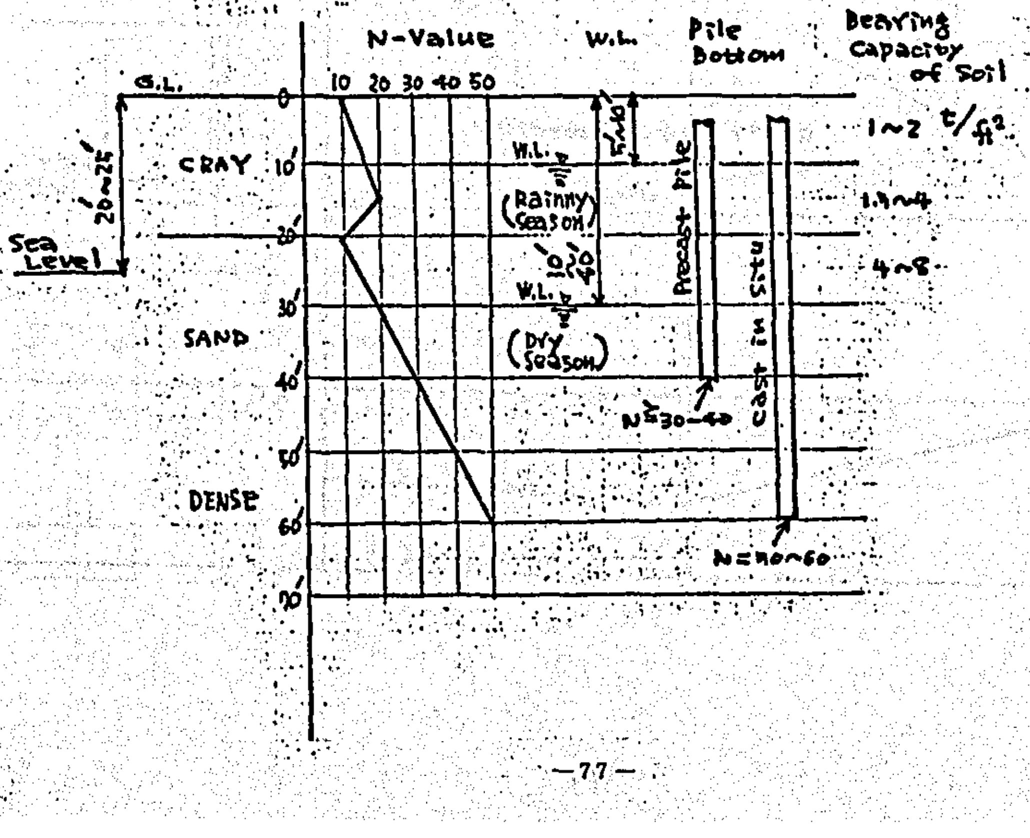
To keep the existing building free from the effect of vibration during piling, cast in situ should be used. (In previous works, also cast in situ piles were used.)

*

Information on cast in situ which was collected by the 2nd survey team is as follows.

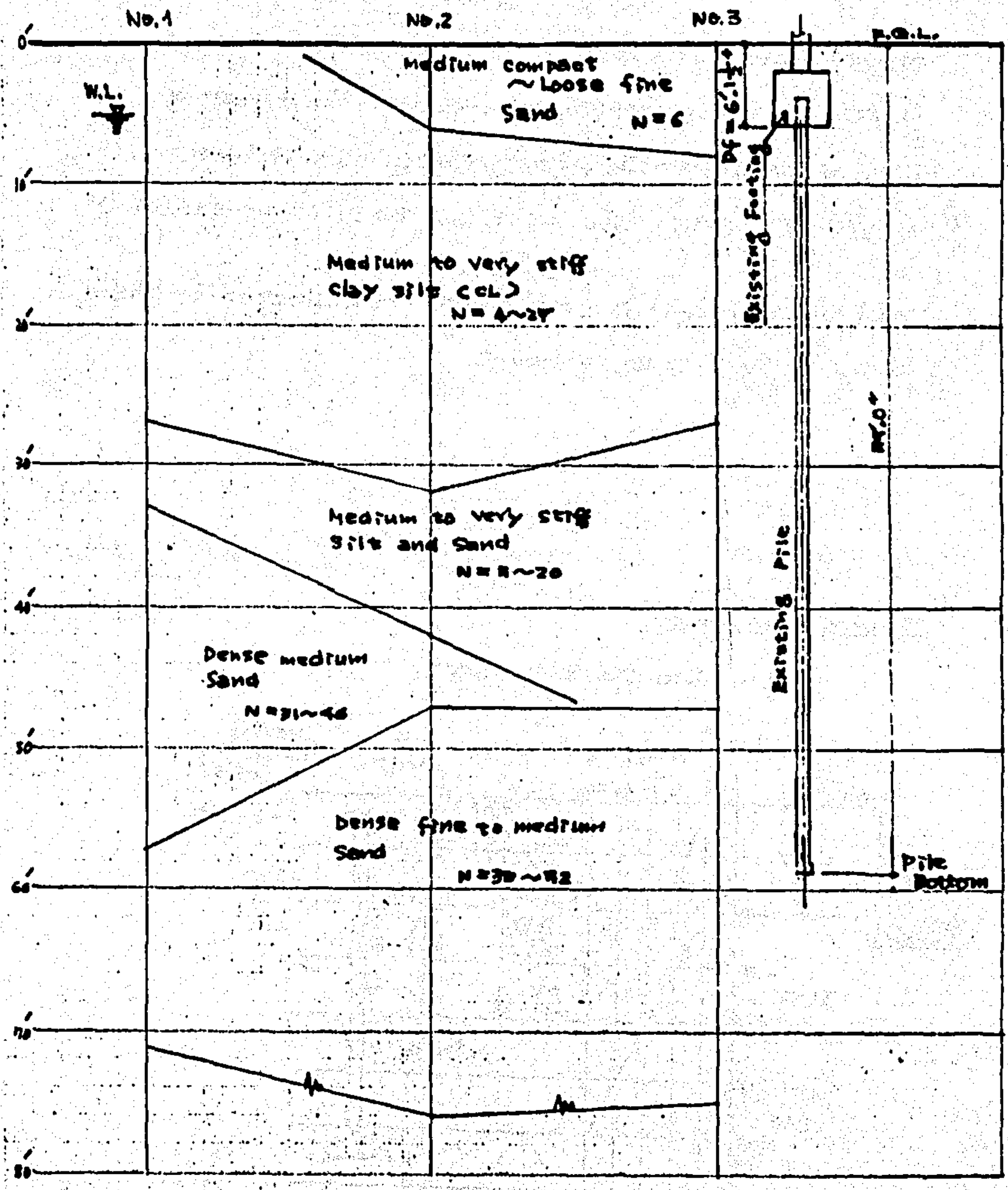
Geological Data

Typical Bore Chart in Dacca

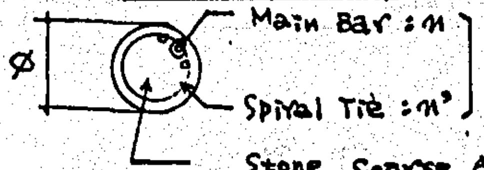


Bore Chart

(According to "30,7,77 — Preliminary Report" by "Foundation Consultant, Dacca")



Pile Standard

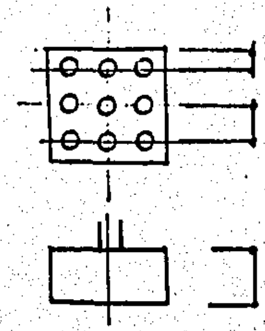


(F = 35,000 P.S.i)

Stone Coarse Agglegate concrete ($_{28}Fc$ = 2,800 P.S.i)

φ		n		n'		Usual Design Capacity		L max from G.L.	
12"	304.8 MM	5-5/8"φ	5-16φ	1/4"φ @6"	6φ @150			80'	24.384 M
14	355.6	〃	〃	〃	〃	60	t/Each	〃	〃
16	406.4	6-5/8"φ	6-16φ	〃	〃	70	〃	〃	〃
18	457.2	6-3/4"φ	6-19φ	3/8"φ @6"	9φ @150	75	〃	〃	〃
20	508.0	7-3/4"φ	7-19φ	〃	〃	80 − 85	〃	100'	30.480 M
22	558.8	8-7/8"φ	8-19φ	〃	〃	90 − 95	〃	〃	〃
24	609.6	〃	〃	1/2"φ @6"	13φ @150	100 − 110	〃	120'	36.576 M
30	762.0	10-7/8"φ	10-19φ	〃	〃	105 − 120	〃	〃	〃
36	914.4 MM	12-1"φ	12-25φ	〃	〃	130	〃	〃	〃
12"~14" = Unsual		Reif. Ratio 1% ≥ Pg ≥ 0.4%				N ≥ 50 FS = 3		Slender Ratio 80 ≥ L/φ	

Pile layout in Footing

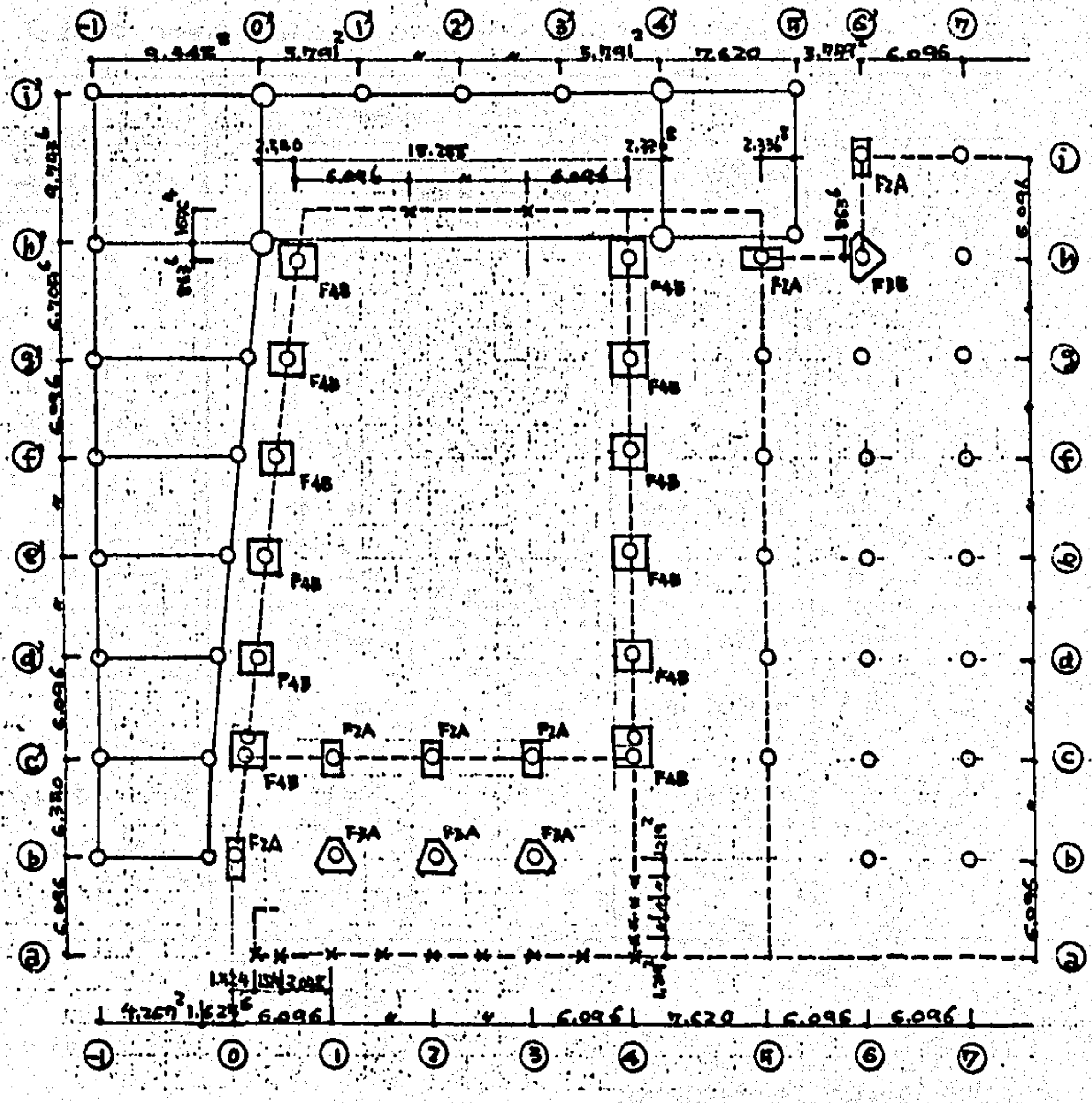


e (Clearance) ≥ 1.5 φ

P (Pitch) ≥ 3.0 φ

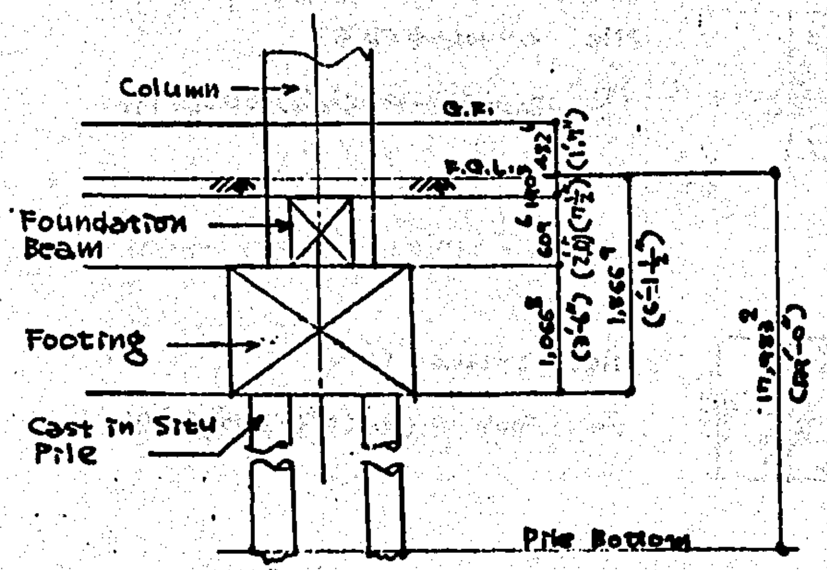
D (Depth) = 2'-0 ~ 6'-0

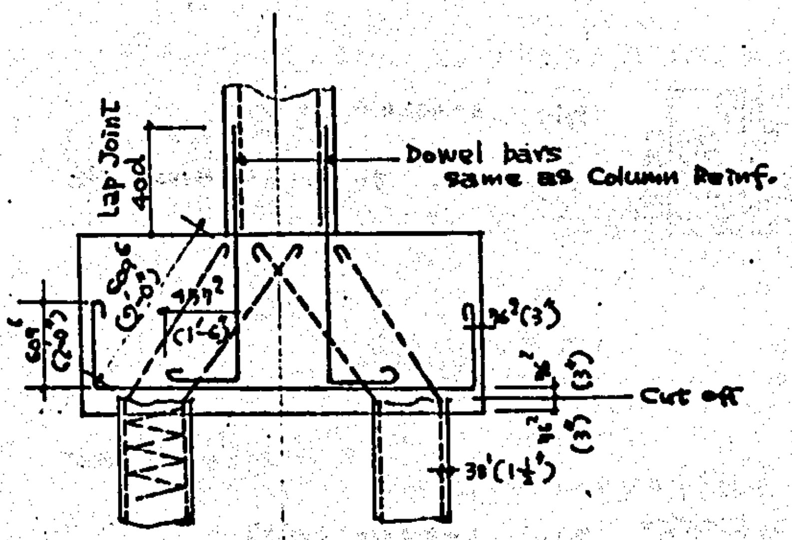
Data on Existing Foundation



1' = 12" = 304.8 MM
1" = 25.4 MM

General Note on Existing Footing and Pile





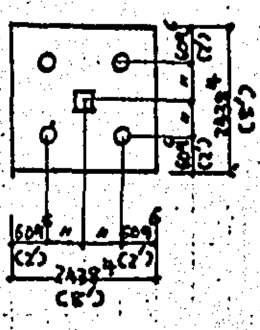
- Main Reinforcement of Pile
  - 5 - 16φ (5/8"φ) for 355.6 φ (14"φ)
  - ~
  - 7 - 16φ (5/8"φ) for 406.4φ (16"φ)
- Spiral Hoop
  - 6φ (1/4"φ) @ 150 (6") c/c

Bearing Capacity of Pile

355.6φ 40 t/Each
406.4φ 50 t/Each

Data on Existing Footing

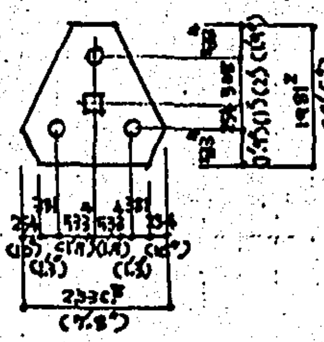
F4B



Pile 4-406.4φ (16"φ)

Each 16-19φ(3/4"φ)@150(6")c/c

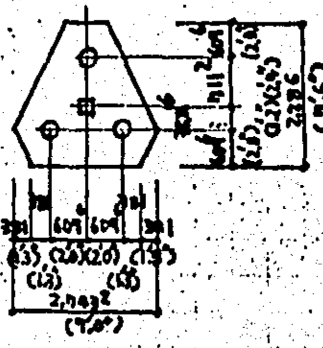
F3A



Pile 3-355.6φ (14"φ)

Each 9-19φ(3/4"φ)@150(6")c/c

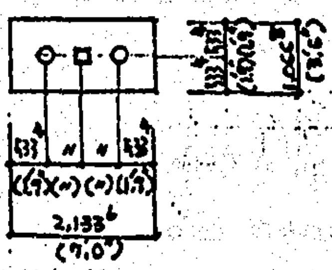
F3B



Pile 3-406.4φ (16"φ)

Each 8-19φ(3/4"φ)@150(6")c/c

F2A



Pile 2-355.6φ (14"φ)

8-19φ(3/4"φ)

12-13φ(1/2"φ)

(1' = 12" = 304.8 MM
1" = 25.4 MM)

Design Capacity of Pile

$$R = \frac{1}{3}\left\{15\overline{N}A_p + \left(\frac{N_s L_s}{5} + 2N_c L_c\right)\psi\right\} - W$$

$$= \frac{1}{3}\left\{15 \times 40 \times \frac{\pi \times 0.4064^2}{4} + \left(\frac{9.144 \times 10}{5} + 2 \times 9.144 \times 5\right)\pi \times 0.4064\right\} - W$$

$$= \frac{1}{3}\left\{77.83 + (18.288 + 91.440)1.276\right\} - W$$

$$= \frac{1}{3}\left\{77.83 + 140.09\right\} - W$$

$$= 72.64 - W$$

$$\downarrow$$

$$= 50\ t/pile - \text{Self Load}$$

Footing Dead Load

$$48'' \times 48'' \times 60'' \times 2\ t/m^3 = 1.219^2 \times 1.524 \times 2 = 4.5\ t/pile$$

Pile Self Load

$$\frac{\pi \times 16''^2}{4} \times 60' \times 2.4\ t/m^3 = \frac{\pi \times 0.4064^2}{4} \times 18.288 \times 2.4 = 5.7\ t/pile$$

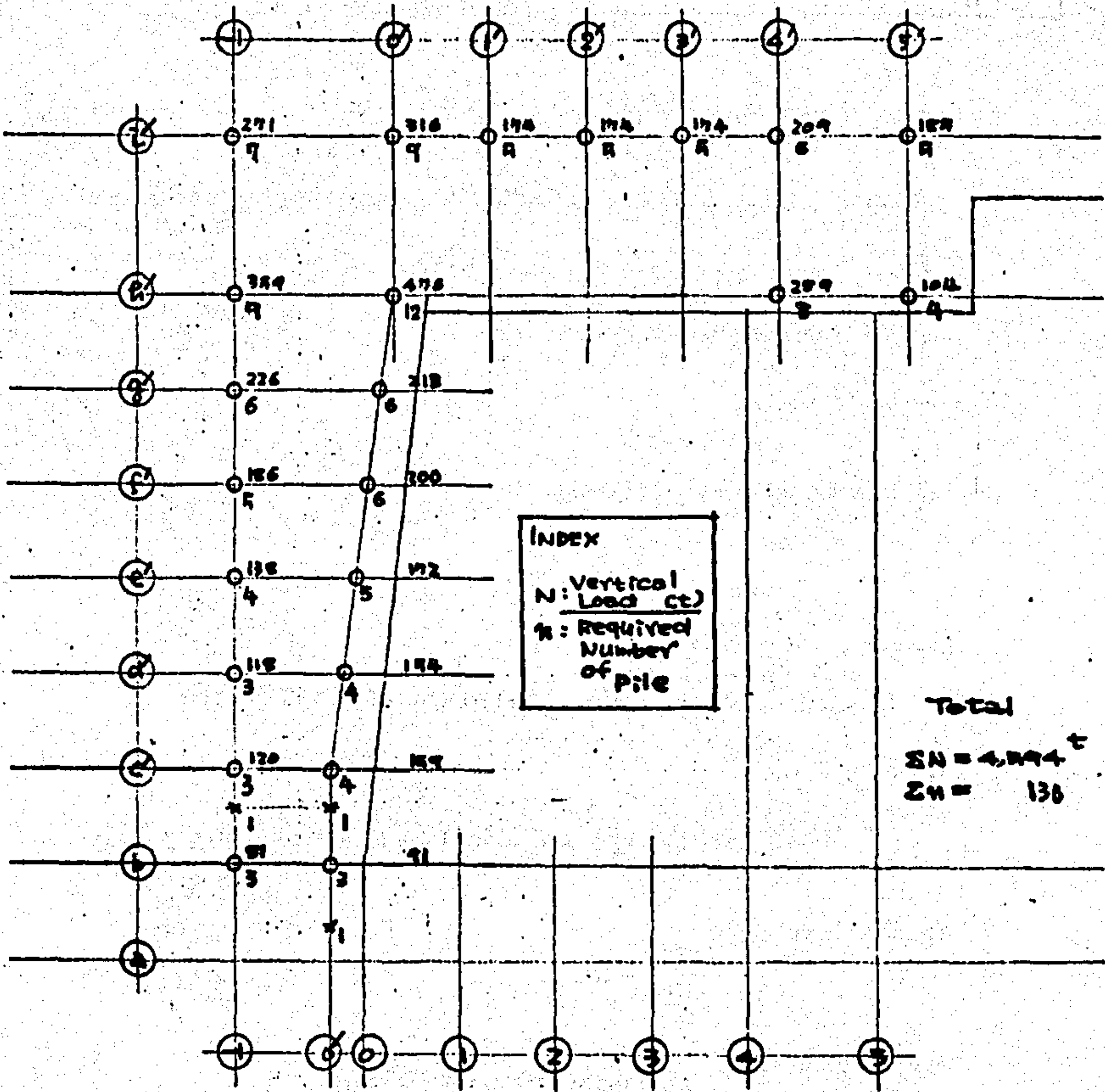
Slender Ratio

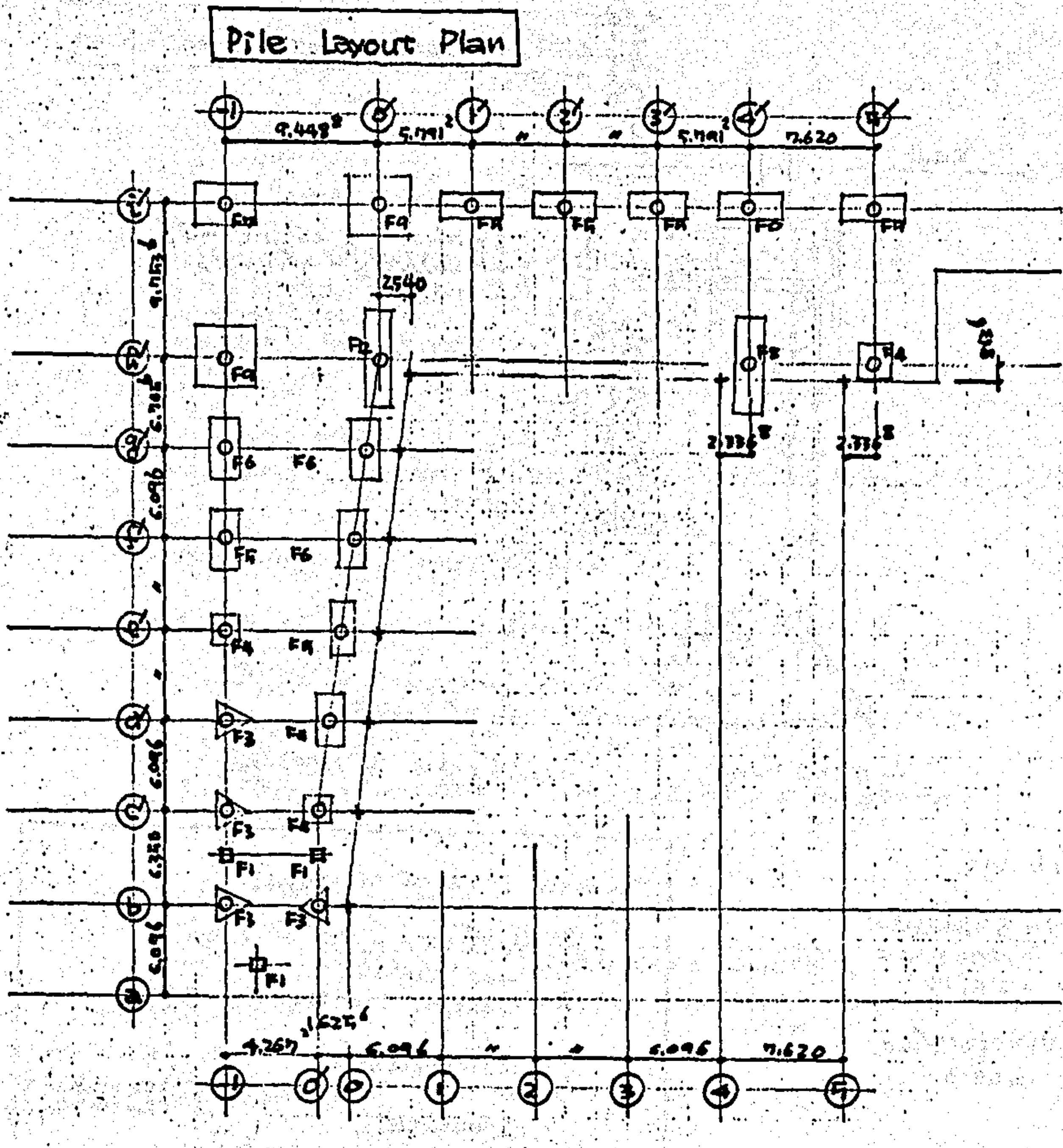
$$\frac{60'}{16''} = 45$$

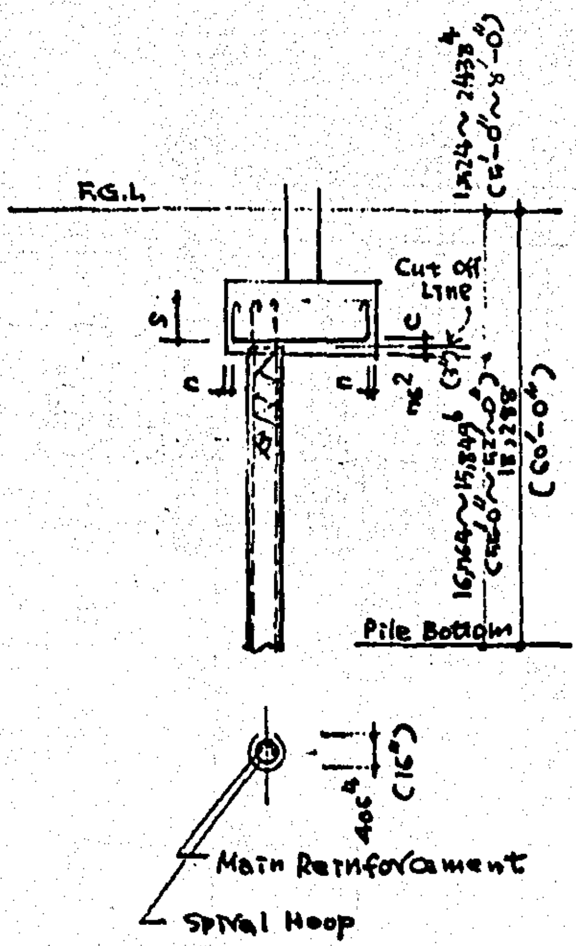
Net capacity

$$50 - (4.5 + 5.7) \rightarrow 40\ t/pile$$

Decision of Pile Numbers




Pile Layout Plan
9.448
5.791
7.620
2540
2.336
4.267
1.625
6.096
F1
F3
F6
F9



S = Anchoring 609.6 (2'-0")
C = Covering 76.2 (3")

Main Reinforcement 6- 5/8" (16) Φ

Spiral Hoop 3/8" (9) Φ @ 6" (150) %c

N = 40t

H = ΣN × Kh 0.05
= 4594 × 0.05
= 229.7t

ΔH = 229.7/130
= 1.8 t

General Note of Material

Cast In Situ
406 (16") Φ
Design Capacity = 40t/pile

Reinforcement
M.S. Bar (F=33,000 P.S.I = 2,400 Kg/cm²)

Concrete
Stone Coarse Aggregate
(28Fc = 3,000 P.S.I = 210 Kg/cm²)

Footing

Reinforcement
JIS Standard SD35

Concrete
Brick Coarse Aggregate
(28Fc = 2,600 P.S.I = 180 Kg/cm²)

1 P.S.I = 0.07030 Kg/cm² = 7.03 t/cm²

Check on Horizontal Load for Pile

Vertical Load

$N = 40t$

Horizontal Load

$\Sigma N = 4,594t$

$k_H = 0.05$ (Horizontal Load Coefficient)

$H = 4,594 \times 0.05 = 229.7\ t$

$\Sigma n = 131$ piles

$\Delta H = 229.7 / 130 = 1.77\ t/pile$

$K_H = 2.00$ *: lateral Direction Coefficient of Ground (kg/cm^3)
(For N Value = 5)

$D = 40.64$: Diameter of Pile (cm)

$E = 1.99 \times 10^5$: Young Modulus (kg/cm^2)

$I = \frac{\pi \times 40.64^4}{64}$: Moment of Inertia (cm^4)

$= 133,901$

$\beta = \sqrt[4]{\frac{K_H \cdot D}{4EI}} = 0.003255\ (cm^{-1}) \sim \ell = 60' = 1828.8\ (cm) \sim \beta\ell = 9.6$

Pile Top Displacement

$y = 0.5 \times \frac{\Delta H}{EI\beta^3} = 0.5 \times \frac{1770}{1.99 \times 10^5 \times 133,901 \times 0.003255^3}$

$= 0.23\ (cm)$

Level of Max. Moment

$\ell = 0.8 \times \frac{1}{\beta} = 152.2\ (cm)$

Max. Moment

$M = 0.3 \times \frac{\Delta H}{\beta} = 0.3 \times \frac{1,770}{0.003255}$

$= 99,905\ (kg\ cm)$

$= 1.00\ (tm)$

*

N = 40,000 (kg)

M = 99,905 (kgcm)

D = 40.64 (cm)

N/D^2 = 24.219
M/D^3 = 1.488

~

According to Circle Column Design Chart

Main Bar fc = 140 → 120 (kg/cm^2)
rfc = 15×120 = 1800 (〃)
ft = 2,320 (〃)

~

N/D^2fc = 0.20
M/D^3fc = 0.012] Pg = 0 %

N/D^2rfc = 0.013
M/D^3rfc = 0.0008] Pg = 0

N/D^2ft = 0.010
M/D^3ft = 0.0006] Pg = 0

~

Pg min = 0.4 % ~ 1.0 %
ag 〃 = 5.19 cm^2 ~ 12.97 cm^2

~

Designed ———————— 6 − 5/8" (16) φ
(1.999 × 6 = 11.88 cm^2)

*

Spiral Tie

pw = 0.2 %

3/8" (9) φ

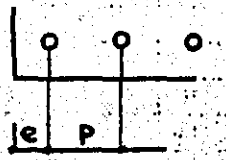
as = 0.7126 cm^2

P = $\frac{0.7162 \times 2}{40.64 \times 0.002}$
= 17.53 cm

~

Designed ———————— 3/8" (9) φ
@ 6" (150)

Design of Footing



e : Clearance 1,219 (4'-0")

P : Pitch 609 (2'-0")

Material

Reinforcement : JIS Standard SD35

ft (Tension) 2,200 kg/cm²

fb (Bond) 18 "

Concrete : 28Fc = 2,600 P.S.I. = 180 kg/cm²

fs (Shear) 6 kg/cm²

fp (Punching) 15 "

Minimum Depth for Punching

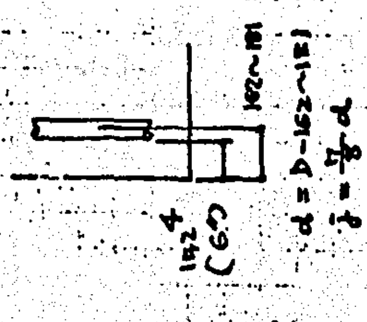
$$\frac{P}{\pi \psi d} < fp \sim d > \frac{P}{\pi \psi fp}$$

$$= \frac{40,000}{\pi \times 40.64 \times 15}$$

$$= 20.9 \text{ cm}$$

D = 3'-0"

= 91.44 cm

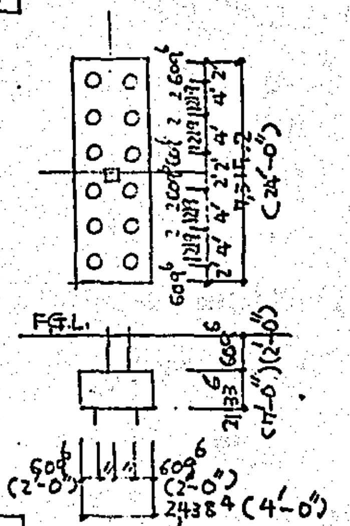


ALLOWABLE STRESS INTENSITY

SD35 $f_t = 2.2$ [t/cm²]
$f_b = 19.0$ [kg/cm²]
Fc 180 $f_s = 6.0$ 〃

[CASE-2
M/S-BAR $f_t = 1.265$ [t/cm²]
$f_b = 10.8$ [kg/cm²]]

F12



D 213.36 cm d 197.2 cm j 172.5 cm B 243.84 cm

QF = 40×6 = 240 t

MF = 240×(1.219×1.5−0.45) = 330.9 tm

φ 77.3 cm QAL 252.4 t

at 97.2 cm

[φ 128.8~64.4, at 191.6]

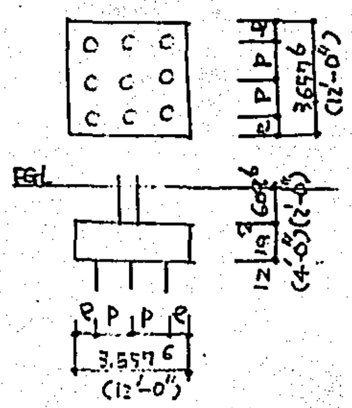
↕ 23~12−D22 (@100~200)

[31~16−1"]

↔ 29−D16 (@250)

[29−5/8"]

F9



D 121.92 d 103.8 j 90.8 ΣD+a 268.6

QF = 40×2 = 80

MF = 80(1.219²−0.30) = 73.5

φ 48.9 QAL 146.3

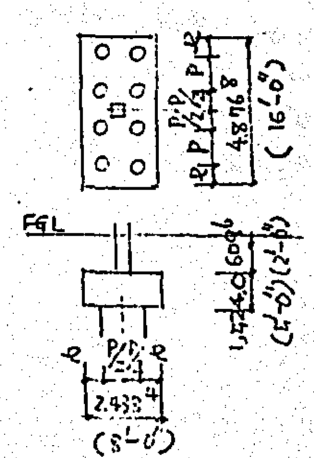
at 36.8

[φ 81.6, at 64.0]

✛ 15−D19 (@250)

[23−3/4"]

F8



D 152.40 d 136.2 j 119.2 B 243.84

QF = 40×4 = 160

MF = 160(1.219−0.45) = 123.6

φ 74.6 QAL 174.4

at 46.9

[φ 124.3~62.2, at 81.6~22.3]

↕ 19−D19 (@125)

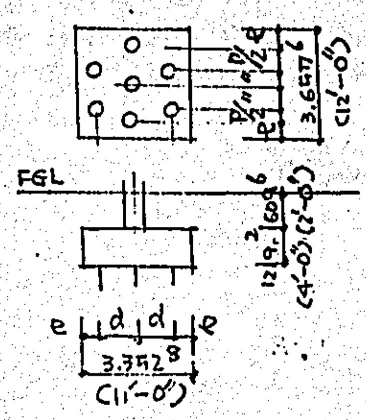
[23−7/8"]

↔ 20−D16 (@250)

[20−5/8"]

F7

D 121.92 d 103.8 j 90.8 2D+a 268.6



$d = 1066^{8}$ (3'-6")

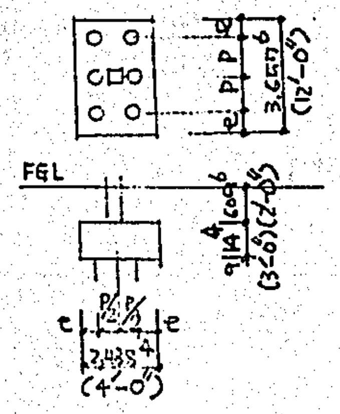
1
QF = 40.0 + 2×40.0×0.37
= 40.0 + 29.6
= 69.6 φ 42.6 QAL 146.3
[φ 71.0]

$M_F = 40.0\,(1.219^{2} - 0.3) + 29.6\,(0.609^{6} - 0.3)$
= 36.8 + 9.2
= 46.0 at 23.0 [at 40.0]
13 − D19 (@250) [23−3/4"]

↔
QF = 2×40.0×0.74 = 59.2 φ 36.2 QAL 146.3
$M_F = 59.2\,(1.066^{8} - 0.3) = 45.4$ at 22.7
15 − D19 (@250)
[φ 60.4, at 39.5, 23−3/4"]

F6

D 91.44 d 75.24 j 65.8 2D+a 211.4

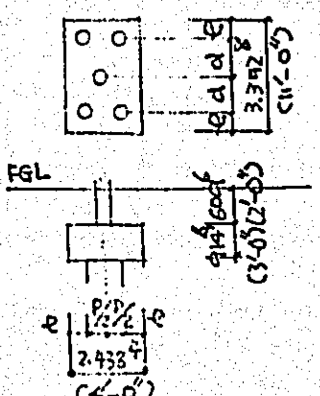


1
QF = 2×40.0 = 80.0 φ 67.5 QAL 83.5
$M_F = 80.0\,(1.219^{2} - 0.3) = 73.5$ at 50.8
19 − D19 (@125)
[φ 112.6, at 85.3, 31−3/4"]

↔
QF = 40.0 φ 33.8 QAL 83.5
$M_F = 40.0\,(0.609^{6} - 0.3) = 12.9$ at 8.9
15 − D16 (@250)
[φ 56.3, at 15.5, 15−5/8"]

F5

D 91.44 d 75.24 j 65.8 2D+a 211.4

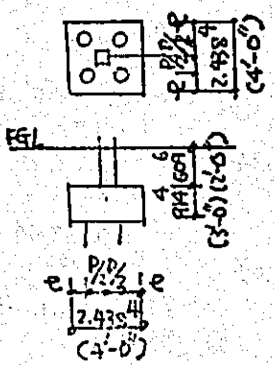


$d = 1066^{8}$ (3'-6")

1
QF = 2×40.0 = 80.0 φ 67.5 QAL 83.5
$M_F = 80.0\,(1.066^{8} - 0.3) = 61.3$ at 42.3
16 − D19 (@150)
[φ 112.6, at 73.6, 19−7/8"]

↔
13 − D16 (@250)
[13−5/8"]

F4



D 91.44 d 73.34 j 64.2 2D+a 207.6

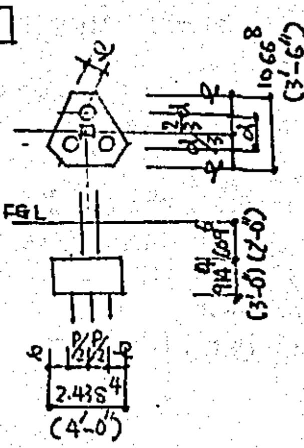
QF = 40.0   φ 34.6   QAL 80.0

MF = 40.0 (0.609 − 0.3) = 12.4   at 8.8

4 10-D16 (@250)

[φ 97.7, at 15.3, 12-5/8"]

F3



d = 1066.8

D 91.44 d 71.44 j 62.5 B 105.6 min.

