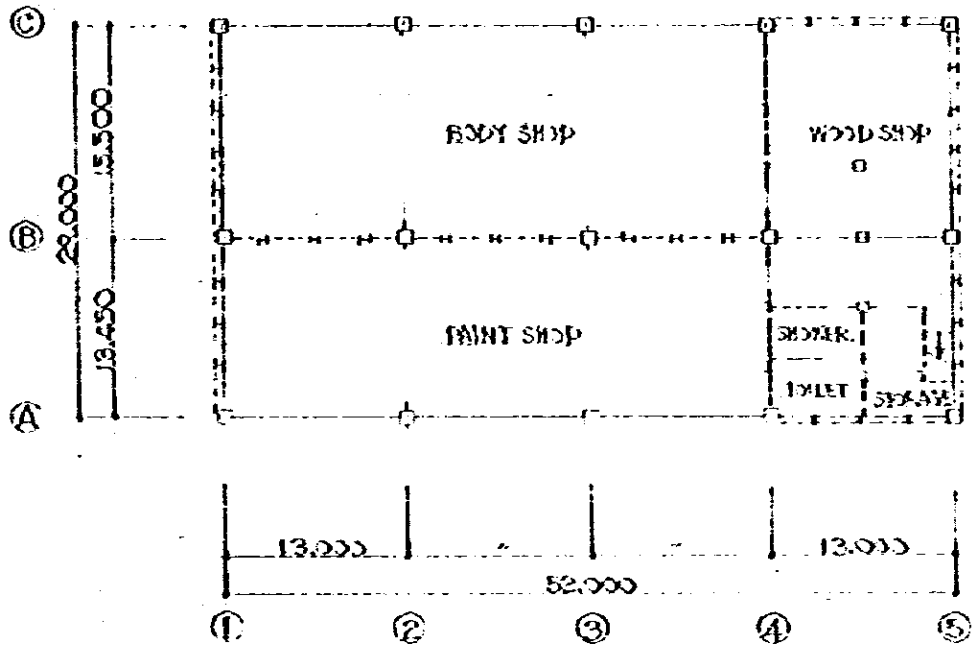
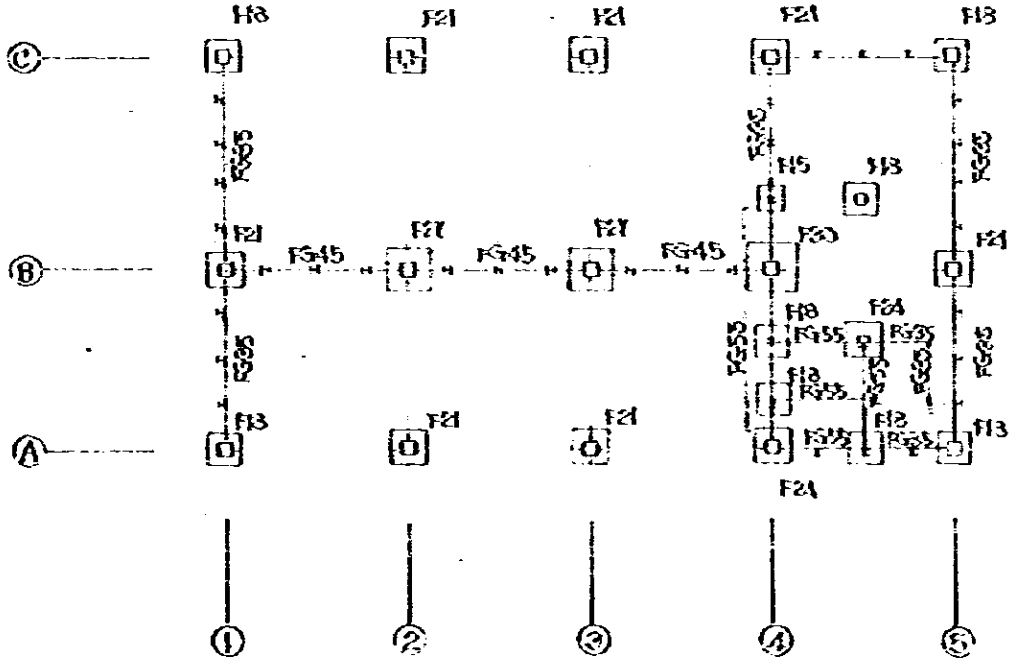
14　定期点検整備工場