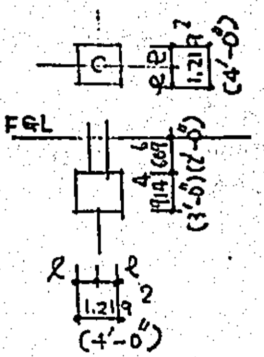
QF = 40.0   φ 35.6   QAL 39.6

MF = 40.0 (0.7112 − 0.3) = 16.5   at 12.0

✱ 17-D16 (@150) + 2-D16

[φ 59.3, at 20.9, 10-3/4"]

F1

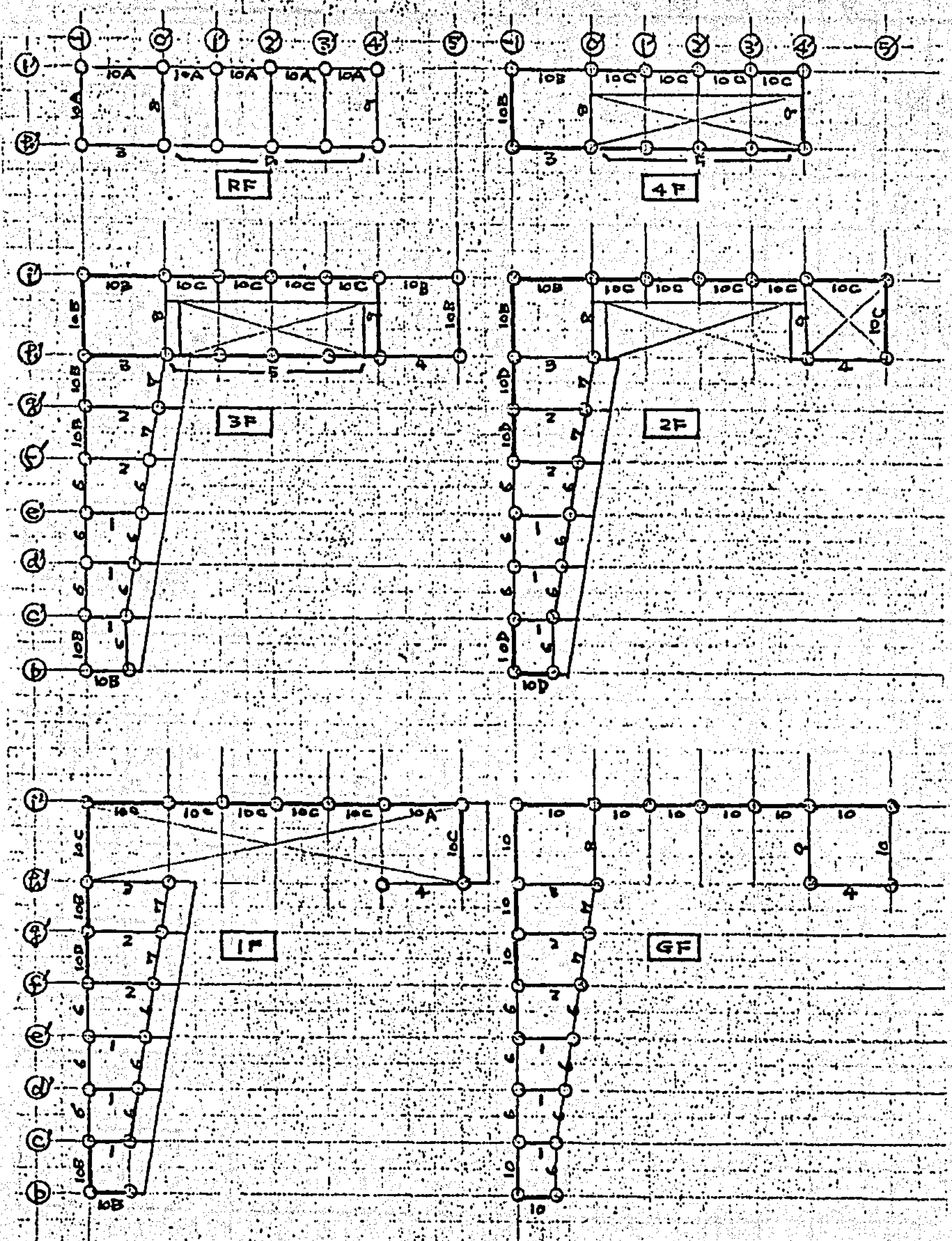


D 91.44

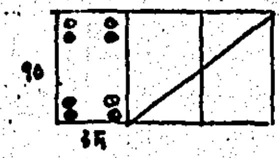
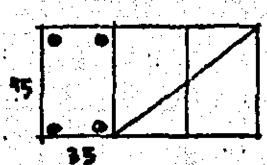
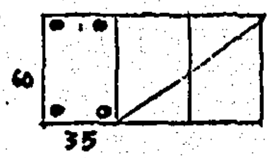
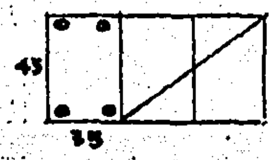
4 6-D16 (@200)

[6-5/8"]

4- DESIGN OF BEAM

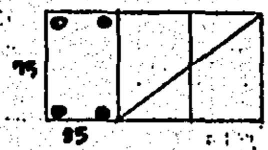
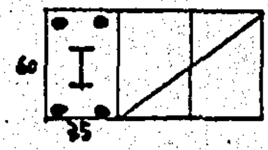
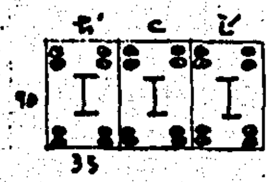
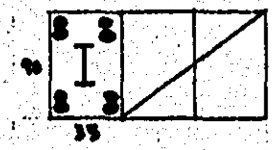


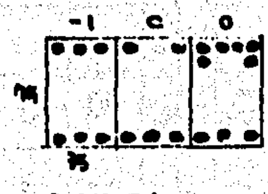
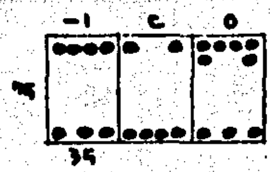
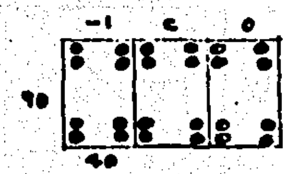
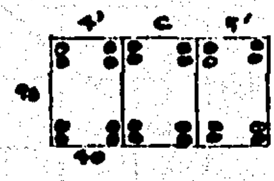
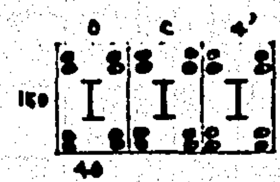
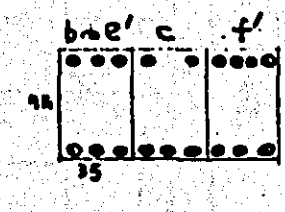
BEAM MARK KEYPLAN

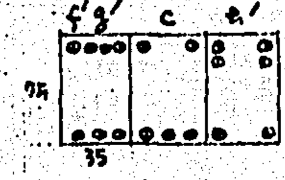
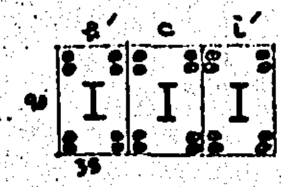
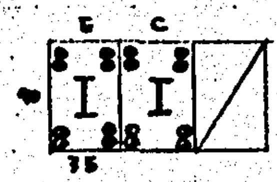
		STRESS V	H	I	C / GA	Pt / α	γ / ΔQ	at / Pw	D / φ		
R~4 G 10A	M									b 35 D 90 d 85 j 74.38 0.8 10.8	
	Q										
R~4 G 10B	M									b 35 D 75 d 70 j 61.25 0.8 8.7	
	Q										
R~4 G 10C	M									b 35 D 60 d 55 j 48.13 0.8 6.6	
	Q										
R~4 G 10D	M									b 35 D 45 d 40 j 35.00 0.8 4.3	
	Q										

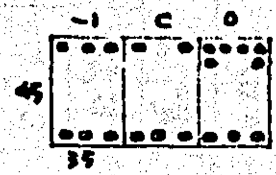
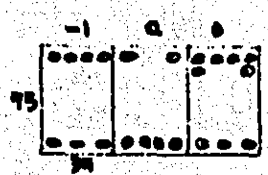
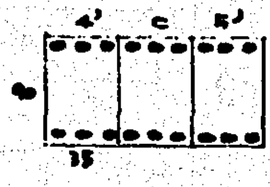
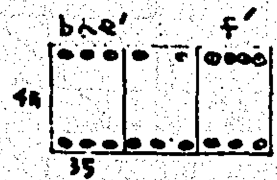
		V	H	I							
G	M									b D d j	
	Q										
G	M									b D d j	
	Q										

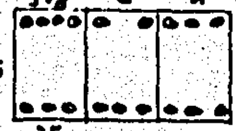
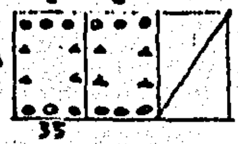
			STRESS V	H	T	C / θA	Pt / σ	γ / ΔQ	Pc / Pw	n / φ		SECTION
RG3	M										b 35 D 90 d 85 j 74.4	90 × 35
	Q											
RG5	M										b D d j	90 × 35
	Q											
RG8	M	r′	23.5	6.7					14.9		b D d j	r′ c l′ 90 × 35
		c	14.9						9.1			
		l′	23.5	6.7					14.9			
	Q		17.6	1.4		18.2		0				
RG9	M										b D d j	90 × 35
	Q											
G	M										b D d j	
	Q											
G	M										b D d j	
	Q											

			STRESS V	H	T	C / Q_A	P_t / α	γ / ΔQ	at / P_w	n / ϕ		SECTION
4G[illegible]	M										b 35 D 75 d 70 j 61.25	
	Q											
4G[illegible]	M										b 35 D 60 d 55 j 48.13	
	Q											
4G[illegible]	M	t'	25.0	12.4					15.3		b 35 D 90 d 85 j 74.38	
		c	13.3						8.1			
		t'	24.3	9.7					13.3			
	Q		19.6	2.3		18.2		0				
4G[illegible]	M										b 35 D 90 d 85 j 74.38	
	Q											
G	M										b D d j	
	Q											
G	M										b D d j	
	Q											

			STRESS V	STRESS H	STRESS T	C Pt γ at n GIA	α	ΔQ	Pw	φ		SECTION
$^{3}G_{1}$	M	-1	2.5 4.4	4.3 3.5	2.0 3.5				3.17		b 35	
									0.9		D 45	
		c	2.6 5.0						3.7		d 40	
		0	10.3 11.9	4.3 3.5					2.2		j 61.25	
			7.2-8.4	2.0 1.3		12.9		0		11.4		D D10 @ 150
$^{3}G_{2}$	M	-1	6.8 19.5	3.3 2.9					14.7		b	
		c	7.4 22.3						16.8		D	
		0	14.3 26.4	3.3 2.9					19.6		d	
											j	
			9.6-19.5	0.9 0.7		12.9	1.38	2.0	0.0029	26.9		D D10 @ 100
$^{3}G_{3}$	M										b 35	
											D 90	
											d 85	
											j 74.38	
$^{3}G_{4}$	M	4'	26.7	3.8					16.3		b	
		c	19.7						12.0		D	
		5'	9.7	3.4					5.9		d	
											j	
			14.9	1.6		14.6		0		16.7		
$^{3}G_{5}$	M					12.2					b 40	
											D 150	
											d 143	
											j 106.9	
											0.4 30.0	
$^{3}G_{6}$	M	b	7.4	3.4					5.8		b 35	
		c	5.4						4.0		D 45	
		c' 5' f'	8.6	2.3					6.4		d 40	
											j 61.25	
			6.7	0.9		12.9		0		9.1		

			STRESS			C Pt γ mt Ц						SECTION
			V	H	T	QA	α	ΔQ	Pw	φ		
3G7	M	g'	14.4	2.3					10.7		b 35	
		c	8.3						6.9		D 75	
		h'	16.3	6.1					12.1		d 70	
											j 61.25	
	Q		12.4	1.2								
3G9	M	h'	26.1	6.8					16.0		b 35	
		c	13.4						8.2		D 90	
		i'	31.9	8.2					14.6		d 85	
											j 74.38	
											0.4 10.8	
	Q		17.8	1.5		15.6	1.45	0		19.9		
3G9	M										b D d j	
	Q											
G	M										b D d j	
	Q											
G	M										b D d j	
	Q											
G	M										b D d j	
	Q											

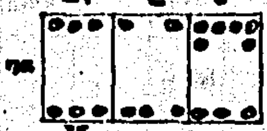
			STRESS V	STRESS H	STRESS T	C / Q_A	Pt / a	γ / ΔQ	at / Pw	D / φ		SECTION
$^{2}G_{1}$	M	-1	4.5-7.3	5.1 3.7		13.0	1.09	0	15.2		b 35 D 45 d 40 j 35	
		c	4.3						3.6			
		0	6.3-8.6	5.1 3.7		19.4	2.17	0	30.4			
	Q		5.9-6.8	2.4 1.4		7.4		0		16.4		
$^{2}G_{2}$	M	-1	9.5-25.9	6.9 7.2		15.1	0.83	0.75	20.3		b 35 D 75 d 70 j 61.25	
		0	15.5						11.5			
		c	13.3-29.8	6.9 7.2		16.2	1.24	0.4	30.4			
	Q		8.6-18.0	1.9 1.7		17.9	1.25	1.9	0.0029	24.8		D10 @100
$^{2}G_{3}$	M	-1	18.0	6.6		15.0	1.02	0.8	30.4		b 35 D 90 d 85 j 74.38	
		c	39.8						22.9			
		0	42.0	8.9		20.6	1.36	0.9	40.6			
	Q		31.2	4.6		15.6	1.36	10.0	0.0058	35.0		D13 @150 100
$^{2}G_{4}$	M	4'	3.9	7.6	11.5 3.17				4.4 1.4		b D 〃 d j	
		c	2.5						1.5			
		5'	4.9	7.3	9.2 5.4				3.8 2.1			
	Q		3.2	2.0	7.2							
G	M										b D d j	
	Q											
$^{2}G_{6}$	M	b	17.4	3.8							b 35 D 45 d 40 j 35	
		c	5.6						7.3			
		c' 5 f'	8.6	3.6		15.4	1.09	0.4	19.2			
	Q		6.7	1.2		7.4		0		16.0		

			STRESS V	H	T	C Pt γ at n: Q_A	a	ΔQ	Pw	φ		SECTION
2G7	M	f′ g′	10.8	3.6		19.8	1.45	0.7	20.3		b D d j	f′,g′ c h′ 45 35  ◻D10 @100
		c	3.3									
		h′	8.2	2.1		14.6			14.2			
	Q		8.4	1.2		7.4	1.0	1.0	0.0028	20.0		
2G8	M	h′	24.7	10.5					15.1		b 35 D 90 d 85 j 74.38	h′ c i′ 90 35 
		c	14.5						8.9			
		i′	23.2	9.7					14.3			
	Q		17.8	21		15.6	1.52	0		19.9		
2G9	M	e	24.5	11.0					15.0		b D d j	e c 90 35  ◻D10 @100
		c	15.0						9.2			
	Q		14.1	1.5		15.6		0		15.8		
G	M					2G9 Torsion Mt (from CS1) = 0.55 t/m × 9.7536 m/2 = 2.68 tm ψ_0 = 2 (80+25) = 210 cm A_0 = 80×25 = 2,000 cm² $a_t = \frac{M_t \psi_0}{2 f_t A_0}$ $= \frac{268 \times 210}{2 \times 2.0 \times 2000}$ = 7.0 → 4-D16					b D d j	
	Q											
G	M					$p_w = \frac{M_t}{2 f_t b A_0} + 0.002$ $= \frac{268}{2 \times 2 \times 35 \times 2{,}000} + 0.002$ = 0.00296					b D d j	
	Q											
G	M										b D d j	
	Q											

			STRESS V	H	T	C Pt γ at n QA	α	ΔQ	Pw	φ	
1G1	M	-1	3.0 4.7	18.7 11.6	21.7 / 13.7	12.7 / 9.2			10.1 / 9.3		b 35
		c	3.9								D 95
		e	3.1 14.1	12.7 15.6	23.8 / 11.6	18.0 / 6.8			12.0 / 5.4		d 90 / j 61.25
	Q		4.5 7.1	5.5 5.9	23.4	12.9 / 19.3	1.13	0 / 1.9	0.0027	21.2	
1G2	M	-1	14.9 38.1	18.1 13.1		21.6	1.66	0.95	40.6		b
		0	28.2						18.7		D '
		c	14.8 41.2	13.1 13.1		24.0	1.66	1.0	40.6		d / j
	Q		14.1 31.8	4.1 3.1		12.9	1.40	18.7	0.0084	43.5	
1G3	M	-1	31.8	9.8		12.6			19.4		b 35
		c	28.6						17.9		D 90 / d 85
		e	42.4	9.7		16.5	1.02	0.8	30.4		j 44.38
	Q		28.8	2.1		15.6	1.36	4.5	0.0037	28.9	
1G4	M	4'	2.0	8.9	6.9 / 10.9				2.7 / 4.3		b
		c	4.8								D ' / d
		5'	16.3	9.6					9.9		j
	Q		5.3	2.4	9.1	15.6		0		6.8	
1G5	M	b									b 35
		c	6.9						9.0		D 75 / d 40 / j 61.23
		c'	10.2	9.9	20.1				9.4		
	Q		7.5	1.9		12.9		.01		10.2	
1G7	M	f' g'	13.6	5.9					11.6		b
		c	12.4						9.2		D ' / d
		h'	9.8	14.3	24.1 / 4.5				11.2 / 2.1		j
	Q		2.9-10.0	1.9-2.9		12.9		.01		17.6	

SECTION

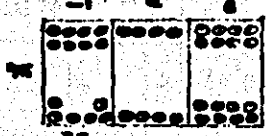
-1 c e



35

D10 @150

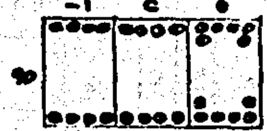
-1 c e



35

D13 @75

-1 c e



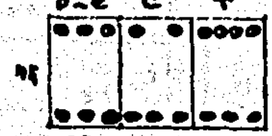
35

D16 @100 13

4' c 5'

35

b~e' c f'



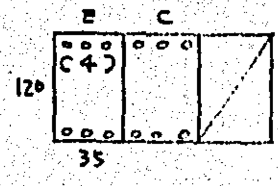
35

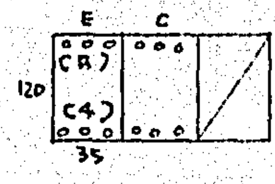
f',g' c h'

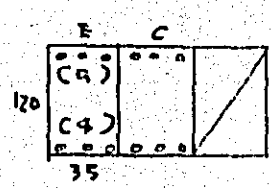
35

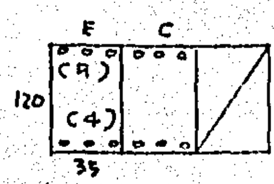
( ) = CASE 2 , M/S-BAR , UNLESS NOTED SAME TO CASE 1

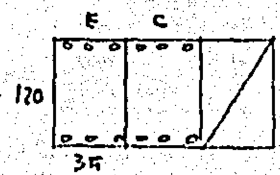
			STRESS			C Pt γ at n						SECTION
			V	H	T	QA	α	ΔQ	Pw	φ		
FG 1	M	E	1.0–1.7	11.4-16.1	19.4 17.4				5.7 (11.8) 5.1 (10.6)		b 35.56 D 121.92 d 111.92 j 97.73	
		c	9.1						1.9			
	Q		2.8-3.5	8.6-6.1	200	31.3		0		17.0 (18.9)		
FG 2	M	E	5.6–11.9	14.9 13.9	25.8 9.3				7.5 (15.7) 2.7 (5.6)		b D d j	
		c	16.2						7.5			
	Q		7.9	4.1-3.3	16.1	31.3		0		14.7 (15.2)		
FG 3	M	-1	6.3	9.0	15.3 2.7				7.1 (4.3) 1.8 (1.6)		b D d j	
		c	3.9						1.8			
		0	9.1	21.6	30.7 12.5				9.0 (18.6) 3.6 (7.6)			
	Q		5.7	3.2	11.6	31.3		0		9.9 (11.0)		
FG 4	M	4'	3.1	23.3	26.4 20.2				7.7 (16.0) 5.9 (12.3)		b D d j	
		c	6.9						3.2			
		5'	1.8	9.4	7.6 11.2				2.2 (4.6) 3.3 (6.8)			
	Q		4.6	4.3	13.2	31.3		0		11.2 (12.5)		
FG 6	M	b	1.5	6.6	7.1 5.1				2.1 (4.3) 1.5 (3.1)		b D d j	
		c	2.6						1.2			
		c' f, f'	4.5	5.4	9.9 0.9				2.9 (6.0) 0.3 (0.6)			
	Q		4.2	1.8	7.8	31.3		0		6.6 (7.4)		
FG 7	M	f', g'	3.4	3.5	8.9 2.1				2.6 (5.4) 0.6 (1.3)		b D d j	
		c	1.5						0.7			
		h'	6.5	15.6	22.1 9.1				6.4 (13.4) 2.7 (5.5)			
	Q		4.0	3.1	10.2	31.3		0		8.7 (9.6)		

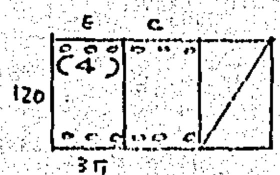


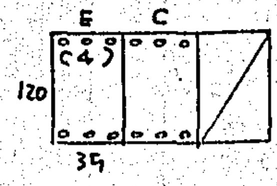
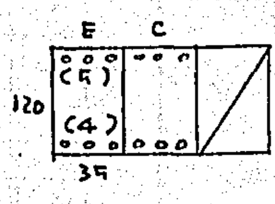
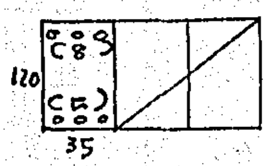
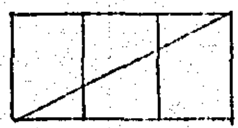
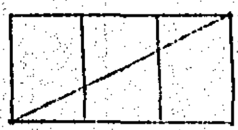






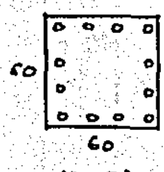
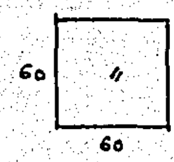
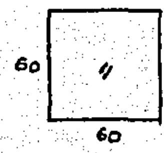
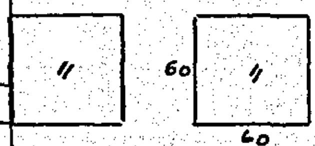
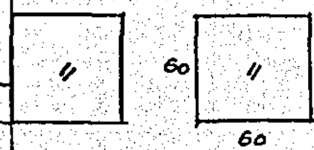




			STRESS			C / Q_A	Pt / α	γ / △Q	mt / Pw	η / φ		SECTION
			V	H	I							
F G 8	M	R′	3.1	10.8	13.9 / 7.7				4.1 (8.4) 2.2 (4.5)		b D d J	
		c	1.1						0.5			
		L′	6.5	18.9	25.4 / 12.4				7.4 (15.4) 3.6 (7.9)			
	Q		4.0	3.0	10.0	31.3		0		8.5 (9.9)		
F G 9	M	R′	7.9	19.1	27.0 / 11.7				7.9 (16.4) 3.3 (6.8)		b D d J	
		c	9.6						3.2			
		L′	5.7	19.1	24.8 / 13.4				7.2 (14.7) 3.9 (8.1)			
	Q		5.3	1.5	8.3	31.3		0		7.1 (7.8)		
F G 10C	M	E	6.6	33.5	40.1 / 26.9				11.6 (24.3) 7.8 (16.3)		b D d j	
		c	5.8						2.7			
	Q		5.1	6.9	12.9	31.3		0		16.1 (17.8)		
G	M										b D d J	
	Q											
G	M										b D d J	
	Q											
G	M										b D d J	
	Q											

5. — DESIGN OF COLUMN

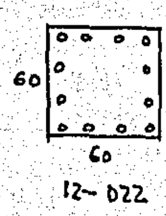
( ) = CASE 2, M/S BAR, UNLESS NOTED SAME TO CASE 1.

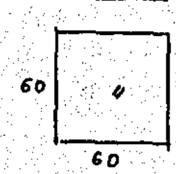
Column	Dir.		STRESS V	STRESS H	STRESS T	N/BD M/BD² Pt at — QA ΔQ Pw φ		SECTION
$_2C$ c'o'	X	N	39.4	2.0	41.4 / 37.4		B 60 pg 0.8	
		M U	-4.0	4.3	0.3 / 8.3		D 〃 ag 28.8	
		M L	-3.6	0.8	2.8 / 4.4		J 48.125	
		Q	2.3	1.5	5.3	17.3 / 26.0 0		
	Y	N	39.4	0.2	39.6 / 39.7		B	12-D22
		M U	-5.9	4.3	10.2 / 1.6		D	(12-7/8")
		M L	5.7	2.5	8.2 / 3.7		J	
		Q	3.4	1.7	6.8	〃 0		
$_1C$	X	N	80.3	4.4	84.7 / 75.9		B	
		M U	-3.7	4.3	0.6 / 8.0		D	
		M L	-4.2	6.4	2.2 / 10.6		J	
		Q	-2.5	3.4	9.3	〃 0		
	Y	N	80.3	0.2	80.5 / 80.1		B	
		M U	1.7	3.6	5.3 / 1.9		D	
		M L	2.9	4.4	7.3 / 1.5		J	
		Q	0.17	2.5	5.17	〃 0		
$_GC$	X	N	131.5	13.2	144.7 / 118.3	40.2 / 32.9	B	
		M U	-1.5	12.3	10.8 / 13.8		D	
		M L	-0.6	18.4	17.8 / 19.0	8.2 / 8.8 0 (0)	J	
		Q	-0.4	5.9	12.2	〃 0		
	Y	N	131.5	2.4	133.9 / 129.1		B	
		M U	1.9	5.5	7.4 / 3.6		D	
		M L	1.5	10.3	11.8 / 8.8		J	
		Q	0.17	3.1	6.9	〃 0		
$_2C$ g'o'	X	N	70.7	0.7	71.4 / 70.0		B	
		M U	11.4	2.9	14.3 / 8.5		D	
		M L	5.8	1.6	7.4 / 4.2		J	
		Q	5.1	1.3	7.7	17.3 / 26.0 0		
	Y	N	70.7	0.4	71.1 / 70.3		B	(18-7/8") 14-D22
		M U	0.3	4.3	4.6 / 4.0		D	
		M L	0.7	1.4	2.1 / 0.7		J	
		Q	0.1	1.7	3.5	〃 〃		
$_1C$	X	N	123.6	2.4	126.0 / 121.2	34.3	B	
		M U	7.6	5.6	13.2 / 2.0		D	
		M L	13.8	3.8	17.6 / 10.0	6.4 0.5 18.0 (0.65) (23.4)	J	
		Q	6.7	3.0	12.7	〃 〃		
	Y	N	123.6	0.1	123.7 / 123.5		B	
		M U	1.8	5.5	7.3 / 3.7		D	
		M L	1.5	5.5	7.0 / 4.0		J	
		Q	1.0	3.4	7.8	〃 〃		
$_GC$	X	N	182.1	5.5	187.6 / 176.6		B	
		M U	9.3	9.3	18.6 / 0		D	
		M L	9.3	13.9	23.2 / 4.6		J	
		Q	3.6	4.9	13.4	〃 〃		
	Y	N	182.1	0.9	183.0 / 181.2		B	
		M U	0.5	5.7	6.2 / 5.2		D	
		M L	0.2	10.5	10.7 / 10.3		J	
		Q	0.1	3.1	6.3	〃 〃		

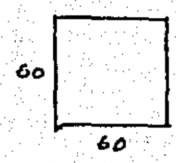
			STRESS V	STRESS H	STRESS T	N/BD, M/BD², Pt, at / Q_A, ΔQ, Pw, φ	B, D, j	SECTION
$_4C$ (1'1')	X	N					B	90 × 60
		M U					D	
		M L					j	
		Q						
	Y	N	46.9	0		8.7	B 60 Pg 1.8	16-D22
		M U	25.4	0		5.2 0.12 (0.2) 6.5 (10.8)	D 90 ag 43.2	(16-7/8")
		M L	8.7	0			j 74.375	
		Q	11.8	0		26.8 / 40.2 0		
$_4C$ (8'0')	X	N					B 90 Pg 0.8	90 × 90
		M U					D 90 ag 64.8	
		M L					j 74.375	
		Q						
	Y	N	96.6	1.4	98.0 / 95.2	11.9	B	20-D22
		M U	23.5	6.7	30.2 / 16.8	3.2 (0/0)	D	(20-7/8")
		M L	17.6	0	17.6		j	
		Q	14.2	2.3	18.8	40.2 / 60.2 0		
$_3C$	X	N					B	90 × 90 〃
		M U					D	
		M L					j	
		Q						
	Y	N	210.5	3.7	214.2 / 206.8		B	
		M U	7.4	12.4	19.8 / 5.0		D	
		M L	5.5	5.3	10.8 / 0.2		j	
		Q	3.3	4.5	12.3	〃 0		
$_2C$	X	N	323.6	1.3	324.9 / 322.3		B	90 × 90
		M U	10.2	9.5	19.7 / 0.7		D	
		M L	20.0	1.7	21.7 / 18.3		j	
		Q	8.9	3.3	15.2	〃 0		
	Y	N	323.6	4.0	327.6 / 319.6		B	
		M U	4.3	7.6	11.9 / 3.3		D	
		M L	10.6	3.2	13.8 / 7.4		j	
		Q	4.4	3.2	10.8	〃 0		
$_1C$	X	N	401.3	2.9	414.2 / 398.4		B	90 × 90
		M U					D	
		M L					j	
		Q						
	Y	N	401.3	5.2	406.5 / 396.1		B	
		M U	5.9	9.4	15.3 / 3.5		D	
		M L	5.1	5.0	10.1 / 0.1		j	
		Q	0.2	4.5	9.2	〃 0		
$_0C$	X	N	450.1	5.0	455.1 / 445.1	56.2	B	90 × 90
		M U	13.5	3.8	17.3 / 9.7	4.3 (0/0)	D	
		M L	9.1	21.6	30.7 / 12.5		j	
		Q	6.7	4.9	16.5	〃 0		
	Y	N	450.1	2.3	452.4 / 447.8	55.9	B	
		M U	4.7	8.8	13.5 / 4.1	3.8 (0/0)	D	
		M L	1.4	26.4	27.8 / 25.0		j	
		Q	0.6	6.8	14.3	〃 0		

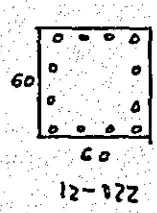
Member	Dir.			STRESS V	STRESS H	STRESS T	N/BD M/BD² Pt at / QA ΔQ Pw φ		
$_2C^{R'-1}$	X	N		155.1	5.4	160.5 / 149.7	44.6 / 41.6	B	60 0.8
		M	U	0	3.1	3.1	1.4 0 (0)	D	〃 28.8
			L	0	1.0	1.0		J	48.175
		Q		0	1.2	1.2	17.3 / 26.0 0		
	Y	N						B	
		M	U					D	
			L					J	
		Q							
$_1C$	X	N		234.8	7.0	241.8 / 227.5		B	
		M	U					D	
			L					J	
		Q							
	Y	N						B	
		M	U					D	
			L					J	
		Q							
$_9C$	X	N		286.1	9.1	295.2 / 277.0	82.0 / 76.9	B	
		M	U	1.5	6.0	7.5 / 4.5		D	
			L	2.6	9.0	11.6 / 6.4	5.4 0 (0)	J	
		Q		0.8	2.9	5.3	〃 0		
	Y	N						B	
		M	U					D	
			L					J	
		Q							
$_2C^{R'5'}$	X	N		24.8	1.6	26.4 / 23.2		B	
		M	U	9.7	3.4	13.1 / 6.3		D	
			L	6.9	1.5	8.4 / 5.4		J	
		Q		4.9	1.5	7.9	17.3 / 26.0 〃		
	Y	N						B	
		M	U					D	
			L					J	
		Q							
$_1C$	X	N		49.2	3.6	52.8 / 45.6	13.7 / 12.7	B	
		M	U	-5.0	5.8	0.8 / 10.8	6.6 0.27 / 8.1 0.12	D	
			L	-14.3	3.3	11.0 / 17.6		J	
		Q		6.0	2.5	9.8	〃 〃		
	Y	N						B	
		M	U					D	
			L					J	
		Q							
$_9C$	X	N		82.6	6.0	88.6 / 76.6		B	
		M	U	-8.5	6.3	2.2 / 14.8		D	
			L	-1.8	9.4	7.6 / 11.2		J	
		Q		2.0	3.0	8.0	〃 〃		
	Y	N		82.6	30.3	112.9 / 52.3	20.9 / 9.7	B	
		M	U	0	62.3	62.3	12.8 0.38 20.5 (0.70) (37.8)	D	
			L	0	33.5	33.5		J	
		Q		0	18.5	37.0			

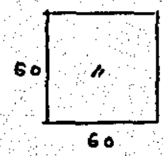
SECTION

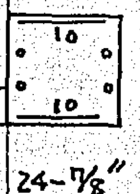


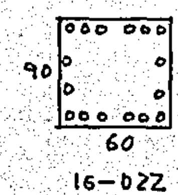




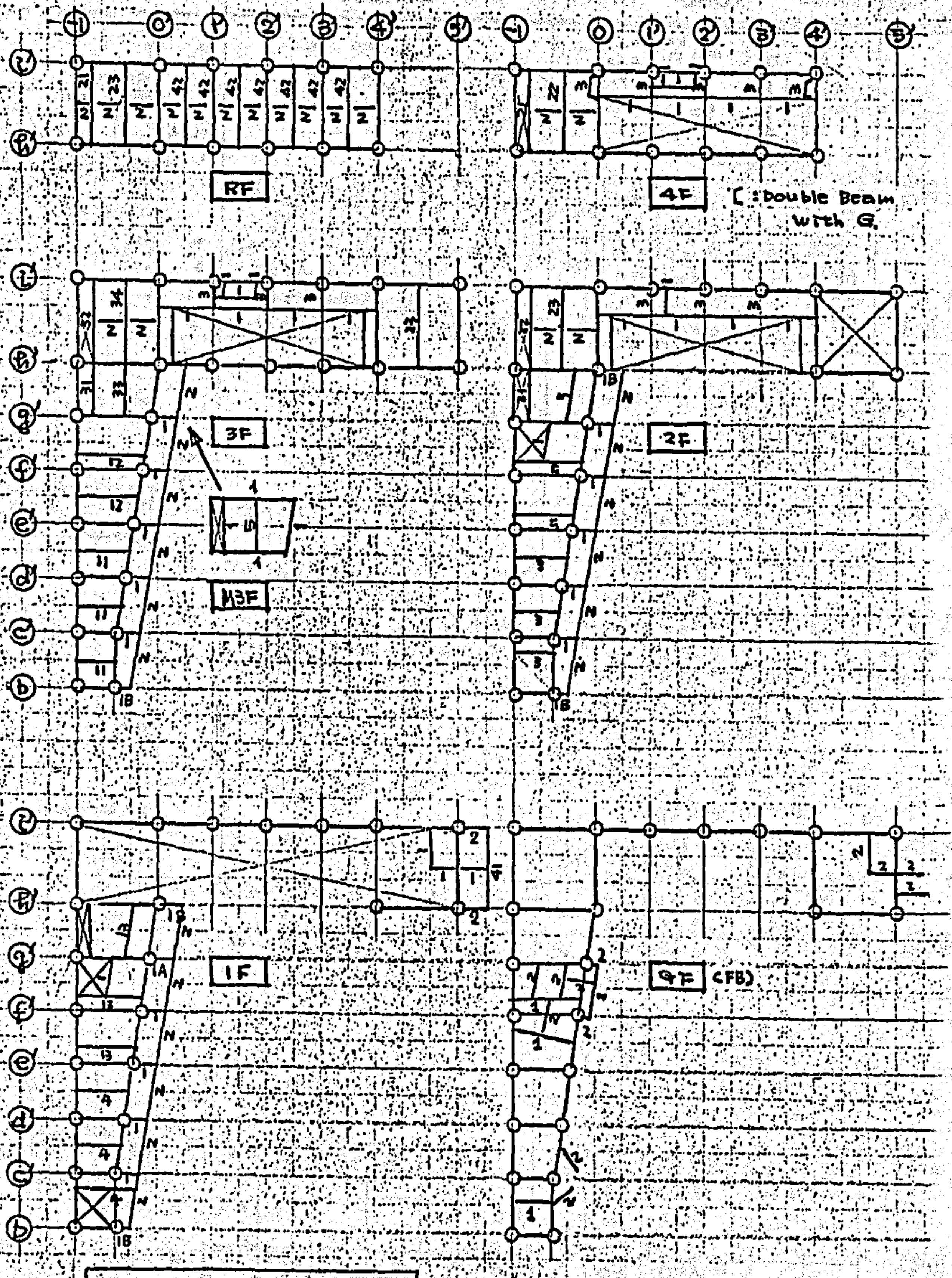








6-DESIGN OF SUB MEMBER

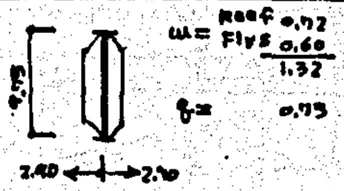


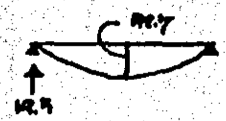
CANTILEVER & SUBBEAM MARK KEYPLAN

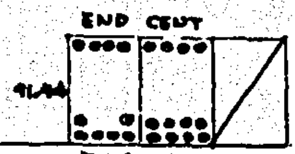
	LOAD	STRESS	SECTION

$_{R}B_{R}$

(0)-(1) (h)-(i)







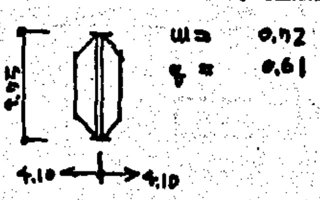
C	1.32 × 2 × 10.9	28.8	34.7
	0.75 × 9.75²/12	5.9	
M	× 16.6	43.8	52.7
	× 9.75²/8	8.9	
Q	× 6.0	14.8	19.5
	× 9.75/2	3.7	

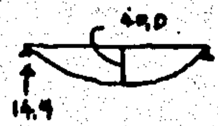
	C	Pt	γ	at	n
Mc	52.7				31.7
Q	ψA	α	ΔQ	Pw	φ
19.5	18.8	1.0	0.7	0.0023	12.8

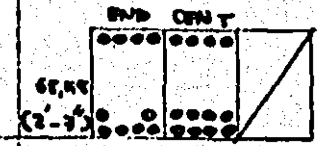
39.56 φD25
□D10-@150
b 39.56
D 41.44
d 36.44
j 31.66

$_{R}B_{23}$

(1)-(0) (h)-(i)







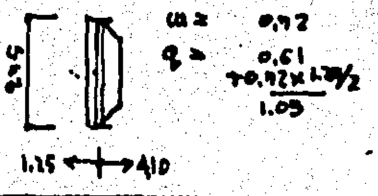
C	0.72 × 2 × 14.9	21.5	26.3
	0.61 × 9.75²/12	4.8	
M	× 22.8	32.8	40.0
	× 9.75²/8	7.2	
Q	× 7.9	11.4	14.4
	× 9.75/2	3.0	

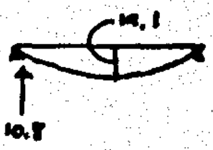
	C	Pt	γ	at	n
Mc	40.0				32.7
Q	ψA	α	ΔQ	Pw	φ
14.4	13.8	1.0	0.7	0.0024	12.3

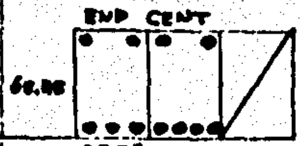
39.56 φD25
□D10-@150
b 39.56
D 68.86
d 63.86
j 55.63

$_{R}B_{21}$

(1)-(0) (h)-(i)







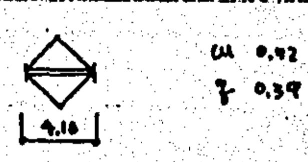
C	0.72 × × 14.9	10.8	19.1
	1.05 × × 2.75²/12	8.3	
M	× 22.8	16.4	28.9
	× /8	12.5	
Q	× 7.9	5.7	10.8
	× 8.75/2	5.1	

	C	Pt	γ	at	n
Mc	19.1				19.6
Q	ψA	α	ΔQ	Pw	φ
10.8	13.8		0		9.2

39.56 φD25
□D10-@150

$_{R}B_{1}$

(1)-(h) (0)-(0)



C	0.72 × 2 × 1.8	2.6	3.1
	0.39 × 4.1²/12	0.5	
M	2.9	4.3	5.1
	× /8	0.8	
Q	× 2.1	3.0	3.8
	× 4.1/2	0.8	

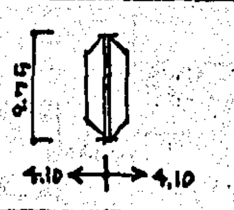
	C	Pt	γ	at	n
Mc	5.1				6.5
Q	ψA	α	ΔQ	Pw	φ
3.8	6.3				9.9

23.40 (0'-10") φD19
□D10-@150
b 23.40
D 45.72
d 40.72
j 35.63

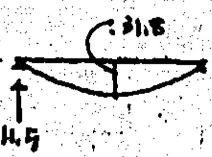
	LOAD	STRESS	SECTION

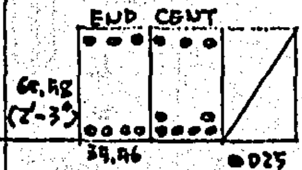
$_4B_{22}$

①-⓪' Ⓚ-Ⓛ'



ω 0.54
q 0.61





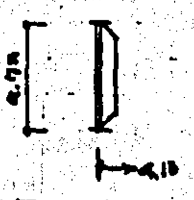
C	0.54×2 ×14.9		16.1	20.9
	0.61 ×9.93²/12		4.8	
M		×22.8	24.6	31.8
		×9.93²/8	7.2	
Q		×7.9	8.5	11.5
		×9.75/2	3.0	

	C	Pt	γ	at	n
Mc	31.8				26.0
Q	QA	α	ΔQ	Pw	φ
11.5	13.8		0		9.8

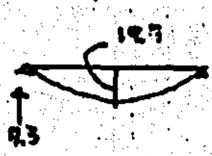
□D10-@150
b 38.86
D 68.58
d 63.58
j 55.63

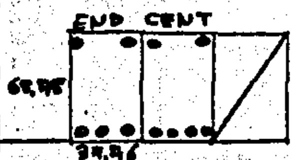
$_4B_{21}$

①-⓪' Ⓚ'-Ⓛ'



ω 0.54
q 0.61





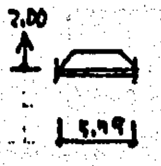
C	0.54	×14.9	8.0	12.8
	0.61	×9.93²/12	4.8	
M		×22.8	12.3	19.9
		×9.93²/8	7.2	
Q		×7.9	4.3	7.3
		×9.75/2	3.0	

	C	Pt	γ	at	n
Mc	19.9				18.9
Q	QA	α	ΔQ	Pw	φ
7.3	13.8		0		6.2

□D10-@150
4

$_4B_1$

Ⓚ-Ⓛ' ⓪-Ⓟ

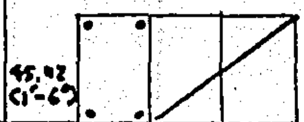


ω 0.54
q 0.39

0.54×2/4+0.39=0.93

k=0.75 k=1.00

	0.43	0.57		
−2.6	+2.6	−2.6		+2.6
+2.6	+1.3			
(2.7) 3.9	−0.6	−0.7	(2.7) 3.9	
0	+3.3	−3.3		−2.6
2.2 (3.3)			0.9 (2.8)	



25.40 (0-K') -D19

C	0.93	×5.99²/12	2.6	2.6
M		×5.99²/8	3.9	3.9
Q		×5.99/2	2.9	2.7

	C	Pt	γ	at	n
M E	3.3				4.3
M c	2.2				
Q	QA	α	ΔQ	Pw	φ
3.3	6.3				6.6

□D10-@150
b 25.40
D 45.92
d 40.92
j 35.63

B

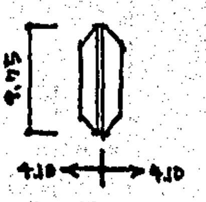
○-○ ○-○

C				
M				
Q				

	C	Pt	γ	at	n
M					
Q	QA	α	ΔQ	Pw	φ

	LOAD	STRESS	SECTION

$_3B_{34}$

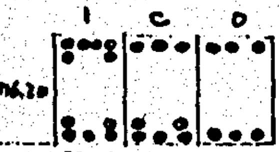


ω 0.66
q 0.61

Moment distribution: 0.59 | 0.41; −11.4 +11.4 | +11.4 −24.8 | +24.8 −24.7; (8.8) 17.7 | (13.4) 37.3; 3.4 (13.2) | 23.0 (16.3)

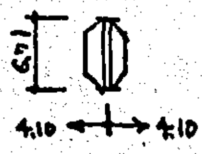
C	0.66 × 2 × 14.9	19.7	24.5
	0.61 × 9.15²/12	4.8	
M	× 22.8	30.1	39.3
	× 9.15²/8	9.2	
Q	× 7.9	10.4	13.4
	× 9.15/2	3.0	

M	C	Pt	γ	mt	n
0	0				
c	23.0				16.9
1	28.7	15.9	1.20	0.83	30.4
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
16.3	18.8	1.18	0		18.7



39.86 ●D25
□D10 @150
b 35.86
D 96.20
d 91.20
j 62.30

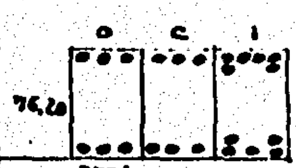
$_3B_{33}$



ω 0.92
q 0.61

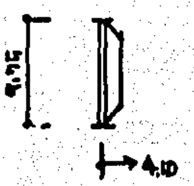
C	0.92 × 2 × 6.4	9.1	11.4
	0.61 × 6.91²/12	2.3	
M	× 10.1	14.3	17.7
	× 6.91²/8	3.4	
Q	× 4.8	6.8	8.9
	× 6.91/2	2.1	

M	C	Pt	γ	mt	n
1	28.7				
c	3.4				22.9
0	0				
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
13.2	15.5		0		10.1



39.36 ●D25
□D10 @150

$_3B_{32}$

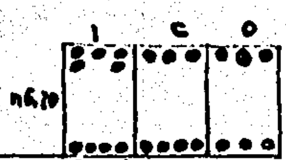


ω 0.66
q 0.61 + W 1.08 = 1.69

Moment distribution: 0.59 | 0.41; −6.9 +6.9 | +6.9 −23.2 | +23.2 −23.2; (5.5) 8.8 | (17.4) 37.6; +24.8 | −24.8; −3.6 (9.2) | 25.2 (15.9)

C	0.66 × 14.9	9.8	23.2
	1.69 × 9.15²/12	13.4	
M	× 22.8	15.0	37.6
	× 9.15²/8	22.6	
Q	× 7.9	5.2	13.4
	× 9.15/2	8.2	

M	C	Pt	γ	mt	n
0	0				
c	25.2				18.4
1	24.8	13.8	1.00	0.17	26.4
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
13.9	18.9	1.24	0		



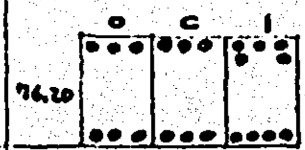
35.56 ●D25
□D10 @150

$_3B_{31}$

ω 0.92
q 0.61

C	0.92 × 6.4	4.6	6.9
	0.61 × 6.91²/12	2.3	
M	× 10.1	7.3	8.8
	× 6.91²/8	1.5	
Q	× 4.8	3.5	5.5
	× 6.91/2	2.0	

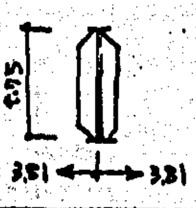
M	C	Pt	γ	mt	n
1	24.8				
c	−3.6				
0	0				
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
9.2	15.8		0		



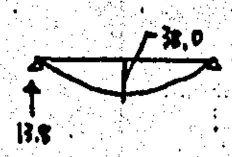
39.36 ●D25
□D10 @150

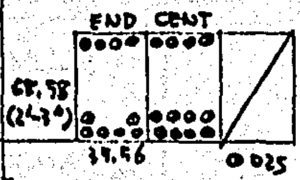
	LOAD	STRESS	SECTION

$_3B_{23}$ (④⑤ ⓗⓘ)



ω 0.92
q 0.61

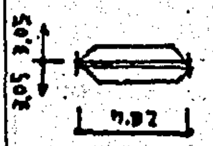




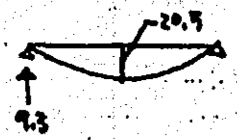
						C	Pt	γ	mt	n
C	0.92 × 2	× 14.0	20.2	25.0						
	0.61	× 9.15²/12	4.8							
M		× 21.4	30.8	38.0	Mc	38.0				31.6
		× /8	7.2							
Q		× 7.5	10.8	13.8	Q	QA	α	ΔQ	Pw	φ
		× 9.15/2	3.0		13.8	13.8		0		13.8

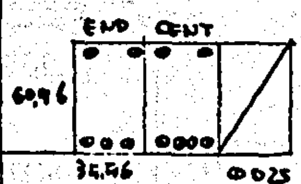
35.56 Φ D25
□D10-@150
b 35.56
D 68.58
d 63.58
j 55.63

$_3B_{12}$ (④⑤ ⓘⓙ)



ω 0.92
q 0.61

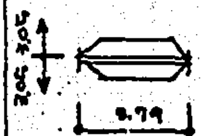




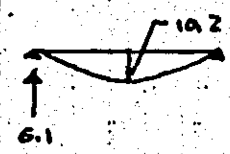
						C	Pt	γ	mt	n
C	0.92 × 2	× 9.2	10.4	13.5						
	0.61	× 7.32²/12	3.1							
M		× 11.0	15.8	20.5	Mc	20.5				19.0
		× /8	4.1							
Q		× 4.8	6.9	9.3	Q	QA	α	ΔQ	Pw	φ
		× 7.82/2	2.4		9.3	12.2		0		10.6

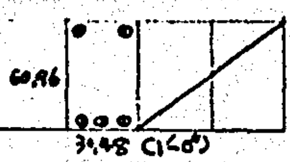
35.56 Φ D25
□D10-@150
b 35.56
D 60.96
d 55.96
j 48.97

$_3B_{11}$ (②③ ⓘⓙ)



ω 0.92
q 0.44

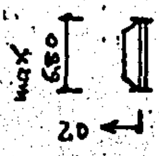




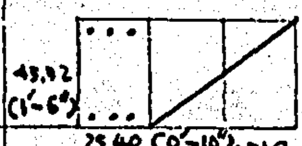
						C	Pt	γ	mt	n
C	0.92 × 2	× 3.17	5.3	6.5						
	0.44	× 5.79²/12	1.2							
M		× 5.8	8.4	10.2	Mc	10.2				7.5
		× /8	1.8							
Q		× 3.3	4.8	6.1	Q	QA	α	ΔQ	Pw	φ
		× 5.79/2	1.3		6.1	9.0		0		6.9

30.48 (1'-0")
□D10-@150
b 30.48
D 60.96
d 55.96
j 48.97

$_3B_2$ (③④ ⓗⓘ)



ω 0.92
q 0.39 + 0.23 = 0.62
0.92 × 1 + 0.62 = 1.34

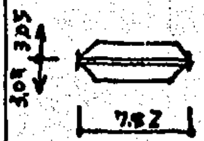


						C	Pt	γ	mt	n
C	1.34	× 6.8²/12		5.2						
M		× /8		7.7	Mc	5.2				6.6
Q		× 6.8/2		4.6	Q	QA	α	ΔQ	Pw	φ
					4.6	7.4		0		9.2

25.40 (0'-10") D19
□D10@150
b 25.40
D 45.72
d 40.72
j 35.63

	LOAD	STRESS	SECTION

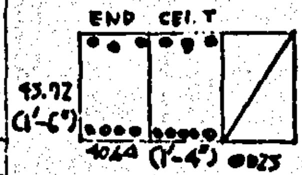
$_2B_7$



w 0.66
q 0.39

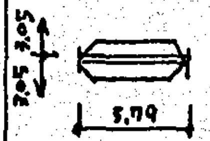
C	0.66 × 2 × 7.2	9.5	11.5
	0.39 × × 7.82²/12	2.0	
M	× 11.0	14.5	17.5
	× /8	3.0	
Q	× 4.8	6.3	7.8
	× 7.82/2	1.5	

	M	C	Pt	γ	at
Mc	17.5				22.3
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
7.8	5.7		0		10.4



□ D10 @150
b 40.64
D 45.92
d 40.92
j 35.63

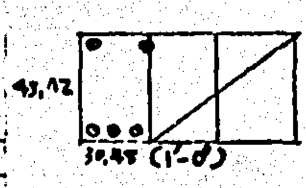
$_2B_3$



w 0.66
q 0.39

C	0.66 × 2 × 3.7	4.9	6.0
	0.39 × 5.79²/12	1.1	
M	× 5.8	7.7	9.3
	× /8	1.6	
Q	× 3.3	4.4	5.5
	× 5.79/2	1.1	

	M	C	Pt	γ	at
Mc	9.3				11.9
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
5.5	6.5		0		9.4



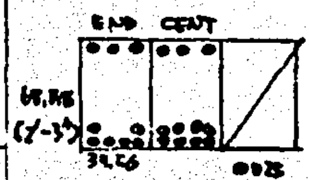
□ D10 @150
b 30.48
D 45.92
d 40.92
j 35.63

$_2B_{23}$

C M Q = $_3B_{34}$

C			24.5
M			37.3
Q			13.4

	M	C	Pt	γ	at
Mc	37.3				30.5
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
13.4	13.5		0		17.4



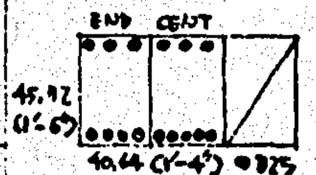
□ D10 @150
b 35.56
D 68.58
d 63.58
j 55.63

$_2B_5$

C M Q = $_3B_{33}$

C			11.4
M			17.7
Q			8.9

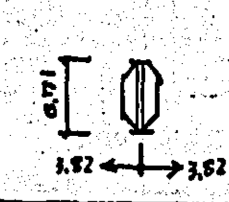
	M	C	Pt	γ	at
Mc	17.7				22.6
Q	**QA**	**α**	**ΔQ**	**Pw**	**φ**
8.9	8.7	1.0	0.2	0.0021	13.9



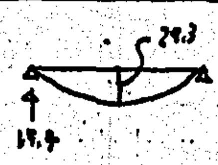
□ D10 @150
b 40.64
D 45.92
d 40.92
j 35.63

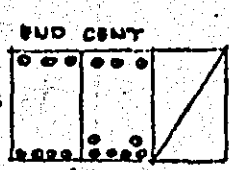
	LOAD	STRESS	SECTION

1B_B (①⑩' ⑧⑧')



w 0.96
q B 0.44 + W 1.53 / 1.97



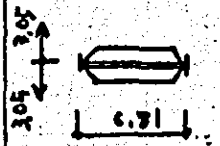


C	0.96 × 2 1.97	× 6.1 × 6.71²/12	11.7 7.4	19.1
M		× 9.5 × /8	18.2 11.1	29.3
Q		× 4.6 × 6.71/2	3.8 6.6	13.4

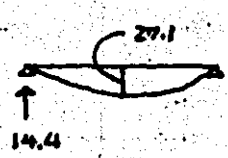
	M	C	Pt	γ	at
Mc	29.3				29.2
Q	Qa	α	ΔQ	Pw	R
13.4	10.4	1.0	4.0	0.0049	14.0

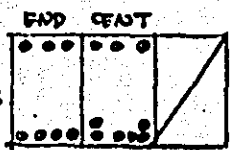
□ D13-@150
b 35.56
D 60.96
d 55.96
j 48.97

1B_B (⑥⑦' ①⑩')



w 0.96
q 1.97



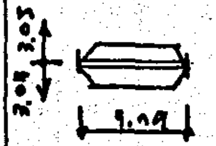


C	0.96 × 2 1.97	× 5.3 × 6.81²/12	10.2 7.6	17.8
M		× 8.2 × /8	15.7 11.4	27.1
Q		× 4.0 × 6.81/2	7.7 6.7	14.4

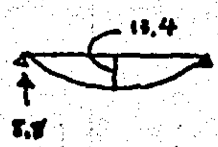
	M	C	Pt	γ	at
Mc	27.1				27.2
Q	Qa	α	ΔQ	Pw	R
14.4	10.4	1.0	4.0	0.0043	14.0

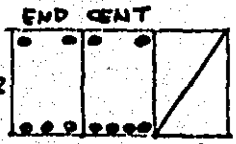
□ D13-@150
b 35.56
D 60.96
d 55.96
j 48.97

1B_4 (⑥⑦' ①⑩')



w 0.59
q B 0.39 + W 1.18 / 1.57



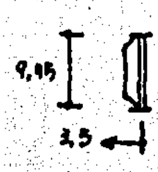


C	0.59 × 2 1.57	× 3.7 × 5.09²/12	4.4 4.4	8.8
M		× 5.8 × /8	6.8 6.6	13.4
Q		× 3.3 × 5.09/2	3.9 4.5	8.4

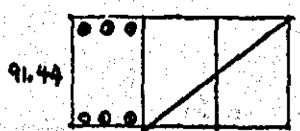
	M	C	Pt	γ	at
Mc	13.4				12.1
Q	Qa	α	ΔQ	Pw	R
8.4	7.6	1.0	0.8	0.0026	11.2

□ D10 @ 150
b 35.56
D 45.72
d 40.72
j 35.56

1B_41 (⑥○ ⑪⑪')



w 0.72
q 0.79



C	0.72 0.75	× 13.0 × 9.95²/12	9.4 5.9	15.3
M		× 19.8 × /8	14.3 9.9	23.2
Q		× 7.0 × 9.95/2	5.0 3.7	8.7

	M	C	Pt	γ	at
Mc	23.2				13.9
Q	Qa	α	ΔQ	Pw	R
8.7	16.2				5.5

□ D10 @ 150
b 35.56
D 91.44
d 86.44
j 75.64

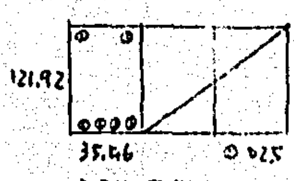
	LOAD	STRESS	SECTION

FB1

⑤ ⑧ ① ⓪

$q \doteqdot B_{1.04} + W_{2.43} \times 2 = 5.90$ (span 7.82)

					M	C	Pt	γ	nt
C									
M	5.90	× 7.81²/8	45.1	Mc	45.1				20.3
Q		× 7.82/2	23.1	Q	Qa	α	ΔG	Pw	φ
				23.1	20.9	1.45	0		11.2



DD10-@150
b 35.56
D 121.92
d 111.92
j 97.93

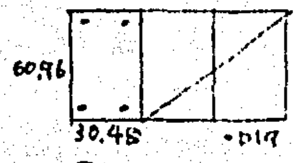
c.f.

FB2

○○ ○○

$q \doteqdot B_{0.92} + W_{2.43} = 2.97$ (span 3.05)

					M	C	Pt	γ	nt
C									
M	2.97	× 3.05²/8	3.9	Mc	3.5				3.6
Q		× 3.05/2	4.5	Q	Qa	α	ΔG	Pw	φ
				4.5	8.2		0		4.8



DD10-@150
b 30.48
D 60.96
d 50.96
j 44.59

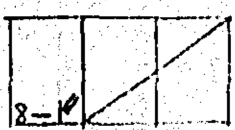
B

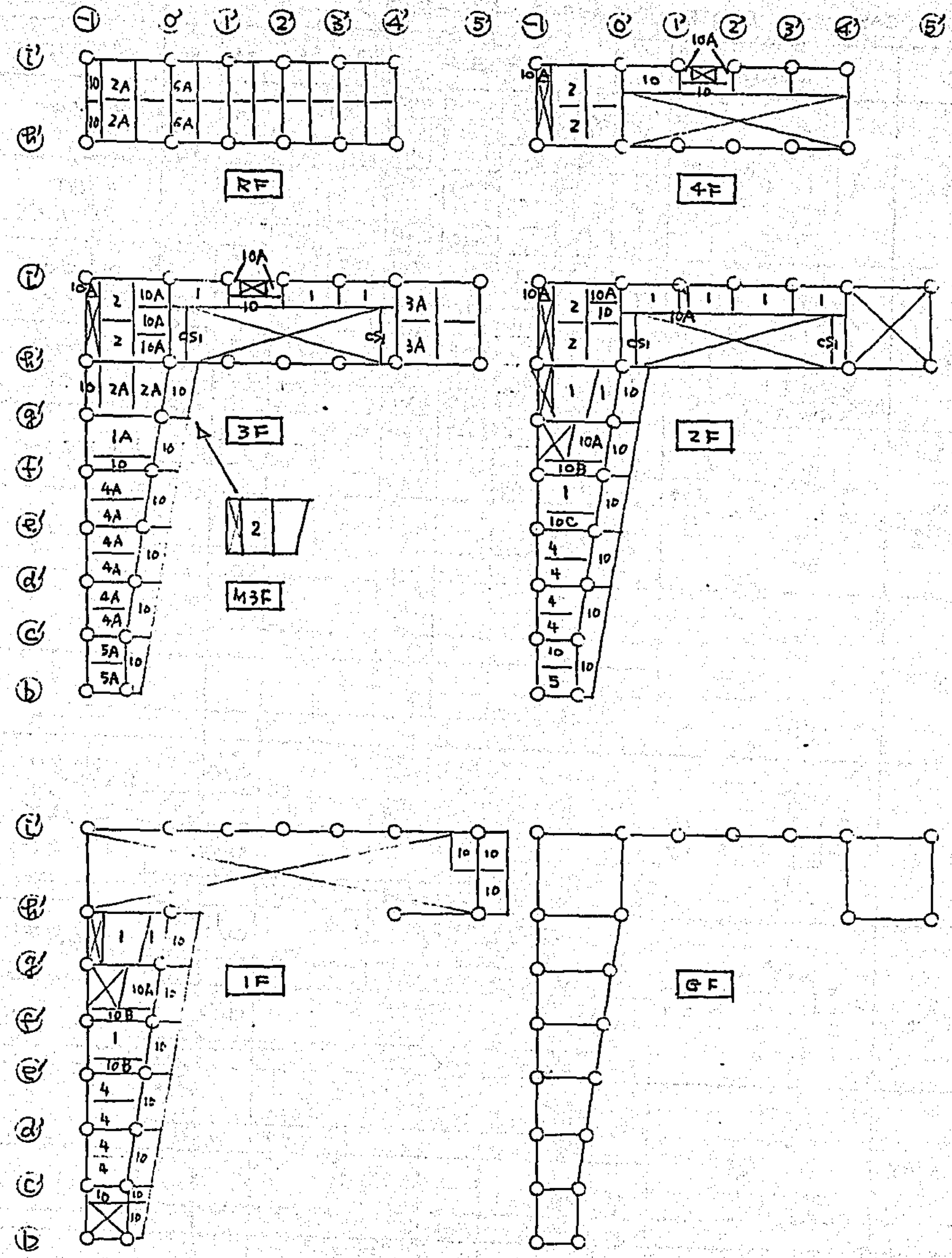
○○ ○○

					M	C	Pt	γ	nt
C									
M				M					
Q				Q	Qa	α	ΔG	Pw	φ

FB1 CASE-2 M/S-BAR

					M	C	Pt	γ	nt
C									
M				M					36.48
Q				Q	Qa	α	ΔG	Pw	φ
									18.8





SLAB KEYPLAN

CASE－1 D-BAR (CASE-2 M/S－BAR)

	LOAD			STRESS			D	J	at	φ	SECTION
$_RS_{6A}$	$2,895^{6}$ × $4,896^{8}$ ω 0,74 λ 1,7	X	M E/C	6.20	0,075	0,47	12.7		2.6 (4.5)		D10 @200 (1/2") ~
			Q	2.14	0.52	1.11		8.9		6.9 (11.4)	
		Y	M E/C		0.042	0.26			1.6 (2.8)		〃 @250 ~
			Q		0.46	0.99		8.1		6.8 (11.3)	
$_RS_{2A}$	$4,099^{4}$ × $4,896^{8}$ ω 0,74 λ 1.2 $D \geq \frac{4,099^{4}}{15+24\times1.2} = 9.2$[illegible]	X	M E/C	12.44	0,056	0,90	12.7		3.9 (6.8)		D10 @150 (1/2") ~
			Q	3.03	0.49	1.49				9.3 (15.5)	
		Y	M E/C		0,037	0.46			2.8 (4.9)		〃 @250 ~
			Q		0.45	1.37				9.4 (15.7)	
$_RS_{10}$	$1,250$ × $9,953^{6}$ ω 0,74 λ 7.8	X	M E/C	1.16	0,083	0.10	12.7		0.6 (1.0)		D10 @200 (1/2") D.
			Q	0.93	0.51	0.47				4.4 (7.3)	
		Y	M C								〃 200 D.
			Q								
S		X	M E/C								
			Q								
		Y	M E/C								
			Q								
$_4S_2$	$4,099^{4}$ × $4,896^{8}$ ω 0.59 λ 1.2	X	M E/C	9.91	0,056	0.56	12.7		3.1 (5.4)		D10 @150 (1/2") ~
			Q	2.43	0.49	1.19		8.9		7.4 (12.3)	
		Y	M E/C		0,037	0,37			2.3 (4.0)		@200 ~
			Q		0.45	1.09		8.1		7.5 (12.5)	
$_4S_{10}$	$5,791^{2}$ × 〃 $7,008$ ω 0.59 λ 2.9	X	M E/C	2.36	0,083	0.20	12.7		0.1 (0.2)		D10 @200 (1/2") D
			Q	1.18	0.51	0.60				3.7 (6.2)	
		Y	M E/C		0.057	0.13			0.8 (1.4)		〃 250 D
			Q		0.46	0.54				3.7 (6.2)	
S		X	M E/C								
			Q								
		Y	M E/C								
			Q								
S		X	M E/C								
			Q								
		Y	M E/C								
			Q								

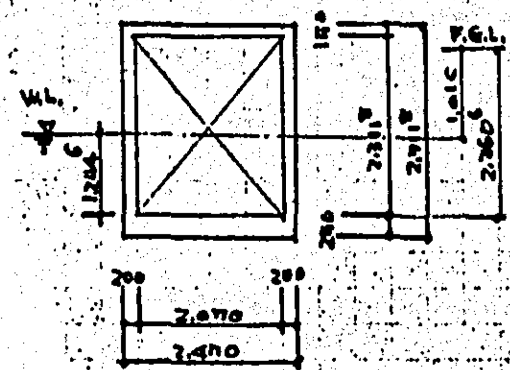
	LOAD			STRESS			D	J	at	ρ	SECTION
3 S 2A 2 2	4,097^4 4.876^8 ω 0.76 λ 1.2	X	M	12.77	0.056	0.72	12.7		4.0 (7.0)		D10 @150 (½") ~
			Q	3.17	0.49	1.53		8.9		9.6 (16.0)	
		Y	M		0.037	0.47			2.9 (5.0)		// @200 ~
			Q		0.45	1.40		8.1		9.6 (16.0)	
3 S 3A	3,810 4.876^6 ω 0.74 λ 1.3	X	M	10.74	0.062	0.617	12.7		3.8 (6.6)		D10 @150 (½") ~
			Q	2.82	0.50	1.41				8.8 (14.7)	
		Y	M		0.042	0.45			2.8 (4.9)		// @200 ~
			Q		0.46	1.30				3.1 (9.2)	
3 S 1A 2 1	±4.000 ÷ 2,331^2 ω 0.74 λ 2.1	X	M	11.84	0.082	0.917	12.7		5.4 (9.4)		D13 @150 (½"@100) ~
			Q	2.96	0.51	1.51				9.4 (15.7)	
		Y	M		0.042	0.50			3.1 (5.4)		// @200 (½"@100) ~
			Q		0.46	1.36				9.3 (15.5)	
3 S 4A 2 4	5,331^2 4,267^2 3,048 ω 0.76 λ 2.7	X	M	7.06	0.053	0.59	12.7		3.3 (5.7)		D10 @200 (½") ~
			Q	2.32	0.51	1.18				7.4 (12.3)	
		Y	M		0.057	0.40			2.5 (4.3)		// @250 ~
			Q		0.46	1.07				7.3 (12.2)	
3 S 5A	4,267^2 3,175 ω 0.76 λ 1.3	X	M	7.66	0.063	0.48	12.7		2.7 (4.7)		D10 @150 (½") ~
			Q	2.41	0.50	1.21				7.6 (12.7)	
		Y	M		0.042	0.32			2.0 (3.5)		// @250 ~
			Q		0.46	1.11				7.6 (12.7)	
3 S 10 2	±2,000 6,096 ~ 6,705^6 ω 0.76 λ 3.4	X	M	3.04	0.063	0.25	12.7		1.4 (2.4)		D10 @200 (½") ~
			Q	1.42	0.51	0.78				4.9 (8.2)	
		Y	M		0.057	0.17			1.0 (1.7)		// @250 ~
			Q		0.46	0.70				4.8 (8.0)	
2 S 5	4,267^2 4,000 1.0t ω 0.76 + 0.06 = 0.82 λ 1.1	X	M	13.12	0.050	0.66	12.7		3.7 (6.4)		D10 @150 (½") ~
			Q	3.28	0.46	1.51				9.4 (15.7)	
		Y	M		0.042	0.55			3.4 (5.9)		// @150 ~
			Q		0.45	1.48				10.2 (17.0)	
C 2 S 1	1.5 ω 0.74 P 0.20	X	M	(0.74 0.20	1.5²/2 1.5)	1.13	15.2		5.1 (8.9)		D10 @100 (½" @100 @200)
			Q	(0.74 0.20	1.5)	1.31		11.1		6.6 (11.0)	
		Y	M								@250 D.
			Q								

	LOAD		STRESS				D	J	at	φ	SECTION
${}_1S_1$	4.099 4; 6.705 6; ω 1.06; λ 1.6	X	M E C	17.81	0.078	1.39	12.7		7.8 (13.6)		D13 @150 (½" @100) ~
			Q	4.35	0.51	2.22		8.9		13.9 (23.2)	
		Y	M E C		0.057	1.02			6.3 (11.0)		〃 @200 (½" @100) ~
			Q		0.46	2.00		8.1		13.7 (22.8)	
${}_1S_1$	≒ 7.315 2; 3.800; ω 1.06; λ 1.8	X	M E C	16.96	0.081	1.37	12.7		7.7 (13.4)		D13 @150 (½" @100) ~
			Q	4.24	0.51	2.16				13.5 (22.4)	
		Y	M E C		0.057	0.97			6.0 (10.4)		〃 @200 (½" @100) ~
			Q		0.46	1.95				13.4 (22.3)	
${}_1S_4$	4.267 2 ~ 6.299 2; 3.048; ω 0.71; λ 2.1	X	M E C	6.60	0.083	0.55	12.7		3.1 (5.4)		D10 @200 (½") ~
			Q	2.16	0.51	1.10				6.9 (11.5)	
		Y	M E C		0.057	0.38			2.3 (4.0)		〃 @250 ~
			Q		0.46	1.00				6.9 (11.5)	
${}_1S_{10}$	≒3,000; ≒ 4800; ω 0.74; λ 1.6	X	M E C	6.66	0.018	0.52	12.7		2.9 (5.0)		D10 @200 (½") ~
			Q	2.22	0.51	1.13				7.1 (11.5)	
		Y	M E C		0.057	0.38			2.3 (4.0)		〃 @250 ~
			Q		0.46	1.02				7.0 (11.7)	
${}_1S_{10B}$		X	M E C								D13 @150 (½" @100) 300 (200)
			Q								
		Y	M E C								D10 @250 (½")
			Q								
S		X	M E C								
			Q								
		Y	M E C								
			Q								
S_T	l=2.0; P 0.4; q 1.18	X	M E C	M = (0.4×2) + (1.18×2²/2) = 3.16; Q = 0.4 + (1.18×2) = 2.76							at 6.6 (10.4); φ 6.4 (10.6)
			Q				D=30	j=24			
		Y	M E C		2-D13 (2-½") / step						
			Q	W20A							
S		X	M E C		M = 3.16/2 = 1.58; D20 j 15.3				at 5.2 (8.2)		
			Q		D13 @ 200 (½" @150)						
		Y	M E C								
			Q								

Design of Underground Corridor & Orchestra Pit

Underground Corridor

CASE – 1.



Unit Load [kg/m²]

Upper Slab

L.L.	360			
D.L.	Finish	65	]	425
	R.C.	360		
T.L.	785			

Lower Slab

L.L.	180			
D.L.	Finish	100	]	700
	R.C.	600		
T.L.	880			

Wall

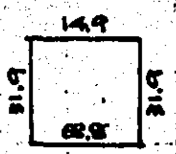
D.L.	Finish	50	]	530
	R.C.	480		$\sim \times 2.56 = 1.36$ t/m

Stiffness Ratio

$$\frac{15^3}{227} = 14.9$$

$$\frac{25^3}{227} = 68.8$$

$$\frac{20^3}{251} = 31.9$$



Vertical Load

T.L. $(0.785 \times 2.47) + (1.36 \times 2) + (0.88 \times 2.07) = 6.48$ t

$6.48 / 2.47 = 2.62$ t/m²

$<$ Bearing Capacity 5.00 t/m²

O.K

D.L. $(0.425 \times 2.47) + (1.36 \times 2) + (0.70 \times 2.07) = 5.22$ t

$5.22 / 2.47 = 2.11$ t/m²

$>$ Buoyancy 1.50 t/m²

O.K.

CMoQ

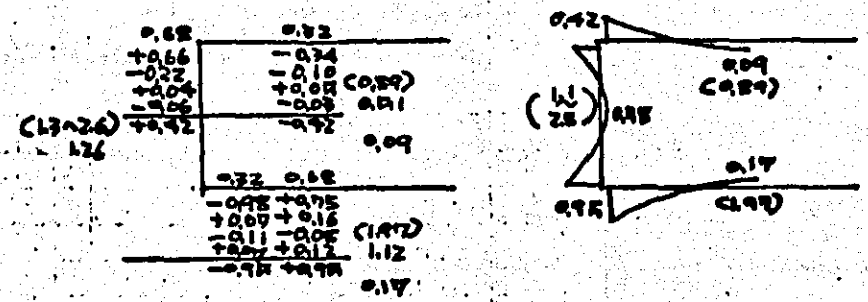
q = 0.788 [t/m] C 0.788 × 2.27²/12 = 0.34 [tm]
Mo /8 = 0.51
Q 2.27/2 = 0.89 [t]

q = 2.62 [t/m]
−0.88
= 1.74
C 1.740 × 2.27²/12 = 0.75 [tm]
Mo /8 = 1.12
Q × 2.27/2 = 1.97 [t]

$w_{max} = k_a \gamma h + \{k_a(\gamma-1)+1\} h'$
= 0.5 × 1.8 × (0.3 + 1.02) + {0.5 (1.8 − 1) + 1} 1.37
= 3.11 [t/m]
W = 3.11 × 2.51/2
= 3.91 [t]

C 3.91 × 2.51 × 0.067 ~ 0.100 = 0.66 ~ 0.98 [tm]
Mo × 0.128 = 1.26
Q 3.9 × 0.33 ~ 0.67 = 1.3 ~ 2.6 [t]

Stress Analysis



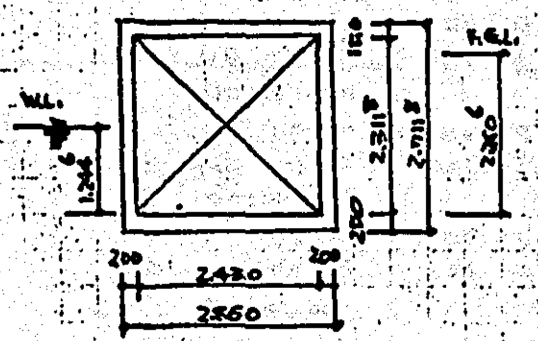
Member Design

Upper Slab M 0.42 [tm] D 19 [cm] at 1.9 [cm²]
Q 0.89 [t] 10.9 [cm] q 4.5 [cm] QAL 6.9 [t]
D13 − @200

Wall M 0.95 D 20 at 3.3
Q 2.80 14.4 q 10.5 QAL 8.6
D13 − @200

Lower Slab M 0.95 D 20 at 2.9
Q 1.97 16.2 q 6.5 QAL 9.7
D13 − @200

CASE – 2.