PAINT & BODY FACTORY

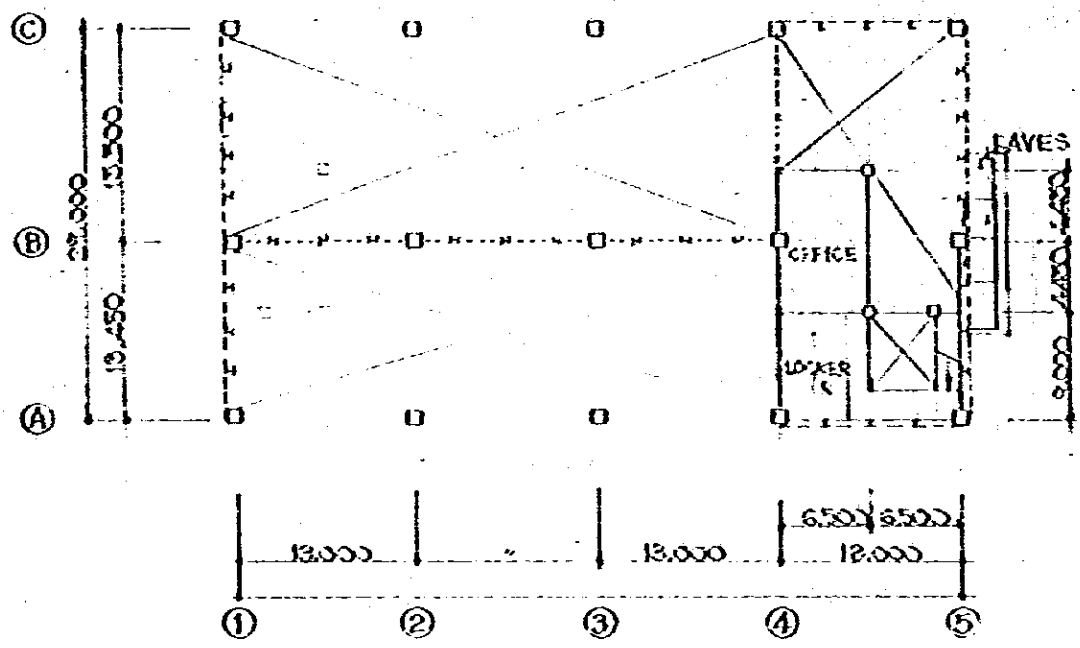
GF PLAN



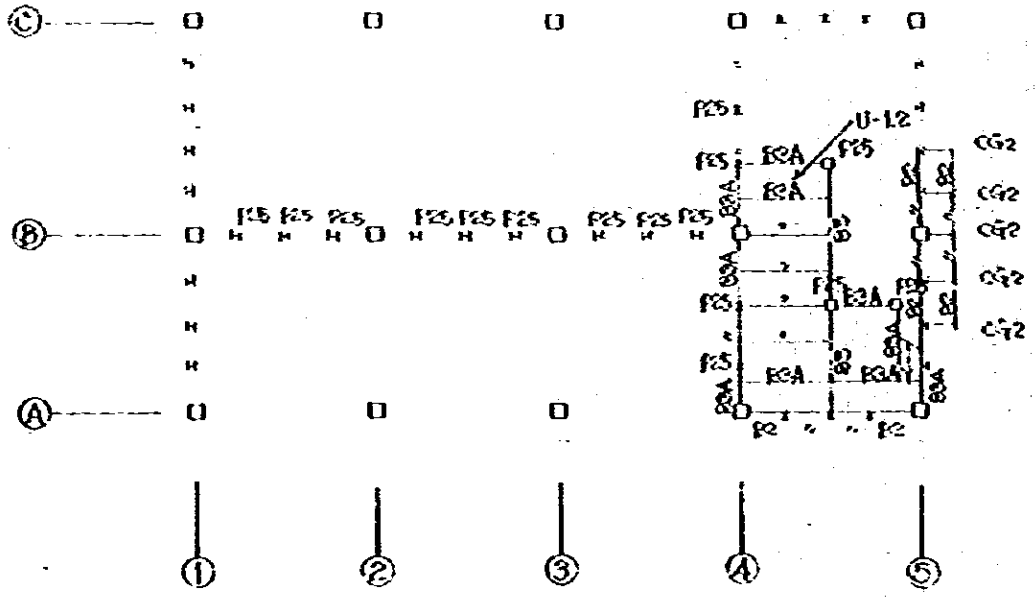
GF KEY PLAN



1F PLAN

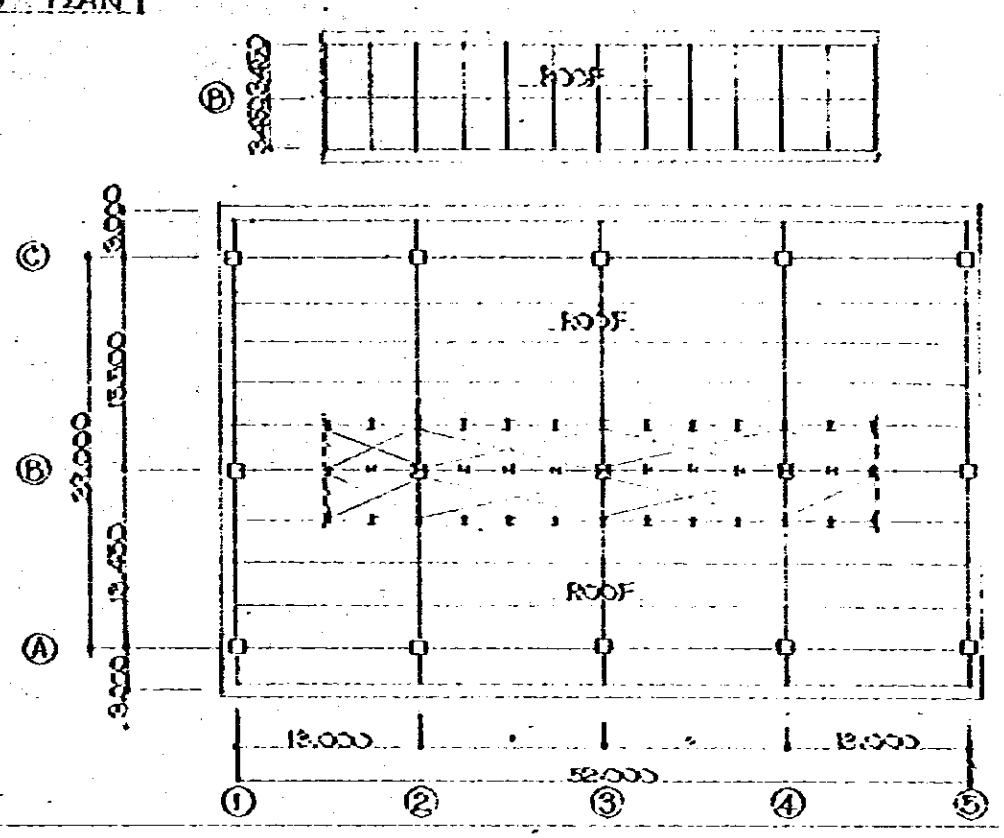


1F KEY PLAN

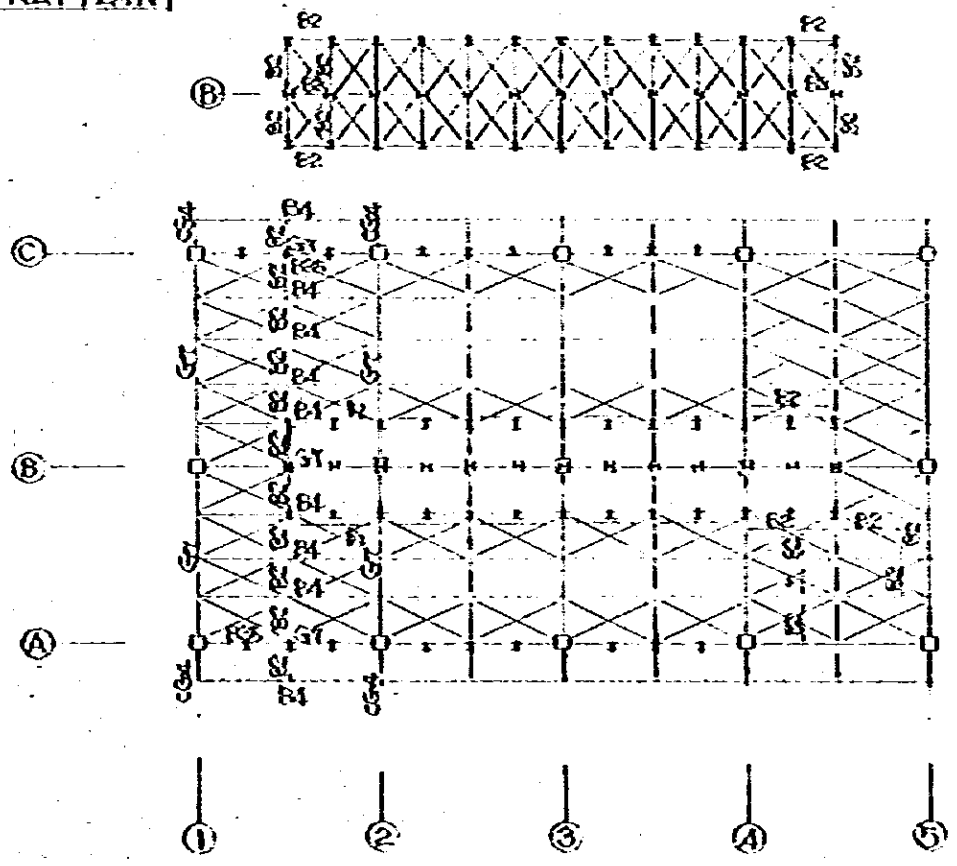


○ : C19
□ : P3

RF PLAN

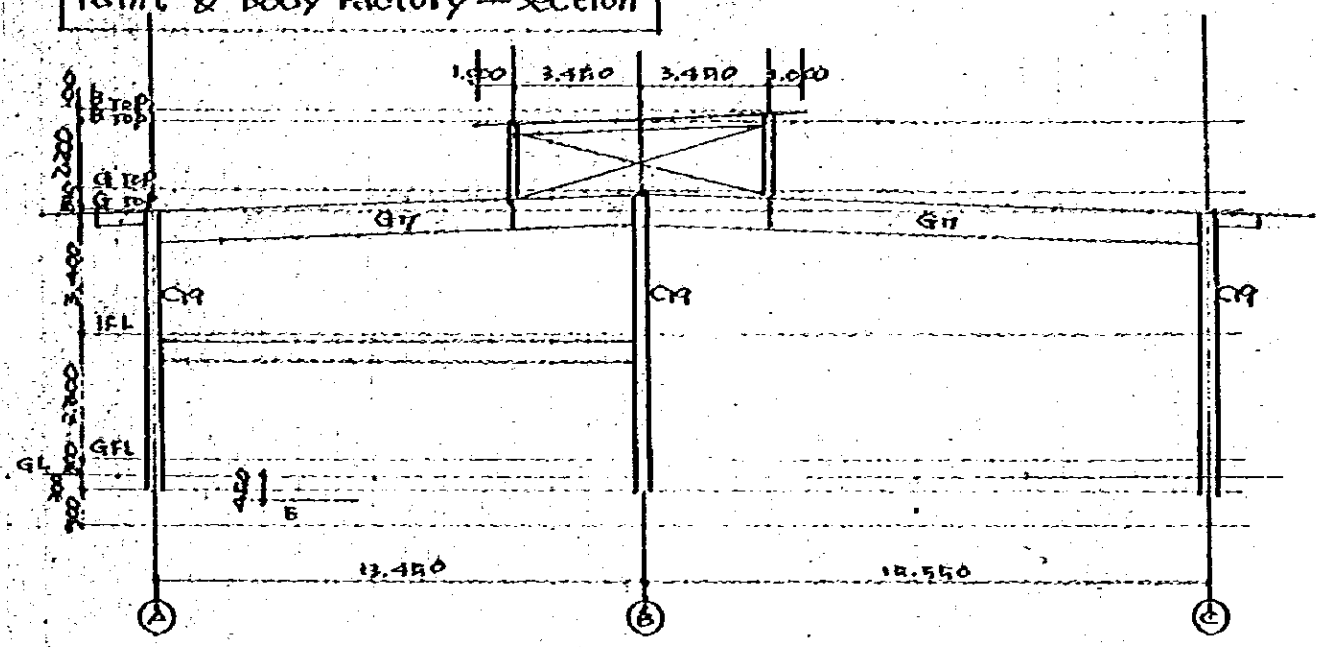


RF KEY PLAN



1 : PI

Paint & Body Factory — Section



Unit Load

Floor

		D. L.		L. L.		T. L.
Roof		Shell type roof	0.02	S,B	0.09	0.11 (0.15)
				G,C,F	0.07	0.09 (0.13)
		Ceiling	(0.04)	K	0.03	0.05 (0.09)
			0.02 (0.06)			
Office Locker		Finish	0.13	S,B	0.30	0.31
		Deck	0.02	G,C,F	0.18	* 0.39
		Ceiling	0.04	K	0.08	0.29
			0.21			
						* With Above Ceiling 0.43
Stair case		Step	0.06	S,B	0.30	0.40
		String	0.04	G,C,F	0.18	0.28
				K	0.18	0.18
			0.10			

Beam

	t/m			t/each						
	Steleton	Finish	Σ	ℓ						
Beam G9	0.25	0	0.25							
$\overline{G9}$	0.15	0	0.15							
Subbeam	0.05	0	0.05							
Foundation Beam	1.26	0	1.26							

Column

	t/m			t/each						
	Steleton	Finish	Σ							
Column $\square_{450}$	0.20	0	0.25							
$\square_{350}$	0.13	0	0.15							
Post	0.05	0	0.05							

Wall

	t/m2			t/m						
	Steleton	Finish	Σ							
Siding	0.01	0.01	0.02							
Partition	0.01	0.07	0.08							
Sash	0.01	0.04	0.05							
Brick $\parallel_{25}$	0.49	0.11	0.60							

Wind Pressure

Velosity of Wind

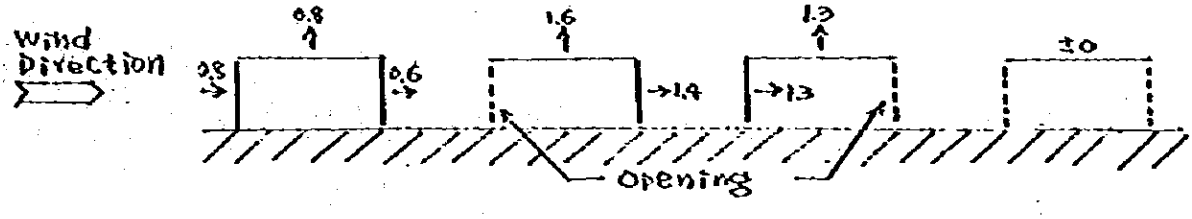
Cyclone 130 Miles/Hour = 130 × 1609.34/3,600
= 58.1 m/sec
→ 60.0 m/sec (h = 10 m)

(In 1970, At chicagon, recorded
103 m.p.h. = 46.0 m/sec)

Velosity Pressure $q = \frac{1}{2}\rho V^2 = \frac{1}{2} \times \frac{1}{8}\left(60\sqrt{\frac{h}{15}}\right)^2$
$= 60\sqrt{h}$

Block	Surface		$\bar{h}$ [m]	$60\sqrt{\bar{h}}$	q [kg/m²]	cq [kg/m²]
Heavy Repair Factory	Monitor Roof	Roof	12.7	214	220	
		Wall				
		Roof	10.5, 6.9	194, 153	200, 160	
		Wall			140, 120	
Parts Storage	Monitor Roof	Roof	11 – 9.29	184 – 183	180	
		Wall				
		Roof	7.35 – 7.00	163	160	
		Wall			120	
Inspection Factory	Monitor Roof	Roof				
		Wall				
		Roof	7.20 – 7.10	161	160	
		Wall			120	
Periodical Repair Factory	Monitor Roof	Roof	8.33 – 8.23	183	180	
		Wall				
		Roof	7.23 – 7.00	151	160	
		Wall			120	
Paint & Body Factory	Monitor Roof	Roof	8.41 – 8.31	184	180	
		Wall				
		Roof	8.31 – 7.00	162	160	
		Wall			120	
Retreading & Metal Casting Factory	Monitor Roof	Roof	8.45 – 8.39	184	180	
		Wall				
		Roof	8.39 – 7.00	162	160	
		Wall			120	

Coefficient of Wind Pressure



Axial force (t) 439

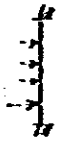
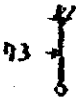
		C1		C2					
MR_F	S								
	G,B								
	C								
	W								
	Σ								
	W.L.								
	Σ'								
R_F	S	0.09 × 80.6	7.3	× 139.8	12.6				
	G,B	0.15 × 14.3	2.1	× 20.8	1.9				
		0.05 × 25.6	1.3	× 49.8	2.5				
	C	0.15 × 6.9	1.0	× 6.17	1.0				
	W	0.02 × 8.1	0.2	× 0					
		0.08 × 0		× 0					
		0.05 × 45.6	2.2	× 87.2	4.4				
		0.06 × 3.3	1.4	× 0					
	Σ		15.5		22.4				
	W.L.	-0.20 × 80.6	-16.1	× 139.8	-28.0				
	Σ'		-0.6		-5.6				
I_F	S								
	G,B								
	C								
	W								
	Σ								
	W.L.								
	Σ'								

		B1		B2		B4		B W	
MR_F	S			0.09 × 57.9	5.2				
	G,B			0.05 × 70.1	3.5				
	C			0.05 × 20.0	1.0	] =82			
	W			0.08 × 6.9	0.6				
				0.05 × 52.0	2.6				
	Σ				12.9	12.9	12.9		
	W.L.			-0.21 × 57.9	-12.2		-12.2		
	Σ'				0.7	0.7	0.7		
R_F	S	0.09 × 108.6	9.8	× 98.5	8.9				
	G,B	0.15 × 21.0	3.2	× 27.5	4.1	] =82	17.1		
		0.06 × 34.0	1.7	× 60.0	3.0				
	C	0.15 × 7.0	1.1	× 7.0	1.1				
	W	0.02 × 8.9	0.2	× 0		× 0			
		0.08 × 8.9	0.7	× 17.9	1.4	× 8.9	0.7		
		0.09 × 0		× 0		× 0			
		0.20 × 4.9	2.9	× 4.9	2.9	× 2.4	1.4		
	Σ		19.6		34.3	21.4	32.1	19.2	
	W.L.	-0.20 × 108.6	-21.7	× 98.5	-19.7	=82	-19.7		
	Σ'		-2.1		2.1	1.4	0.2	-0.5	
I_F	S					0.43 × 7.3	3.1		
	G,B					0.08 × 11.0	0.6		
	C								
	W					0.02 × 0			
						0.08 × 11.1	0.9	0.08 × 5.5	0.4
						0.05 × 15.3	0.8		
						0.60 × 13.6	8.6	0.60 × 1.5	0.9
	Σ					49.1	13.0	[K] 1.3	1.3
	W.L.						0		0
	Σ'					13.2	13.0	1.3	1.3

		A1		A2		A4		1W	
M_{RF}	S								
	G,B								
	C								
	W								
	Σ								
	W.L.								
	Σ′								
R_F	S	0.09 × 72.9	6.6	× 126.4	11.4				
	G,B	0.15 × 13.2	2.0	× 19.1	3.0				
	C	0.05 × 28.4	1.4	× 42.2	2.1	} =A2	14.5		
	W	0.15 × 6.7	1.0	× 6.7	1.0				
		0.02 × 8.7	0.2	× 0		× 8.5	0.2		
		0.08 ×		× 0		× 0			
		0.05 × 43.6	2.2	× 87.2	4.4	× 43.6	2.2		
		0.60 × 2.9	1.8	× 0		× 2.4	1.4		
	Σ		14.9		21.9	21.3	21.3		
	W.L.	-0.20 × 72.9	-14.6	× 126.4	-26.3	=A2	-25.3		
	Σ′		0.3		-3.4	-4.0	-4.0		
1_F	S					0.43 × 7.3	3.1		
	G,B					0.06 × 7.1	0.4		
	C								
	W					0.02 × 0		0.02 × 5.6	0.1
						0.08 × 7.1	0.6		
						0.05 × 0			
						0.60 × 6.3	3.8	0.60 × 1.5	0.9
	Σ					29.2	7.9	[1/M] 1.0	1.0
	W.L.						0		0
	Σ′					3.9	7.9	1.0	1.0

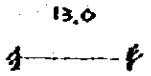
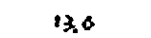
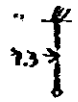
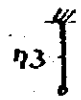
		A A/5		A/B 4		A/B A/5		4W	
M_{RF}	S								
	G,B								
	C								
	W								
	Σ								
	W.L.								
	Σ′								
R_F	S								
	G,B								
	C								
	W								
	Σ								
	W.L.								
	Σ′								
1_F	S	0.43 × 21.9	9.4	× 14.6	6.3	× 29.3	12.6		
	G,B	0.05 × 15.9	0.8	× 11.6	0.6	× 22.0	1.1		
	C	0.05 × 6.7	0.3	× 6.7	0.3	× 6.7	0.3		
	W	0.02 × 16.9	0.3	× 0		× 0			
		0.08 × 0		× 11.1	0.9	× 11.1	0.9		
		0.05 × 0		× 15.3	0.8	× 30.6	1.8		
		0.60 × 4.9	2.9	× 12.6	7.6	× 12.6	7.6	0.60 × 2.8	1.7
	Σ		13.7		16.5	24.0	24.0	[1/M] 1.7	1.7
	W.L.		0		0		0		0
	Σ′		13.7		16.5	24.0	24.0	1.7	1.7

(tm, t)

	Load			C		M_o		Q	
↑ kCG	 1.5	0.84 × 29.3 0.05 × 14.5	P	3.36 × 1.5	5.0			× 1.0	3.4
T.L.					5.0				3.4
//	 4	(-1.6×0.16 - 0.07) × 29.3	P	-8.59 × 1.5	-14.3			× 1.0	-9.6
W.L.					-14.3				-9.6
↑ RG	 13.45	0.09 × 13.0 0.65×13×5/345 0.15	g	1.613 × 13.45²/12	22.8	× 1/8	34.2	× 13.45/2	10.2
T.L.					22.8		34.2		10.2
//		(0.8×0.16 - 0.07) × 13.0 2.9	g P	-2.594 × 13.45²/12 1.8×3.45×0.24/0.26	-38.8 ±4.6 ±1.6	× 1/8 0.9 × 13.45/2	-58.2 ±4.7	× 13.45/2 2.5 × 0.24/0.26	-14.3 ±1.8 ±0.7
W.L.				D U 43.4 34.2 40.4 ~ 37.2		62.9 ~	53.5	19.1 ~ 18.0	15.5 16.6
↑ RG	 12.45	0.09 × 13.0 0.65×13×5/345 0.13	g	1.629 × 12.45²/12	20.8	× 1/8	46.2	× 12.45/2	11.9
T.L.					30.8		46.2		11.9
//		(0.8×0.16 - 0.07) × 13.0 2.6	g P	-2.599 × 13.45²/12 2.6×3.45×0.22/0.18	-51.9 ±1.9 ±6.7	× 1/8 0.6 × 12.45/2	-77.8 ±4.7	× 12.45/2 2.5 × 0.22/0.18	-20.0 ±0.6 ±1.9
W.L.				D U 53.8 50.0 58.6 ~ 46.2		82.5 ~	73.1	20.6 ~ 21.9	19.4 18.1
↑ C	 13	5.6 × 1/2	P	2.8 × 13.3/8	2.6	× 1/4	5.1	× 1/2	1.4
K.L.				(2.6 × 1.5	3.4)				
//	 13	(0.9 ~ 0.6 × 0.12) × 49.5	P	4.6 ~ 3.4 × 13.3/8	4.2 ~ 3.1	× 1/4	8.4 ~ 6.2	× 1/2	2.3 ~ 1.7
W.L.				(4.2 ~ 3.1 × 1.5	6.3 ~ 4.7)		8.4 ~ 6.2		2.3 ~ 1.7

C M・Q

[tm, t]

	Load			C		M_0		Q
← RG	13.0 	(2.09×3.36)+0.15	t	0.432 × 13.0²/12	5.4	× 1/8	9.11	× 13.0/2	2.9
T.L.					5.4		9.11		2.9
//	13.0 	(-0.8×0.35-0.07)×3.36	t	-0.065 × 13.0²/12	-9.4	× 1/8	-14.0	× 13.0/2	-4.3
W.L.					-9.4		-14.0		-4.3
← C	7.3 	5.6 × 3/3	t	3.4 × 7.3/8	3.4	× 1/4	6.8	× 1/2	1.9
				(3.4 × 1.5 | 5.1)				
K.L.					3.4		6.8		1.9
← C	7.3 	(0.8~0.4 × 0.17)×3.36	t	0.31 / 0.23 × 7.3²/12	1.4 ~ 1.0	× 1/8	2.1 ~ 1.5	× 7.3/2	1.1 ~ 0.8
				(1.4 / 1.0 × 1.5 | 2.1 / 1.5)				
W.L.					1.4 ~ 1.0		2.1 ~ 1.5		1.1 ~ 0.8

Seismic Force

(t)

			W	k	kw	Q
4RF	S	0.05×39.5×8.9	17.6			
	B	0.04×{(39.0×3)+(6.9×13)}	10.3			
	P	0.05×2.2×39	4.3			
	W	(0.08×13.8×2.2)+(0.05×98.0×2.7)	11.0			
	Σ	ῳ4 = 43.2/(39.0×6.9) = 0.16 [t/m²]	43.2	0.10	4.3	5.0
RF	S	0.05×{(52.6×35.0)−(39.0×6.9)}	78.4			
	G	0.18×{(52.0×3)+(22.0×5)}	49.2			
	B	0.05×{(42.0×9)+(1.5×10)+(29.0×4)}	30.0			
	C	0.15×7.0×19/2	7.9			
	P	0.05×11.0×35/2	6.1			
	W	(0.02×73×3.4)+(0.03×98×3.4)+(0.05×98×2.7)	36.7			
	Σ	ῳ1 = 204.3/(52.5×35.0) = 0.11 [t/m²]	204.3	〃	20.4	26.0
IF	S	0.29×132.0	38.3			29.0
	B	0.04×{(6.5×11)+(4.5×8)}	5.4			
	W	0.08×43.0×3.7	12.7			
	Σ	ῳ4 = 56.4/132.0 = 0.43 [t/m²]	56.4	〃	5.6	

Wind Force

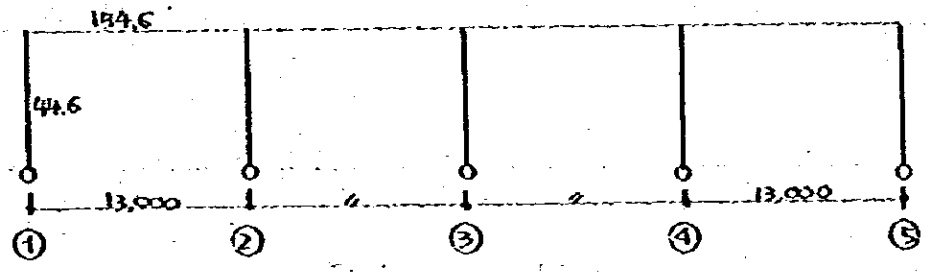
(t)

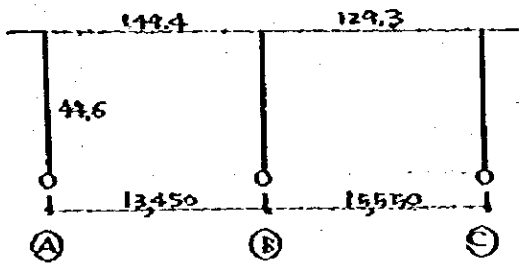
DIR.	LEV.	C	q		A	H	Q	
→	4RF	0.8+0.6	0.18	11.2×2.3	16.6	4.3	4.5	
	RF	〃	0.12	29.5×3.5	103.3	17.3	22.0	< K.L.
	IF	〃	〃	↑				
←	4RF	0.8+0.6	0.18	39.3×9.3	90.4	22.8	23.0	
	RF	〃	0.12	52.5×3.4	178.5	30.9	53.0	> K.L.
	IF	〃	〃	↑				

Stiffness Ratio

	J	ℓ, ft	1300	1345	1545		6316	
H-900×300×13×24	201,000		154.6	149.4	129.3			
□ - 350×350×19 ~16	40,100 ~35,300						59.5 (×0.74=44.6)	

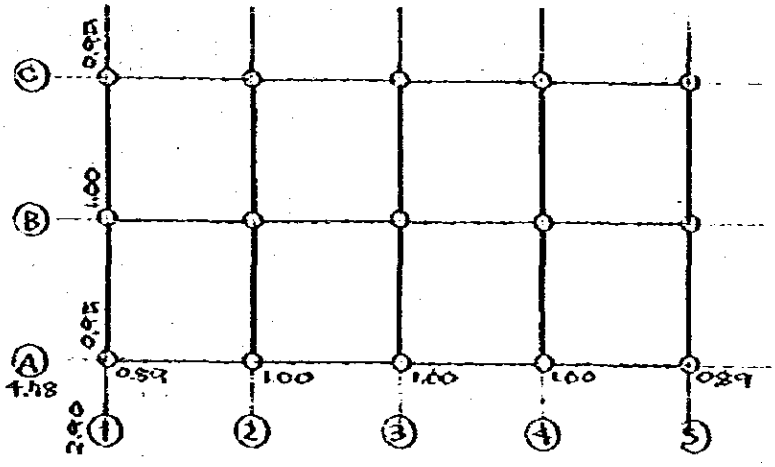
$$Je = \frac{1}{4} Jmax = 0.20 + 0.80 \sqrt[3]{\left(\frac{35,300}{40,100}\right)^2} Jmax = 0.93\ Jmax$$





Distribution Factor & Inflection Point

DIR.	D					D'	Y			ΣY	R	K.L.			W.L.		
	kc	Σkb	k	a	D		Yo	Y1	Y2.3			Q	MU	MU	Q	MU	ML
↔	49.6	154.6	3.61	0.22	9.90	0.89				0	6.35	2.8	20.3	0	2.6	15.0	0
	〃	369.2	7.22	0.23	10.00	1.00				0	〃	3.1	22.8	0	2.3	16.9	0
↕	49.6	149.4	3.50	0.22	9.36	0.85				0	〃	3.1	23.0	0	4.5	33.0	0
	〃	298.7	6.91	0.23	9.94	1.00				0	〃	3.3	24.3	0	4.7	34.5	0
	〃	129.3	3.02	0.21	9.18	0.95				0	〃	3.1	23.0	0	4.5	33.0	0



Unit Stress

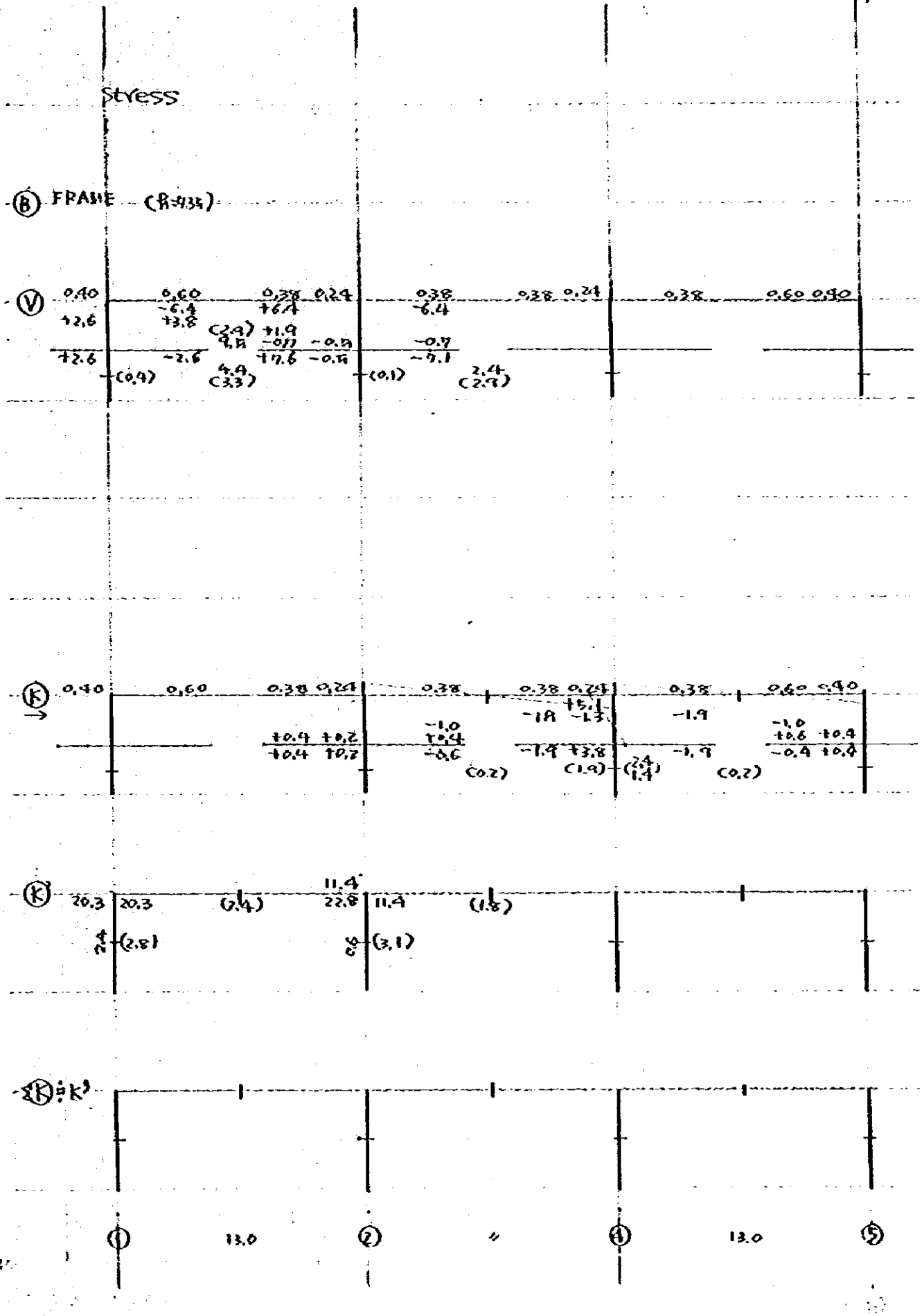
case / DIR.	K.L.						N.L.					
	Total			⑧/④ Frame			Total			④ Frame		
	Q	ΣD	Q/ΣD	Q	ΣD	Q/ΣD	Q	ΣD	Q/ΣD	Q	ΣD	Q/ΣD
↔	29.0	14.34	2.0	15.0	4.58	3.1	22.0	14.34	1.5	11.0	4.08	2.3
↕	〃	14.50	2.0	9.5	2.80	3.3	53.0	14.50	3.7	13.5	2.90	4.7