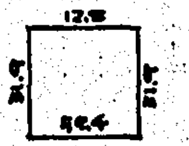


Stiffness Ratio

$$\frac{15^3}{263} = 12.8$$

$$\frac{25^3}{263} = 59.4$$

$$\frac{20^3}{251} = 31.9$$



Vertical Load

T.L. $(0.785 \times 2.83) + (1.36 \times 2) + (0.88 \times 2.43) = 7.08\ t$

$7.08/2.86 = 2.48\ [t/m^2]$

< Bearing Capacity

D.L. $(0.425 \times 2.83) + (1.36 \times 2) + (0.70 \times 2.43) = 5.62\ t$

$5.62/2.86 = 1.97\ [t/m^2]$

> Buoyancy

C Mo Q

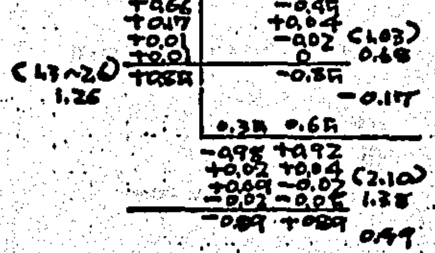
$q = 0.785$

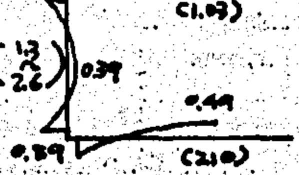
C	$0.785 \times 2.63^2/12$	=	0.45
Mo	$/8$	=	0.68
Q	$\times 2.63/2$	=	1.03

$q = 2.48 - 0.88 = 1.60$

C	$1.60 \times 2.63^2/12$	=	0.92
Mo	$/8$	=	1.38
Q	$\times 2.63/2$	=	2.10

Stress Analysis

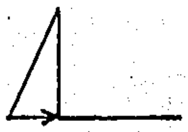




Member Design

Upper Slab	M	0.85	D	15	at 3.9	
	Q	1.03	j	10.9	φ 5.2	@AL 6.5
					D13 - @200	
Wall	M	0.89	D	20	at 3.1	
	Q	2.60	j	14.4	φ 10.0	@AL 8.6
					D13-@200	
Lower Slab	M	0.89	D	25	at 2.7	
	Q	2.10	j	16.2	φ 7.2	@AL 9.7
					D13-@200	

CASE - B.



Cantilever Type Wall

w_{max} 3.11 [t/m]

M 3.98 × (0.30 + 2.26)/3 = 3.40 [tm/m]

Q 3.11 × (0.30 + 2.26)/2 = 3.98 [t/m]

D 20 j 14.4 at 11.8

φ 15.4 @AL 8.6

D16 @ 150

Vertical Load

T.L. 0.785 × 8.05 × 4.45
1.36 × (7.85 + 4.25) × 2
0.88 × 7.65 × 4.05] = 88.8 [t]

88.3 / 8.05 × 4.45 = 2.46 [t/m²]

< Bearing Capacity

D.L. 0.425 × 8.05 × 4.45
1.36 × (7.85 + 4.25) × 2
0.70 × 7.65 × 4.05] = 69.8 [t]

69.8 / 8.05 × 4.45 = 1.95 [t/m²]

> Buoyancy

Lower Slab

w 2.46 [t/m²] −0.88   lx 4.25 ly 7.85 λ 1.85   D 25 j 16.2

M 1.58 × 4.25² × 0.082 = 2.34   at 7.2

Q × 4.25 × 0.51 = 3.43   φ 11.8

D16 @ 150

Upper Slab

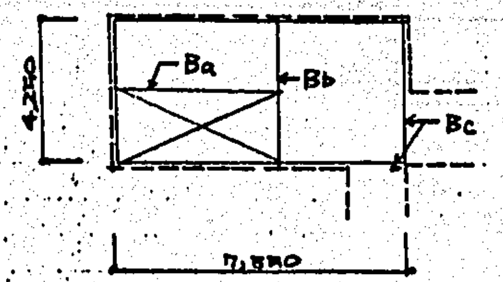
w 0.785   lx ≒ 3.5 ly 4.25 λ 1.2   D15 j 10.9

M 0.785 × 3.5² × 0.064 = 0.62   at 2.8

Q × 3.5 × 0.49 = 1.35   φ 6.9

D13 @ 150

Beam along slab opening.



b 20 ~ 25 D40 d35 j 30.6

QAL 3.68 ~ 4.59

Ba $q =$ slab $0.785 \times 1.0 +$ Beam $0.10 = 0.885$ [t/m]

$M_0 = 0.885 \times 4.5^2/8 = 2.24$ [tm] at 3.66 2-D16

$Q = \times 4.5/2 = 1.99$ [t] φ 3.6

Bb $P = 1.99$ (from Ba) [t]

$W = 0.785 \times 4.25^2/4 = 3.54$ [t]

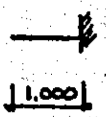
$M_0 = 1.99 \times 4.25/4 + 3.54 \times 4.25/6 = 4.62$ [tm] at 7.54 2-D25

$Q = 1.99/2 + 3.54/2 = 2.77$ [t] φ 5.0

Bc = Ba

Staircase

L.L.	180		
D.L.	Finish	100	460 × 1.5
	RC	360	
T.L.	870		[kg/m²]



M $0.87 \times 1^2/2 = 0.44$ [tm] at 0.92 [cm²]

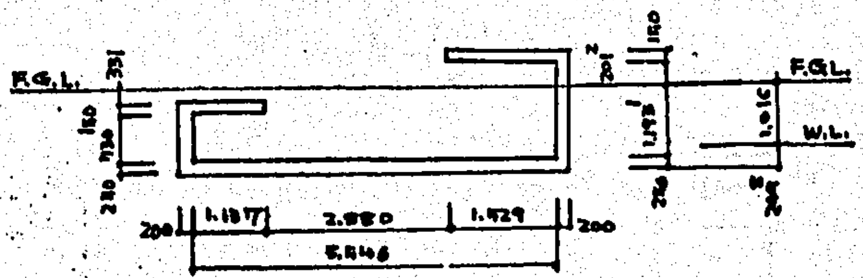
Q $0.87 \times 1 = 0.87$ [t] φ 2.01 [cm]

D ≒ 30

j 24

1-D13/step

Orchestra Pit



Unit Load [kg/m²]

Upper Slab	L.L.	360			
	D.L.	Finish	65	425	
		R.C.	360		
	T.L.	785			
Lower Slab	L.L.	180			
	D.L.	Finish	100	700	
		R.C.	600		
	T.L.	880			
Wall	D.L.	Finish	50	530	
		R.C.	480		

~ × 1.39 = 740 [kg/m]
× 0.76 = 400 [〃]

Cantilever Slab

M 0.785 × 1.53²/2 = 0.92* [tm] D13 j 10.9 [cm]

Q × 1.53 = 1.20 [t] at 4.2 [cm²]

ψ 6.1 [cm]

Wall D 20 j 14.4 [cm]

w_{max} = 0.5 × 1.8 × 1.49 = 1.34 [t/m]

M = 1.34 × 1.49²/6 = 0.50

Q = × 1.49/2 = 1.00 ψ 3.9 [cm]

ΣM = 0.92* + 0.50 = 1.42 at 4.9 [cm²]

D13 @200

Lower Slab

DL = 429 > Buoyancy 249 [kg/m²]

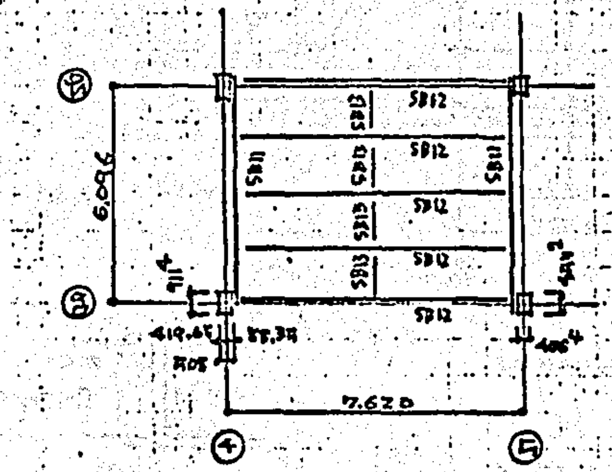
O.K.

7 - DESIGN OF STEEL FRAME

DESIGN OF HARDLE FLOOR BEAM

(1) HARDLE FLOOR (1)

w = D.L. 100
L.L. 500
T.L. 600 [kg/m²]



SB13 [-250×50×4.0×[illegible]

SB12

$q = 0.6 \times 1.5 = 0.9$ t/m

Span = 7,328.5

$$J_N = \frac{5 \times 0.009 \times 732.8^4}{384 \times 2{,}100 \times 732.8/300} = 6{,}587.8 \quad [cm^4]$$

H-350×175×7×11 (Y=14)

J = 13,600 > 6,587.8
O.K.

$M_0 = 0.9 \times 7.328^2/8 = 6.04$ [tm]

$\ell_b = 732.8/2 = 366.4$, $i_b = 4.58$, $\lambda_b = 80.1$, $C = 1.0$, $\eta = 8.33$
$f_b = 1.36$ $Z_x = 775$

$$\frac{\sigma}{f} = \frac{604}{775 \times 1.36} = 0.57 < 1.00$$

$Q = 0.9 \times 7.328/2 = 3.3$ [t]

SB11

$q \fallingdotseq 0.6 \times 7.328/2 = 2.2$ t/m

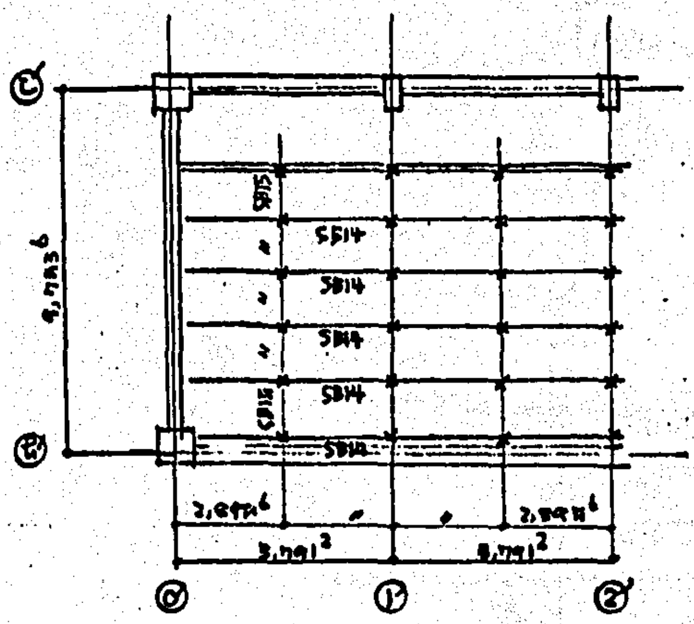
Span = 6,553.2

$$J_N = \frac{5 \times 0.022 \times 655.3^4}{384 \times 2{,}100 \times 655.3/300} = 11{,}515.5 \quad [cm^4]$$

[-380×100×10.5×16

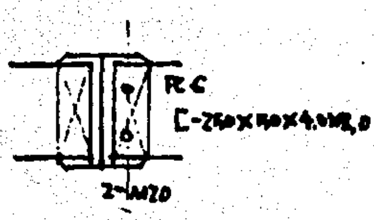
J = 14,500 > 11,515.5
O.K.

(2) HARDLE FLOOR (2)



w = D.L. 100
L.L. 500
T.L. 600 [kg/m²]

SB12 [-250×50×4.0×8.0



SB14

$q = 0.6 \times 1.5 = 0.9$ t/m

SPAN 2,595^6 m

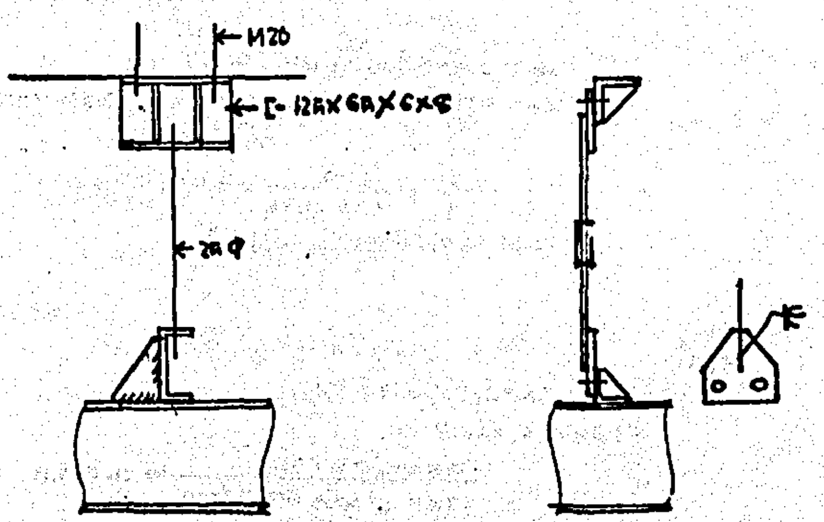
∴ LIKE TO SB12

H-300×175×7×11 (r=14)

SUSPENSION BAR

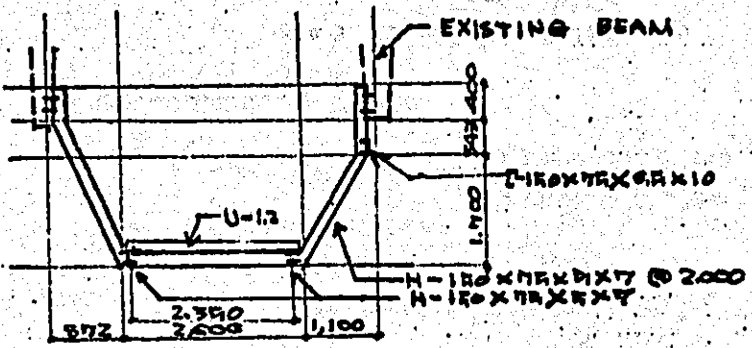
$N = 0.6 \times 2,595^6 \times 1.5 = 2.6$ [t]

$a_n = 2.6 / 1.0 = 2.6$ [cm²]



DESIGN OF SPOT ROOM

(1) CEILING SPOT



LOAD FLOOR

			WALL
D.L.	FINISH	90	30 [kg/m²]
	DECK	15	
	FRAME	35	
	CEILING	30	
L.L.		350	

T.L. DECK 135 + 350 = 485 [kg/m²]

FRAME 170 + 350 = 520

DECK q 0.485 [t/m]

span 2.35 [m]

$$J_n = \frac{5 \times 0.00485 \times 235^3 \times 300}{384 \times 2,100} = 117.8 \ [cm^4]$$

$$Z_n = \frac{0.485 \times 235^2 \times 100}{8 \times 1.4} = 23.9 \ [cm^3]$$

U-1.2 $J = 136 > 117.8$

$Z = 35.5 > 23.9$

BEAM q $(0.52 \times 1.3) + (0.03 \times 2.4) = 0.748$ [t/m]

span 2 m

$$J_n = \frac{5 \times 0.00748 \times 200^3 \times 300}{384 \times 2,100} = 111.3$$

H-150×75×5×7 (r=8)

$J = 666 > 111.3$

l_b 200, i_b 1.96, λ_b 102.0, C 1.00, η 5.60

f_b 1.58, Z_x 88.8

$$\frac{\sigma}{f} = \frac{0.748 \times 2^2 \times 100}{8} \times \frac{1}{88.8 \times 1.58}$$

$$= 0.27 < 1.00$$

$M_D = 2.2 \times 6.553^2 / 8 = 11.8$ [tm]

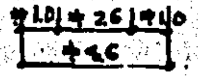
$Z_x = 762$

$$\frac{\sigma}{f} = \frac{1180}{762 \times 1.6} = 0.97 < 1.00$$

$Q = 2.2 \times 6.553 / 2 = 7.2$ [t]

FRAME

P = 0.748 × 2 = 1.5 t



Q = 1.5 [t]

M = 1.5 [tm]

$$\delta = \frac{Pa(3l^2 - 4a^2)}{24EJ} \leq \frac{l}{300}$$

$$\sim \quad J_n > \frac{1.5 \times 100(3 \times 460^2 - 4 \times 100^2)}{24 \times 2,100 \times (460/300)} = 1,154.5 \ [cm^4]$$

H−150×150×7×10

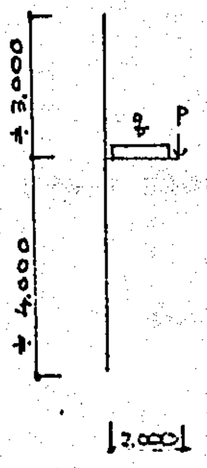
$J = 1,640 > 1,154.5$

ℓ_b 260, i_b 4.12, λ_b 63.1, C 1.00, i 4.12

f_b 1.43, Z_x 219

$$\frac{\sigma}{f} = \frac{150}{219 \times 1.43} = 0.48 < 1.00$$

DESIGN OF SIDE-SPOT ROOM



ROOF AND WALL

$P \doteqdot 0.10\ [t/m^2] \times 3.0\ [m] \times 1.5\ [m] = 0.45\ [t]$

FLOOR

$q \doteqdot 0.40\ [t/m^2] \times 1.5\ [m] = 0.60\ [t/m]$

└ (D.L. 200 + L.L. 200 = 400 [kg/m²]

$$J_n = \frac{P l^3}{3E\,\delta_{cr}} + \frac{q l^4}{8E\,\delta_{cr}} \qquad \delta_{cr} = \frac{200}{200} = 1\ [cm]$$

$$= \frac{0.60 \times 200^3}{3 \times 2100 \times 1} + \frac{0.004 \times 200^4}{8 \times 2{,}100 \times 1}$$

$$= 761.9 + 381.0$$

$$= 1{,}142.9 \quad [cm^4]$$

H-150×150×7×10

$J = 1{,}640 > 1{,}142.9$

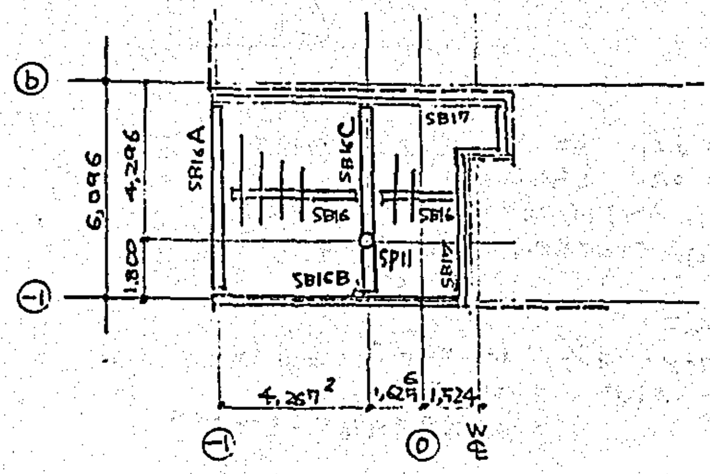
$M = 0.6 \times 2 + 0.4 \times 2^2/2 = 2.0\ [tm]$

l_b 200 i_b 4.12 λ_b 48.5 f_b 1.60 C 1.75 η 4.12

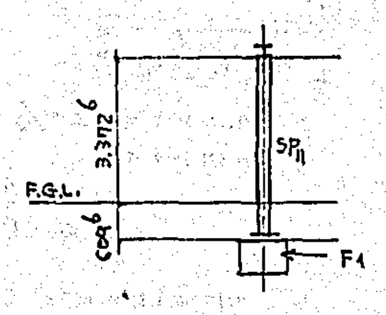
$$\frac{\sigma}{f} = \frac{M}{Z f} = \frac{200}{219 \times 1.6} = 0.57$$

$M/h = 2.0/7.0 = 0.29\ [t]$

DESIGN OF ENTRANCE CANOPY



keyplan



key section

Unit load [t/m^2]

D.L. Roof 0.06, Purlin 0.01, Frame 0.06, Ceiling 0.06 → 0.13 → 0.19 → 0.03

W.L. C = −1.3, q = 0.12, Cq = −0.16

Purlin @600 span ≒ 3,000

$q = 0.13 \times 0.6 = 0.078$ [t/m]

$J_n = \frac{5 \times 0.00078 \times 300^4}{384 \times 2,100} = 39.2$ [cm^4]

$Z_n = \frac{0.078 \times 3^2 \times 100}{8} \times \frac{1}{1.4} = 6.3$ [cm^3]

[− 100 × 50 × 20 − 2.3   J 80.7 [cm^4] Z 16.1 [cm^3]

SubBeam (SB16A)

P = 0.19 × 2.15 × 3.0 = 1.23 [t]

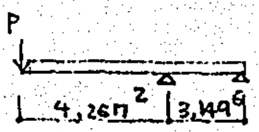
$M_0 = 1.23 \times 6 / 4 = 1.84$ [tm]

H − 250 × 250 × 9 × 14

lb 300 ib 6.87 λb 43.7 C 1.0 η 4.91 fb 1.6 Zx 867

$\frac{\sigma}{f} = \frac{184}{867 \times 1.6} = 0.13 < 1.00$

Cantilever (SB16B)



P $0.19 \times 2.15 \times 3.0/2 = 0.61$ [t]

q $0.19 \times 1.5 = 0.29$ [t/m]

$M_E = (0.61 \times 4.27) + (0.29 \times 4.27^2/2) = 5.3$ [tm]

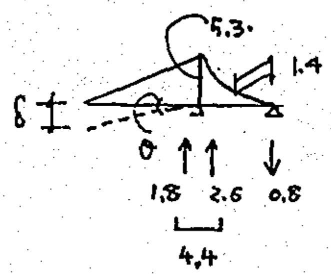
$Q = (0.61) + (0.29 \times 4.27) = 1.8$ [t]

q $0.19 \times 1.5 = 0.29$ [t/m]

$M_o = 0.29 \times 3.15^2/2 = 1.4$ [tm]

$Q = \quad \times 3.15 = 0.9$ [t]

$Q' = 0.9 \pm 5.3/3.15 = 2.6 \sim -0.8$



H-250×250×9×14 (r=16)

ℓ_b 427 i_b 6.87 λ_b 62.2 C 1.75

η 4.91 f_b 1.6 Z_x 867 [cm³]

$$\frac{\sigma}{f} = \frac{M_E}{Z_x \cdot f_b} = \frac{530}{867 \times 1.60} = 0.38 \leq 1.00$$

J = 10,800 [cm⁴]

$$\delta_0 = \frac{P\ell^3}{3EJ} + \frac{q\ell^4}{8EJ} = \frac{0.61 \times 427^3}{3 \times 2,100 \times 10,800} + \frac{0.0029 \times 427^4}{8 \times 2,100 \times 10,800}$$

$= 0.71 + 0.53$

$= 1.24$ [cm]

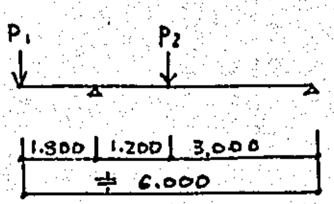
$$\theta = \frac{M_E \ell}{4EJ} = \frac{530 \times 315}{4 \times 2,100 \times 10,800} = 0.0018 \text{ [RAD]}$$

$\delta' = 0.0018 \times 427 = 0.79$ [cm]

→ $\Sigma \delta = 2.03$ [cm]

$\delta/\text{span} = 1/210$

cantilever (SB16C)



P_1 SB16B より 4.4 [t]

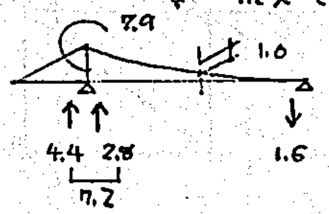
$M_E = 4.4 \times 1.8 = 7.9$ [tm]

$Q = 4.4$ [t]

P_2 $0.19 \times 2.15 \times 3.0 = 1.2$ [t]

$M_0 = 1.2 \times (1.2 \times 3.0 / 4.2) = 1.0$ [tm]

$Q = 1.2 \times (3.0 \sim 1.2/4.2) = 0.9 \sim 0.3$ [t] $\sim \pm \frac{7.9}{4.2} = 2.8 \sim -1.6$ [t]



H-250×250×9×14

$\sigma/f = 790/(867 \times 1.6) = 0.57 \le 1.00$

$\delta_0 = \frac{4.4 \times 180^3}{3 \times 2{,}100 \times 10{,}800} = 0.38$ [cm]

$\theta = \frac{790 \times 420}{4 \times 2{,}100 \times 10{,}800} = 0.0037$ [RAD]

$\delta' = 0.0037 \times 180 = 0.66$ [cm]

→ $\Sigma\delta = 1.04$ [cm]

$\delta/\text{span} = 1/173$

Post (SP11)

$N = 7.2$ [t]

H-250×250×9×14

ℓ_k 390 i_y 6.29 λ_y 62 f_c 1.28 A 92.18

$\sigma/f = 7.2/92.18 \times 1.28 = 0.06 < 1.0$

BPL 19×280×280

$\sigma_c = 7{,}200/(28 \times 28) = 9.2$ [kg/cm²]

$M = 9.2 \times 14^2/2 = 900$ [kg cm]

$\sigma = 1{,}600$

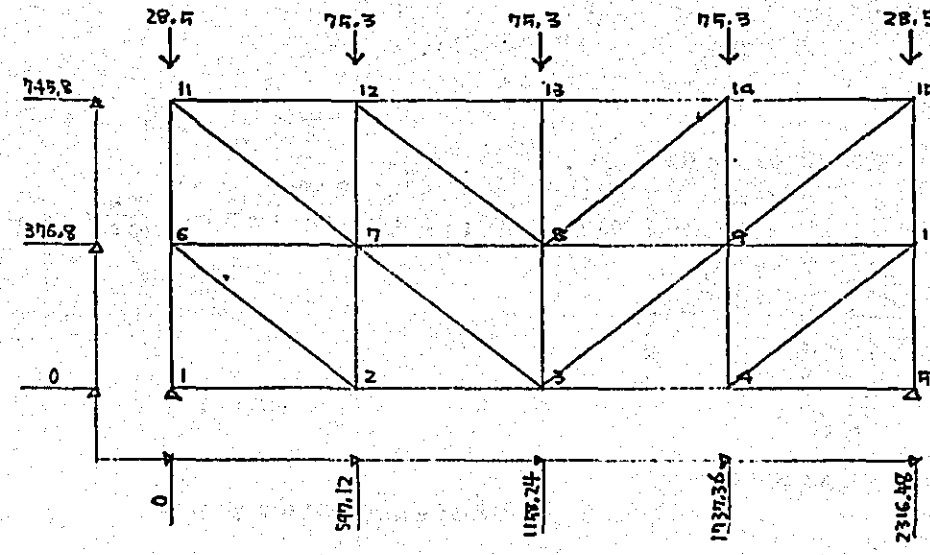
$Z_n = 900/1{,}600 = 0.5625$ [cm³]

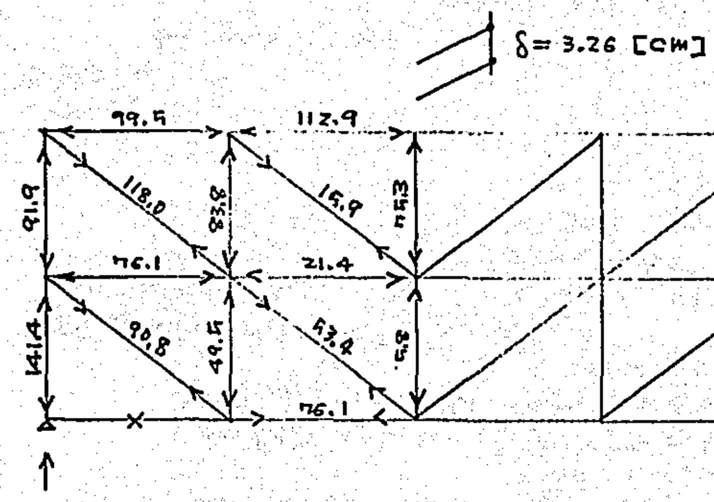
$t_n = \sqrt{6 \times 0.5625} = 1.837$ [cm] → PL19

Tie Beam (SB17)