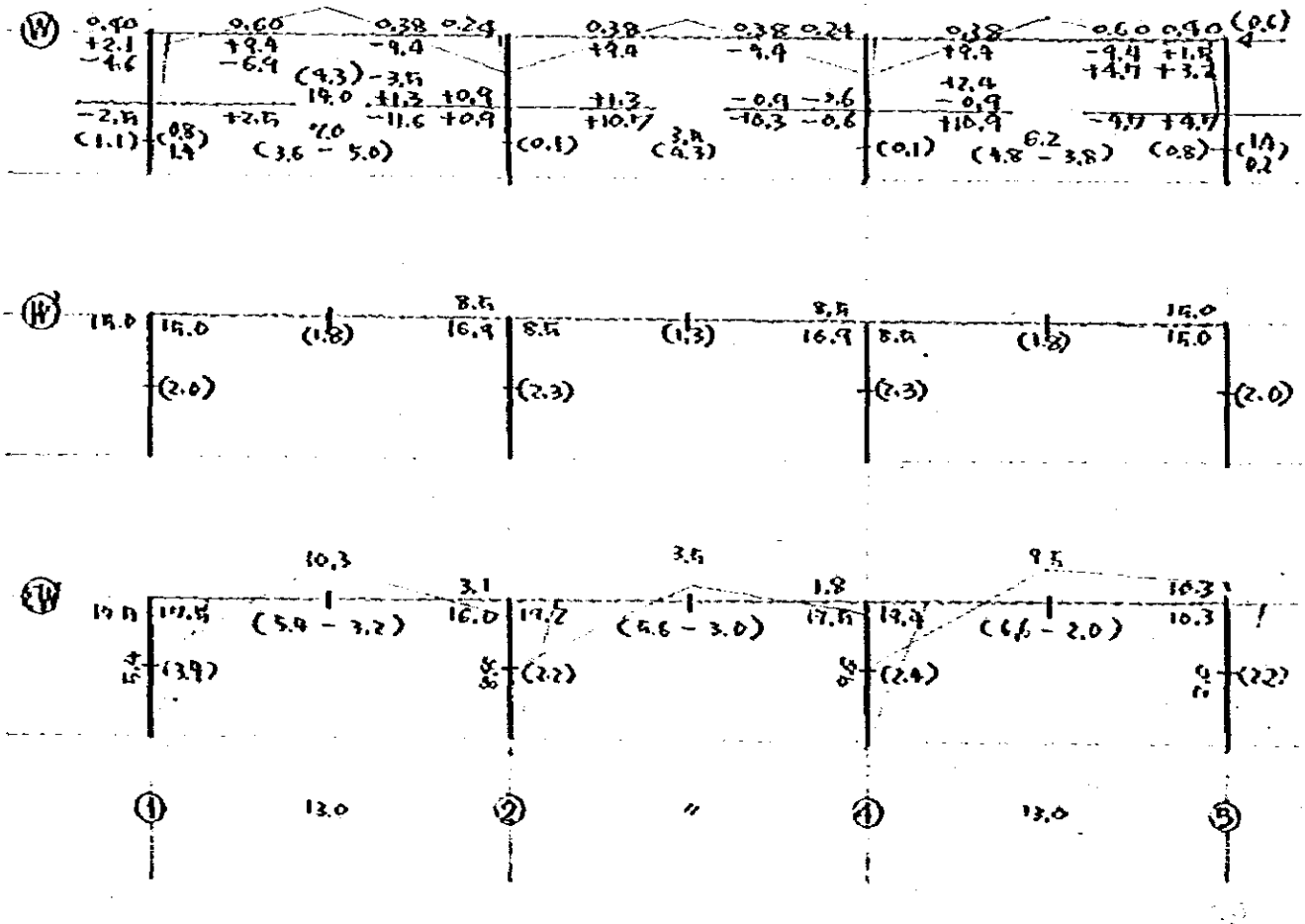
Deflection by Horizontal Force

			Q	ΣD	$h_0^2/12Ek_0$	δ	δ/h	
↔	K.L.	Σ	29.0	14.33×10.00	$(38^2/12\times2{,}100)$	3.24	1/196	
	W.L.		22.0	〃	〃	2.45	1/259	
↕	K.L.		29.0	14.50×9.94	〃	3.22	1/197	
	W.L.		53.0	〃	〃	5.98	1/108	

Stress

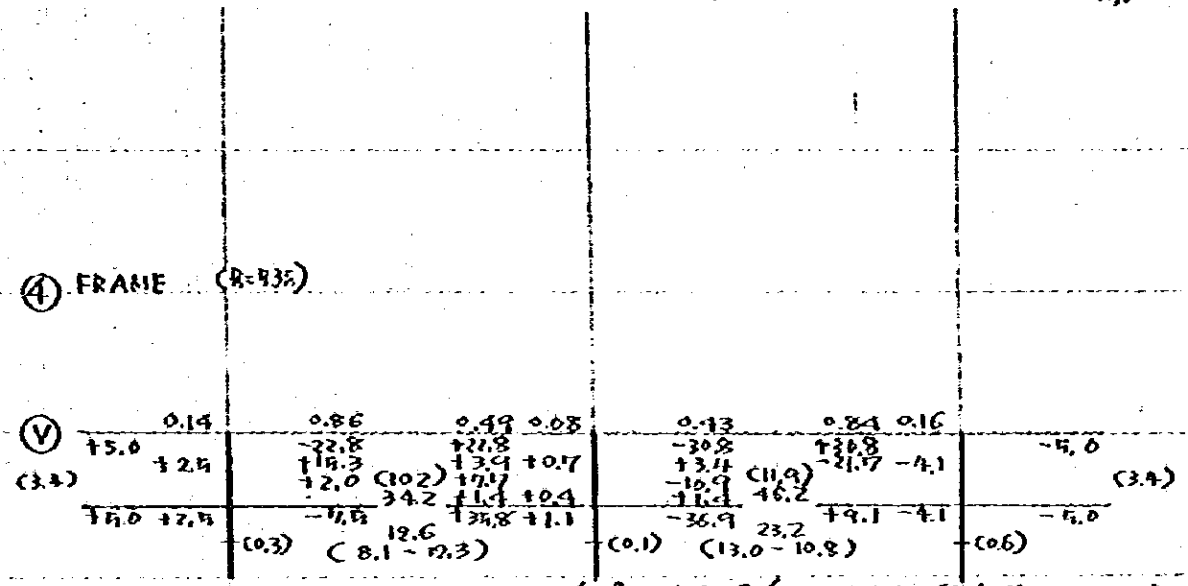
(B) FRAME (R=9.3t)




Ⓦ
Ⓦ
Ⓦ
① 13.0 ② " ④ 13.0 ⑤

FB

④ FRAME (R=935)



$$\frac{1}{r} = 11.9 \times 2 / 18.95 = 1.631 [t/m]$$

$$\delta = \frac{5}{384} \frac{1}{EJ} l^4 - \frac{8Mc}{16EJ} l^2$$

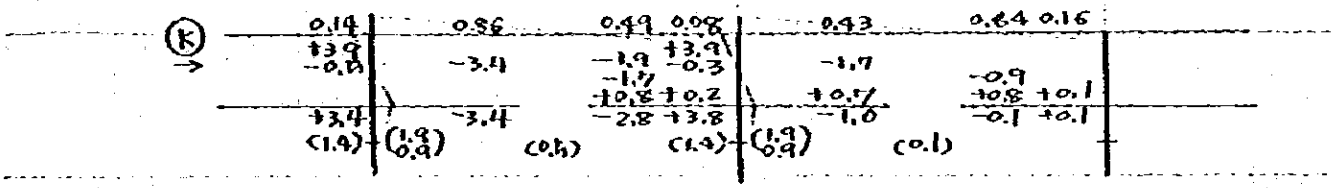
$$= \frac{5 \times 0.01631 \times 1895^4}{384 \times 2{,}100 \times 201{,}000} - \frac{(365 + 310) \times 1895^2}{16 \times 2{,}100 \times 201{,}000}$$

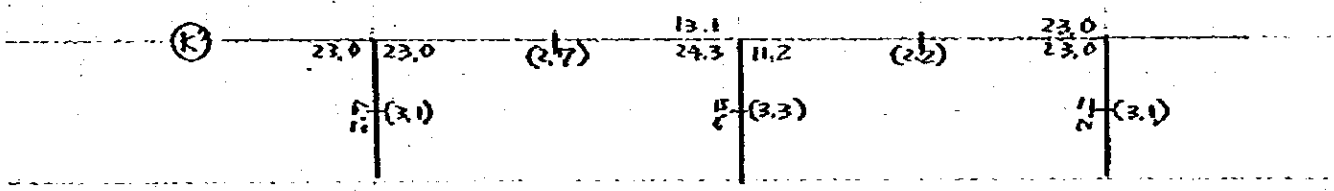
$$= 2.76 - 1.64$$

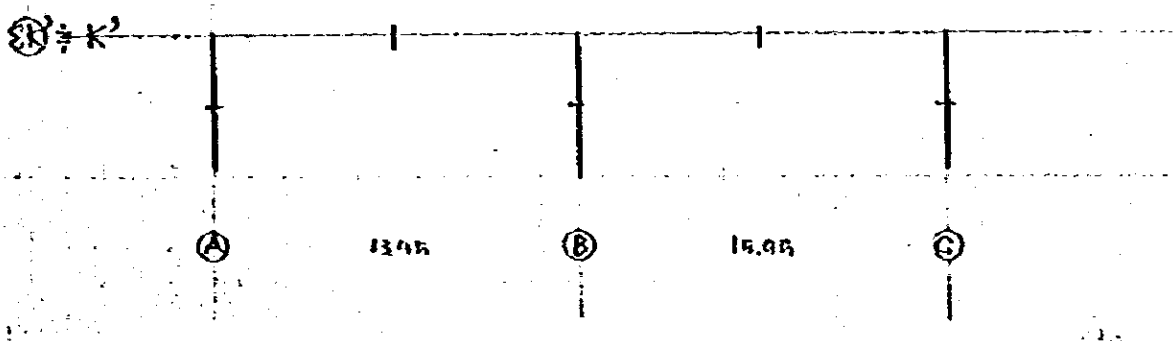
$$= 1.12 \quad < 2.00$$

$$\frac{\delta}{span} = \frac{1.12}{1895} = \frac{1}{1{,}388} < \frac{1}{300}$$

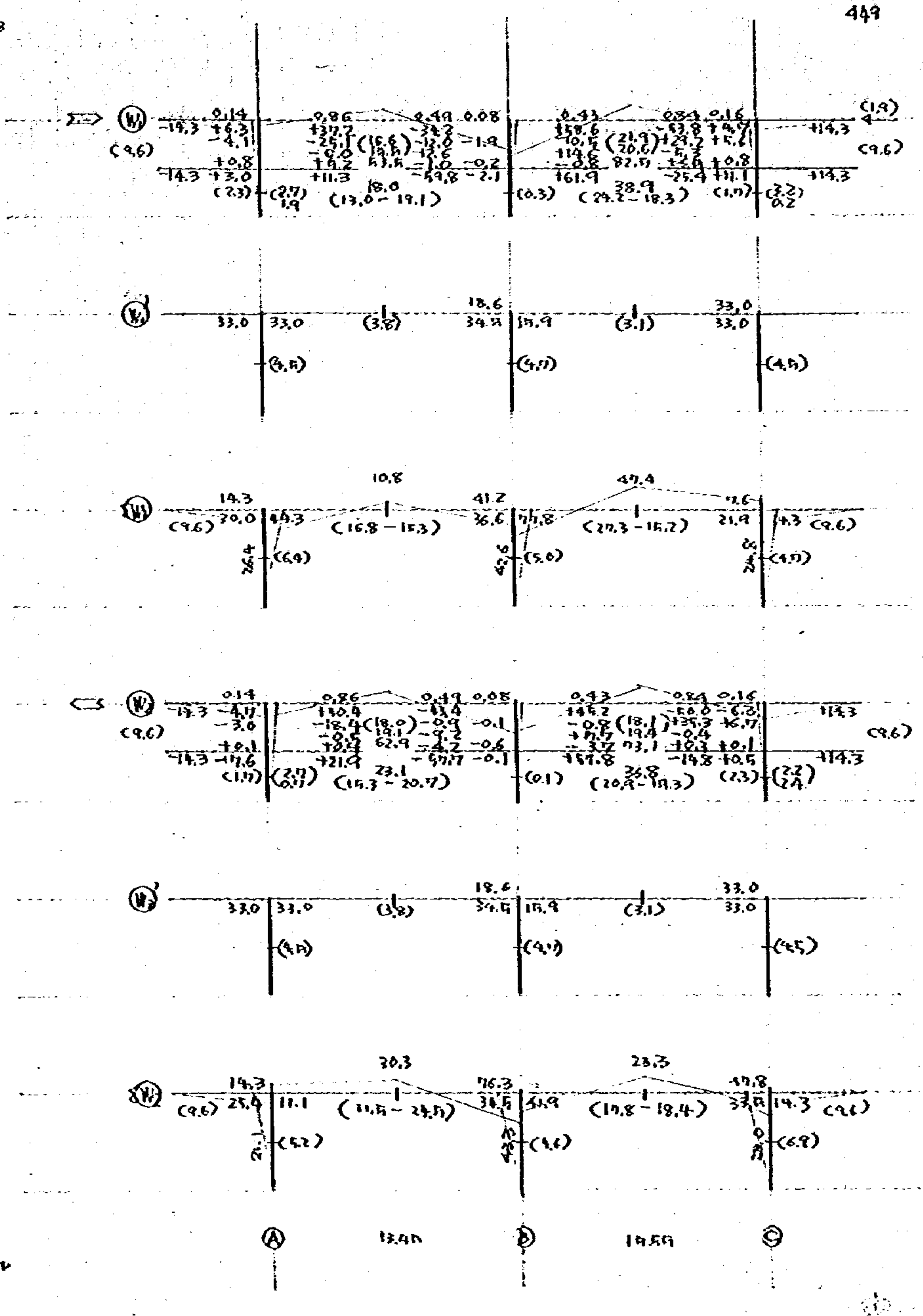
H-700×300×13×24 , J = 201,000 [cm⁴]



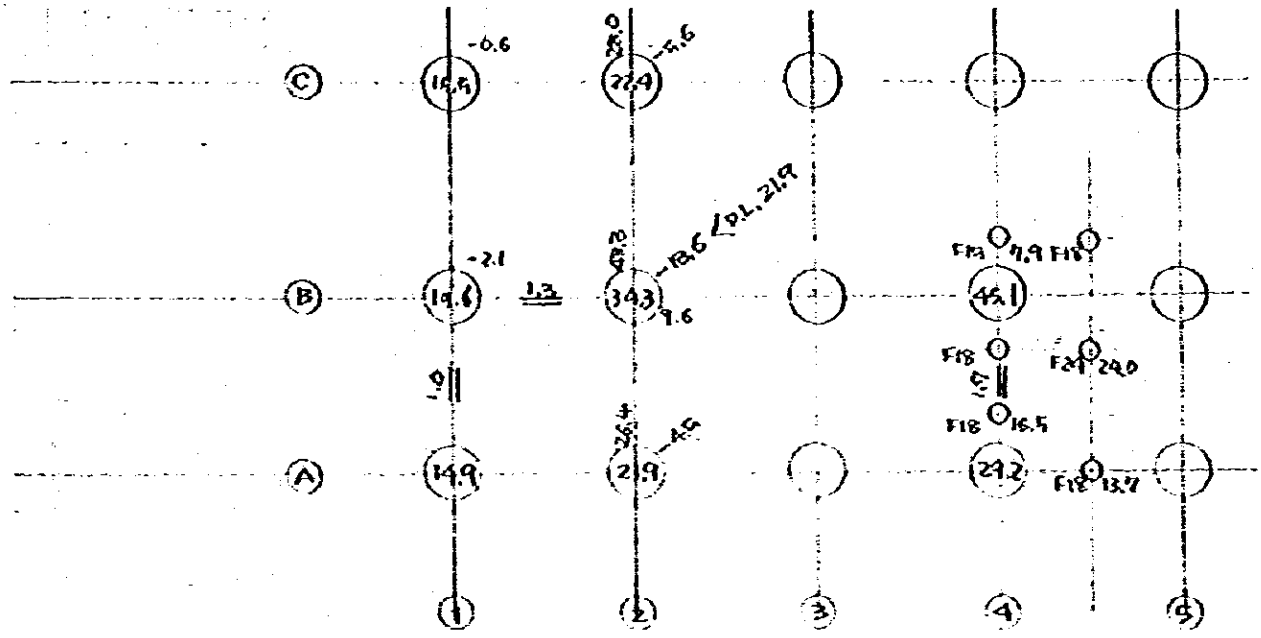




18



Footing



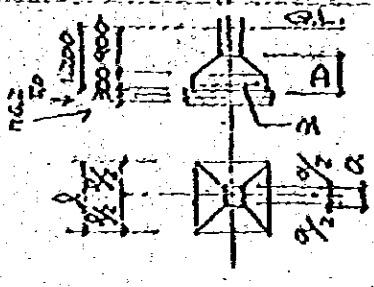
Independent Footing

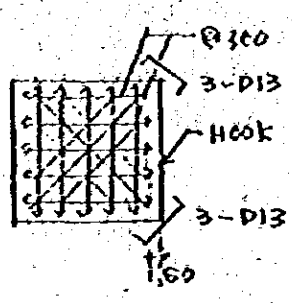
	N	fe	fea	An	ln	l	Type								-N	ΔN	-N ∨ ΔN
C1	15.5	8.4	5.4	2.87	1.69	1.8	F18										
C2	22.4			4.19	2.04	2.1	F21								-5.6	13.2	OK
B1	19.6			3.63	1.91	2.1	〃										
B2	34.3			6.35	2.52	2.7	F27								-9.0	21.8	OK
B4	45.1			8.36	2.89	3.0	F30										
A1	14.9			2.76	1.617	1.8	F18										
A2	21.9			4.06	2.02	2.1	F21								-4.5	13.2	OK
A4	29.2			5.41	2.33	2.4	F24										

Continuous Footing

Line	q	fe	fea	An	Bn	B	Type
1	1.0	6.2	3.2	0.32	0.32	0.35	FG1
B	1.3			0.41	0.41	0.45	FG2
4	1.5			0.54	0.54	0.55	FG3

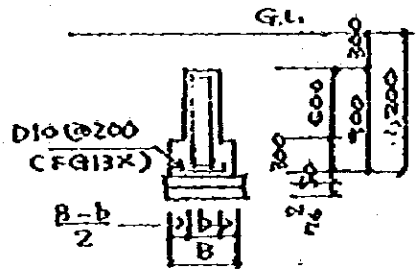
Design of Independent Footing





Type	ℓ	A	fca	Na	a	ℓ/a	N/Na	Q/N	M	a	D	j	at	Cp	2Dta	QA	n
F30	3.000	9.00	5.4	48.6	550	5.45	0.365	0.243	9.8	11.8	800	62.1	7.9	12.7	215	66.8	10-D13 @300
27	2.700	7.29	〃	39.4	〃	4.91	0.285	0.240	6.2	9.4	〃	〃	5.0	10.1	〃	〃	9-D13 〃
24	2.400	5.76	〃	31.1	〃	4.36	0.240	0.238	4.1	7.4	700	53.4	3.8	9.2	195	52.0	8-D13 〃
21	2.100	4.41	〃	23.8	〃	3.82	0.191	0.233	2.6	5.5	〃	〃	2.4	6.9	〃	〃	7-D13 〃
18	1.800	3.24	〃	17.5	〃	3.28	0.160	0.229	1.5	4.0	600	44.6	1.7	6.0	175	39.0	6-D13 〃
15	1.500	2.25	〃	12.2	〃	2.73	0.110	0.217	0.7	2.6	〃	〃	0.8	3.9	〃	〃	5-D13 〃

Design of Foundation Beam



Type	B	b		TOP R.	BTM R.	SIDE R.	Stp.	TIE
FG_{35}	350	350		2-D19	2-D19	2-D10	□D10 @200	⌐D10 @600
45	450	〃		〃	〃	〃	〃	〃
55	550	〃		〃	〃	〃	〃	〃

For Stress Between Piling Footing

w = (FG35) 1.26 + (Brick Wainscot) 0.6×2.9
= 3.0 [t/m]

Span 4.5 [m]

M_0 $3.0\times4.5^2/8$ 7.6 [tm] at 5.4 [cm²]) 2-D19
Q $\times4.5/2$ 6.8 [t] Φ 6.9 [cm])