[-250×90×9×13

DESIGN OF PROCENIUM FRAME





Stress by DEMOS-E

DEMOS-E PROGRAM AND OUTPUT DATA

```
コチラ ハ DEMOS-E センタ デス
/000/ ØN
      78-01-17,18:02
/001/ BAT C
      * データ ヲ イレテ クダサイ :
ØN
-LIB-FRAP-GEN
 11
 2T
   1 TTL1 TR:BTV-TRUSS:
   2 GEN1 1,1,15,2,2316.48,745.8
   3 CNT1 ,2100
  11-JNT4 1,0,1,6,11
  12      1,5■■79.12,2,7,12
  13      1,115■■.24,3,8,13
  14      1,1737.36,4,9,14
  15      1,2316.48,5,10,15
  16      2,0,1,2,3,4,5
  17      2,376.8,6,7,8,9,10
  18      2,745.8,11,12,13,14,15
  21 JNT5 110000,1
  22      010000,5
  31-SCT2 1,4,50,20,1,1.6
  32      2,4,20,20,0.8,1.2
  41-MMB4 1,,,,1,2,2,3,3,4,4,5,11,12,12,13,13,14,14,15,1,6,6,11,5,10,10,15
  42      2,,,,6,7,7,8,8,9,9,10,2,7,7,12,3,8,8,13,4,9,9,14,2,6,3,7,7,11,8,12,4,10,3,9,9,15,8,14
  51 J-L3 1,,-28.5,,,,,,11,15
  52      1,,-75.3,,,,,12,13,14
  61 Ø-G1 1,2,3,4,5,6.3,6.4,6.6,6.7
ØFF
-/EØJ
      イッカツショリ ヲ ウケツケマシタ. BSN "R0245" BRT "17-18-03-27".
/002/
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TR:B - 1

***** STRUCTURAL ANALYSIS BY FRAP-GEN. NTT *****

* TITLE TV-TRUSS:

* TYPE OF STRUCTURE --- PLANE TRUSS + PLATE

* METHOD OF ANALYSIS --- EXACT SOLUTION

* SHEAR DEFORMATION --- NON

* TEST VALUES

UNBALANCE FORCE TBL	---	1.00000E-05
ZERO TEST (STIFF.)	---	1.00000E-02
ZERO TEST (LOAD)	---	1.00000E-01
VERTICAL DRCTN COS.	---	1.00000E-03

TR:B - 2

***** JOINT DISPLACEMENT *****

NO	LD		U-X	U-Y
15	1		-3.392E-01	-3.748E-01
14	1		-9.147E-02	-2.449E+00
13	1		1.895E-01	-3.259E+00
12	1		4.705E-01	-2.449E+00
11	1		7.182E-01	-3.748E-01
10	1		-2.438E-01	-2.291E-01
9	1		9.447E-02	-2.212E+00
8	1		1.895E-01	-3.046E+00
7	1		2.845E-01	-2.212E+00
6	1		6.228E-01	-2.291E-01
5	1	SPT	3.790E-01	0.000E+00
4	1		3.790E-01	-2.069E+00
3	1		1.895E-01	-2.877E+00
2	1		9.909E-15	-2.069E+00
1	1	SPT	0.000E+00	0.000E+00

***** MEMBER FORCE (MEMBER AXIS) *****

I-	J	LD	AXIAL	SHEAR-Y	AXIAL	SHEAR-Y
1-	2	1	-3.981E-12	0.000E+00	3.981E-12	0.000E+00
1-	6	1	1.414E+02	0.000E+00	-1.414E+02	0.000E+00
2-	3	1	-7.614E+01	0.000E+00	7.614E+01	0.000E+00
~~2-~~	~~6~~	~~1~~	~~-9.084E+01~~	~~6.040E-14~~	~~9.084E+01~~	~~2.842E-14~~
2-	7	1	4.954E+01	0.000E+00	-4.954E+01	0.000E+00
3-	4	1	-7.614E+01	0.000E+00	7.614E+01	0.000E+00
3-	7	1	-5.342E+01	6.750E-14	5.342E+01	4.619E-14
3-	8	1	5.827E+01	0.000E+00	-5.827E+01	0.000E+00
3-	9	1	-5.342E+01	3.553E-15	5.342E+01	0.000E+00
~~4-~~	~~5~~	~~1~~	~~-7.958E-13~~	~~0.000E+00~~	~~0.000E+00~~	~~0.000E+00~~
4-	9	1	4.954E+01	0.000E+00	-4.954E+01	0.000E+00
4-	10	1	-9.084E+01	-3.553E-15	9.084E+01	-2.487E-14
5-	10	1	1.414E+02	0.000E+00	-1.414E+02	0.000E+00
6-	7	1	-7.614E+01	0.000E+00	-7.614E+01	0.000E+00
6-	11	1	9.191E+01	0.000E+00	-9.191E+01	0.000E+00
~~7-~~	~~8~~	~~1~~	~~2.139E+01~~	~~0.000E+00~~	~~-2.139E+01~~	~~0.000E+00~~
7-	11	1	-1.180E+02	1.776E-14	1.180E+02	6.750E-14
7-	12	1	-8.382E+01	0.000E+00	-8.382E+01	0.000E+00
8-	9	1	2.139E+01	0.000E+00	-2.139E+01	0.000E+00
8-	12	1	-1.585E+01	9.903E-14	1.585E+01	-9.370E-14
8-	13	1	7.530E+01	0.000E+00	-7.530E+01	0.000E+00
~~8-~~	~~14~~	~~1~~	~~-1.585E+01~~	~~-5.773E-15~~	~~-1.585E+01~~	~~-3.864E-14~~
9-	10	1	7.614E+01	0.000E+00	-7.614E+01	0.000E+00
9-	14	1	8.382E+01	0.000E+00	-8.382E+01	0.000E+00
9-	15	1	-1.180E+02	1.066E-14	1.180E+02	-4.263E-14
10-	15	1	9.191E+01	0.000E+00	-9.191E+01	0.000E+00
11-	12	1	9.952E+01	0.000E+00	-9.952E+01	0.000E+00
12-	13	1	-1.129E+02	0.000E+00	-1.129E+02	0.000E+00
13-	14	1	1.129E+02	0.000E+00	-1.129E+02	0.000E+00
14-	15	1	9.952E+01	0.000E+00	-9.952E+01	0.000E+00

TR:B - 4

***** SUPPORT REACTION *****

NO	LD	F-X	F-Y
1	1	-3.981E-12	1.414E+02
5	1	0.000E+00	1.414E+02

P001 M ケイサン オワリ

CASE 1. SM50A + H.T.B. F10T

H-500×200×10×16 (r=20)

$A = 114.2$

Web 6-M20 $R = 9.42 \times 6 = 56.5$

Ae $[50 - \{2(1.6+2.0)\} + (2.1 \times 6)\}] \times 1.0 = 30.2$

Na $30.2 \times 2.2 = 66.4 > 56.5$

PL $56.5 / 1.6\{38 - (6 \times 2.1)\} \times 2 = 0.70 \rightarrow$ PL 9×400

Flg Ae $\{114.2 - (40.36 \times 1.0) - 6(2.1 \times 1.0)\}/2 = 30.6$

Na $30.6 \times 2.2 = 67.4$

8-M20 $R = 9.42 \times 8 = 75.4 > 67.4$

PL 16 × 200 $1.6\{20 - (2 \times 2.1)\} \times 1.6 = 40.4$] 74.9

2PLs 22 × 70 $2.2\{14 - (2 \times 2.1)\} \times 1.6 = 34.5$

$\Sigma Na = 56.5 + (2 \times 67.4) = 191.3 > N_{max}\ 141.4$

Between Truss Joint ~ As R.C.C. Beam

$q = 6.43\ t/m$

$M_0 = 6.43 \times 5.791^2/8 = 27.0$ [tm] at 1.9

$Q = \,\,//\,\, \times 5.791/2 = 18.6$ [t] φ 64

$< Q_{AL}$ 68.1 [t]

D 745.8 j 648.2

Lower Code ~ 2-D25 O.K.

H-300×150×6.5×9 (r=13)

A = 46.78

Web 3-M20 R = 9.42×3 = 28.3

Ae [30-{2(0.9+1.3)+(2.1×3)}]×0.65 = 12.5

Na 12.5×2.2 = 27.6 < 28.3

PL 27.6/1.6×{20-(3×2.1)}×2 = 0.63 → PL9×200

Flg Ae {46.78-(25.6×0.65)-4(2.1×0.9)}/2 = 11.3

Na 11.3×2.2 = 24.8

4-M20 R = 4.71×6 = 28.3 > 24.8

PL 24.8/1.6×{15-(2×2.1)} = 1.44 → PL16×150

Σ Na = 27.6 + (2×24.8) = 77.2

→ Temporary works use

H-200×200×8×12 (r=13)

A = 63.53

Web 3-M20 R = 9.42×3 = 28.3

Ae [20-{2(1.2+1.3)+2.1}]×0.8 = 10.3

Na 10.3×2.2 = 22.7 < 28.3

PL 22.7/1.6×(10-2.1)×2 = 0.90 → PL9×100

Flg Ae {63.53-(15×0.8)-4(2.1×1.2)}/2 = 20.7

Na 20.7×2.2 = 45.6

6-M20 R = 9.42×6 = 56.5 > 45.6

PL9×200 0.9{20-(2×2.1)}×1.6 = 22.8] 45.5

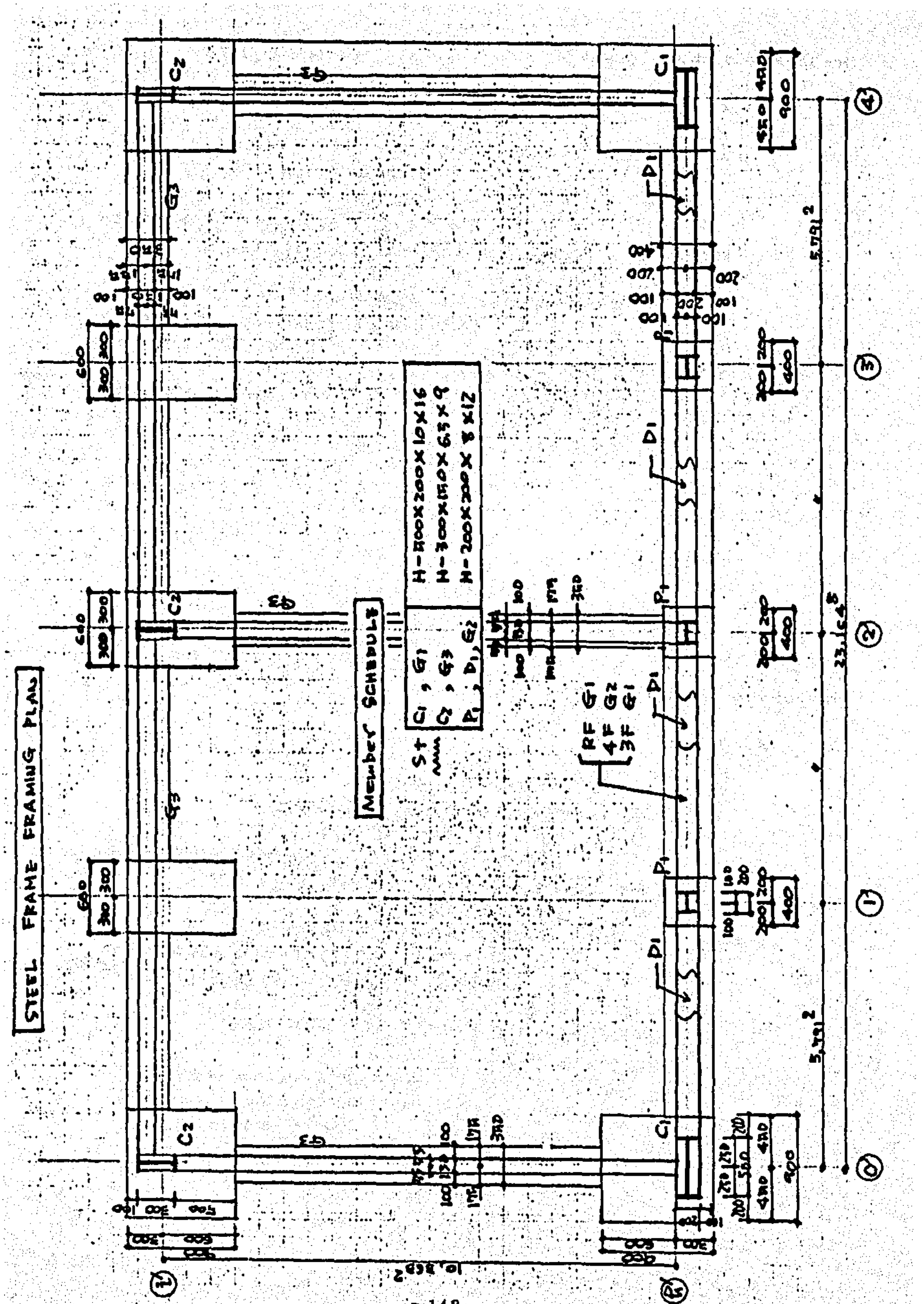
2PLs 12×80 1.2{16-(2×2.1)}×1.6 = 22.7]

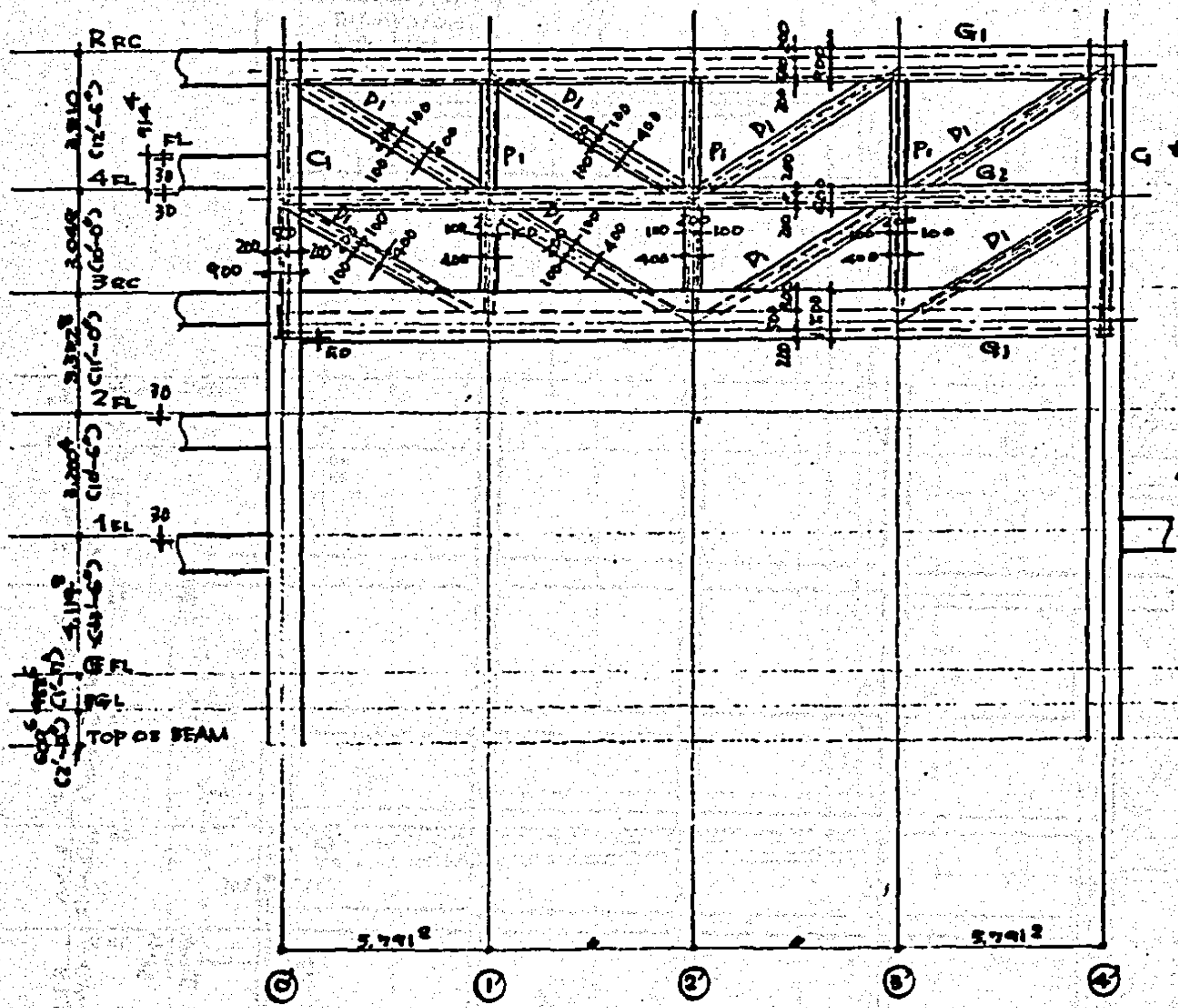
Σ Na = 22.7 + (2×45.5) = 113.7 < Nmax 118.0

ΔN = 118.0 - 113.7 = 4.3 [t]

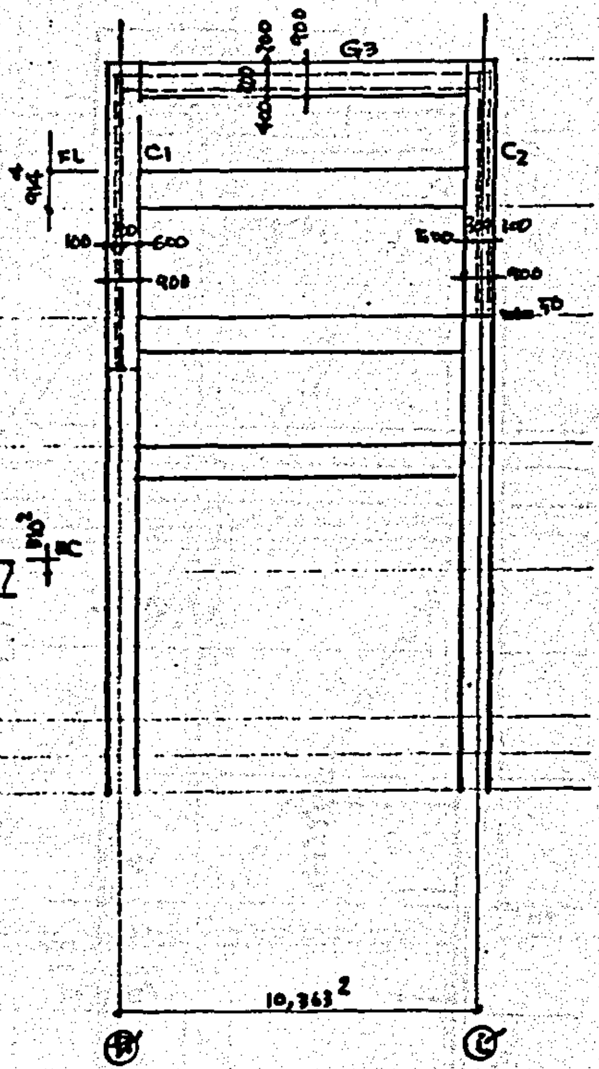
as = 4.3/2.2 = 2.0 [cm²]

~ 4-D19

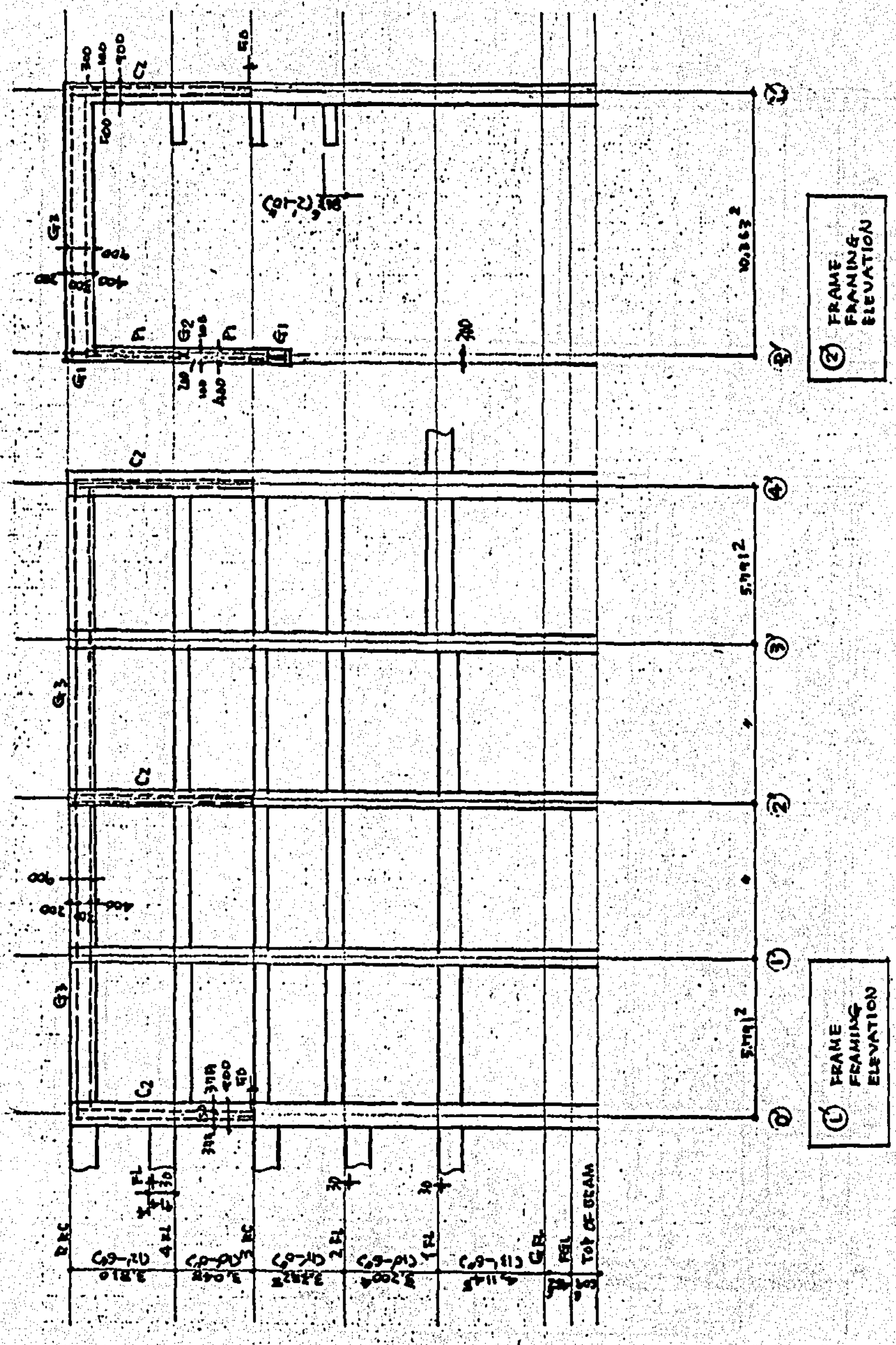

STEEL FRAME FRAMING PLAN
Member Schedule
St mm
C1 , G1 H-300X200X10X16
C2 , G3 H-300X150X6.5X9
P1 , D1 , G2 H-200X200X8X12
RF G1
4F G2
3F G1
C1
C2
P1
D1
G3
5,791
23,164
10,362

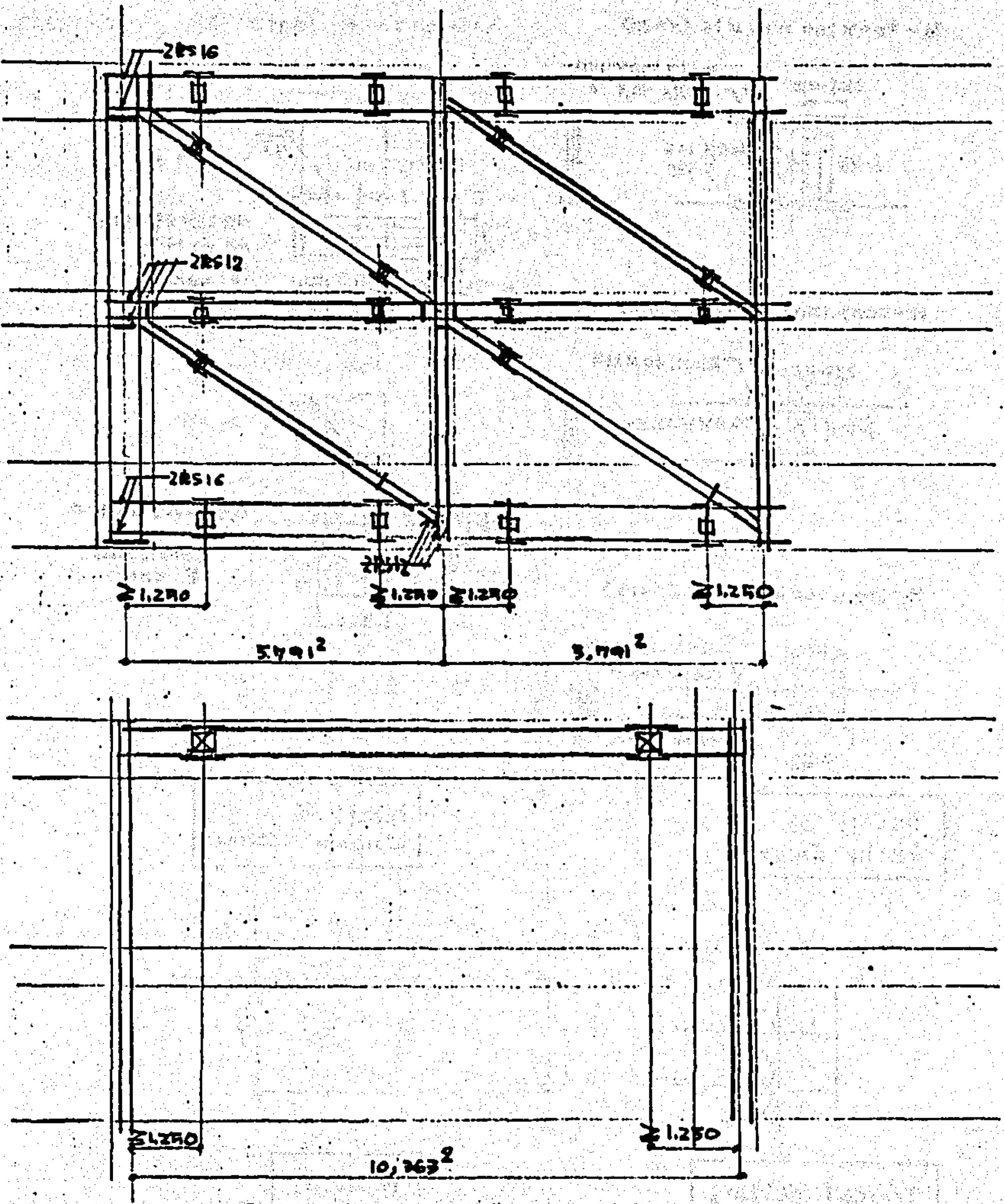


FRAME FRAMING ELEVATION

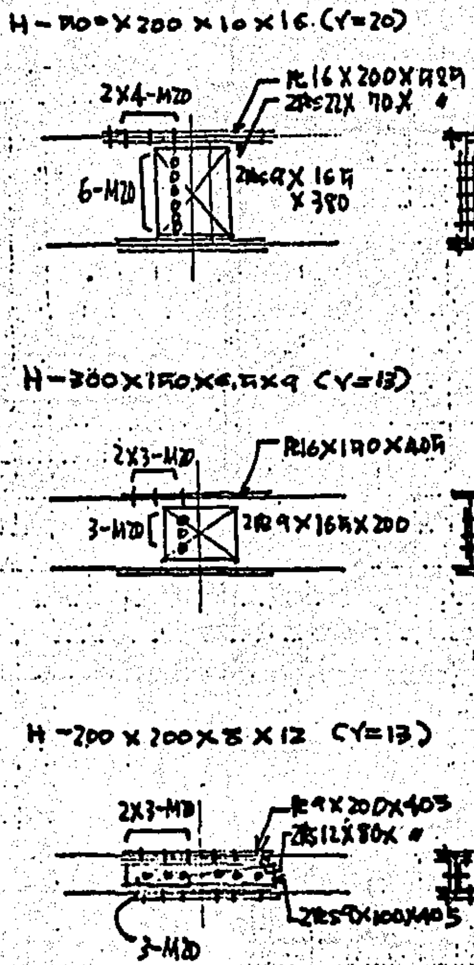


FRAME
FRAMING ELEVATION

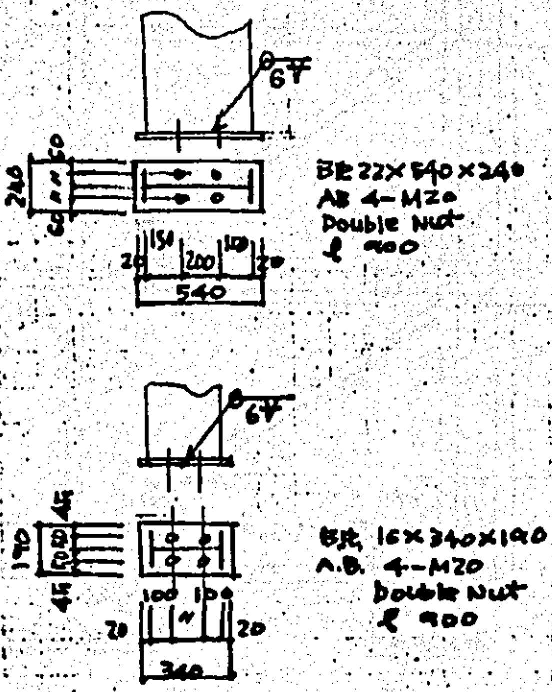

FRAME
FRAMING
ELEVATION
FRAME
FRAMING
ELEVATION



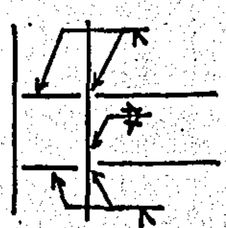
STEEL FRAME
FRAMING ELEVATION



Detail of Beam Joint



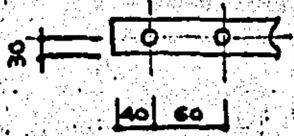
Detail of Column Bottom



Typical Welding

Material

H, Rib PL SM50A
Splice PL SS41
H.T.B. F10T



CASE - 2 M/S STEEL + WELDING

CODE MEMBER

L - 3" × 3" × 3/8" A = 13.484 [cm²]

f_t = 1.265 [t/cm²]

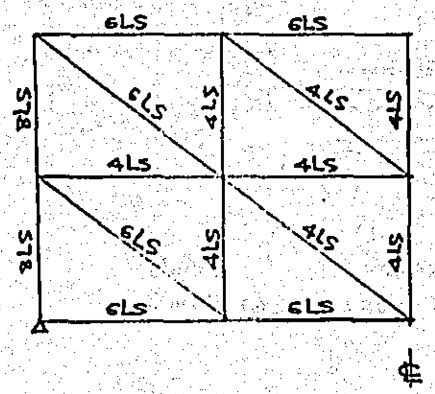
F = 13.484 × 1.265 = 17.1 [t]

FULL STRENGTH

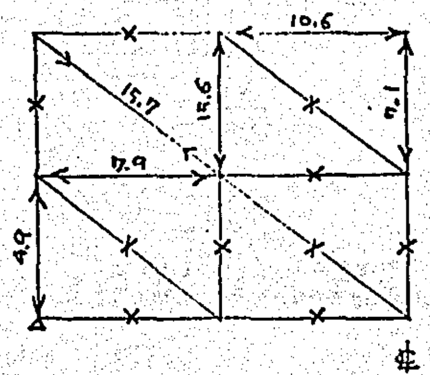
For 4LS F = 68.2 [t]

" 6LS F = 102.3 "

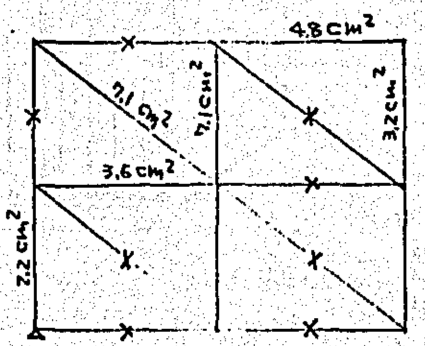
" 8LS F = 136.5 "



SECTION



Over Stress



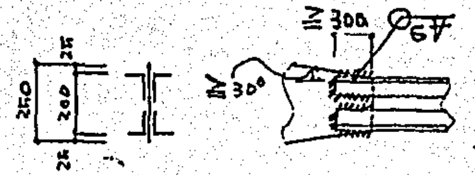
~4-D19

Needed Reinforcement

Member End

4LS − 3"×3"×3/8"

F = 68.2 [t]



PL nA = 13.484×4 = 53.936 [cm²]

nD = 53.964/2.54 = 21.234 → 25 [cm] = PL 1"

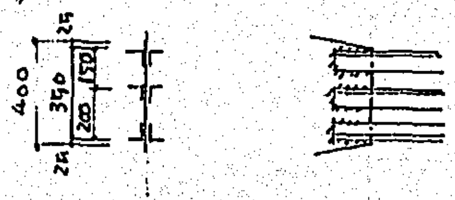
WELDING ~ FOR 2LS

6▽ R = 0.6×0.7×0.8 = 0.336 [t/cm] = 1/4" ▽

nl = 13.484 [cm²]×1.265 [t/cm²] / 0.336 [t/cm]

= 50.766 [cm] → 60 [cm]

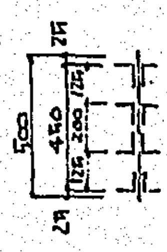
CLS — "



PL nA = 13.484×6 = 80.904 [cm²]

nD = 80.904/2.54 = 31.852 → 40 [cm]

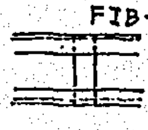
8LS — "

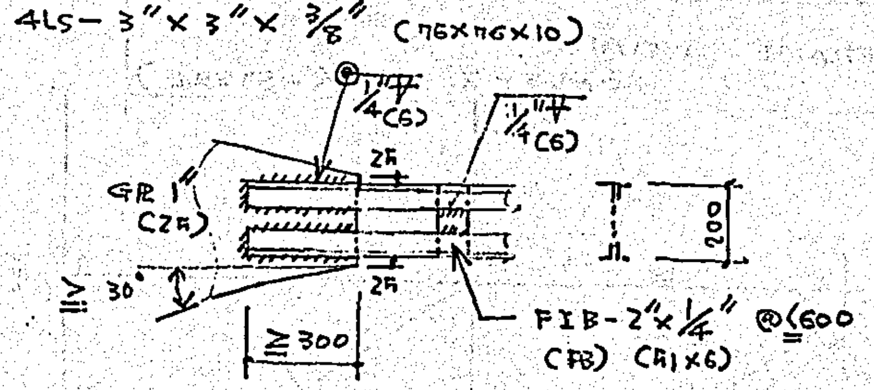


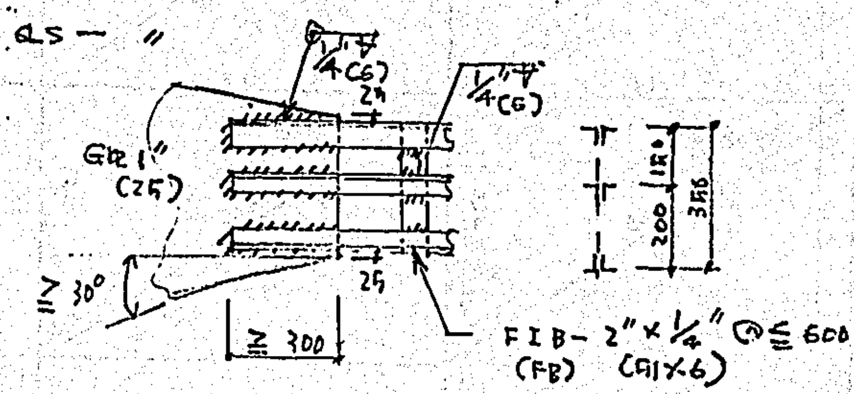
PL nA = 13.484×8 = 107.872 [cm²]

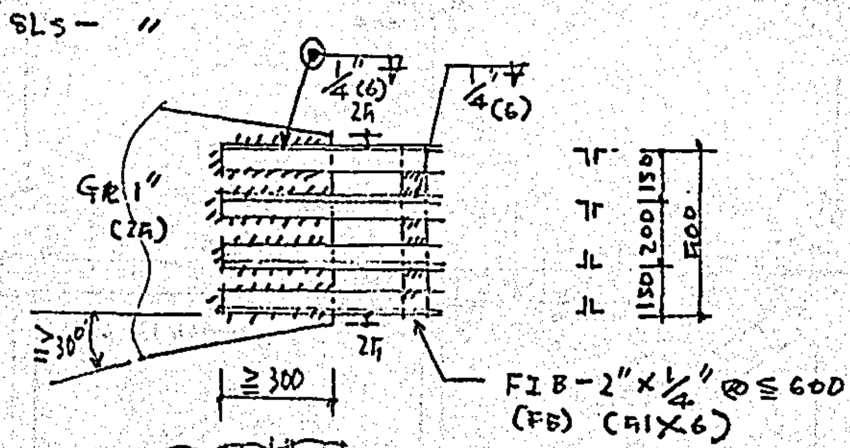
nD = 107.872/2.54 = 42.469 → 50 [cm]

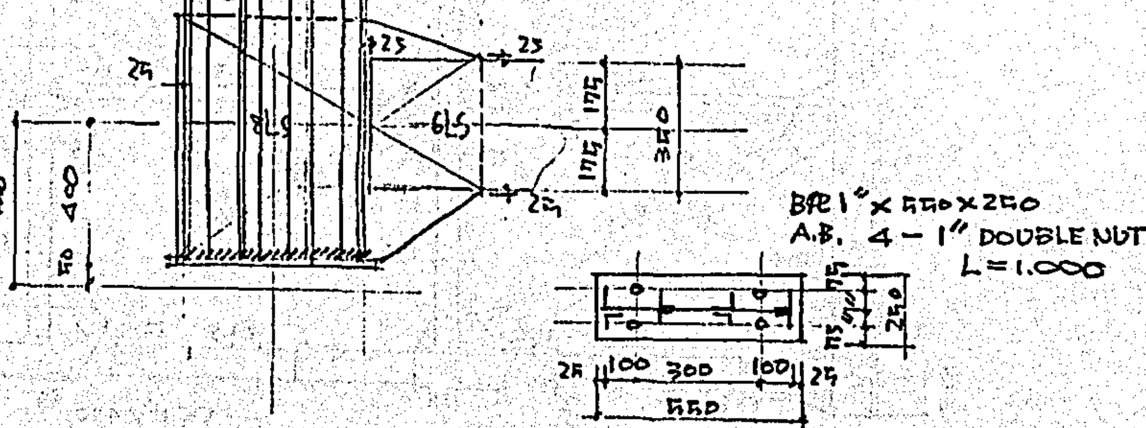
TIE PL FIB − 2"×1/4" @ 2'-0"







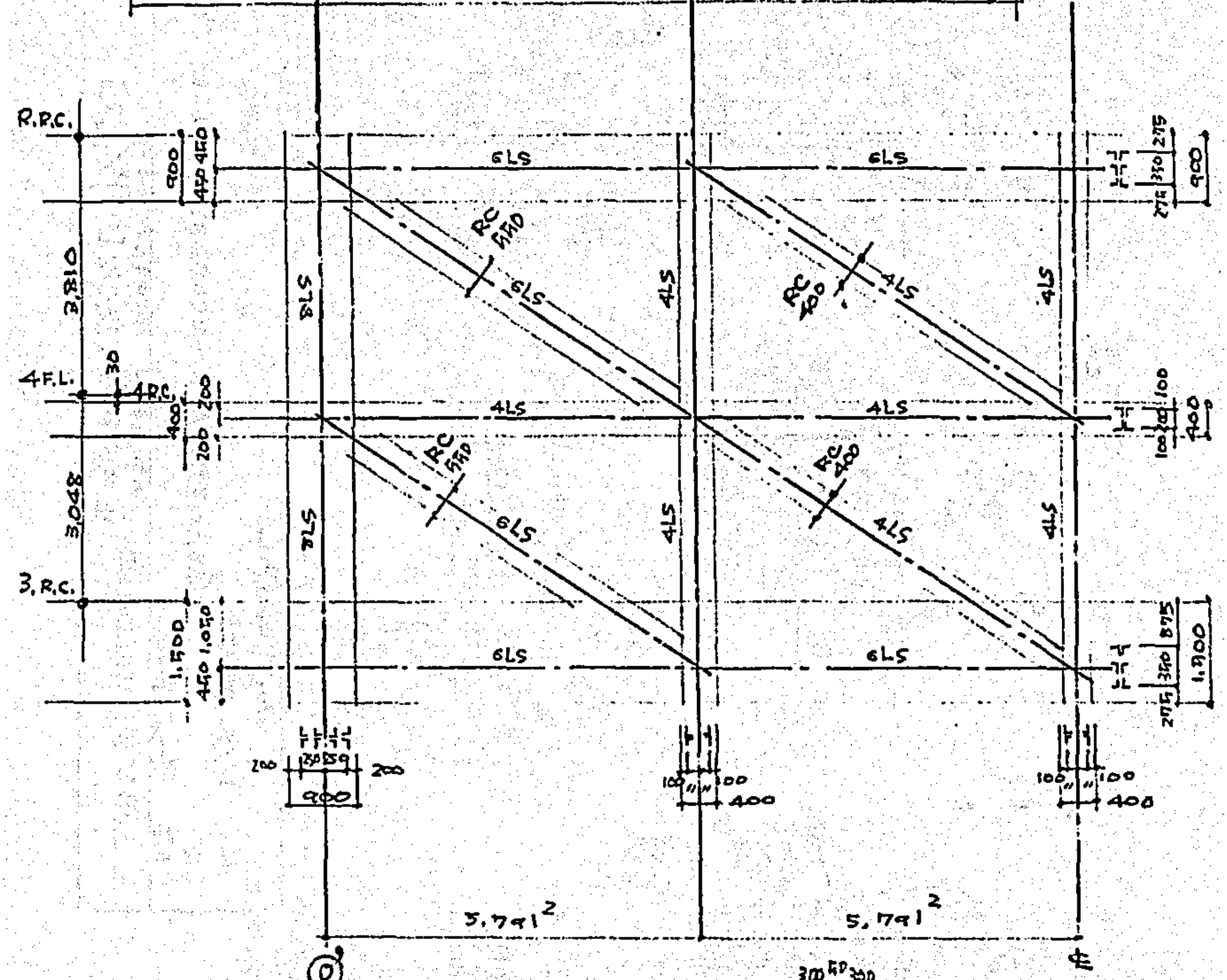


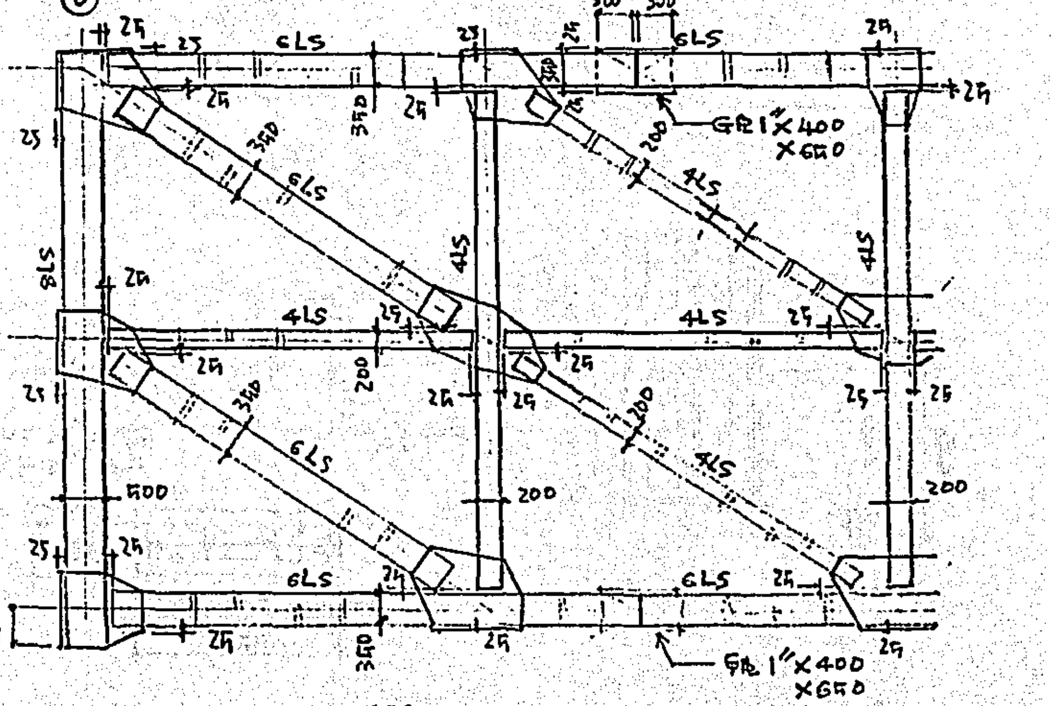


MATERIAL

L	M/S STEEL	
PL	"	("SANJUKTA"PL-WELDABLE QUALITY)
A.B.	M/S BAR	
FILLET WELDING	DESIGN INTENSITY	$f_t = 0.8t/cm^2 \doteqdot 12$ [KIP/IN²]

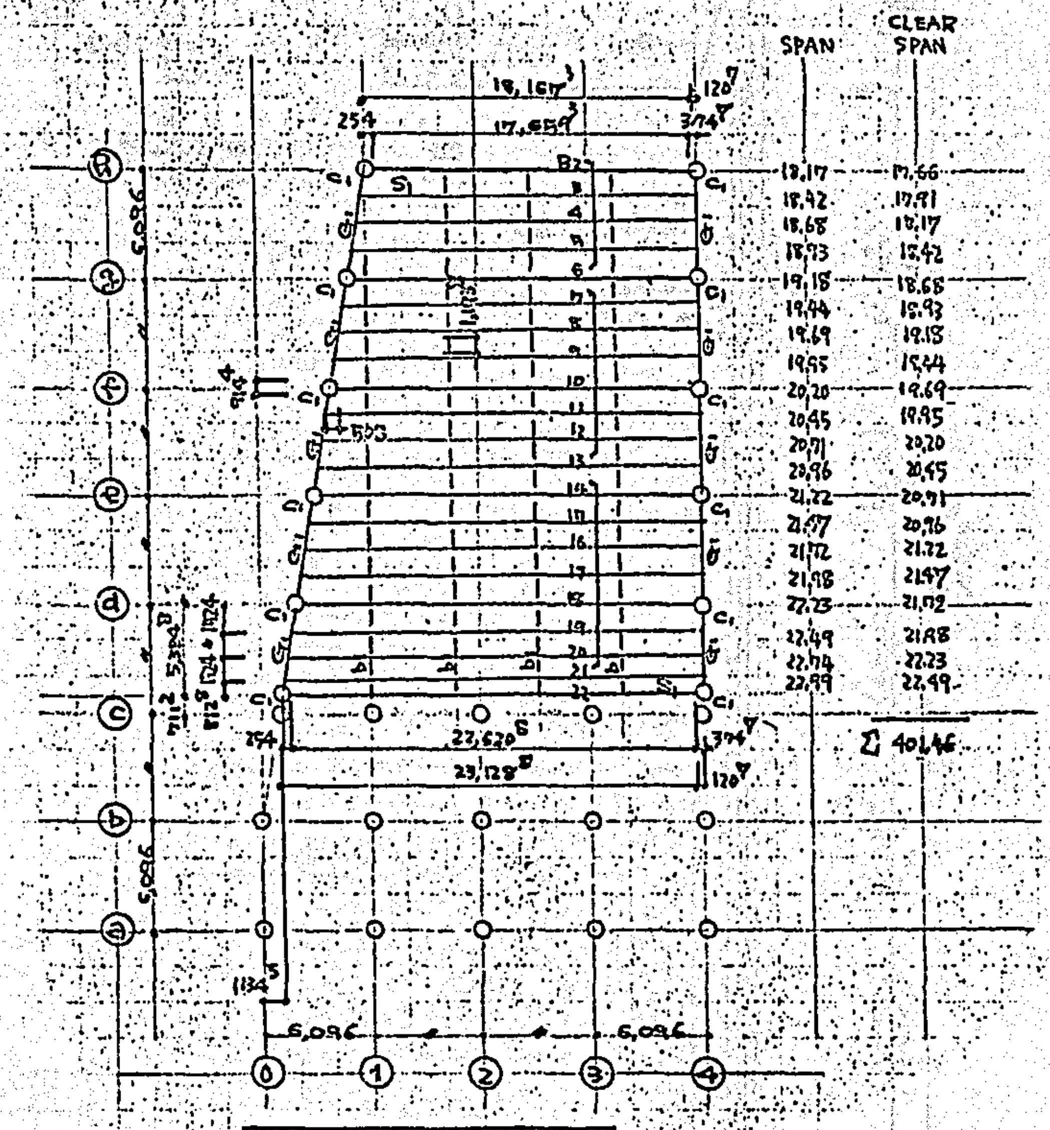
(h) HITE
STEEL FRAME DATAIL
CASE-2. (M/S-STEEL)



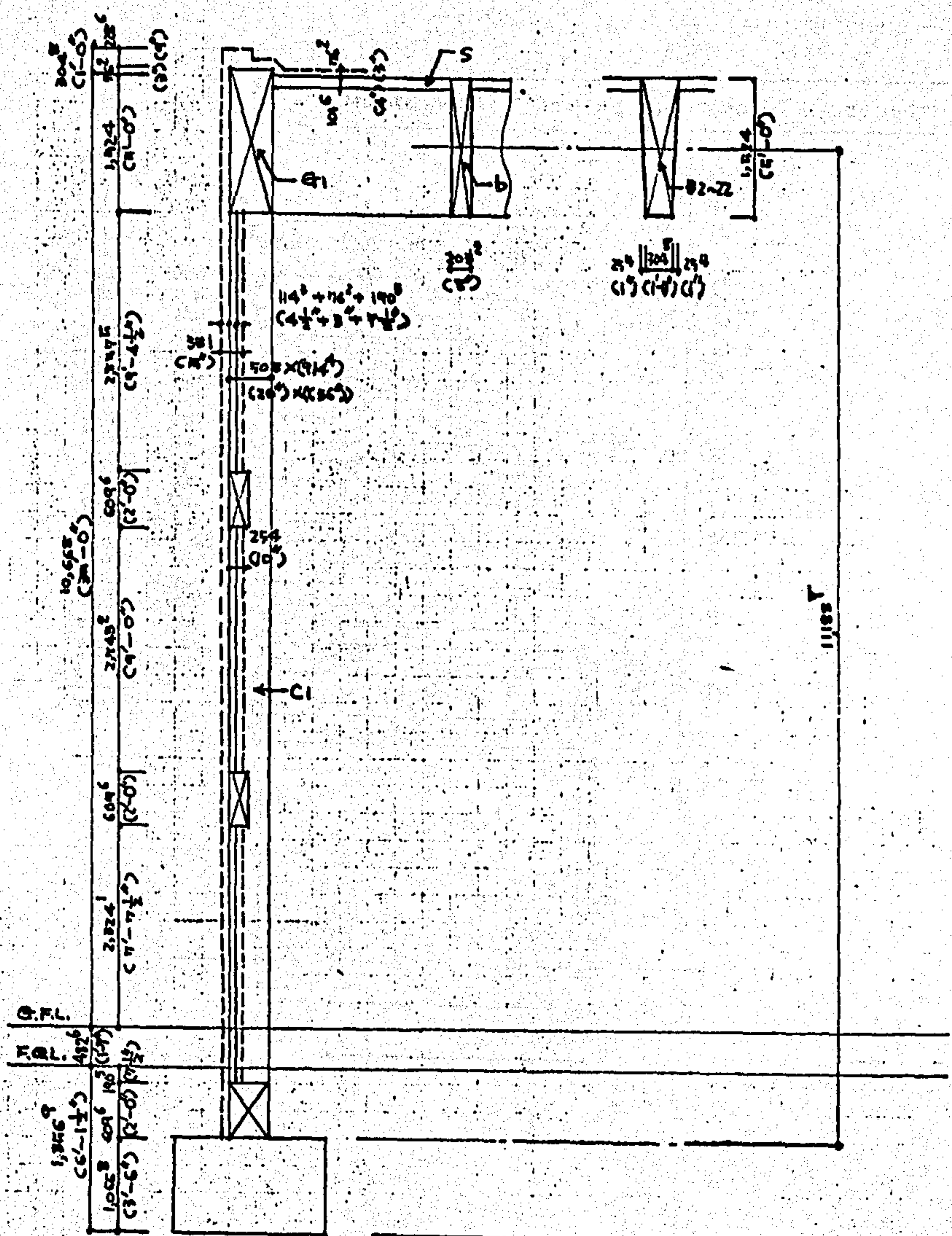


8 - CHECK OF EXISTING PART

STRUCTURAL CHECK OF EXISTING AUDITORIUM



FRAMING PLAN — ROOF



SECTION

STIFFNESS RATIO

Column

b 91.44

D 50.8

$$k = \frac{91.44 \times 50.8^3}{12} \times \frac{1}{1{,}119} = 892.7$$

Beam

b 33.02

D 152.4

$$b_a = \{0.5 - 0.6\,(a/l)\}\,a$$

$$= \{0.5 - 0.6\,(119.3/1817 \sim 2313)\}\,119.3$$

$$= 55.0 \sim 56.0$$

$$B = 33.02 + 2 \times 55.5$$

$$= 144$$

$$B/b = 144/33.02 = 4.36$$

$$t/D = 12.7/152.4 = 0.083$$

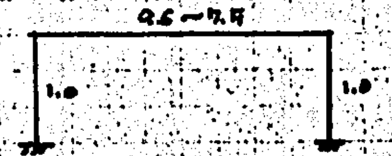
$$\phi = 1.6$$

$$k = 1.6 \times \frac{33.02 \times 152.4^3}{12} \times \frac{1}{1{,}817 \sim 2{,}313}$$

$$= 8{,}576.6 \sim 6{,}737.4$$

$k' = 9.6 \sim 7.5$

$(k_0 = 892.7)$



D-Value

k_c	Σk_b	$\bar{k}$	a	D
1.0	9.6	9.6	0.87	0.87
	7.5	7.5	0.84	0.84

$y = 0.55$

UNIT LOAD

FLOOR

kg/m2

	DEAD LOAD			LIVE LOAD		TOTAL LOAD
ROOF		WATERPROOF	275	S	90	730
		RC 4"	245	V	70	710
		CEILING	120	H	30	670
			640			
ROOF ABOVE FRONT STAGE			640	S	90 + 250	1030
			+	V	70 + 250	1010
		STEEL FRAME	50	H	30 + 125	845
			690			
LIGHTING ROOM		FINISH	60	S	350	550
		STEEL FRAME	100	V	250	450
		CEILING	40	H	150	350
			200			

BEAM

b × D	SKELETON (t/m)	FINISH (t/m)	Σ (t/m)	t/CLEAR SPAN							
20" × 60"	1.827	—	1.827								
10" × 24"	0.372	—	0.372								
8" × 60"	0.694	—	0.694								
12" ~ 14" × 60"	1.127	—	1.127								

COLUMN

b × D	SKELETON (t/m)	FINISH (t/m)	Σ (t/m)	t/CLEAR HEIGHT							
					ℓ=10.427						
20" × 36"	1.117	—	1.117		11.62						

WALL

	SKELETON	FINISH	Σ	t/CLEAR HEIGHT.m							
					NET ℓ=8.59						
4½"+3+7½"	0.183	0.488 +0.060	0.731		629						

VERTICAL LOAD OF COLUMN

MINIMUM (C1)	S	1.01 × 9.09 × 3.05	=	28.0		
	B	1.83 × 2.59	=	4.7		
		0.37 × 2.59 × 2	=	1.9		
		0.69 × 1.19 × 3	=	2.5		
		1.13 × 17.66/2	=	10.0		
	C	11.6	=	11.6		
	W	6.3 × 2.59	=	16.3	75.0	[t]
MAXIMUM (C2)	S	0.71 × 10.61 × 6.10	=	46.0		
	B	1.83 × 5.18	=	9.5		
		0.37 × 5.18 × 2	=	3.8		
		0.69 × 1.19 × 8	=	6.6		
		1.13 × 20.71/2	=	11.7		
	C	11.6	=	11.6		
	W	6.3 × 5.18	=	32.6	121.8	[t]

C·Mo·Q OF BEAM

MINIMUM (B2)

$q = (1.01 \times 1.524) + (1.13) + (0.69 \times 1.19 \times 3/19.17) = 2.80$ [t/m]

C	$2.80 \times 19.17^2/12$	=	77.6	[tm]
Mo	$/8$	=	118.6	
Q	$\times 19.17/2$	=	25.4	[t]

MAXIMUM (B22)

$q = (1.01 \times 1.524) + (1.13) + (0.69 \times 1.19 \times 4/22.99) = 2.81$ [t/m]

C	$2.81 \times 22.99^2/12$	=	123.7	[tm]
Mo	$/8$	=	185.6	
Q	$\times 22.99/2$	=	32.3	[t]

SEISMIC FORCE

Total Vertical Load

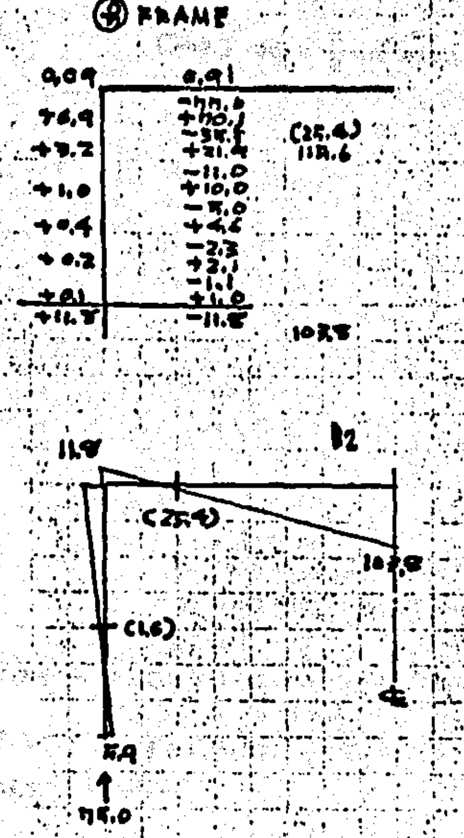
Floor	$0.845 \times 18.68 \times 6.10$	96.3		
	$0.67 \times 21.22 \times 23.67$	336.6		
	0.35×50.0	17.5	450.4	
Beam	$1.827 \times (30.18 + 29.77)$	109.5		
	$0.372 \times (30.18 - 4.57 + 29.77 - 4.77)$	18.9		
	1.127×401.46	452.4		
	$0.694 \times (1.193^{8} \times 73 + 0.482^{6} \times 4)$	61.8	642.6	
Column	$11.62 \times 12/2$	69.7		$\Sigma = 1{,}322.5$ [t]
Wall	$6.29 \times (30.18 - 4.75 + 29.77 - 4.57)/2$	159.8		

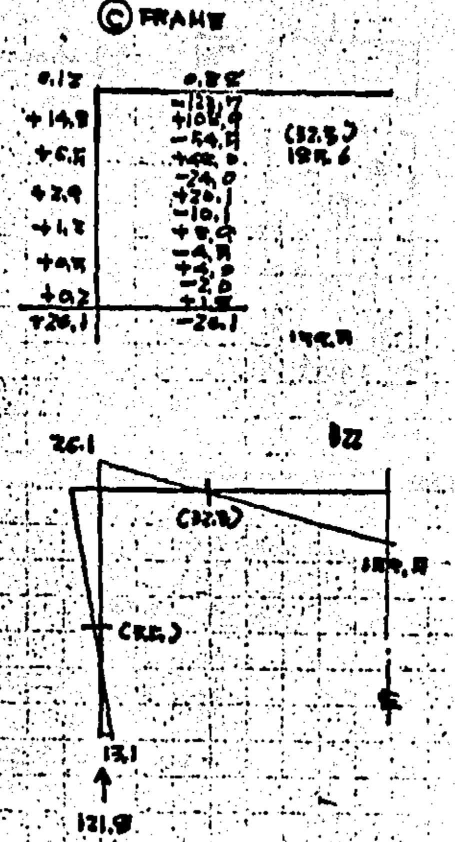
(Area $= \{(18.17 + 23.13)/2\} \times \{(6.096 \times 5) - 0.711^2\} = 614.7$ [m²]
Average Load $= 1{,}322.5 / 614.7 = 2.15$ [t/m²])

Coefficient of Horizontal Force = 0.05

Horizontal Force $= 1{,}322.5 \times 0.05 = 66.1$ [t]

STRESS FOR VERTICAL LOAD



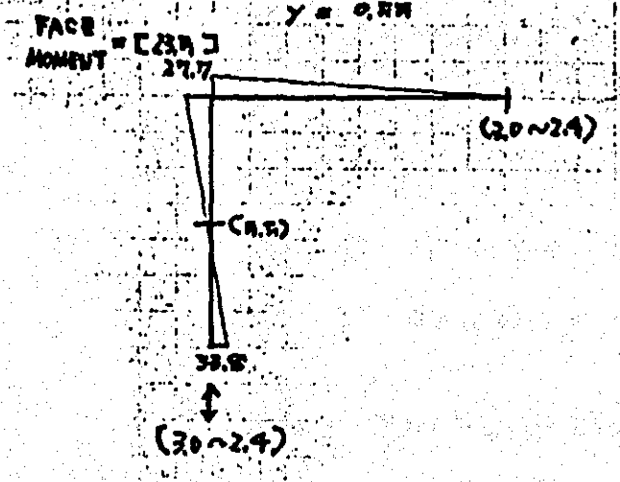


STRESS FOR SEISMIC FORCE

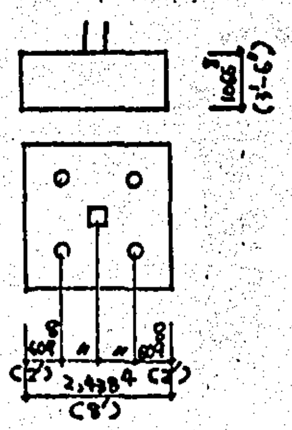
$\overline{Q}_c$ = 66.1 / 12.0 = 5.5 (D = 0.84 ~ 0.87 , Dmax ≒ Dmin)

TM = 5.5 × 11.19 = 61.5

y = 0.55



ALLOWABLE STRESS OF EXISTING FOOTING : F4B



$d = (106.68 - 18.24) \times \frac{7}{8} = 80$ [cm]

PILE 4-406.4φ (16"φ)

$R_A = 70\ t/p$

Vertical Load (75.0 ~ 121.8 ≪ 70×4

MIN $M_A = \frac{75.0}{2} \times 1.219^b = 45.7 > 5.9 + 33.8 = 39.7$

MAX 〃 $= \frac{121.8}{2} \times$ 〃 $= 74.3 > 13.1 + 33.8 = 46.9$

O.K.

REINFORCEMENT 16-19φ (3/4"φ) @150(6") c/c

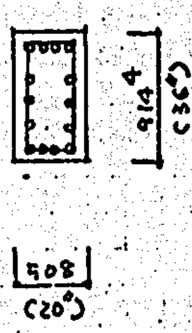
$M_A = 16 \times 2.85^{[cm^2]} \times 2.4^{[t/cm^2]} \times 0.8^{[m]}$

$= 87.6$ [tm]

$> \frac{121.8}{2} \times \frac{1.219^b}{2} = 37.1$

O.K.

ALLOWABLE STRESS OF EXISTING COLUMN



• 14−25φ (1"φ)

Formula on Ultimate Intensity

$N \leqq 0.4bDFc$

$$Mu = 0.8\,a_t \sigma_y D + 0.5ND\left(1 - \frac{N}{bDFc}\right)$$

$N > 0.4bDFc$

$$Mu = 0.8\,a_t \sigma_y D + 0.12\,bD^2 Fc$$

In this case

$N = 75.0 \sim 121.3$ [t]

$0.4bDFc = 0.4 \times 91.44 \times 50.8 \times 180 = 334.45$ [t] $> N$

$\sim$

$$Mu = 0.8 \times (5 \times 5.07) \times 2.4 \times 50.8 + 0.12 \times 91.44 \times 50.8^2 \times 180$$

$= 2472.5 + 5{,}097{,}032.4$

$= 5{,}099{,}504.9$ [kgcm]

$= 51.0$ [tm]

M Ⓡ $11.8 + 23.5 = 35.3$

Ⓒ $26.1 + 23.5 = 49.6$] $< Mu$

o.k.

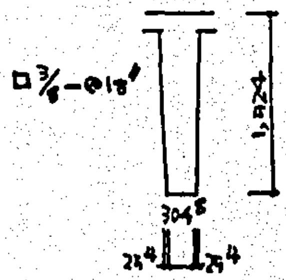
$QAS = 91.44 \times (50.8 - 5)\frac{7}{8} \times 9 = 33.0$ [t]

$>$ QD Ⓡ $1.6 + (5.5 \times 1.5) = 9.9$ [t]

Ⓒ 3.5 〃 $= 11.8$

o.k.

はり の許容耐力　　　　　　B2 ～ 22



$\bar{b} = (30.48 + 35.56)/2 = 33.02$
$D = 152.4$
$d \doteqdot 152.4 - 10 = 142.4$
$j = 142.4 \times \frac{7}{8} = 124.6$

	at	φ
1/2" (12.7)	1.27	3.99
1 1/8" (28.6)	6.41	8.98

$M_u = 0.9\, a_t\, \sigma_y\, d$ -------- σ_y = (Mild Steel Bar) = 33,000 [P.S.I] = 2.3 [t/cm²]

$Q_{AL} = b\, j\, f_s = 33.02 \times 124.6 \times 6 = 24.7$ [t]
St. □ 3/8" @ 18" (9.5φ @ 457.2) --- $P_w = 0.00051$
$Q_{Ab} = \varphi\, f_b\, j$ ----- $f_b = 7.2 \sim 10.8$ [kg/cm²]

			n	at	φ	d	j	Mu	QAb
B22	END	TOP	(2 − 1/2)+(3 − 1 1/8)	21.77	34.91	142.4	124.6	64.2	31.3 ~ 47.0
		BTM	(5 − 1 1/8)	32.07		〃	〃	94.5	
	CENT	TOP	(2 − 1/2)	2.53		〃	〃	7.5	
		BTM	(8 − 1 1/8)	51.30		〃	〃	151.2	
B 14～21	END	TOP	(2 − 1/2)+(6 − 1 1/8)	41.01	61.84	〃	〃	120.9	55.5 ~ 83.3
		BTM	(8 − 1 1/8)	51.30		〃	〃	151.2	
	CENT	TOP	(2 − 1/2)	2.53		〃	〃	7.5	
		BTM	(14 − 1 1/8)	89.78		〃	〃	264.6	
B 11～13	END	TOP	(2 − 1/2)+(4 − 1 1/8)	28.19	43.89	〃	〃	83.1	39.4 ~ 59.1
		BTM	(8 − 1 1/8)	51.30		〃	〃	151.2	
	CENT	TOP	(2 − 1/2)	2.53		〃	〃	7.5	
		BTM	(12 − 1 1/8)	76.96		〃	〃	226.9	
B 2～12	END	TOP	(2 − 1/2)+(4 − 1 1/8)	28.19	43.89	〃	〃	83.1	39.4 ~ 59.1
		BTM	(6 − 1 1/8)	38.48		〃	〃	113.4	
	CENT	TOP	(2 − 1/2)	2.53		〃	〃	7.5	
		BTM	(10 − 1 1/8)	64.13		〃	〃	189.0	

		V		H	T		
B2	Ms	11.8		27.7	39.5	<	83.1
	C	103.8	±	0	103.8	<	139.0
	Q	25.4		3.0×1.5	29.9	<	34.4 ~ 49.1
							O.K.
B22	Ms	26.1		27.7	53.8	<	64.2
	C	154.5	±	0	154.5	<	161.2
	Q	32.3		2.4×1.5	35.9	<	31.3 ~ 47.0
							O.K.

By above investigation

Existing auditorium is safe for seismic force.

(In long direction, existing walls resists for seismic force.)

(END)

2. Calculation Sheet of Acoustics

(Calculation Sheets)

ACOUSTICAL DESIGN OF AUDITORIUM

1. The Acoustical Effects of the Auditorium

The acoustical effects of the auditorium have been so designed as to obtain the planned reverberation time by appropriate combinations of the low-, medium- and high-frequency and extensive frequency band sound absorbing materials. The results of the design calculations are given on pages 1 to 5.

The major design conditions assumed are summarized as below:

(1) Boards shall be used as a sound reflecting material both at the surface of the side walls and at the surface of the ceiling and sound diffusers shall be provided in the front side walls in consideration of sound diffusion.
These boards can be expected to produce limited sound absorption effects due to resonance absorption in the low frequency.

(2) To compensate for sound absorption in the low frequency, perforated calcium silicate boards shall be used in the borders of the ceiling and a slit type sound absorbing construction shall be adopted for some parts of the rear ceiling.

(3) A sound absorbing construction consisting of slits and perforated calcium silicate boards covered with cloth will be adopted as a extensive frequency band sound absorbing material in the rear wall.

(4) Porous boards shall be employed as a medium and high-frequency sound absorbing material in some parts of the rear side walls.

(5) Medium- and high-frequency sound absorbing materials will be used in the walls and ceiling of the stage-flys in order to shorten the reverberation time in the auditorium to the required value without using slage sound reflectors.
By selecting and distributing the different types of sound absorbing materials in the auditorium in the manner as noted above, it can be

expected to obtain a reverberation time of 1.1 seconds (500Hz) with stage sound reflectors in use and a reverberation time of about 0.96 seconds without the reflectors when the auditorium is full.

2. Noise Control Design on Air-Conditioning Duct System

The duct system of the air-conditioning unit will be fitted inside with a required number of sound absorbing devices, such as chambers and elbows, to keep the fan noise transmitted through the ducts to levels below the permissible noise levels established according to the use of rooms.

Three to five of the sound absorbing devices will be installed in the air-conditioner room to reduce the fan noise as much as possible before leaving the room. The rest of the devices will be installed in the ceilings of the rooms served by the air-conditioner.

To minimize noises produced by air stream in the duct system, the air velocity in the ducts will be kept to a value lower than the 5 m/sec, and provision is made for installation of a sound absorbing device at the end of the duct system.

Tables five to eleven show the results of calculations made in respect of air-conditioner noises in the measure systems of the auditorium and of the sub-control room. As can be noted the permissible noise level of NC-25 can be expected to be met in the auditorium, the stage and the sub-control room.

Table . 1 残響時間の計算(1)

Calculation of Reverberation Time of ETV Hall

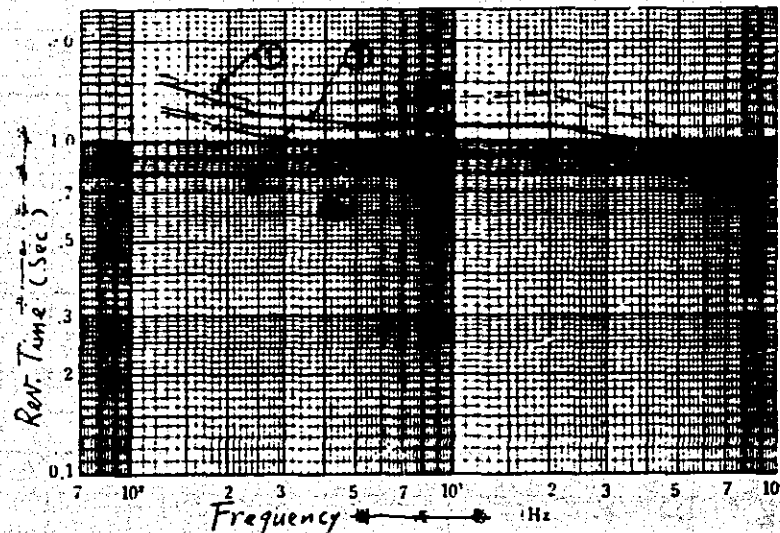
Dimension

L		m
W		m
H		m
F		m²
S	1745.3	m²
V	3291.5	m³
V/S	1.89	m

Design Goal 500Hz

T 1.10 sec
α 0.241
A 420.6 m²
(at Full Occupancy, with Stage Sound Reflectors)

A壁	
B壁	
C壁	
D壁	
天井	



Items	S	Si/S	125 Hz αi	125 Hz Ai	250 Hz αi	250 Hz Ai	500 Hz αi	500 Hz Ai	1000 Hz αi	1000 Hz Ai	2000 Hz αi	2000 Hz Ai	4000 Hz αi	4000 Hz Ai	8000 Hz αi	8000 Hz Ai
[1] with Stage Sound Reflectors																
1) when empty	1745.3		.175	304.5	.206	359.0	.207	360.9	.200	349.5	.187	326.2	.196	341.5	.207	362.0
Rev. Time ①			1.58		1.31		1.31		1.36		1.47	(1.37)	1.39	(1.15)	1.31	(0.80)
2) at full occupancy	1745.3		.211	368.0	.239	416.7	.243	424.4	.240	418.7	.227	395.4	.232	405.0	.234	408.2
Rev. Time ②			1.28		1.11		1.09		1.11		1.18	(1.11)	1.15	(0.98)	1.15	(0.74)