b 35 D90 j 0.9 Q_{AL} 12.4 [t] > Q

w = 1.26 + (0.6×1.8) + (0.08×8.8) = 2.84

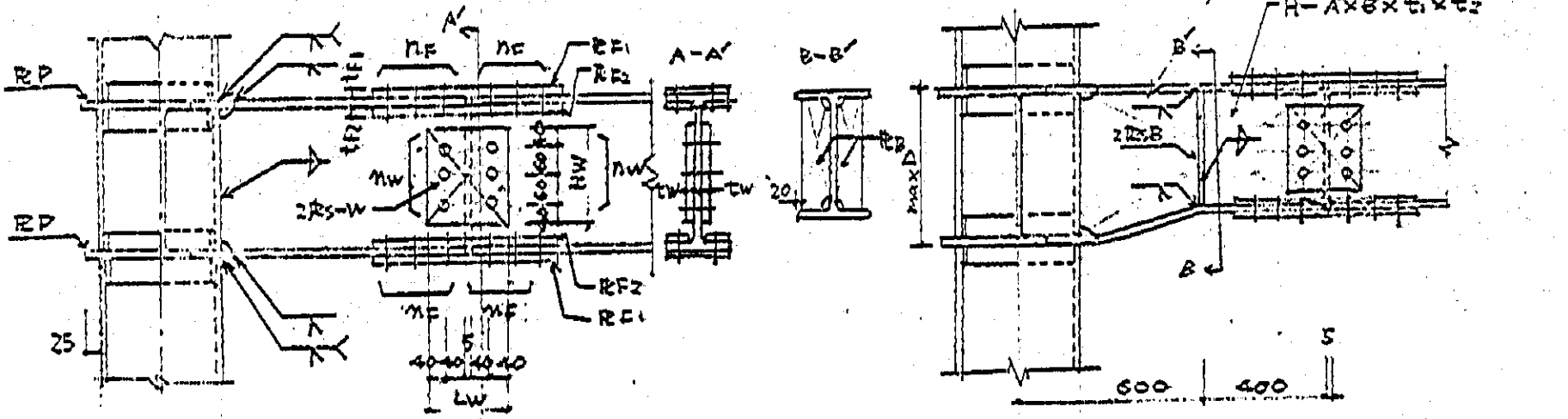
Span 5.3

M_0 $2.84\times5.3^2/8$ 10.0 at 7.0 ~ 3-D19
Q $\times5.3/2$ 7.5

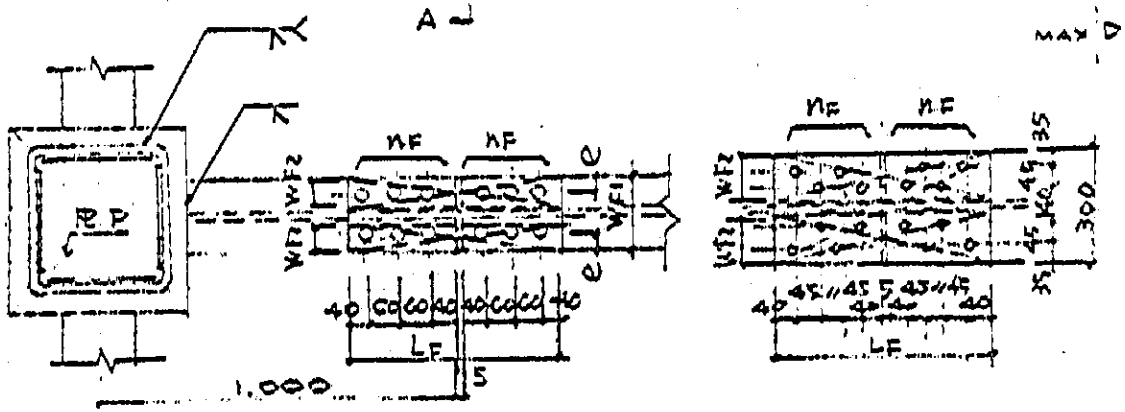
Design of Beam

			Stress V	K	W1	W2	1.5V	V+K	V+W1	V+W2	Max	Member	φb	Zb	λb	M	C	fb	Z	φZ	Type	Note
4	M	ⓒ	2.6	20.3	17.5	10.3	3.9	22.9			22.9	H 700×300×13×24									G7	
		CENT	4.4	4.5	10.3	9.5	6.6	8.9	5.9	5.1	8.9											
		Ⓑ	7.6	11.4	8.1	19.4	11.4	19.0	4.5	11.8	19.0											
	Q		3.3	2.4	-5.4	-6.6	5.0	5.7	1.9	3.7	5.7											
	M	○																				
		○																				
	Q																					
1	M	Ⓒ	9.1	23.0	7.6	47.8	13.7	13.9	16.7	38.7	38.7	H 700×300×13×24									G7	
		CENT	23.2	5.9	47.4	28.8	34.8	29.1	24.2	5.1	34.8											
		Ⓑ	30.9	11.2	77.3	41.9	53.4	25.7	40.9	5.0	53.4											
	Q		10.8 13.0	2.2	-15.2 -27.3	-18.4 -17.8	16.2 19.5	13.0 10.8	4.4 14.3	7.6 4.8	19.5											
	M	Ⓑ	35.8	13.1	41.2	76.3	53.7	48.9	5.4	40.5	53.7	H 700×300×13×24	336	7.87	42.7	7.62	1.00	1.60	7240	0.81	G7	
		CENT	12.6	5.0	10.8	30.3	18.9	17.6	1.4	17.7	18.9											
		Ⓐ	7.5	23.0	44.3	11.1	11.3	30.5	36.8	3.6	36.8											
	Q		12.3 8.1	2.7	-15.3 -10.8	-24.5 -11.5	18.5 12.2	15.0 10.8	3.0 8.7	12.2 3.4	18.5											

STEEL BEAM SCHEDULE



MAX D = MAXIMUM DEPTH OF BEAMS CONNECTING TO THE SAME COLUMN.



WF	e
150	30
175	30
200	35
250	45

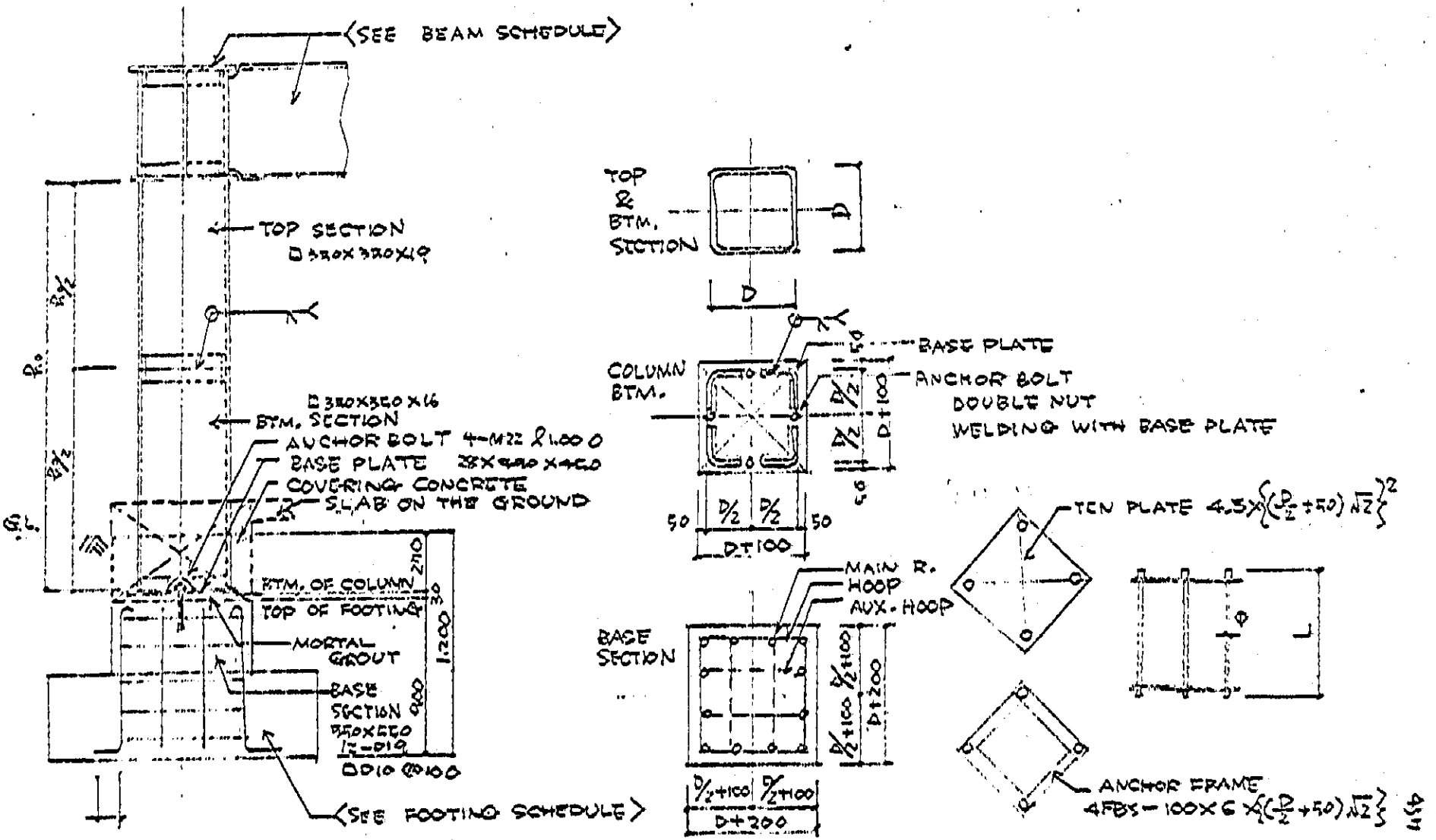
$$\tan\alpha \geq \sqrt{2}\,\frac{t_f}{2d}$$

MARK	MEMBER	RP	RB	RF1 $t_{f1} \times L_f \times W_{f1}$	RF2 $t_{f2} \times L_f \times W_{f2}$	nF	Rw $t_w \times L_w \times H_w$	nW	NOTE
G9	H900X300X16X28	28							
G8	H800X300X14X26	28	16	19 X300X615	22 X107X615	2X6-M22	12 X168X620	10-M22	
G7	H700X300X13X24	25	16	19 X300X525	19 X107X525	2X5-M22	9 X168X560	9-M22	
G6	H588X300X12X20	22	16	16 X300X435	16 X107X435	2X4-M22	9 X168X440	7-M22	
G6A	H600X200X11X17	19	16	16 X200X400	16 X113X405	2X3-M22	9 X168X440	7-M22	
G5	H482X300X11X15	16	16						
G5A	H500X200X10X16	16	16	12X200X405	16 X113X405	2X3-M22	9 X168X380	6-M22	
G4	H390X300X10X16	16	16						
G4A	H400X200X8X13	16	16	9 X200X285	12X113X285	2X2-M22	9 X168X260	4-M22	

Design of Column

Joint	Dir.		V	K	W1	W2	1.5V	V+K	V+W1	V+W2	Max	Member	ℓk/ℓb	ik/ib	λk/λb	n	c	fc/fb	A/Z	σ/f	Type	Note
			Stress																			
B1	↔	N	19.6	2.4	-5.4	2.0	29.4	22.0	14.2	21.6	29.4											
		M U	2.6	20.3	-19.5	10.3	3.9	22.9	14.9	12.9	22.9			cf.	Chart							
		M L	0																			
		Q	0.4	2.8	-3.4	2.2	0.6	3.2	3.0	2.6	3.2											
	↕	N																				
		M U																				
		M L																				
		Q																			C19	
C4	↔	N	21.9	0.6	9.6	/	32.9	22.5	31.5	/	32.9											
		M U	0.5	22.8	17.5	/	0.8	23.3	18.0	/	23.3											
		M L	0																			
		Q	0.1	3.1	2.4	/	0.2	3.2	2.5	/	3.2											
	↕	N	21.9	2.2	-24.8	-28.0	32.9	24.1	46.7	-6.1	46.7											
		M U	4.1	23.0	21.9	-33.5	6.2	27.1	26.0	-29.4	26.0											
		M L																				
		Q	0.6	3.1	4.7	-6.9	0.9	3.7	5.3	-6.3	6.3										C19	
B4	↔	N	34.3	0.6	9.6	/	51.5	34.9	43.9	/	51.5											
		M U	0.5	22.8	17.5	/	0.8	23.3	18.0	/	23.3											
		M L	0																			
		Q	0.1	3.1	2.4	/	0.2	3.2	2.5	/	3.2											
	↕	N	34.3	0.5	-42.6	-43.3	51.5	34.8	-8.3	-9.0	51.5	□										
		M U	1.1	24.3	-36.6	-34.5	1.7	25.4	-35.5	-33.4	35.5	350×350×19										
		M L																				
		Q	0.1	3.3	-5.0	-4.6	0.2	3.4	-4.9	-4.5	4.9									OK	C19	
A4	↔	N	22.3	0.6	9.6	/	33.5	22.9	31.9	/	33.5											
		M U	0.5	22.8	17.5	/	0.8	23.3	18.0	/	23.3											
		M L	0																			
		Q	0.1	3.1	2.4	/	0.2	3.2	2.5	/	3.2											
	↕	N	22.3	2.9	-26.4	21.1	33.5	26.0	-4.1	43.4	43.4											
		M U	2.5	23.0	-30.0	25.4	3.8	25.5	-27.5	27.9	27.9											
		M L																				
		Q	0.3	3.1	-6.4	5.2	0.5	3.4	-6.1	5.5	6.1										C19	