[2] with Stage Curtains (without Stage Sound Reflectors)																
1) when empty	1745.3		.182	318.3	.222	386.6	.235	409.3	.239	417.2	.227	396.7	.235	409.2	.248	432.5
Rev. Time ③			1.52		1.21		1.13		1.11		1.18	(1.11)	1.13	(0.98)	1.07	(0.70)
2) at full occupancy	1745.3		.219	381.8	.255	444.3	.271	472.8	.279	486.4	.267	465.9	.271	472.7	.274	478.7
Rev. Time ④			1.23		1.03		0.96		0.93		0.98	(0.94)	0.96	(0.84)	0.95	(0.65)

( ): 60% Relative Humidity

NHK (建築)

Table 2

No. 2 Sound Absorption Power 1

残響時間の計算(2)

NHK 建築

	Item	S_i	S_i/S	125Hz a_i	125Hz A_i	250Hz a_i	250Hz A_i	500Hz a_i	500Hz A_i	1000Hz a_i	1000Hz A_i	2000Hz a_i	2000Hz A_i	4000Hz a_i	4000Hz A_i	8000Hz a_i	8000Hz A_i
Floor	Stage Floor (Wood)	106.3		.20	21.3	.15	15.9	.12	12.8	.09	9.6	.09	9.6	.09	9.6	.10	10.6
	Floor Carpet (Needle Punch)	85.0		.07	6.0	.07	6.0	.08	6.8	.10	8.5	.20	17.0	.30	25.5	.35	29.8
	Orch. Pit Floor (Vin. Tile)	4.8		.12	0.6	.10	0.5	.08	0.4	.04	0.2	.04	0.2	.05	0.2	.05	0.2
	Orch. Pit Seats (46)	26.2		.13	3.4	.21	5.5	.29	7.6	.34	8.9	.32	8.4	.32	8.4	.34	8.9
	Audience Seats (531)	302.7		.12	36.3	.20	60.5	.29	87.8	.34	102.9	.32	96.9	.32	96.9	.34	102.9
	Audit. Floor (Vin. Tile)	38.5		.03	1.2	.03	1.2	.04	1.5	.05	1.9	.06	2.3	.06	2.3	.07	2.7
Wall	Stage Front (Hard Wood)	13.7		.10	1.4	.08	1.1	.05	0.7	.04	0.5	.05	0.7	.05	0.7	.06	0.8
	Glass Windows 10mm	8.8		.15	1.3	.06	0.5	.04	0.4	.03	0.3	.02	0.2	.02	0.2	.03	0.3
	Doors	13.3		.20	2.7	.15	2.0	.10	1.3	.10	1.3	.10	1.3	.12	1.6	.15	2.0
	Dug-out Wall (Morta.)	28.5		.03	0.9	.03	0.9	.03	0.9	.04	1.1	.04	1.1	.05	1.4	.05	1.4
	Skirting (Hard Wood)	19.4		.03	0.6	.03	0.6	.04	0.8	.04	0.8	.05	1.0	.05	1.0	.06	1.2
Ceiling	Opening for Loud-Speaker	5.3		.20	1.1	.30	1.6	.40	2.1	.45	2.4	.50	2.7	.50	2.7	.55	2.9
	Opening for Lighting	16.7		.30	5.0	.35	5.8	.40	6.7	.45	7.5	.50	8.4	.50	8.4	.50	8.4
	Lighting Tools	2.3		.15	0.3	.13	0.3	.10	0.2	.09	0.2	.07	0.2	.05	0.1	.05	0.1
	Anemostat & Nozzle	8.1		1.25	10.1	1.15	9.3	1.00	8.1	.80	6.5	.73	5.9	.70	5.7	.70	5.7
Others	Stage Sound Reflectors	138.2		.20	27.6	.15	20.7	.12	16.6	.06	8.3	.06	8.3	.07	9.7	.08	11.1
	Reflector's Gap (Curtain)	41.6		.30	12.5	.35	14.6	.45	18.7	.60	25.0	.65	27.0	.70	29.1	.70	29.1
	Dug-out Opening	2.9		.30	0.9	.35	1.0	.35	1.0	.35	1.0	.35	1.0	.35	1.0	.35	1.0
	Total	862.3			133.2		148.0		174.4		186.9		192.2		214.5		219.1

Table 3

表 3 Sound Absorption Power 2

残響時間の計算(2)

NHK（建築）

	Items	S.	S.S	125Hz a_i	125Hz A_i	250Hz a_i	250Hz A_i	500Hz a_i	500Hz A_i	1000Hz a_i	1000Hz A_i	2000Hz a_i	2000Hz A_i	4000Hz a_i	4000Hz A_i	8000Hz a_i	8000Hz A_i
Wall	Sound Diffuser (A.C.B t=24 A.S.700)	28.6		.12	3.4	.10	2.9	.08	2.3	.06	1.7	.06	1.7	.08	2.3	.10	2.9
	Asb.Cal.Board t=6 (7ᵠ15ᵖ)																
	+GW t=50 + A.S.350	17.4		.60	11.6	.85	16.5	.75	14.6	.85	16.5	.80	15.5	.65	12.6	.55	10.7
	Asb.Cal.Board t=12 A.S.400	20.8		.13	2.7	.11	2.3	.08	1.7	.06	1.2	.06	1.2	.07	1.5	.08	1.7
	" " " t=24 A.S.350	89.1		.12	10.7	.10	8.9	.08	7.1	.06	5.3	.06	5.3	.06	5.3	.07	6.2
	" " " t=24 A.S.400	73.6		.12	8.8	.10	7.4	.08	5.9	.06	4.4	.06	4.4	.07	5.2	.08	5.9
	Other Part of Side Wall (t=24 A.S.300)	45.7		.12	5.5	.10	4.6	.08	3.7	.06	2.7	.06	2.7	.06	2.7	.07	3.2
	Side Wall of Lighting Spot R.																
	(Asbestus Board t=24 A.S.50)	36.4		.12	4.4	.10	3.6	.08	2.9	.06	2.2	.06	2.2	.06	2.2	.07	2.5
	Rear Wall (Steel Rib (22×20, w=60),																
	+A.S.45 + Cloth + Asb.Board t=6																
	(9ᵠ15ᵖ) + GW t=50 + A.S.150)	58.1		.55	32.0	.75	43.6	.84	48.8	.80	46.5	.70	40.7	.60	34.9	.50	29.1
Ceiling	Asb.Flex.B. t=12 + GW t=50 + A.S.	230.4		.18	41.5	.13	30.0	.10	23.0	.08	18.4	.08	18.4	.09	20.7	.10	23.0
	" " " t=6 + GW t=50 + A.S.50	46.2		.14	6.5	.12	5.5	.08	3.7	.06	2.8	.07	3.2	.08	3.7	.09	4.2
	" " " t=6 + GW t=50 + A.S.300	12.5		.20	2.5	.15	1.9	.09	1.1	.07	0.9	.07	0.9	.08	1.0	.10	1.3
	" " " t=6 Slit (300+																
	300, w=100, + GW t=50 + A.S.70)	130.3		.15	19.5	.40	52.1	.42	54.7	.36	46.9	.21	27.4	.25	32.6	.28	36.5
	Asb.Flex.B. t=6 + GW t=50 + A.S.	49.7		.22	10.9	.16	8.0	.10	5.0	.08	4.0	.08	4.0	.09	4.5	.10	5.0
	Ceiling Boarder (Hard Wood)	13.9		.10	1.4	.08	1.1	.05	0.7	.04	0.6	.05	0.7	.05	0.7	.06	0.8
	" " (Asb.C.B. t=6 (9ᵠ45ᵖ)																
	+GW t=50 + A.S.75)	28.3		.35	9.9	.80	22.6	.40	11.3	.30	8.5	.20	5.7	.25	7.1	.35	9.9
	Total	883.0			171.3		211.0		126.5		162.6		134.0		137.0		142.9

Table 4

残響時間の計算(2)

·4 Total Sound Absorption Power.

NHK 建築

Items	S.	S·S	125Hz a.	125Hz A.	250Hz a.	250Hz A.	500Hz a.	500Hz A.	1000Hz a.	1000Hz A.	2000Hz a.	2000Hz A.	4000Hz a.	4000Hz A.	8000Hz a.	8000Hz A.
[1] With Stage Sound Reflectors																
1) when empty																
sound absorption power 1	862.3			133.2		148.0		174.4		186.7		192.2		204.5		217.1
sound absorption power 2	883.0			171.3		211.0		186.5		162.6		134.0		137.0		142.9
	1745.3	①	.175	304.5	.206	359.0	.207	360.7	.200	349.5	.187	326.2	.196	341.5	.207	362.0
2) at Full Occupancy																
additional Sound Absorption Power by Audiences (577)		②	.11	63.5	.10	57.7	.11	63.5	.12	69.2	.12	69.2	.11	63.5	.08	46.2
	1745.3	①+②	.211	368.0	.239	416.7	.243	424.4	.240	418.7	.227	395.4	.232	405.0	.234	408.2
[2] With Stage Curtains (Without Stage Sound Reflectors)																
1) when empty																
additional sound absorption power by curtains	138.2	③	.10	13.8	.20	27.6	.35	48.4	.49	67.7	.51	70.5	.49	67.7	.51	70.5
	1745.3	①+③	.182	318.3	.222	386.6	.235	409.3	.239	417.2	.227	396.7	.235	409.2	.248	432.5
2) at Full Occupancy																
	1745.3	①+② +③	.217	381.8	.255	444.3	.271	472.8	.279	486.4	.267	465.9	.271	472.7	.274	478.7

Table. 5 Calculation of Ventilation Noise Insulation (for Fan Noise)

Date :

Building BTV Hall

Room Name Audience Hall Ducting Rout AC-2 (Supply) Type of Fan SF-2 11.0KW

Object of Room : Auditorium Horsepower of Fan : HP = 14.7

Volume of Use : $V = 3291.5\ m^3$ Power Level of Fan : $PWL = 90 + 10\log HP = 101.7$ dB

Total Surface Area of Room : $S = 1745.3\ m^2$ Total Amount of Ventilation : $F = 18300\ m^3$

Mean Absoroption Coefficient : $\bar{\alpha} = 0.21$ Amount of Ventilation at Opening : $f = 610\ m^3$

Absorbing Power : $A = S\bar{\alpha} = 360.7\ m^2$ Divisional Ratio : $K_b = 10\log\frac{f}{F} = -14.8$ dB

Room Constant : $R = S\bar{\alpha}/1-\bar{\alpha} = 455.1$ Number of Ventilation Opening : $n = 30$

Type of Ventilation Opening : Anemostat Effective Number of Ventilation Opening : $n_e = 3$

Dimension of Ventilation Opening : $s = 0.0398\ m^2$ $r_c = 0.14\sqrt{QR} = 4.2$ $r_{min} = 3.0$

Directivity Factor : $Q = 2$

$SPL_{ne} = 10\log\frac{Q}{4\pi r^2} + 10\log n_e = -12.8$ $SPL_{n-ne} = 10\log\frac{4}{R} + 10\log(n-n_e) = -6.2$ $\Delta L = -6.6$ dB

$N_j = \frac{1}{6}$ $N_{Di} = 0.222$ $N_D = \frac{1}{2}$ $X = 10\log N_j \cdot N_{Di} \cdot N_D = -17.3$ dB

Radiation Coefficient $K_r = 10\log\left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) = -15.8$ dB

Noise Criterion Value NC = 25 Ventilation Velocity : $v = 4.2$ m

	Octave Band Frequency	63	125	250	500	1000	2000	4000	8000	Notes
1	P.W.L. of Fan	96.7	95.7	94.7	93.7	91.7	88.7	83.7	78.7	
2	K_b	-14.8	-14.8	-14.8	-14.8	-14.8	-14.8	-14.8	-14.8	
3	Correction of Other Noise	—	—	—	—	—	—	—	—	
4	Attenuation at Opening	-14.5	-11.5	-5.5	-2.5	-0.5	—	—	—	
5	P.W.L. of Ventilation Open.	67.4	69.4	74.4	76.4	76.4	73.9	68.9	63.9	(1)+(2)+(3)+(4)
6	Permissible Noise S.P.L.	57	47	39	32	28	25	22	21	
7	$-10\log n_e + X$	-24.1	-24.1	-24.1	-24.1	-24.1	-24.1	-24.1	-24.1	
8	$-K_r$	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	
9	Permissible Band P.W.L. of Noise at Vent. Opening	50.7	40.7	32.7	25.7	21.7	18.7	15.7	14.7	(6)+(7)+(8)
10	Necessary Attenuation Value	16.7	28.7	41.7	50.7	54.7	55.2	53.2	49.2	(5)−(9)
11	CH_1 (1.6×1.5×1.2)	3	6	6.5	7	8	8	7	7	
	CH_2 (1.5×0.75×1.6)	3	6	6.5	7	8	8	7	7	
	EL_1 (0.7×0.55)	5	7.5	8.5	12.5	13.5	14	13.5	13.5	
	CH_3 (0.95×0.5×1.5)	2	4	5	6	6	6	6	6	
	CH_4 (1.1×0.7×[illegible])	2	4	5	6	6	6	6	6	
	EL_2 (0.1×0.5)	5	6.5	7	12.5	14.5	15.5	13	12.5	
	EL_3 (225φ)	7	6	[illegible]	[illegible]	15	10	11	14	
	CH_5 (0.65×0.65×0.35)	—	—	—	—	—	—	—	—	
	Total	22	38	47	57	65	65	63	63	

Table. 6 **Calculation of Ventilation Noise Insulation (for Fan Noise)**

Date :

Building BTV Hall

Room Name Audience Hall Ducting Rout AC-2 (Return) Type of Fan { SF-2 11.0 KW / FI-2 5.5 KW

Object of Room : Auditorium

Horsepower of Fan : $HP_1 = 14.7$ $HP_2 = 7.3$

Volume of Use : $V = 3271.5\ m^3$

Power Level of Fan : $PWL_1 = 90 + 10\log HP_1 = 101.7$ dB; $PWL_2 = 90 + 10\log HP_2 = 96.7$ dB

Total Surface Area of Room : $S = 1745.3\ m^2$

Total Amount of Ventilation : $F = 19520\ m^3$

Mean Absoroption Coefficient : $\bar{\alpha} = 0.21$

Amount of Ventilation at Opening : $f = 610\ m^3$

Absorbing Power : $A = S\bar{\alpha} = 360.7\ m^2$

Divisional Ratio : $K_b = 10\log \frac{f}{F} = -15.1$ dB

Room Constant : $R = S\bar{\alpha}/1-\bar{\alpha} = 455.1\ m^2$

Number of Ventilation Opening : $n = 32$

Type of Ventilation Opening : Anemostat

Effective Number of Ventilation Opening : $n_e = 3$

Dimension of Ventilation Opening : $s = 0.0398\ m^2$ $r_c = 0.14\sqrt{QR} = 4.2\ m$ $r_{min} = 3.0\ m$

Directivity Factor : $Q = 2$

$SPL_{ne} = 10\log \frac{Q}{4\pi r^2} + 10\log n_e = -12.8$ dB $SPL_{n-ne} = 10\log \frac{4}{R} + 10\log (n-n_e) = -6.2$ dB $\Delta L = -6.6$ dB

$N_j = \frac{1}{6}$ $N_{Di} = 0.268$ $N_D = \frac{1}{2}$ $X = 10\log N_j \cdot N_{Di} \cdot N_D = -16.5$ dB

Radiation Coefficient $K_r = 10\log \left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) = -15.8$ dB

Noise Criterion Value $NC = 25$ Ventilation Velocity : $v = 4.2$ m

	Octave Band Frequency	63	125	250	500	1000	2000	4000	8000	Notes
1	P.W.L. of Fan	87.3	87.3	86.0	85.0	83.0	80.1	75.2	70.2	
2	K_b	−15.1	−15.1	−15.1	−15.1	−15.1	−15.1	−15.1	−15.1	
3	Correction of Other Noise	—	—	—	—	—	—	—	—	
4	Attenuation at Opening	−14.5	−11.5	−5.5	−2.5	−0.5	—	—	—	
5	P.W.L. of Ventilation Open.	59.7	60.7	65.4	67.4	67.4	65.0	60.1	55.1	(1)+(2)+(3)+(4)
6	Permissible Noise S.P.L.	57	47	37	32	28	25	22	21	
7	$-10\log n_e + X$	−21.3	−21.3	−21.3	−21.3	−21.3	−21.3	−21.3	−21.3	
8	$-K_r$	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	
9	Permissible Band P.W.L. of Noise at Vent. Opening	51.5	41.3	33.5	26.5	22.5	19.5	16.5	15.5	(6)+(7)+(8)
10	Necessary Attenuation Value	8.2	19.4	31.9	40.9	44.9	45.5	43.6	39.6	(5)−(9)
11	CH_1 (1.1×0.9×1.6)	2	4	5	6	6	6	6	6	
	CH_2 (1.1×0.95×1.6)	2	4	5	6	6	6	6	6	
	EL_1 (0.6×0.56)	5	7.5	8.5	12.5	13.5	14	13.5	13.5	
	CH_3 (1.0×0.9×0.85)	3	6	6.5	7	8	8	7	7	
	EL_2 (0.62×0.55)×3	15	22.5	25.5	37.5	40.5	42	40.5	40.5	
	CH_4 (0.65×0.65×0.35)	—	—	—	—	—	—	—	—	
	Total	27	44	50.5	69	74	76	73	73	

Table [illegible] Calculation of Ventilation Noise Insulation (for Fan Noise)

Date :

Building [illegible]

Room Name [illegible] Ducting Rout A-1 ([illegible]) Type of Fan EF-1 30KW

Object of Room : [illegible]

Horsepower of Fan : HP = 40

Volume of Use : V = [illegible] m³

Power Level of Fan : PWL = 90 + 10 log HP = 106.0 dB

Total Surface Area of Room : S = 1247.7 m²

Total Amount of Ventilation : F = 5600 m³

Mean Absorption Coefficient : $\bar{\alpha}$ = 0.40

Amount of Ventilation at Opening : f = 140 m³

Absorbing Power : $A = S\bar{\alpha}$ = 1247 m²

Divisional Ratio : $K_b = 10\log\frac{f}{F}$ = −16.0 dB

Room Constant : $R = S\bar{\alpha}/1-\bar{\alpha}$ = 2077.8 m²

Number of Ventilation Opening : n = 40

Type of Ventilation Opening : [illegible]

Effective Number of Ventilation Opening : n_e = 20

Dimension of Ventilation Opening : s = 0.5 m²

$r_c = 0.14\sqrt{QR}$ = 9.0 m r_{min} = 2.0 m

Directivity Factor : Q = 2

$SPL_{ne} = 10\log\frac{Q}{4\pi r^2} + 10\log n_e$ = −1.0 dB $SPL_{n-ne} = 10\log\frac{4}{R} + 10\log(n-n_e)$ = −14.2 dB ΔL = 13.2 dB

$N_j = \frac{1}{20}$ N_{Di} = 0.684 $N_D = \frac{1}{2}$ $X = 10\log N_j \cdot N_{Di} \cdot N_D$ = −19.7 dB

Radiation Coefficient $K_r = 10\log(\frac{Q}{4\pi r^2} + \frac{4}{R})$ = −13.8 dB

Noise Criterion Value NC = 25

	Octave Band Frequency	63	125	250	500	1000	2000	4000	8000	Notes
1	P.W.L. of Fan	101.0	100.0	99.0	98.0	96.0	93.0	88.0	83.0	
2	K_b	−16	−16	−16	−16	−16	−16	−16	−16	
3	Correction of Other Noise	—	—	—	—	—	—	—	—	
4	Attenuation at Opening	−6	−3	−1	—	—	—	—	—	
5	P.W.L. of Ventilation Open.	79.0	81.0	82.0	82.0	80.0	77.0	72.0	67.0	(1)+(2)+(3)+(4)
6	Permissible Noise S.P.L.	57	47	37	32	28	25	22	21	
7	$-10\log n_e + X$	−30.7	−30.7	−30.7	−30.7	−30.7	−30.7	−30.7	−30.7	
8	$-K_r$	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	
9	Permissible Band P.W.L. of Noise at Vent. Opening	40.1	30.1	22.1	15.1	11.1	8.1	5.1	4.1	(6)+(7)+(8)
10	Necessary Attenuation-Value	38.9	50.9	59.9	66.9	68.9	68.9	66.9	62.9	(5)−(9)
11	CH. (3.3×1.7×1.5)	3	6	6.5	7	8	8	7	7	
	EL_1 (1.2×1.2) ×6	36	60	66	84	72	78	84	84	
	EL_2 (1.2×1.2)	—	—	—	—	—	—	—	—	
	Total	39	66	72.5	91	80	86	91	91	

Table 8 Calculation of Ventilation Noise Insulation (for Fan Noise)

Date :

Building BTV Hall

Room Name Stage   Ducting Rout AC-1 (Return)   Type of Fan SF-1 30KW

Object of Room : Stage   Horsepower of Fan : HP = 40

Volume of Use : V = 8067.7 m³   Power Level of Fan : PWL = 90 + 10 log HP = 106.0

Total Surface Area of Room : S = 3119.7 m²   Total Amount of Ventilation : F = 56000 m³

Mean Absoroption Coefficient : $\bar{\alpha} = 0.40$ Amount of Ventilation at Opening : f = 24640 m³

Absorbing Power : $A = S\bar{\alpha} = 1247.7\ m^2$ Divisional Ratio : $K_b = 10\log\frac{f}{F} = -3.6$ dB

Room Constant : $R = S\bar{\alpha}/1-\bar{\alpha} = 2079.8\ m^2$ Number of Ventilation Opening : n = 2

Type of Ventilation Opening :   Effective Number of Ventilation Opening : $n_e = 1$

Dimension of Ventilation Opening : s = 5.4 m² $r_c = 0.14\sqrt{QR} = 9.0$ m $r_{min} = 6.0$ m

Directivity Factor : Q = 2

$SPL_{ne} = 10\log\frac{Q}{4\pi r^2} + 10\log n_e = -23.5$ dB $SPL_{n-ne} = 10\log\frac{4}{R} + 10\log(n-n_e) = -27.2$ dB $\Delta L = 3.7$ dB

$N_j = \frac{1}{2}$ $N_{Di} = 0.77$ $N_D = \frac{1}{2}$ $X = 10\log N_j \cdot N_{Di} \cdot N_D = -7.2$ dB

Radiation Coefficient $K_r = 10\log\left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) = -13.8$ dB

Noise Criterion Value NC = 25   Ventilation Velocity : v = 1.3 m

	Octave Band Frequency	63	125	250	500	1000	2000	4000	8000	Notes
1	P.W.L. of Fan	96.0	95.0	94.0	93.0	91.0	88.0	83.0	78.0	
2	K_b	−3.6	−3.6	−3.6	−3.6	−3.6	−3.6	−3.6	−3.6	
3	Correction of Other Noise	—	—	—	—	—	—	—	—	
4	Attenuation at Opening	—	—	—	—	—	—	—	—	
5	P.W.L. of Ventilation Open.	92.4	91.4	90.4	89.4	87.4	84.4	79.4	74.4	(1)+(2)+(3)+(4)
6	Permissible Noise S.P.L.	57	47	37	32	28	25	22	21	
7	$-10\log n_e + X$	−7.2	−7.2	−7.2	−7.2	−7.2	−7.2	−7.2	−7.2	
8	$-K_r$	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	
9	Permissible Band P.W.L. of Noise at Vent. Opening	63.6	53.6	45.6	38.6	34.6	31.6	28.6	27.6	(6)+(7)+(8)
10	Necessary Attenuation Value	28.8	37.8	44.8	50.8	52.8	52.8	50.8	46.8	(5)−(9)
11	CH₁ (3.7×1.7×2.65)	3	6	6.5	7	8	8	7	7	
	EL. (1.2×1.0)×5	25	45	50	55	60	60	60	60	
	CH₂ (1.4×1.2×2.2) I	2	4	5	6	6	6	6	6	
	CH₃ (3.4×2.2×1.5)	—	—	—	—	—	—	—	—	
	Total	30	55	57	68	74	74	73	73	

Table 9 **Calculation of Ventilation Noise Insulation (for Fan Noise)**

Date :

Building BTV Hall

Room Name Sub-Cont. Room Ducting Rout AC-5 (Supply) Type of Fan SF-5 3.7 KW

Object of Room : V·A·L Control

Horsepower of Fan : $HP = 4.9$

Volume of Use : $V = 190.0\ m^3$

Power Level of Fan : $PWL = 90 + 10\log HP = 96.9\ dB$

Total Surface Area of Room : $S = 262.8\ m^2$

Total Amount of Ventilation : $F = 4150\ m^3$

Mean Absorption Coefficient : $\bar{\alpha} = 0.3$

Amount of Ventilation at Opening : $f = 635\ m^3$

Absorbing Power : $A = S\bar{\alpha} = 78.8\ m^2$

Divisional Ratio : $K_b = 10\log \frac{f}{F} = -8.2\ dB$

Room Constant : $R = S\bar{\alpha}/1-\bar{\alpha} = 112.6\ m^2$

Number of Ventilation Opening : $n = 4$

Type of Ventilation Opening : Anemostat

Effective Number of Ventilation Opening : $n_e = 2$

Dimension of Ventilation Opening : $s = 0.03\ m^2$ $r_c = 0.14\sqrt{QR} = 2.1\ m$ $r_{min} = 1.2\ m$

Directivity Factor : $Q = 2$

$SPL_{ne} = 10\log \frac{Q}{4\pi r^2} + 10\log n_e = -6.6\ dB$ $SPL_{n-ne} = 10\log \frac{4}{R} + 10\log (n - n_e) = -11.5\ dB$ $\Delta L = 4.9\ dB$

$N_j = \frac{1}{4}$ $N_{Di} = 0.61$ $N_D = \frac{1}{3}$ $X = 10\log N_j \cdot N_{Di} \cdot N_D = -12.9\ dB$

Radiation Coefficient $K_r = 10\log \left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) = -8.4\ dB$

Noise Criterion Value $NC = 25$ Ventilation Velocity : $v = 5.4\ m$

	Octave Band Frequency	63	125	250	500	1000	2000	4000	8000	Notes
1	P.W.L. of Fan	91.9	90.9	87.9	88.9	86.9	83.9	78.9	73.9	
2	K_b	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	
3	Correction of Other Noise	—	—	—	—	—	—	—	—	
4	Attenuation at Opening	-14.5	-11.5	-5.5	-2.5	-0.5	—	—	—	
5	P.W.L. of Ventilation Open.	69.2	71.2	76.2	78.2	78.2	75.7	70.7	65.7	(1)+(2)+(3)+(4)
6	Permissible Noise S.P.L.	57	47	39	32	28	25	22	21	
7	$-10\log n_e + X$	-15.9	-15.9	-15.9	-15.9	-15.9	-15.9	-15.9	-15.9	
8	$-K_r$	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	
9	Permissible Band P.W.L. of Noise at Vent. Opening	49.5	39.5	31.5	24.5	20.5	17.5	14.5	13.5	(6)+(7)+(8)
10	Necessary Attenuation Value	19.7	31.7	44.7	53.7	57.7	58.2	56.2	52.2	(5)−(9)
	CH₁ (1.0×0.8×0.8)	3	6	6.5	7	8	8	7	7	
	EL₁ (0.45×0.3)×2	9	12	16	25	27	26	24	26	
	CH₂ (1.2×0.7×0.5)	3	6	6.5	7	8	8	7	7	
	EL₂ (1.05×0.2)	6	7	9	11	14	14	14	14	
	CH₃ (0.6×0.6×0.4)	3	6	6.5	7	8	8	7	7	
11	Total	24	37	44.5	57	67	64	59	61	

Table 10 Calculation of Ventilation Noise Insulation (for Fan Noise)

Date :

Building BTV Hall

Room Name Sub-Cont. Room Ducting Rout AC 5 (Return) Type of Fan SF 5 3.7 KW

Object of Room : V.A.L Control

Horsepower of Fan : $HP = 4.9$

Volume of Use : $V = 170.0\ m^3$

Power Level of Fan : $PWL = 90 + 10\log HP = 96.7\ dB$

Total Surface Area of Room : $S = 262.8\ m^2$

Total Amount of Ventilation : $F = 4150\ m^3$

Mean Absorption Coefficient : $\bar{\alpha} = 0.3$

Amount of Ventilation at Opening : $f = 3670\ m^3$

Absorbing Power : $A = S\bar{\alpha} = 78.8\ m^2$

Divisional Ratio : $K_b = 10\log \frac{f}{F} = -0.5\ dB$

Room Constant : $R = S\bar{\alpha}/1-\bar{\alpha} = 112.6\ m^2$

Number of Ventilation Opening : $n = 1$

Type of Ventilation Opening :

Effective Number of Ventilation Opening : $n_e = 1$

Dimension of Ventilation Opening : $s = 0.5\ m^2$ $r_c = 0.14\sqrt{QR} = 2.1\ m$ $r_{min} = 2.1\ m$

Directivity Factor : $Q = 2$

$SPL_{ne} = 10\log \frac{Q}{4\pi r^2} + 10\log n_e =$ $SPL_{n-ne} = 10\log \frac{4}{R} + 10\log (n - n_e) =$ $\Delta L =$

$N_j = 1$ $N_{Di} = 0.77$ $N_D = \frac{1}{3}$ $X = 10\log N_j \cdot N_{Di} \cdot N_D = -5.3\ dB$

Radiation Coefficient $K_r = 10\log \left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) = -8.4\ dB$

Noise Criterion Value $NC = 25$ Ventilation Velocity : $v = 2.0\ m$

	Octave Band Frequency	63	125	250	500	1000	2000	4000	8000	Notes
1	P.W.L. of Fan	86.9	85.9	84.9	83.9	81.9	78.9	73.9	68.9	
2	K_b	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	
3	Correction of Other Noise	—	—	—	—	—	—	—	—	
4	Attenuation at Opening	-6	-3	-1	—	—	—	—	—	
5	P.W.L. of Ventilation Open.	80.4	82.4	83.4	83.4	81.4	78.4	73.4	68.4	(1)+(2)+(3)+(4)
6	Permissible Noise S.P.L.	57	47	39	32	28	25	22	21	
7	$-10\log n_e + X$	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	
8	$-K_r$	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	
9	Permissible Band P.W.L. of Noise at Vent. Opening	60.1	50.1	42.1	35.1	31.1	28.1	25.1	24.1	(6)+(7)+(8)
10	Necessary Attenuation Value	20.3	32.3	41.3	48.3	50.3	50.3	48.3	44.3	(5)−(9)
11	CH_1 (1.25×1.0×0.8)	3	6	6.5	7	8	8	7	7	
	EL_1 (0.45×0.3) ×2	9	12	14	25	27	26	24	26	
	EL_2 (0.45×0.3) ×2	9	12	14	25	27	26	24	26	
	CH_2 (1.25×0.7×0.5)	3	6	6.5	7	8	8	7	7	
	Total	24	36	41	64	74	68	62	66	

Table. 11 Calculation of Ventilation Noise Insulation (for Fan Noise)

Date :

Building BTV Hall

Room Name Sub-Cont. Room Ducting Rout Fan Coil Unit Type of Fan

Object of Room : Horsepower of Fan : HP =

Volume of Use : $V = 170.0\ m^3$ Power Level of Fan : $PWL = 90 + 10\log HP =$

Total Surface Area of Room : $S = 262.8\ m^2$ Total Amount of Ventilation : $F =$

Mean Absoroption Coefficient : $\bar{\alpha} = 0.3$ Amount of Ventilation at Opening : $f =$

Absorbing Power : $A = S\bar{\alpha} = 78.8\ m^2$ Divisional Ratio : $K_b = 10\log \frac{f}{F} =$

Room Constant : $R = S\bar{\alpha}/1-\bar{\alpha} = 112.6\ m^2$ Number of Ventilation Opening : $n = 3$

Type of Ventilation Opening : Effective Number of Ventilation Opening : $ne = 2$

Dimension of Ventilation Opening : $s = 0.22\ m^2$ $r_c = 0.14\sqrt{QR} = 2.1\ m$ $r_{min} = 1.2\ m$

Directivity Factor : $Q = 2$

$SPL_{ne} = 10\log \frac{Q}{4\pi r^2} + 10\log ne = -6.6\ dB$ $SPL_{n-ne} = 10\log \frac{4}{R} + 10\log(n-ne) = -14.5\ dB$ $\Delta L = 7.9\ dB$

$N_J = \frac{1}{2}$ $N_{Di} = \frac{1}{2}$ $N_D = \frac{1}{3}$ $X = 10\log N_J \cdot N_{Di} \cdot N_D = -10.8$

Radiation Coefficient $K_r = 10\log\left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) = -8.4\ dB$

Noise Criterion Value $NC = 25$

	Octave Band Frequency	63	125	250	500	1000	2000	4000	8000	Notes
1	P.W.L. of Fan	48.2 (44.2)	57.2 (48.2)	55.2 (42.2)	52.2 (37.7)	46.7 (33.7)	39.2 (25.7)	31.2 (22.7)	24.7 (21.7)	High (Low)
2	K_b	—	—	—	—	—	—	—	—	
3	Correction of Other Noise	—	—	—	—	—	—	—	—	
4	Attenuation at Opening	—	—	—	—	—	—	—	—	
5	P.W.L. of Ventilation Open.	48.2 (44.2)	57.2 (48.2)	55.2 (42.2)	52.2 (37.7)	46.7 (33.7)	39.2 (25.7)	31.2 (22.7)	24.7 (21.7)	(1)+(2)+(3)+(4)
6	Permissible Noise S.P.L.	57	47	39	32	28	25	22	21	
7	$-10\log ne + X$	−13.8	−13.8	−13.8	−13.8	−13.8	−13.8	−13.8	−13.8	
8	$-K_r$	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	
9	Permissible Band P.W.L. of Noise at Vent. Opening	51.6	41.6	33.6	26.6	22.6	19.6	16.6	15.6	(6)+(7)+(8)
10	Necessary Attenuation - Value	—	15.6 (6.6)	21.6 (8.6)	25.6 (11.1)	24.1 (11.1)	19.6 (6.1)	14.6 (6.1)	9.1 (6.1)	(5)−(9)
11	CH (2.8×0.7×0.25)	6	9	12	12	12	12	12	12	

Necessary to use two absorbent-chambers in case of "High" operation.
Sufficient in case of "Low" operation.

3. Calculation Sheet of Ventilation and Air Conditioning

AIR CONDITION

DESIGN CONDITONS

1. OUTDOOR

D.B	35°C
R.H	90%
i (ENTHALPY)	28.5 Kcal/Kg

2. INDOOR

A). SUB-CONTROL ROOM SYSTEM

D.B	24°C
R.H	55%
i (ENTHALPY)	12.0 Kcal/Kg

B). OTHER SYSTEMS

D.B	26°C
R.H	55%
i (ENTHALPY)	13.3 Kcal/Kg

3. VOLUME OF OUTDOORAIR

A) STAGE SYSTEM	26 m^3/Hr·PERSON
B). OTHER ROOM SYSTEMS	15 m^3/Hr·PERSON

4. CALORIFIC VALUE BY EQUIPMENTS

Calorific value by equipments is estimated at 860 Kcal/Hr for 1 Kw, and that by fluorescent lamp is estimated at 1000 Kcal/Hr for 1 Kw (electric power).

5. CALORIFIC VALUE BY PERSON IN ROOM FOR EACH PERSON

A). ROOM TEMP. ----- 26°C (D.B)

	SENSIBLE HEAT	LATENT HEAT
AUDITORIUM	53 Kcal/Hr	35 Kcal/Hr
ROOM (OFFICE ROOM ETC.)	54	46
CANTEEN	60	78
STAGE	69	144

B) ROOM TEMP. ----- 24°C (D.B)

	SENSIBLE HEAT	LATENT HEAT
SUB-CONTROL ROOM RACK ROOM	60 Kcal/Hr	40 Kcal/Hr

6. EQUIVALALENT TEMPERATURE DIFFERENCE

	H	NE	SE	SW	NW
8 o'clock	14.6	8.6	9.4	10.2	9.4
12	15.1	8.6	9.4	10.2	9.3
16	23.1	13.6	14.6	11.3	11.0

7. VALUE OF SOLAR RADIATION THROUGH WINDOWS

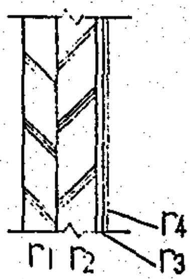
	H	NE	SE	SW	NW
8 o'clock	334	334	271	33	33
12	667	38	60	38	38
16	334	33	33	271	334

8. AIR INFILTRATION

ROOM VOLEME	$50m^3$	$100m^3$	$200m^3$	$300m^3$	$400m^3$	$500m^3$	$1000m^3$
ONE-FACE WALL FACED OUTDOOR AIR	1.2	0.9	0.6	0.5	0.4	0.4	0.3
TWO-FACE WALL FACED OUTDOOR AIR	2.0	1.4	1.0	0.8	0.7	0.6	0.4
THREE-FACE WALL FACED OUTDOOR AIR	2.7	1.9	1.5	1.1	0.9	0.8	0.6
FOUR-FACE WALL FACED OUTDOOR AIR	3.4	2.3	1.6	1.3	1.1	1.0	0.7

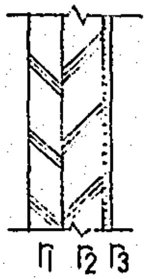
9. HEAT TRANSMISSION COEFFICIENT

A) EXTERNAL WALL



		mm		
r_0	OUTDOOR			= 0.050
r_1	BRICK	120	0.12 / 0.52	= 0.231
r_2	CONCRETE	150	0.15 / 1.4	= 0.107
r_3	MORTAR	30	0.03 / 1.2	= 0.025
r_4	TILE	10	0.01 / 1.1	= 0.009
r_i	INDOOR			= 0.133
				0.555

$K = 1 / 0.555 = 1.802$ Kcal/m²Hr

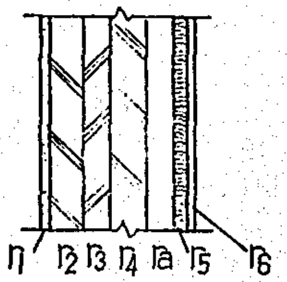


r_0	OUTDOOR			= 0.050
r_1	BRICK	120	0.12 / 0.52	= 0.231
r_2	CONCRETE	150	0.15 / 1.4	= 0.107
r_3	CEMENTED CHIP BOARD	30	0.03 / 0.11	= 0.273
r_i	INDOOR			= 0.133
				0.794

$K = 1 / 0.794 = 1,259$

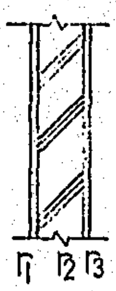
r_0	OUTDOOR			= 0.050
r_1	CONCRETE	300	0.30 / 1.4	= 0.214
r_2	MORTAR	30	0.03 / 1.2	= 0.025
r_3	MARBLE	25	0.025 / 2.4	= 0.011
r_i	INDOOR			= 0.133
				0.433

$K = 1 / 0.433 = 2.309$



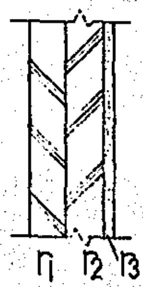
r_0	OUTDOOR			0.050
r_1	MORTAR	25	0.025 / 1.3	= 0.019
r_2	BRICK	120	0.12 / 0.52	= 0.231
r_3	CONCRETE	75	0.075 / 1.3	= 0.058
r_4	BRICK	190	0.19 / 0.52	= 0.366
r_a	AIR GAP			0.170
r_5	GLASS WOOL	50	0.05 / 0.036	= 1.389
r_6	PLASTER BOARD	6	0.006 / 0.13	= 0.046
r_i	INDOOR			0.133
				2.462

$K = 1 / 2.462 = 0.406$



r_0	OUTDOOR			= 0.050
r_1	MORTAR	25	0.025 / 1.3	= 0.019
r_2	CONCRETE	150	0.15 / 1.3	= 0.115
r_3	MORTAR	25	0.025 / 1.2	= 0.021
r_i	INDOOR			= 0.133
				0.338

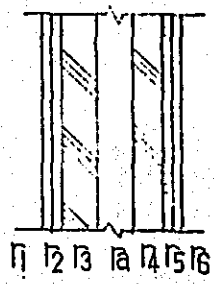
$K = 1 / 0.338 = 2.958$



r_0	OUTDOOR			= 0.050
r_1	BRICK	120	0.12 / 0.52	= 0.231
r_2	CONCRETE	150	0.15 / 1.4	= 0.107
r_3	MORTAR	30	0.03 / 1.3	= 0.023
r_i	INDOOR			= 0.133
				0.544

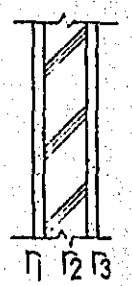
$K = 1 / 0.544 = 1.838$

B) INTERNAL WALL



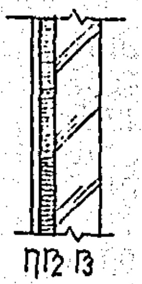
r_i	INDOOR			= 0.133
r_1	MARBLE	25	0.025 / 2.4	= 0.010
r_2	MORTAR	30	0.03 / 1.2	= 0.025
r_3	BRICK	120	0.12 / 0.52	= 0.231
r_a	AIR GAP			= 0.170
r_4	BRICK	120	0.12 / 0.52	= 0.231
r_5	MORTAR	24	0.024 / 1.2	= 0.020
r_6	TILE	6	0.006 / 1.1	= 0.005
r_i	INDOOR			= 0.133
				0.958

$K = 1 / 0.958 = 1.044$



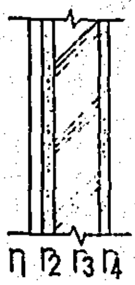
r_i	INDOOR			= 0.133
r_1	MORTAR	25	0.025 / 1.2	= 0.021
r_2	CONCRETE	150	0.15 / 1.3	= 0.115
r_3	MORTAR	25	0.025 / 1.2	= 0.021
r_i	INDOOR			= 0.133
				0.423

$K = 1 / 0.423 = 2.364$



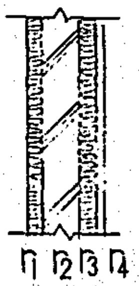
r_i	INDOOR			= 0.133
r_1	PLASTER BOARD	25	0.025 / 0.13	= 0.046
r_2	GLASS WOOL	150	0.15 / 0.036	= 1.389
r_3	CONCRETE	25	0.025 / 1.3	= 0.115
r_i	INDOOR			= 0.133
				1.816

$K = 1 / 1.816 = 0.551$



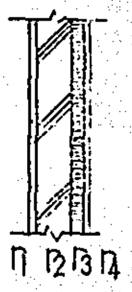
r_i	INDOOR			= 0.133
r_1	MARBLE	25	0.025 / 2.4	= 0.010
r_2	MORTAR	30	0.03 / 1.2	= 0.025
r_3	CONCRETE	150	0.15 / 1.3	= 0.115
r_4	MORTAR	25	0.025 / 1.2	= 0.021
r_i	INDOOR			= 0.133
				0.437

$K = 1 / 0.437 = 2.288$



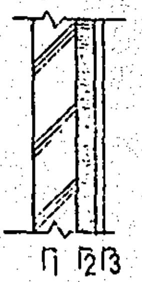
r_i	INDOOR			= 0.133
r_1	GLASS WOOL	50	0.05 / 0.036	= 1.389
r_2	CONCRETE	150	0.15 / 1.3	= 0.155
r_3	GLASS WOOL	50	0.05 / 0.036	= 1.389
r_4	ASBESTUS CEMENT BOARD	8	0.008 / 0.22	= 0.036
r_i	INDOOR			= 0.133
				3.195

$K = 1 / 3.195 = 0.313$



r_i	INDOOR			= 0.133
r_1	MORTAR	25	0.025 / 1.2	= 0.021
r_2	CONCRETE	150	0.15 / 1.3	= 0.115
r_3	GLASS WOOL	50	0.05 / 0.036	= 1.389
r_4	ASBESTUS CEMENT BOARD	8	0.008 / 0.22	= 0.036
r_i	INDOOR			0.133
				1.827

$K = 1 / 1.827 = 0.547$



r_i	INDOOR			= 0.133
r_1	CONCRETE	150	0.15 / 1.3	= 0.115
r_2	GLASS WOOL	50	0.05 / 0.036	= 1.389
r_3	ASBESTUS CEMENT BOARD	8	0.008 / 0.22	= 0.036
r_i	INDOOR			= 0.133
				1.806

$K = 1 / 1.806 = 0.554$

r_i INDOOR				= 0.133
r_1 PLASTER BOARD	6	0.006 / 0.13		= 0.046
r_2 GLASS WOOL	50	0.05 / 0.036		= 1.389
r_a AIR GAP				= 0.170
r_3 CONCRETE	150	0.15 / 1.3		= 0.115
r_4 GLASS WOOL	50	0.05 / 0.036		= 1.389
r_5 ASBESTUS CEMENT BOARD	8	0.008 / 0.22		= 0.036
r_i INDOOR				= 0.133
				3.411

K = 1 / 3.411 = 0.293

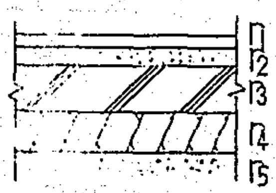
r_i INDOOR			= 0.133
r_1 GLASS	3	0.003 / 0.88	= 0.004
r_i INDOOR			= 0.133
			0.270

K = 1 / 0.270 = 3.704

DOOR WOOD K = 2.4

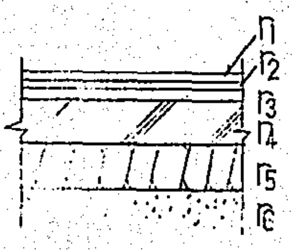
STEEL K = 3.8

C) FLOOR



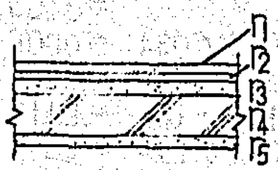
r_i INDOOR			= 0.105
r_1 TERRZZO BLOCK	30	0.03 / 1.55	= 0.019
r_2 MORTAR	40	0.04 / 1.2	= 0.033
r_3 CONCRETE	120	0.12 / 1.3	= 0.092
r_4 BRICK	120	0.12 / 1.5	= 0.080
r_5 EARTH	1000	1.0 / 1.5	= 0.667
			0.996

K = 1 / 0.996 = 1.004 (↗)



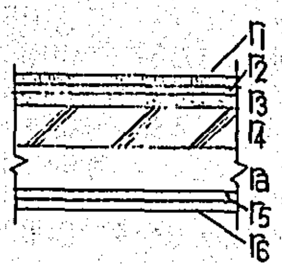
r_i INDOOR			= 0.105
r_1 CARPET	6	0.006 / 0.045	= 0.133
r_2 FELT	4	0.004 / 0.042	= 0.095
r_3 MORTAR	20	0.02 / 1.2	= 0.017
r_4 CONCRETE	200	0.2 / 1.3	= 0.154
r_5 BRICK	120	0.12 / 1.5	= 0.080
r_6 EARTH	1000	1.0 / 1.5	= 0.667
			1.251

K = 1 / 1.251 = 0.799 (↗)



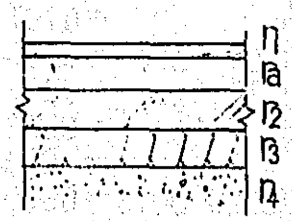
r_i	INDOOR			=0.105
r_1	CARPET	6	0.006 / 0.045	=0.133
r_2	FELT	4	0.004 / 0.042	=0.095
r_3	MORTAR	20	0.02 / 1.2	=0.017
r_4	CONCRETE	200	0.2 / 1.3	=0.154
r_5	MORTAR	25	0.025 / 1.2	=0.021
r_i	INDOOR			=0.105
				0.630

$$K = 1 / 0.630 = 1.587 \quad (\uparrow)$$



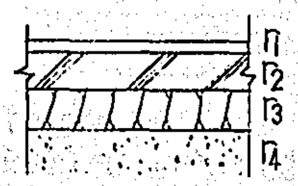
r_i	INDOOR			=0.105
r_1	CARPET	6	0.006 / 0.045	=0.133
r_2	FELT	4	0.004 / 0.042	=0.095
r_3	MORTAR	20	0.02 / 1.2	=0.017
r_4	CONCRETE	200	0.2 / 1.3	=0.154
r_a	AIR GAP			=0.170
r_5	PLASTER BOARD	9	0.009 / 0.015	=0.600
r_6	ROCK WOOL SOUND ABSORBING BOARD	12	0.012 / 0.144	=0.083
r_i	INDOOR			=0.105
				1.462

$$K = 1 / 1.462 = 0.684 \quad (\uparrow)$$



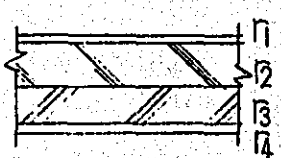
r_i	INDOOR			= 0.105
r_1	LAMINATED WOOD	24	0.024 / 0.12	= 0.200
r_a	AIR GAP			= 0.170
r_2	CONCRETE	120	0.12 / 1.3	= 0.092
r_3	BRICK	120	0.12 / 1.5	= 0.080
r_4	EARTH	1000	1.0 / 1.5	= 0.667
				1.314

$$K = 1 / 1.314 = 0.761 \quad (\uparrow)$$



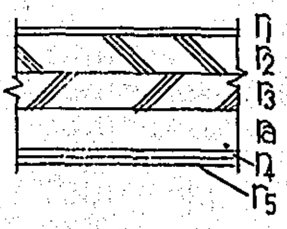
r_i	INDOOR			=0.105
r_1	TERRAZZO	40	0.04 / 12	=0.033
r_2	CONCRETE	120	0.12 / 13	=0.092
r_3	BRICK	120	0.12 / 15	=0.080
r_4	EARTH	1000	1.0 / 15	=0.667
				0.977

$$K = 1 / 0.977 = 1.024 \quad (\uparrow)$$



r_i INDOOR			=0.105
r_1 VINYL TILE	2	0.002 / 0.34	=0.006
r_2 BRICK CONCRETE	200	0.2 / 0.7	=0.286
r_3 CONCRETE	150	0.15 / 1.3	=0.115
r_4 ROCK WOOL SOUND ABSORBING BOARD	50	0.05 / 0.144	=0.347
r_i INDOOR			=0.105
			0.964

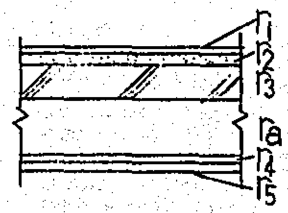
K = 1 / 0.964 = 1.037 (↑)



r_i INDOOR			=0.105
r_1 VINYL TILE	2	0.002 / 0.34	=0.006
r_2 BRICK CONCRETE	200	0.2 / 0.7	=0.286
r_3 CONCRETE	150	0.15 / 1.3	=0.115
r_a AIR GAP			=0.170
r_4 PLASTER BOARD	9	0.009 / 0.015	=0.600
r_5 ROCK WOOL SOUND ABSORBING BOARD	12	0.012 / 0.144	=0.083
r_i INDOOR			=0.105
			1.470

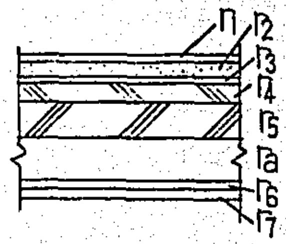
K = 1 / 1.470 = 0.680 (↑)

D) CEILING



r_i INDOOR			=0.167
r_1 VINYL TILE	2	0.002 / 0.34	=0.006
r_2 MORTAR	25	0.025 / 1.2	=0.021
r_3 CONCRETE	120	0.12 / 1.3	=0.092
r_a AIR GAP			=0.230
r_4 PLASTER BOARD	9	0.009 / 0.015	=0.600
r_5 ROCK WOOL SOUND ABSORBING BOARD	12	0.012 / 0.144	=0.083
r_i INDOOR			=0.167
			1.366

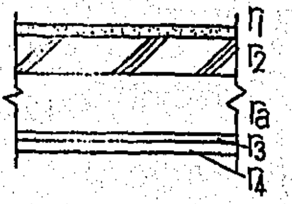
K = 1 / 1.366 = 07.32 (↓)



r_i INDOOR			=0.167
r_1 TILE	10	0.01 / 1.1	=0.009
r_2 MORTAR	30	0.03 / 1.2	=0.025
r_3 〃	5	0.005 / 0.65	=0.008
r_4 BRICK CONCRETE	50	0.05 / 0.7	=0.071
r_5 CONCRETE	120	0.12 / 1.3	=0.092
r_a AIR GAP			=0.230
r_6 PLASTER BOARD	9	0.009 / 0.015	=0.600
r_7 ROCK WOOL SOUND ABSORBING BOARD	12	0.012 / 0.144	=0.083

r_i	INDOOR			=0.167
				1.452

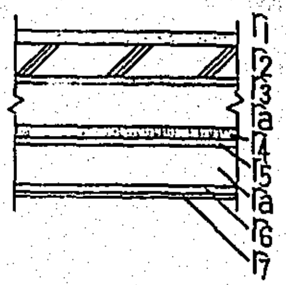
$$K = 1/1.452 = 0.689\ (\checkmark)$$



r_i	INDOOR			=0.167
r_1	MORTAR	30	0.03 / 1.2	=0.025
r_2	CONCRETE	150	0.15 / 1.3	=0.115
r_a	AIR GAP			=0.230
r_3	PLASTER BOARD	9	0.009 / 0.015	=0.600
r_4	ROCK WOOL SOUND ABSORBING BOARD	12	0.012 / 0.144	=0.083
r_i	INDOOR			=0.167
				1.387

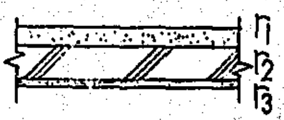
$$K = 1/1.387 = 0.721\ (\checkmark)$$

E) ROOF



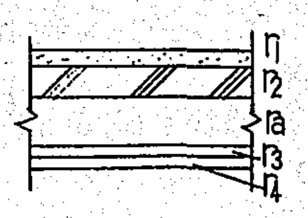
r_o	OUTDOOR			=0.050
r_1	LIME CONCRETE	76	0.076/1.9	=0.040
r_2	CONCRETE	100	0.1 /1.3	=0.077
r_3	CEMENTED CHIP BOARD	30	0.03 /1.2	=0.025
r_a	AIR GAP			=0.230
r_4	GLASS WOOL	25	0.025/0.036	=0.694
r_5	PLASTER BOARD	18	0.018/0.015	=1.200
r_a	AIR GAP			=0.230
r_6	ASBESTUS CEMENT FLEXIBLE BOARD	5	0.005/0.25	=0.020
r_7	CROTH	1	———	= 0
r_i	INDOOR			=0.167
				2.733

$$K = 1/2.733 = 0.366\ (\checkmark)$$



r_o	OUTDOOR			=0.050
r_1	LIME CONCRETE	76	0.076/1.9	=0.040
r_2	CONCRETE	100	0.1 /1.3	=0.077
r_3	CEMENTED CHIP BOARD	30	0.03 /1.2	=0.025
r_i	INDOOR			=0.167
				0.359

$$K = 1/0.359 = 2.786\ (\checkmark)$$



r_0 OUTDOOR			= 0.050
r_1 LIME CONCRETE	76	0.076 / 1.9	= 0.040
r_2 CONCRETE	100	0.1 / 1.3	= 0.077
r_a AIR GAP			= 0.230
r_3 PLASTER BOARD	9	0.009 / 0.015	= 0.600
r_4 ROCK WOOL SOUND ABSORBING BOARD	12	0.012 / 0.144	= 0.083
r_i INDOOR			= 0.167
			1.247

$$K = 1 / 1.247 = 0.802 \ (\checkmark)$$

10. Kw. VALUE BY EQUIPMENTS

A) STAG LIGHT

$270^{Kw} \times 50\%$ (USAGE FACTOR) $= 135^{Kw}$

B) LIGHTING ROOM

$18^{Kw} \times 70\% = 12.6^{Kw}$

TO STAGE	12.6^{Kw}	× 12%	$= 1.5^{Kw}$
TO AUDITORIUM	12.6	× 13	= 1.6
ROOM	12.6	× 75	= 9.5

C) SIDE-SPOT

$6^{Kw} \times 70\% = 4.2^{Kw}$

TO STAGE	4.2^{Kw}	× 12%	$= 0.5^{Kw}$
TO AUDITORIUM	4.2	× 13	= 0.6
ROOM	4.2	× 75	= 3.1

D) PROJECTION ROOM

$20^{Kw} \times 70\% = 14.0^{Kw}$

TO STAGE	14.0^{Kw}	× 12%	1.7^{Kw}
TO AUDITORIUM	14.0	× 13	1.8
ROOM	14.0	× 75	10.5 → × 50% = 5.3^{Kw}

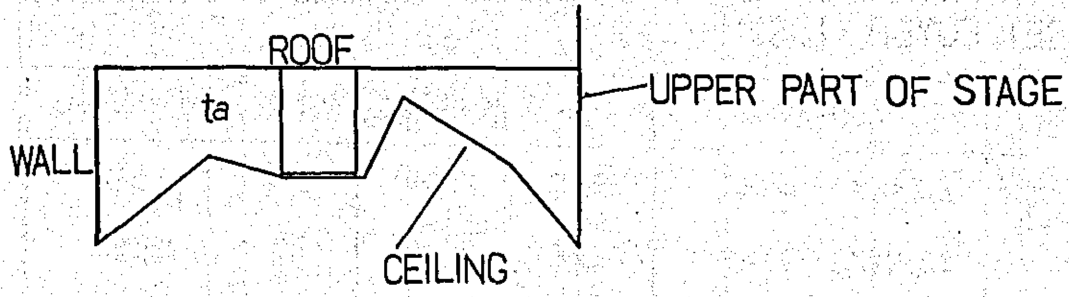
LIGHING LOAD

STAGE	135 + 1.5 + 0.5 + 1.7	=	138.7 Kw
AUDITORIUM	1.6 + 0.6 + 1.8	=	4.0
LIGHTING ROOM		=	9.5
SIDE-SPOT		=	3.1
PROJECTION ROOM		=	5.3

11. DESIGN CONDITION LIST

	ROOM NAME	S (m²)	PERSON		LIGHT (Kw)		STAGE LIGHT (Kw)	OUTDOOR A. (m³/Hr)	
			(P/m²)	(P)	(Kw/m²)	(Kw)		(m³/P)	(m³/Hr)
A	FOYER & ENTRANCE	336.85	—	100	0.025	8.5	—	—	1,780
B	CANTEEN	89.33	0.2	18	0.025	2.3	—	15	270
C	OFFICE 2	8.61	0.2	2	0.025	0.2	—	15	30
D	STAGE	70.27	—	25	—	—	138.7	26	650
E	AUDITORIUM	524.81	—	560	0.02	10.5	4.0	15	8,400
F	SUB-CONTROL ROOM	97.53	—	6	0.025	2.5	30.0	15	90
G	RACK ROOM	28.5	—	1	0.025	0.7	30.0	15	15
H	STORE 3	12.71	—	1	0.025	0.37	—	15	15
I	V.I.P. ROOM	38.71	0.2	2	0.03	1.2	—	15	120
J	OFFICE 3	17.36	0.2	4	0.025	0.4	—	15	60
K	OFFICE 4	14.88	0.2	4	0.025	0.4	—	15	60
L	LOBBY	69.06	0.2	15	0.02	1.4	—	15	225
M	PROJECTION ROOM	47.85	—	5	0.02	1.0	5.3	15	75
N	LIGHTING ROOM	80.66	—	3	0.02	1.6	9.5	15	45
O	SIDE SPOT 2	6.45	—	2	0.02	0.1	3.1	15	30
P	SIDE SPOT 1	7.01	—	2	0.02	0.2	3.1	15	30
Q	OFFICE 1	9.88	0.2	2	0.025	0.3	—	15	30
R	ARTIST WAITING R.	61.16	—	25	0.025	1.5	—	15	375
S	MAKE UP ROOM (M)	22.32	0.5	12	0.03	0.7	—	15	180
T	MAKE UP ROOM (F)	26.4	0.5	14	0.03	0.8	—	15	210

12. BACK CEILING TEMPERATURE OF AUDITORIUM



$$t_a = \frac{t_i \cdot A_c \cdot K_c + t_o (A_r \cdot K_r + A_g \cdot K_g) + t_e \cdot A_e \cdot K_e + C + 0.3 Q t_i}{A_r \cdot K_r + A_c \cdot K_c + A_g \cdot K_g + A_e \cdot K_e + 0.3 Q}$$

A_r : ROOF AREA 424.82 m^2

A_c : CEILING ARER 443.22

A_g : EXTERNAL WALL ARER 61.65

A_e : INTERNAL WALL ARER 233.34

K_r : HEAT TRANSMISSION COEFFICIENT OF ROOF 0.403 $Kcal/m^2Hr$

K_c : ―――― 〃 ―――― OF CEILING 2.825

K_g : ―――― 〃 ―――― OF EXTERNAL WALL 0.406

K_e : ―――― 〃 ―――― OF INTERNAL WALL 2.364

C : LIGHTING LOAD $10.5^{Kw} \times 7\% \times 860 = 610\ Kcal/Hr$

Q : VENTILATION VOLUME 18405 m^3/Hr (AUDITRIUM INLET VOLUME)

t_o : SURFACE TEMPERATURE OF ROOF 26°C+23.1°C= 49.1°C

t_e : TEMPERATURE OF UPPER PART OF STAGE 30.0

t_i : ―― 〃 ―― OF AUDITORIUM 26.0

$$t_a = \frac{26 \times 443.22 \times 2.825 + 49.1(424.82 \times 0.404 + 61.65 \times 0.406) + 30 \times 233.34 \times 2.364 + 610 + 0.3 \times 18405 \times 26}{424.82 \times 0.403 + 443.22 \times 2.825 + 61.65 \times 0.406 + 233.34 + 0.3 \times 18405}$$

$\fallingdotseq 26.9$°C

13.COOLING LOAD ESTIMATION

ENTRANCE & FOYER (16:00)

A	PART	AREA	m^2	K Kcal/m²Hr	Δt °C	H.G. Kcal/Hr
N E	EXTERNAL WALL	6.2×4.6−10.14	18.38	2.309	13.6	578
N W	〃	22.59×4.6−17.65	86.26	2.309	11.0	2,191
S W	〃	16.4×4.6−12.33	63.11	2.309	11.3	1,647
S E	〃	1.4×4.6	6.44	2.309	14.6	218
N W	GLASS	6.44×2.74	17.65	5.3	9.0	842
〃	〃 (RADIATION)	〃	17.65		334.0	5,896
N E	〃	3.7×2.74	10.14	5.3	9.0	484
〃	〃 (RADIATION)	〃	10.14		33.0	335
S W	〃	4.5×2.74	12.33	5.3	9.0	589
〃	〃 (RADIATION)		12.33		271.0	3,342
	INTERNAL WALL	15.5×2.8+5.7×2.4	71.48	1.044	4.5	336
	GLASS	1.6×2.4+5.7×2.8	19.8	3.704	4.5	330
	CEILING		92.8	0.732	4.5	306
	INFILTRATION	300×9×0.29				783
	PERSON	100P×54				5,400
	LIGHT	8.5KW×1000				8,500
	OTHER LOAD					3,173
	S.H.					34,950
	PERSON	100P×46				4,600
	INFILTRATION	300×0.0213×715				4,569
	OTHER LOAD					911
	L H					10,080

CANTEEN (16:00)

N W	EXTERNAL WALL	14.3×4.6−23.92	41.86	1.802	11.0	830
〃	GLASS	2.6×2.3×4	23.92	5.3	9.0	1,141
〃	〃 (RADIATION)		23.92		334×0.56	4,474