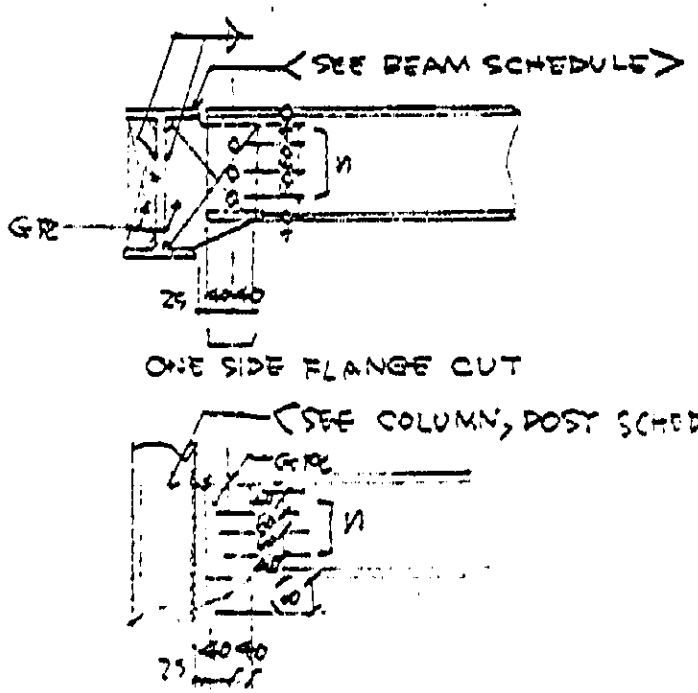
STEEL COLUMN SCHEDULE



Design of Sub Beam

h	l	@	ω D.L.	ω W.L.	ω T.L.	q	Mo	Q	In	Zn	Member	J	Z	lb	ib	λ	η	C	fb	σ/f	Type
9.0	3.25	3.725	0.02	0.8×0.18	0.124	0.462	0.61	0.75	285.0	25.4	H-200×100	1,840	184	325	2.60	125.0	6.49	1.00	1.10	0.20	B2
4.0	13.0	6.70 3.30	0.04	0.8×0.12		0.335 0.222	7.08 6.80	2.18 2.09	15,690 13,159	442.5 383.3	H-300×300	13,600 40,300	776 2,300	325	9.65	33.7	5.08	〃	1.60	0.50	B5
3.6	3.36		0.02	1.6×0.12	0.192	0.181	0.26	0.30	127.7	10.8	H-200×100										B2
7.0	13.0	2.25	0.02	1.6×0.16	0.236	0.531	11.22	3.49	21,700	465.7	H-400×200	23,700	1,190	650	5.26	123.6	8.09	1.75	1.20	0.52	B4
〃	〃	3.36	〃	0.8×0.16	0.108	0.363	7.67	2.26	14,835	319.6	〃										〃
3.6	6.5	2.25 3.50	0.51 0.08			1.492 (S.bk.)	7.83	4.82	8,201	489.2	H-350×175	13,600	779	325	7.58	170.9	8.33	1.75	1.60	0.63	B3A
〃	4.5				[illegible]	0.13	5.75	2.70	3,124	358.4	〃	〃									〃
〃	9.0				[illegible]	〃	23.00	7.82	44,039	1437.9	H-500×200	47,800	1,910	22.5	5.14	43.8	8.03	1.00	〃	0.75	B6
〃	3.25					1.482	1.46	2.41	946	127.5	H-200×100	1,840	184								B2

STEEL SUBBEAM SCHEDULE

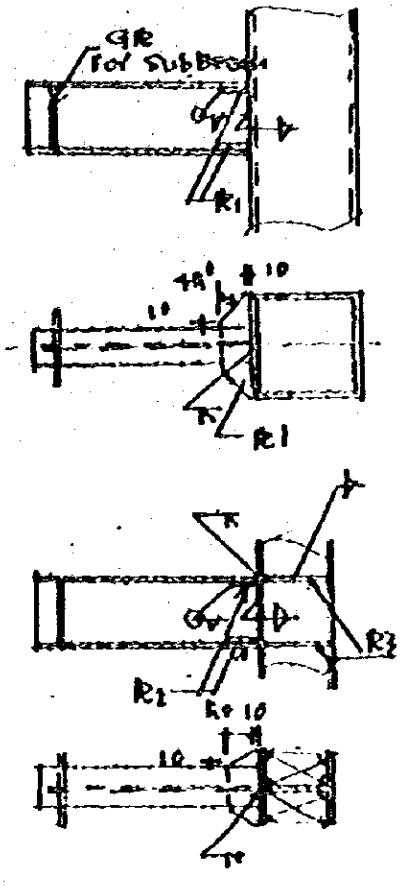


MARK	SECTION	GR	M
B4B	H=3[illegible]X300X10X16	12	5-M20
B4A	H=450X200X9X14	"	"
B4	H=400X200X8X13	"	4-M22
B3A	H=350X175X7X11	"	"
B3	H=300X150X6.5X9	"	3-M22
B2A	H=250X125X6X9	"	"
B2	H=200X100X5.5X8	"	2-M22
B9	H=900X300X16X3	19	12-M22
P C2	H=[illegible]X12X20	16	17-M22
B6	H=600X200X11X17	"	"
B5	H=[illegible]X200X10X16	12	6-M22
B3B	H=[illegible]X12X16	12	2X5-M22

Design of Cantilever

h	l	Q	w D.L.	w W.L.	w T.L.	P (S.L. 0.05)	M_0	Q	Jn	Zn	Member	J	Z	lb	ib	λb	η	C	fb	σ/f	Type
7.0	1.5	13.0	0.02	1.6×0.16	0.236	7.63	11.4	7.63	5812.5	475.0	H-400×200	23,700	1,190	150	5.18	29.0	8.32	1.75	1.60	0.40	CG4
			{0.236× 2.22×1.5²/2} − {0.05×11.4²}																		
2.6	1.5	2.36	0.02	1.6×0.12	0.192	0.61	0.92	0.61	2046	28.3	H-200×100	1,840	184	〃	2.60	57.7	6.09	〃	〃	0.21	CG2

SCHEDULE OF CANTILEVER

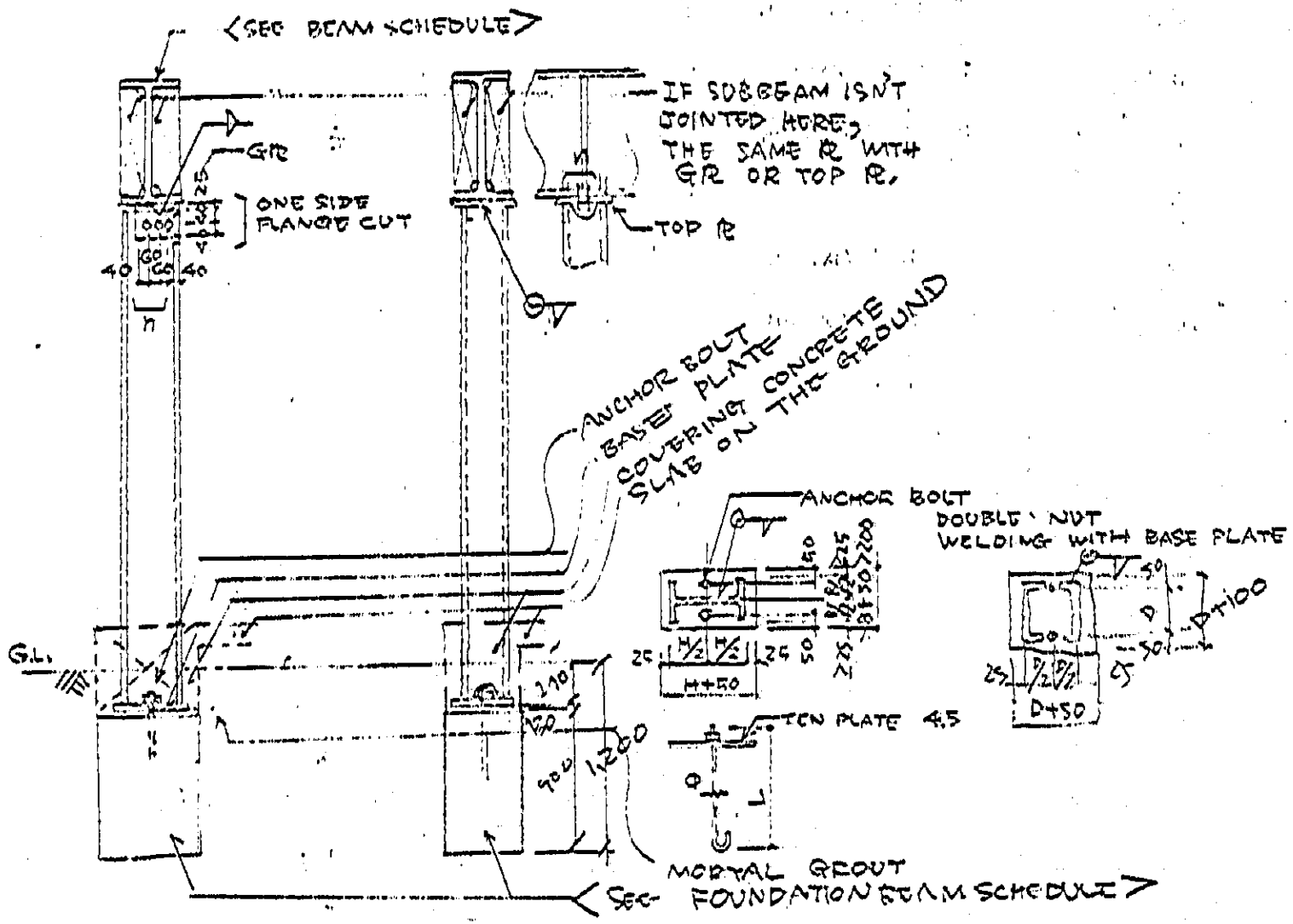


MARK	MEMBER	R1	R2	R3
CG4	H-400X200X8X13	R12	R12	R12
CG3A	H-350X175X7X11	"	"	"
CG3	H-300X150X6.5X9	R9	R9	R9
CG2	H-200X100X5.5X8	"	"	"

DESIGN OF POST

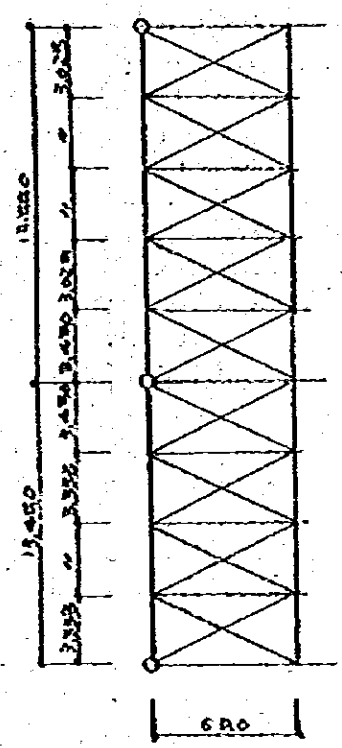
BTM	TOP	h	Ø	D.L. ω	D.L. q	N	W.L. ω	W.L. q	M_0	Q	Z_x	Z_y	Member	J	ℓ_x ℓ_b	i_x i_b	λ_x λ_b	η C	f_c f_b	A Z	σ/f	Type
7.3	9.6	2.3	3.25	0.05	0.16	0.34	0.8X0.18	0.47	0.26	0.49	81.0	10.8	H-100X100									P1
0.3	7.3	7.0	3.36	0.02	0.07	0.49	0.8X0.12	0.32	1.96	1.12	204.7	81.7	H-300X150	7.210	700 //	3.29 1.37	213 181	8.61 1.00	0.21 0.40	46.8 481	0.49	P3
//	//	//				13.7			//	//	//	//	//	//	350 //	// //	106 90	8.61 1.75	0.82 1.40	// //	0.43	//
0.3	7.3	7.0				24.0							□-200²×8	3.620	355	7.78	45.6		1.41	59.8	≤1.00	P20A
//	//	//				16.5							H-250X250		350	6.29	56.4		1.53	92.1	≤1.00	P25

STEEL POST SCHEDULE



MARK	SECTION	GR	n	BASE PLATE	ANCHOR BOLT Φ X L	NOTE
P1	H-400×400×6×8	R 9	2-M22	R 16 X 190X 200	2-M 20 X 900	
P2	H-200×100×5.5×8	DO	〃	R 〃 X 250 X 200	2-M 〃 X 〃	
P2A	H-250×125×6.5×9	DO	3-M22	R 〃 X 300 X 200	2-M 〃 X 〃	
P3	H-300×150×6.5×9	DO	〃	R 〃 X 350 X 200	2-M 〃 X 〃	
P3A	H-350×175×7×11	R 12	4-M22	R 〃 X 400 X 225	2-M 〃 X 〃	
P4	H-400×200×8×13	DO	〃	R 〃 X 450 X 250	2-M 〃 X 〃	
P4A	H-450×200×9×14	DO	5-M22	R 〃 X 500 X 250	2-M 〃 X 〃	
P2B	H-250×250×9×14	R 9	2×2-M22	R19 X 300×300	〃	
P20A	□-200×200×8	TOP R 16×300×300	〃	R 16 X 250×300	〃	
P27A	□-250×250×9	〃 19×300×350	〃	R 19×300×350	〃	

Design of Bracing



B 7.00

@ 3.39

C₁A $0.8 \times 0.12 \times 3.39 = 0.326$

Q $0.326 \times 7.0/2 = 1.14$

D $1.14 \times 7.36/6.50 = 1.29 \sim \times 2 = 2.58$ $A_n = 2.58/2.9 = 1.1$

$$J_n = \frac{13 \times 0.0002 \times 736^3 \times 300}{384 \times 2{,}100} = 385.6$$

$$z_n = \frac{3 \times 0.02 \times 736^2 \times 100}{8 \times 2.9} = 16.9$$

L-130×130×12

A 29.8, J 467.0, Z 49.9

$$J_n' = \frac{5 \times 0.0002 \times 368^3 \times 300}{384 \times 2{,}100} = 18.9$$