	CEILING	(5.4+7.4)×2.1×$\frac{1}{2}$ +(1.0+3.1)×2.5×$\frac{1}{2}$	18.57	0.732	4.5	62
	PERSON	18^P×60				1,080
	INFILTRATION	130×9×0.29				340
	LIGHT	2.3Kw×1,000				2,300
	OTHER LOAD					1,059
	S.H.					11,650
	PERSON	18^P×78				1,404
	INFILTRATION	130×0.0213×715				1,980
	OTHER LOAD					336
	L.H.					3,720

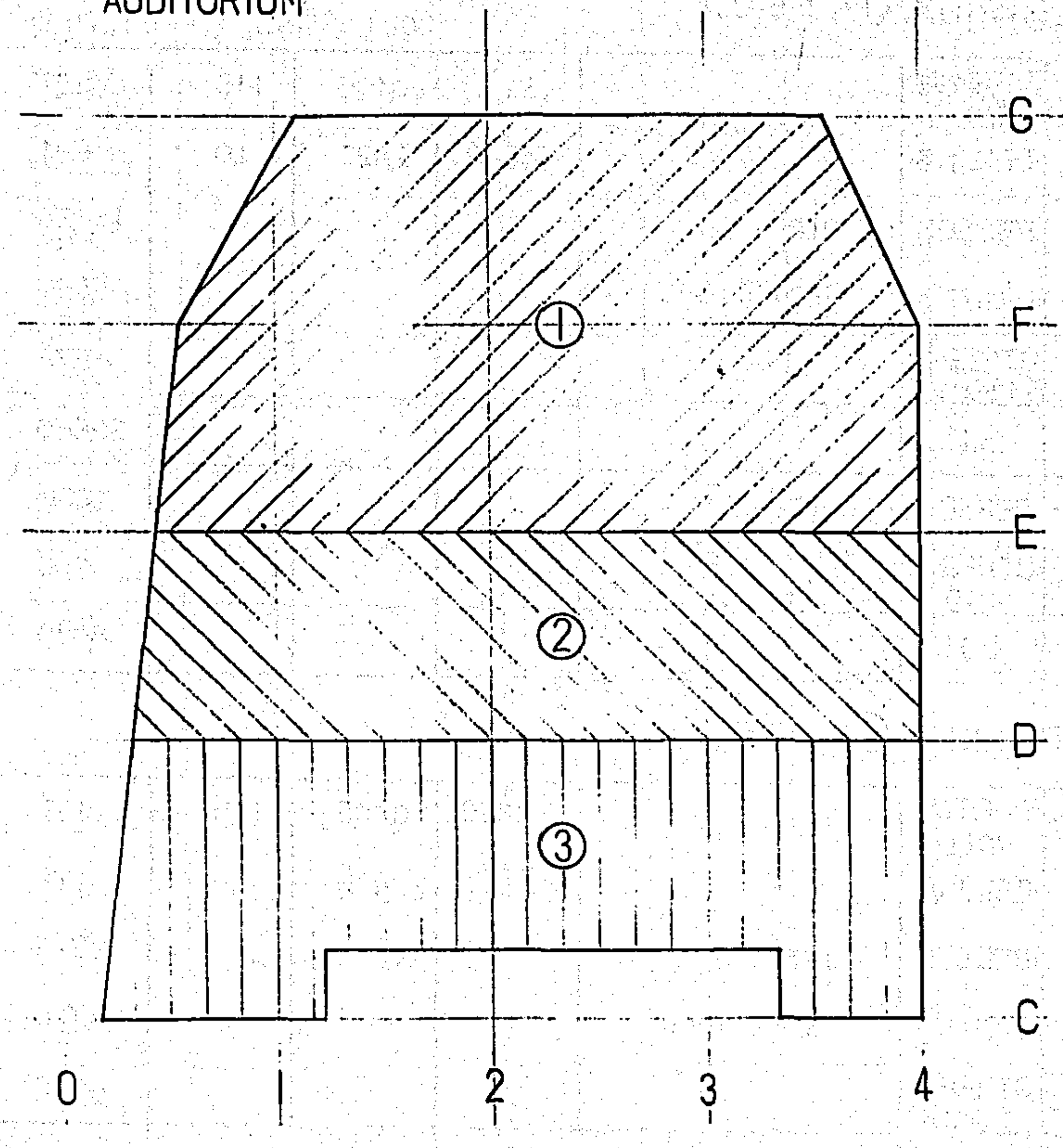
OFFICE 2

	INTERNAL WALL	8.6×2.4	20.64	2.288	4.5	213
	PERSON	2^P×54				108
	LIGHT	0.2Kw×1,000				200
	OTHER LOAD					59
	S.H.					580
	PERSON	2^P×46				92
	OTHER LOAD					8
	L.H.					100

STAGE (16:00)

N E	EXTERNAL WALL	16.46×9.8	161.31	1.259	13.6	2,762
N W	〃	7.62×9.8	74.68	1.259	11.0	1,035
S E	〃	40.24×9.8	394.35	1.259	14.6	7,249
S W	〃	4.6×9.8+2.6×5.2+10.6×2.0	79.8	1.259	11.3	1,136
H	ROOF		70.27	2.786	23.1	4,523
	INTERNAL WALL	25.1×4.12+16.1×3.2+24.8×2.0	204.53	2.364	4.5	2,176
	PERSON	25^{P} × 69				1,725
	LIGHT	138.7^{KW} × 860				119,282
	OTHER LOAD					13,982
	S.H.					153,870
	PERSON	25^{P} × 144				3,600
	OTHER LORD					360
	L.H.					3,960

AUDITORIUM



AREA

① $(14.2+20.3)\times 6.1\times 1/2+(20.3+21.3)\times 6.1\times 1/2=232.11\ m^2$

② $(21.3+22.5)\times 6.1\times 1/2=133.59\ m^2$

③ $(22.5+23.6)\times 6.1\times 1/2+(5.1+5.4)\times 2.0\times 1/2+4.0\times 2.0=159.11\ m^2$

①+②+③ $=524.81\ m^2$

AUDITRIUM ① (16:00)

S W	EXTERNAL WALL		51.52	0.406	11.3	237
	CEILING		245.79	2.825	1.0	694
	PERSON	$210^{P} \times 53$				11,130
	LIGHT	$6.43^{KW} \times 1000$				6,430
	OTHER LOAD					1,876
	S.H.					20,660
	PERSON	$210^{P} \times 35$				7,350
	OTHER LOAD					740
	L.H.					8,090

AUDITRIUM ② (16:00)

S W	EXTERNAL WALL		26.66	0.406	11.3	123
	CEILING		61.42	2.825	1.0	174
	PERSON	$175^{P} \times 53$				9,275
	LIGHT	$3.7^{KW} \times 1000$				3,700
	OTHER LOAD					1,333
	S.H.					14,650
	PERSON	$175^{P} \times 35$				6,125
	OTHER LOAD					615
	L.H.					6,740

AUDITRIUM ③ (16:00)

S W	EXTERNAL WALL		31.49	0.406	11.3	145
	CEILING		146.25	2.825	1.0	413
	PERSON	$210^{P} \times 54$				11,340

	LIGHT	4.41 Kw × 1000				4410
	OTHER LOAD					1,650
	S.H.					18,190
	PERSON	210 P × 35				7,350
	OTHER LOAD					740
	L.H.					8,090

SUB-CONTOROL ROOM

	INTERNAL WALL	89.5×24−5.3	89.5	0.547	5.5	270
	GLASS	5.3×1.0	5.3	3.704	5.5	108
	FLOOR		97.53	1.037	5.5	557
	CEILING		97.53	0.721	5.5	387
	PERSON	6 P × 60				360
	LIGHT	2.5 Kw × 1000				2,500
	EQUIPMENT	30 Kw × 0.8×860				20,640
	OTHER LOAD					2,488
	S.H.					27,310
	PERSON	6 P × 40				240
	OTHER LOAD					20
	L.H.					260.

RACK ROOM

	INTERNAL WALL	15.4×24	36.96	0.547	5.5	112
	FLOOR		28.5	1.037	5.5	163
	CEILING		28.5	0.721	5.5	113
	PERSON	1 P × 60				60

	LIGHT	$0.7^{Kw} \times 1000$				700
	EQUIPMENT	$30^{Kw} \times 0.8 \times 860$				20,640
	OTHER LOAD					2,182
	S.H.					23,970
	PERSON	$1^{P} \times 40$				40
	OTHER LOAD					10
	L.H.					50

STORE 3

	INTERNAL WALL	14.6×2.8	40.88	0.547	5.5	123
	PERSON	$1^{P} \times 60$				60
	LIGHT	$0.37^{Kw} \times 1000$				370
	OTHER LOAD					57
	S.H.					610
	PERSON	$1^{P} \times 78$				78
	OTHER LOAD					12
	L.H.					90

V.I.P. ROOM (8:00)

N E	EXTERNAL WALL	6.1×3.2−7.36	12.16	1.802	8.6	189
〃	GLASS	2.3×1.6×2	7.36	5.3	9.0	351
〃	(RADIATION)		7.36		334×0.56	1,377
	INTERNAL WALL	13.0×2.4	31.2	2.364	4.5	332
	CEILING		38.71	0.721	4.5	126
	INFILTRATION	85×9×0.29				222
	PERSON	$8^{P} \times 54$				432

	LIGHT	$1.2^{Kw}\times1000$				1,200
	OTHER LOAD					421
	S.H.					4,650
	INFILTRATION	85×0,0213×715				1,295
	PERSON	$8^{P}\times46$				368
	OTHER LOAD					167
	L.H.					1,830

OFFICE 3 (8:00)

N E	EXTERNAL WALL	3,0×3,2−3,68	5,92	1,838	8,6	94
〃	GLASS	2,3×1,6	3,68	5,3	9,0	176
〃	〃 (RADIATION)		3,68		334×0,56	689
	INTERNAL WALL	3,1×2,4	7,44	2,364	4,5	80
	CEILING		17,36	0,721	4,5	57
	INFILTRATION	50× 9×0,29				131
	PERSON	$4^{P}\times54$				216
	LIGHT	$0,4^{Kw}\times1000$				400
	OTHER LOAD					187
	S.H.					2,030
	INFILTRATION	50×0,0213×715				762
	PERSON	$4^{P}\times46$				184
	OTHER LOAD					94
	L.H.					1,040

OFFICE 4 (8:00)

N E	EXTERNAL WALL	3.0×3.2−3.68	5.92	1.838	8.6	94
〃	GLASS	2.3×1.6	3.68	5.3	9.0	176
〃	〃 (RADIATION)		3.68		334×0.56	689
	INTERNAL WALL	7.9×2.4	18.96	2.364	4.5	202
	CEILING		14.88	0.721	4.5	49
	INFILTRATION	45×9×0.29				118
	PERSON	4P×54				216
	LIGHT	0.4Kw×1000				400
	OTHER LOAD					196
	S.H.					2,140
	INFILTRATION	45×0.0213×715				686
	PERSON	4P×46				184
	OTHER LOAD					90
	L.H.					960

LOBBY

	GLASS	7.0×2.4	16.8	3.704	4.5	280
	CEILING		69.06	0.721	4.5	224
	PERSON	15P×54				810
	LIGHT	1.4Kw×1000				1,400
	OTHER LOAD					276
	S.H.					2,990
	PERSON	15P×46				690
	OTHER LOAD					70
	L.H.					760

PROJECTION ROOM

	CEILING		36.3	0.721	4.5	118
	PERSON	$5^{P} \times 54$				270
	LIGHT	$1.0^{Kw} \times 1000$				1,000
	EQUIPMENT	$5.3^{Kw} \times 860$				4,558
	OTHER LOAD					594
	S.H.					6,540
	PERSON	$5^{P} \times 46$				230
	OTHER LOAD					20
	L.H.					250

LIGHTING ROOM

S W	EXTERNAL WALL	3.7×3.4	12.58	0.406	11.3	58
H	ROOF		80.66	0.403	23.1	751
	INTERNAL WALL	4.0×3.4	13.6	2.364	4.5	145
	PERSON	$3^{P} \times 54$				162
	LIGHT	$9.5^{Kw} \times 860$				8,170
	OTHER LOAD					924
	S.H.					10,210
	PERSON	$3^{P} \times 46$				138
	OTHER LOAD					12
	L.H.					150

SIDE SPOT 2

S W	EXTERNAL WALL	3.7×2.6	9.62	0.406	11.3	45
	PERSON	2P × 54				108
	LIGHT	3.1Kw × 860				2,666
	OTHER LOAD					281
	S.H.					3,100
	PERSON	3P × 46				92
	OTHER LOAD					8
	L.H.					100

SIDE SPOT 1

	INTERNAL WALL	4.0×2.6	10.4	0.547	4.5	26
	PERSON	2P × 54				108
	LIGHT	3.1Kw × 860				2,666
	OTHER LOAD					280
	S.H.					3,080
	PERSON	2P × 46				92
	OTHER LOAD					8
	L.H.					100

OFFICE 1 (8:00)

S E	EXTERNAL WALL	3.8×4.6−3.2	14.28	1.802	9.4	242
H	ROOF		9.88	0.802	14.6	116
S E	GLASS	2.0×1.6	3.2	5.3	9.0	153
〃	〃 (RADIATION)		3.2		271×0.56	486
	INTERNAL WALL	6.0×2.4	15.36	2.364	4.5	164

	INFILTRATION	30×9×0.29				79
	PERSON	2P×54				108
	LIGHT	0.3Kw×1000				300
	OTHER LOAD					162
	S.H.					1,810
	INFILTRATION	30×0.0213×715				457
	PERSON	2P×46				92
	OTHER LOAD					51
	L.H.					600

ARTIST WATING ROOM

	CEILING	61.16−(2.2×8.2+1.6×2.1)	39.76	0.721	4.5	129
	INTERNAL WALL	28.5×2.8	79.8	2.364	4.5	849
	PERSON	25P×69				1,725
	LIGHT	1.5Kw×1000				1,500
	OTHER LOAD					427
	S.H.					4,630
	PERSON	25P×144				3,600
	OTHER LOAD					360
	L.H.					3,960

MAKE UP ROOM (M)

	CEILING	2.1×3.0	6.3	0.721	4.5	21
	INTERNAL WALL	8.2×2.4	19.68	2.364	4.5	210
	PERSON	12P×54				648
	LIGHT	0.7Kw×1000				700
	OTHER LOAD					151
	S.H.					1,730
	PERSON	12P×46				552
	OTHER LOAD					58
	L.H.					610

MAKE UP ROOM (F)

	CEILING	2.6×2.6	6.76	0.721	4.5	22
	INTERNAL WALL	11.3×2.4	27.12	2.364	4.5	289
	PERSON	14P×54				756
	LIGHT	0.8Kw ×1000				800
	OTHER LOAD					183
	S.H.					2,050
	PERSON	14P×46				644
	OTHER LOAR					66
	L.H.					710

14. STUDY OF AIR HANDLING UNIT

ENTRANCE SYSTEM

ROOM	S(m²)	COOLING LOAD(Kcal/Hr)			S.H.F. (%)	Q (m³/Hr)	O.A. (m³/Hr)	REMARKS
		S.H.	L.H.	T.H.				
FOYER & ENTRANCE	336.85	34,950	10,080	45,030		10,940	1,780	
OFFICE 2	8.61	580	100	680		210	30	
TOTAL		35,530	10,180	45,710	77.7	11,150	1,810	

S.H.F $\frac{35530}{45710} \times 100 = 77.7\ \%$

APPARATUS DEW POINT 14.5°C

OUTLET TEMPERATURE 17.0°C $i = 9.85$ Kcal/Kg

SUPPLY AIR VOLUME $\frac{35530}{0.29 \times (26-15)} = 11,150$ m³/Hr

AIR HANDLING UNIT (FACE VELOCITY 2.0~2.5 m/sec) → (AH-23EA)

$OA./Q = \frac{1810}{11,150} \times 100 = 16.2\ \%$

AIR CONDITION AT INLET

D.B. $= (26.0 \times 0.838) + (35 \times 0.162) = 27.46$°C

$i = (13.3 \times 0.838) + (28.5 \times 0.162) = 15.76$ Kcal/Kg

COOLING CAPACITY $11,150 \times 1.2 \times (15.76 - 9.85) = 80,000$ Kcal/Hr

CANTEEN SYSTEM

ROOM	S (m²)	COOLING LOAD (Kcal/Hr)			S.H.F. (%)	Q (m³/Hr)	O.A. m³/Hr	REMARKS
		S H	L H	T H				
CANTEEN	89.33	11,650	3,720	15,370	75.7	3,650	270	

S.H.F. $\frac{11,650}{15,370} \times 100 = 75.7\ \%$

APPARATUS DEW POINT 14.1°C

OUTLET TEMPERATURE 15.0°C $i = 9.76$ Kcal/Kg

SUPPLY AIR VOLUME $\frac{11,650}{0.29 \times (26-15)} = 3,650$ m³/Hr

AIR HANDLING UNIT (FACE VELOCITY 2.0~2.5 m/sec) → (AH-6EA)

$O.A./Q = \frac{270}{3,650} \times 100 = 7.5\ \%$

AIR CONDITION AT INLET

D.B. $= (26 \times 0.925) + (35 \times 0.075) = 26.68$ °C

$i = (13.3 \times 0.925) + (28.5 \times 0.075) = 14.44$ Kcal/Kg

COOLING CAPACITY $3,650 \times 1.2 \times (14.44 - 9.76) = 21,000$ Kcal/Hr

STAGE SYSTEM

ROOM	S (m^2)	COOLING LOAD (Kcal/Hr)			S.H.F.	Q	O.A.	REMARKS
		S.H.	L.H.	T.H.	(%)	m^3/Hr	m^3/Hr	
STAGE	70.27	153,870	3,960	157,830	97.5	56,000	650	O.A. ADJUST. 8,400 m^3/Hr

S.H.F. $\frac{153870}{157830} \times 100 = 97.5\ \%$

APPARATUS DEW POINT 16.1°C

OUTLET TEMPERATURE 16.5°C $i = 10.9\ Kcal/Kg$

SUPPLY AIR VOLUM $\frac{153870}{0.29 \times (26-16.5)} = 56{,}000\ m^3/Hr$

AIR HANDLING UNIT (FACE VELOCITY 2.0~2.5 m/sec) → (AH-100EA)

$O.A./Q = \frac{650}{56000} \times 100 = 1.1\ \%$ $\xrightarrow{\text{STAGE EXHAUST}}$ 15 % (8400 m^3/Hr)

AIR CONDITION AT INLET

D.B. $= (26 \times 0.85) + (35 \times 0.15) = 27.35$°C

$i = (13.3 \times 0.85) + (28.5 \times 0.15) = 15.58\ Kcal/Kg$

COOLING CAPACITY $56000 \times 1.2 \times (15.58 - 10.9) = 315{,}000\ Kcal/Kg$

AUDITORIUM SYSTEM

ROOM	S (m^2)	COOLING LOAD (Kcal/Hr)			S.H.F. (%)	Q m^3/Hr	O.A. m^3/Hr	REMARKS
		S.H.	L.H.	T.H.				
①	232.11	20,660	8,090	28,750				
②	133.59	14,650	6,740	21,390				
③	159.11	18,190	8,090	26,280				
TOTAL	524.81	53,500	22,920	76,420	70.0	18,300	8,400	

S.H.F $\frac{53500}{76420} \times 100 = 70.0\ \%$

APPARATUS DEW POINT 13.0°C

OUTLET TEMPERATURE 15.5°C $i = 9.6$ Kcal/Kg

SUPPLY AIR VOLUM $\frac{53500}{0.29 \times (26-15.5)} \times 1.05 \doteqdot 18{,}300$ m^3/Hr

OUTDOOR AIR CONDITION AT INLET (ENTHALPY EXCHANGER)

D.B. $= 35 - 8.1 \times 0.79 = 28.7$°C

$i = 28.5 - 15 \times 0.69 = 18.3$ Kcal/Kg

AIR HANDLING UNITE (FACE VELOCITY 2.0~2.5 m/sec) ⟶ (AH-35EA)

OA./Q $\frac{8400}{18300} \times 100 = 45.9\ \%$

AIR CONDITION AT INLET

D.B. $= (26.9 \times 0.541) + (28.7 \times 0.459) = 27.73$°C

$i = (13.5 \times 0.541) + (18.3 \times 0.459) = 15.6$ Kcal/Kg

COOLING CAPACITY $18{,}300 \times 1.2 \times (15.6 - 9.6) = 132{,}000$ Kcal/Hr

SUB-CONTROL SYSTEM

ROOM	S (m^2)	COOLING LOAD (Kcal/Hr)			S.H.F. (%)	Q m^3/Hr	O.A. m^3/Hr	REMARKS
		S.H.	L.H.	T.H.				
SUB-CON. R.	97.53	6,670	260	6,930		2,540	90	EQIPMENT 20,640 Kcal/Hr
RACK ROOM	28.5	3,330	50	3,380		1,260	15	20,640
STORE 3 (BATTERY R.)	14.7	610	90	700		300 (50)	15	
TOTAL		10,610	400	11,010	96.4	4,150	120	QA ADJAST. 300 m^3/Hr

CALORIFIC VALUE BY EQUIPMENT → FAN COIL UNIT

CALORIFIC VALUE BY OTHERS → AIR HANDLING UNIT

S.H.F. $\frac{10610}{11,010} \times 100 = 96.4\%$

APPARATUS DEW POINT 14.1 °C

OUTLET TEMPERATURE 15 °C $i = 9.75$ Kcal/Kg

SUPPLY AIR VOLUM $\frac{10610}{0.29 \times (24-15)} = 4,150$ m^3/Hr

AIR HANDLING UNIT (FACE VELOCITY 2.0~2.5 m/sec) → (AH-8EA)

$O.A./Q = \frac{120}{4,150} \times 100 = 2.9\% \rightarrow 7\%$

(VOLUME OF OUTDOOR AIR = VOLUM OF STORE 3 OUTLET AIR 300 m^3/Hr)

AIR CONDITION AT INLET

$D.B. = (24 \times 0.93) + (35 \times 0.07) = 24.77$ °C

$i = (12 \times 0.93) + (28.5 \times 0.07) = 13.2$ Kcal/Kg

COOLING CAPACITY $4,150 \times 1.2 \times (13.2 - 9.75) = 17,200$ Kcal/Hr

FAN COIL UNIT

CHILLED WATER TEMP. 7~12 °C.
INDOOR CONDITION D.B. 24 °C. W.B. 17.8 °C.

FWV-123 S.H. 5800 Kcal/Hr. T.H. 7400 Kcal/Hr. 24 ℓ/min

V.I.P. ROOM SYSTEM

ROOM	S (m^2)	COOLING LOAD (Kcal/Hr)			S.H.F. (%)	Q (m^3/Hr)	O. A. (m^3/Hr)	REMARKS
		S.H.	L.H.	T.H.				
V.I.P. ROOM	38.71	4,650	1,830	6,480		1,460	120	
OFFICE 3	17.36	2,030	1,040	3,070		640	60	
OFFICE 4	14.88	2,140	960	3,100		670	60	
LOBBY	69.06	2,990	760	3,750		930	130	
TOTAL		11,810	4,590	16,400	72.0	3,700	370	

S.H.F. $\frac{11,810}{16,400} \times 100 = 72.0\ \%$

APPARATUS DEW POINT 13.2°C

OUTLET TEMPERATURE 15°C $i = 9.5$ Kcal/Kg

SUPPLY AIR VOLUM $\frac{11,810}{0.29 \times (26-15)} = 3,700$ m^3/Hr

AIR HANDLING UNIT (FACE VELOCITY 2.0~2.5 m/sec) ⟶ (AH-6EA)

O.A./Q $\frac{370}{3,700} \times 100 = 10\%$

AIR CONDITION AT INLET

D.B $= (26.0 \times 0.9) + (35.0 \times 0.1) = 26.9$°C

$i = (13.3 \times 0.9) + 28.5 \times 0.1) = 14.82$ Kcal/Kg

COOLING CAPACITY 3,700 × 1.2 × (14.82 − 9.5) = 24,000 Kcal/Hr

PROJECTION ROOM SYSTEM

ROOM	S (m^2)	COOLING LOAD (Kcal/Hr)			S.H.F.	Q	O.A.	REMARKS
		S.H.	L.H.	T.H.	(%)	m^3/Hr	m^3/Hr	
PROJECTION ROOM	47.85	6,540	250	6,790	96.3	2,510	75	

S.H.F. $\frac{6,540}{6,790} \times 100 = 96.3\ \%$

APPARATUS DEW POINT 16.0°C

OUTLET TEMPERATURE 17°C $i = 10.95$ Kcal/Kg

SUPPLY AIR VOLUM $\frac{6,540}{0.29 \times (26-17)} = 2,510$ m^3/Hr

AIR HANDLING UNIT (FACE VELOCITY 2.0~2.5 m/sec) ⟶ (AH-4EA)

O.A./Q $\frac{75}{2,510} \times 100 = 3\ \%$

AIR CONDITION AT INLET

D.B. = (26.0×0.97)+(35.0×0.03)= 26.27°C

i = (13.3×0.97)+(28.5 0.03)= 13.76 Kcal/Kg

COOLING CAPACITY 2,510× 1.2×(13.76−10.95)=8,500 Kcal/Hr

LIGHTING ROOM SYSTEM

ROOM	S (m²)	COOLING LOAD (Kcal/Hr)			S.H.F. (%)	Q m³/Hr	O.A. m³/Hr	REMARKS
		S.H.	L.H.	T.H.				
LIGHTING ROOM	80.66	10,210	150	10,360		3,700	45	
SIDE SPOT 2	6.45	3,100	100	3,200		1,130	30	
SIDE SPOT 1	7.01	3,080	100	3,180		1,120	30	
TOTAL		16,390	350	16,740	98.0	5,950	105.	O.A. ADJAST. 1,200 m³/Hr

S.H.F. $\frac{16,390}{16,740} \times 100 = 98.0\ \%$

APPARATUS DEW POINT 16.0°C

OUTLET TEMPERATURE 16.5°C $i = 10.9$ Kcal/Kg

SUPPLY AIR VOLUM $\frac{16,390}{0.29 \times (26-16.5)} = 5,950$ m³/Hr

AIR HANDLING UNIT (FACE VELOCITY 2.0~2.5 m/sec) ⟶ (AH-10EA)

O.A./Q $\frac{105}{5950} \times 100 = 1.5\ \% \longrightarrow 20\ \%$ 1,200 m³/Hr

AIR CONDITION AT INLET

D.B. = $(26.0 \times 0.8) + (35.0 \times 0.2) = 27.8$°C

$i = (13.3 \times 0.8) + (28.5 \times 0.2) = 16.34$ Kcal/Hr

COOLING CAPACITY $5,950 \times 1.2 \times (16.34 - 10.9) = 38,900$ Kcal/Hr

EXISTING SYSTEM

ROOM	S (m²)	COOLING LOAD (Kcal/Hr)			Q (m³/Hr)	REMARKS
		S. H.	L. H.	T. H.		
OFFICE 1	9.88	1,810	600	2,410	570	
ARTIST WAITING ROOM	61.16	4,630	3,960	8,590	1,450	
MAKE UP R. (M)	22.32	1,730	610	2,340	540	
MAKE UP R (F)	26.4	2,050	710	2,760	640	

ROOM TEMPERATURE 26°C
OUTLET TEMPERATURE 15°C
$\Delta t = 11°C$

OFFICE 1 $\frac{1,810}{0.29 \times 11} = 570$ m³/Hr

ARTIST W.R. $\frac{4,630}{0.29 \times 11} = 1,450$

MAKE UP R.(M) $\frac{1,730}{0.29 \times 11} = 540$

〃 (F) $\frac{2,050}{0.29 \times 11} = 640$

15 LIST OF COOLING CAPACITY

<table>
<tr><th colspan="2">SYSTEM</th><th>UNIT</th><th>Q'TY</th><th colspan="2">COOLING CAPACITY (Kcal/Hr)</th><th colspan="2">CHILLED WATER FLOW (ℓ/min)</th><th>REMARKS</th></tr>
<tr><td>1</td><td>ENTRANCE SYSTEM</td><td>A.H.U.</td><td>1</td><td colspan="2">80,000.</td><td colspan="2">270</td><td></td></tr>
<tr><td>2</td><td>CANTEEN</td><td>〃</td><td>1</td><td colspan="2">21,000</td><td colspan="2">80</td><td>EXISTING CHILLED WATER PIPE</td></tr>
<tr><td>3</td><td>STAGE</td><td>〃</td><td>1</td><td colspan="2">315,000</td><td colspan="2">1,050</td><td></td></tr>
<tr><td>4</td><td>AUDITORIUM</td><td>〃</td><td>1</td><td colspan="2">132,000</td><td colspan="2">450</td><td></td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">SUB-CONTROL</td><td>〃</td><td>1</td><td>17,200</td><td rowspan="2">52,000</td><td>60</td><td rowspan="2">210</td><td rowspan="2">EXISTING CHILLED WATER PIPE</td></tr>
<tr><td>F.C.U.</td><td>6</td><td>34,800</td><td>150</td></tr>
<tr><td>6</td><td>V.I.P. ROOM</td><td>A.H.U.</td><td>1</td><td colspan="2">24,000</td><td colspan="2">80</td><td>〃</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">PROJECTION ROOM</td><td>〃</td><td>1</td><td>8,500</td><td rowspan="2">13,500</td><td>30</td><td rowspan="2">50</td><td rowspan="2"></td></tr>
<tr><td>F.C.U.</td><td>2</td><td>5,000</td><td>20</td></tr>
<tr><td>8</td><td>LIGHTING ROOM</td><td>A.H.U.</td><td>1</td><td colspan="2">38,900</td><td colspan="2">130</td><td></td></tr>
<tr><td>9</td><td>ORCHESTRA PIT</td><td>〃</td><td>1</td><td colspan="2">3,000</td><td colspan="2">10</td><td>EXISTING CHILLED WATER PIPE</td></tr>
<tr><td colspan="2">TOTAL</td><td></td><td></td><td colspan="2">679,400</td><td colspan="2">2,330</td><td></td></tr>
</table>

679,400 Kcal/Hr = 224.7 U.S.R.T.

16 CHILLING UNIT

FULL-TIME AIR CONDITIONED ROOMS [SUB-CONTROL SYSTEM / ORCHESTRA SYSTEM]

COOLING CAPACITY

SUB-CONTROL S.	52,000 Kcal/Hr
ORCHESTRA S.	3,000
	55,000 Kcal/Hr

REFRIGERATION LOAD

PIPE LOSS 20 %

55,000 × 1.2 = 66,000 Kcal/Hr

OUTDOOR TEMP. 35°C

CHILLED WATER TEMP. 7~12°C

→ (UWA 40G)

VENTILATION

1. W.C.(1) SYSTEM (NUMBER OF AIR CHANGE 5~10 N/Hr)

(M) $8.3^m \times 6.0^m \times 2.3^m \times 7\,^N/_{Hr} = 800\,^{m^3}/_{Hr}$

(F) $\{3.9 \times 4.0 + (5.2 + 4.9) \times 1.8 \times 1/2\} \times 2.3 \times 7 = 390$

STORE 5 $(18.2 + 18.4) \times 2.0 \times 1/2 \times 2.3 \times 5 = 420$

PAWDER R. $4.35 \times 1.9 \times 2.3 \times 10 = 200$

TOTAL $1810\,^{m^3}/_{Hr}$

FAN (TFU-301) $\times 1810\,^{m^3}/_{Hr} \times 20^{mmAq} \times 0.75^{Kw}$

2. W.C(2)(3) SYSTEM (5~10 N/Hr)

(2) $(1.8 + 2.1) \times 2.1 \times 1/2 \times 2.3 \times 5 = 100$

(3) $\{2.1 \times 1.0 + (1.6 + 1.9) \times 1.4 \times 1/2\} \times 2.3 \times 10 = 140$

WATTIG R. $2.1 \times 1.3 \times 2.3 \times 10 = 60$

TOTAL $300\,^{m^3}/_{Hr}$

FAN (TFU-201) $\times 300\,^{m^3}/_{Hr} \times 15^{mmAq} \times 0.2^{Kw}$

3. WASH ROOM SYSTEM (10 N/Hr)

$(5.0 + 4.0) \times 4.0 \times 1/2 \times 2.3 \times 10 = 450\,^{m^3}/_{Hr}$

FAN (TFU-201) $\times 450\,^{m^3}/_{Hr} \times 20^{mmAq} \times 0.2^{Kw}$

4. W.C.(4) SYSTEM (5 N/Hr)

$\{(4.5 + 4.1) \times 2.2 \times 1/2 - 1.5 \times 0.7\} \times 2.3 \times 5 = 100\,^{m^3}/_{Hr}$

FAN (TFU-201) $\times 100\,^{m^3}/_{Hr} \times 15^{mmAq} \times 0.2^{Kw}$

5. PROJECTION ROOM SYSTEM

FAN (TFU-201) $\times 285\,^{m^3}/_{Hr} \times 15^{mmAq} \times 0.2^{Kw}$

6. KITCHEN & PANTRE SYSTEM

(KITCHEN 30 N/Hr , STORE 4 5 N/Hr)

KITCHEN $\{(3.1+4.2)\times 6.7\times 1/2+3.1\times 0.5\times 1/2\}\times 2.3\times 30=1{,}700\ m^3/Hr$

HOOD $1.0^{m}\times 0.6^{m}\times 0.6^{m/sec}\times 3{,}600^{sec/Hr}=1{,}300\ m^3/Hr$

INLET $1{,}700^{m^3/Hr}-1300^{m^3/Hr}=400\ m^3/Hr$

STORE 4 $3.0\times 2.6\times 2.3\times 5=100\ m^3/Hr$

TOTAL $1{,}800\ m^3/Hr$

FAN: (TFU-301) $\times 1{,}800\ m^3/Hr\times 15^{mmAq}\times 0.75^{Kw}$