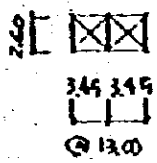
$$z_n' = \frac{0.02 \times 368^2 \times 100}{8 \times 2.9} = 1.4$$

L-75×75×6

A 8.7, J 46.1 Z 9.5

Monitor Roof

Vertical

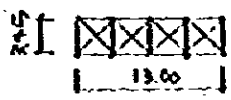


P $1.4 \times 0.18 \times 13.0 \times 2.6/2 = 4.26$

D $4.26 \times 4.32/3.48 \times 1/2 = 2.67$ $A_n = 2.67/2.4 = 1.11$

L-75×75×6

Horizontal

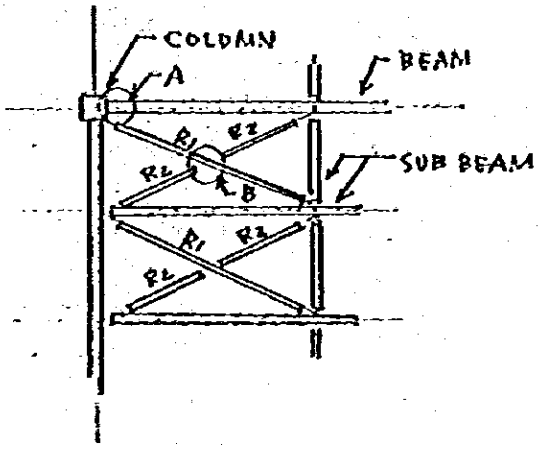


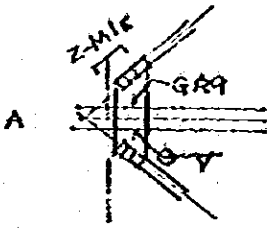
$$J_n = \frac{13 \times 0.0002 \times 474^3 \times 300}{384 \times 2{,}100} = 103.0$$

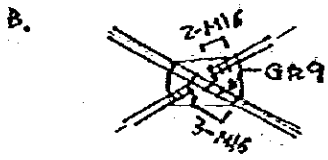
L-100×100×10

A 19.6, J 175.0, Z 24.4

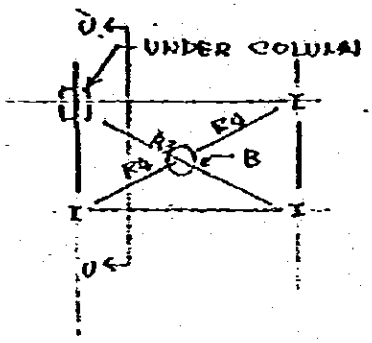
BRACING SCHEDULE

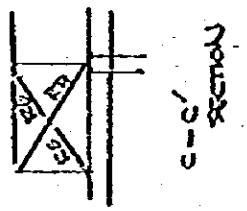






MONITOR ROOF





Mark	Member	Note
R_1	L-130×130×9	At. Paint & Body F. ~ L-130×130×12
2	L-75×75×6	
3	L-100×100×10	
4	L-75×75×6	
5	〃	
6	〃	

Design of Shell Type Roof

Bldg.	Roof level [m]	$q = 60\sqrt{h}$	C	Cq [kg/m²]
Heavy Repair Factory	10.5 ~ 13.0	194 ~ 216	1.6	310 ~ 346
Parts Storage	7.0 ~ 9.5	158 ~ 185	〃	253 ~ 296
Inspection Factory	〃		〃	
Periodical Repair F.	〃		〃	
Paint & Body Factory	〃		〃	
Retreading & M.C. F.	〃		〃	

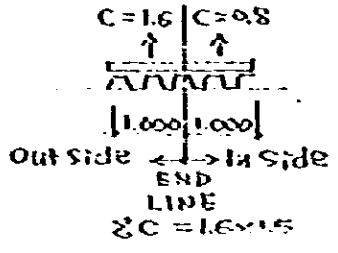
Continuous Beam Type

$$\frac{M}{Z} = \frac{\omega l^2}{8Z} \le f \quad \sim \quad l_2 \le \sqrt{\frac{8Zf}{\omega}}$$

$$\frac{5}{384}\frac{\omega l^4}{EI} \le \frac{l}{300} \quad \sim \quad l_1 \ge \sqrt[3]{\frac{384 \times 2{,}100\, I}{300 \times 5\, \omega}}$$

S-60 0.8 Mx1 Use Z 61.33 [cm³/m]
I 619.94 [cm⁴/m]
Self-ω 13.5 [kg/m²]

ω	Net ω	l_2	l_1	l_{min}
1.5 × 0.346 [t/m²]	0.00492 [t/cm²]	393.6 [cm]	407.6 [cm]	393.6 [cm]
× 0.310	0.00438	396.0	423.8	396.0
× 0.296	0.00417	405.9	430.7	405.9
× 0.253	0.00353	441.1	455.3	441.1



$$l_2 \le \sqrt{\frac{8 \times 61.33 \times 1.4}{\omega}} = \sqrt{\frac{686.896}{\omega}}$$

$$l_1 \le \sqrt[3]{\frac{384 \times 2{,}100 \times 619.94}{300 \times 5 \times \omega}} = \sqrt[3]{\frac{333{,}279.744}{\omega}}$$

Allowable Stress [Cm]

	M. Roof	Roof
H.R. Factory	390	390
Generally	400	440

Cantilever Type

$$\frac{M}{Z} = \frac{w\ell^2}{2Z} \le f \quad \sim \quad \ell_2 \le \sqrt{\frac{2Zf}{w}}$$

$$\frac{w\ell^4}{8EI} \le \frac{\ell}{250} \quad \sim \quad \ell_1 \le \sqrt[3]{\frac{8\times 2{,}100\, I}{250\, w}}$$

w	Net w	ℓ_2	ℓ_1	ℓ_{min}
0.348 [t/m]	0.00333 [t/cm]	196.7 [cm]	210.9 [cm]	196.7 [cm]
0.310	0.00297	208.2	219.1	208.2
0.296	0.00283	213.3	222.7	213.3
0.243	0.00240	231.7	235.2	231.7

$$\ell_2 \le \sqrt{\frac{2\times 61.33\times 0.75^{*}\times 1.4}{w}} = \sqrt{\frac{128.793}{w}}$$

$$\ell_1 \le \sqrt[3]{\frac{8\times 2{,}100\times 619.94\times 0.75^{*}}{250\, w}} = \sqrt[3]{\frac{31{,}244.976}{w}}$$

$\sim$

Allowable Span = 190 [cm]

Designed Type

0.8 ⟶ Size up to 1.0 M

Design of Mezzanine Floor

$w_1 = 0.81$ [t/m²]

U - 1.2 Deck Plate (AL-31) $Z = 35.5$ $I = 13.6$

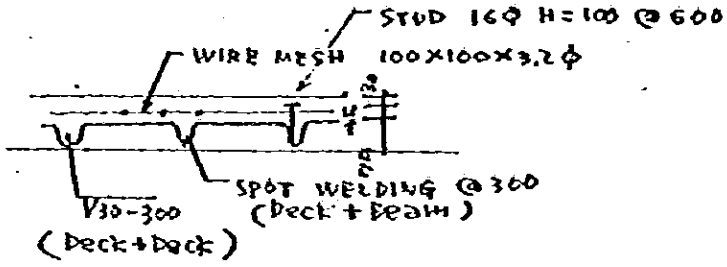
$$\frac{wl^2}{8Z} < f \sim l > \sqrt{\frac{8Zf}{w}}$$

$$= \sqrt{\frac{8 \times 35.5 \times 1.4}{0.0051}} = 279.2$$

$$\frac{5}{384}\frac{wl^4}{EI} < \frac{l}{350} \sim l > \sqrt[3]{\frac{384EI}{1500w}}$$

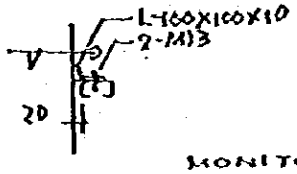
$$= \sqrt[3]{\frac{384 \times 2{,}100 \times 13.6}{1{,}500 \times 0.0051}} = 242.9$$

—— Allowable Span 240 [cm]



Design of Furring Strip

Outside Wall



MONITOR ROOF　C-120×60×20-4.5　@≒900
GENERAL　C-100×50×20-3.2　@≒900
OR -2.3　@≒700

MONITOR ROOF ～ GENERAL WALL

	Span	@	D.L.	W.L.
H.R.F.	3.68 ～ 3.95	0.9～0.7	50	220 ～ 140
P.S.	3.60 ～ 3.60	〃	〃	130 ～ 120
I.C.	/ ～ 3.33	〃	〃	/ ～ 120
P.R.F.	3.53 ～ 3.90	〃	〃	180 ～ 120
P.B.F.	3.45 ～ 3.25	〃	〃	180 ～ 120
R.M.C.F.	3.00 ～ 3.38	〃	〃	180 ～ 120

CASE-1. CH.R.F. MONITOR ROOF)

D.L. 0.05×0.9 = 0.045 [t/m]
W.L. 0.22×0.8×0.9 = 0.158 [〃]
Span 3.68 [m]

C-100×50×20-2.3

$$\frac{\delta}{f} = \frac{3.68^2 \times 100}{8 \times 1.4}\left(\frac{0.045}{6.06} + \frac{0.158}{16.1}\right)$$

$$= 2.08 < 2.10$$

$$\delta = \frac{5 \times 368^4}{384 \times 2100}\sqrt{\left(\frac{0.00045}{19.8}\right)^2 + \left(\frac{0.00158}{80.9}\right)^2}$$

$$= 3.49 \text{ [cm]}$$

C-100×50×20-3.2

$$\delta = \frac{5 \times 368^4}{384 \times 2100}\sqrt{\left(\frac{0.00045}{24.8}\right)^2 + \left(\frac{0.00158}{101}\right)^2}$$

$$= 2.67 \text{ [cm]}$$

C-100×50×20-4.5

$$\delta = \frac{5 \times 368^4}{384 \times 2100}\sqrt{\left(\frac{0.00045}{30.9}\right)^2 + \left(\frac{0.00158}{139}\right)^2}$$

$$= 2.10 \text{ [cm]}$$

C-120×60×20-4.5

$$= \sqrt{\left(\frac{\quad}{53.0}\right)^2 + \left(\frac{\quad}{252.0}\right)^2}$$

$$= 1.13 \text{ [cm]}$$

$\delta/\text{span} = 1.13/368 = 1/324 < 1/300$ O.K.

CASE - 2. (H.R.F. MONITOR ROOF)

D.L. $0.09 \times 0.9 = 0.045$ [t/m]

W.L. $0.18 \times 0.8 \times 0.9 = 0.130$ ["]

Span 3.60 [m]

$C = 100 \times 50 \times 20 - 3.2$

$$\delta = \frac{5 \times 360^4}{384 \times 2{,}100} \sqrt{\left(\frac{0.00045}{24.5}\right)^2 + \left(\frac{0.00168}{60}\right)^2}$$

$= 2.45$ [cm]

$C = 100 \times 50 \times 20 - 4.5$

$$\delta = \sqrt{\left(\frac{\quad}{30.9}\right)^2 + \left(\frac{\quad}{139}\right)^2}$$

$= 1.92$ [cm]

$C = 120 \times 60 \times 25 - 4.5$

$$\delta = \sqrt{\left(\frac{\quad}{58.0}\right)^2 + \left(\frac{\quad}{262.0}\right)^2}$$

$= 1.03$ [cm]

$\delta/\text{span} = 1.03/360 = 1/346 < 1/300$ O.K.

CASE - 3. (H.R.F. GENERAL WALL)

D.L. $0.05 \times 0.9 = 0.045$ [t/m]

W.L. $0.14 \times 0.8 \times 0.9 = 0.101$ ["]

Span 3.55 m

$C = 100 \times 80 \times 20 - 2.3$

$$\delta = \frac{1 \times 385^4}{185 \times 2{,}100} \sqrt{\left(\frac{0.00045}{19.0}\right)^2 + \left(\frac{0.00101}{80.7}\right)^2}$$

$= 1.51$ [cm]

$C = 100 \times 50 \times 20 - 3.2$

$$\delta = \sqrt{\left(\frac{\quad}{24.5}\right)^2 + \left(\frac{\quad}{107}\right)^2}$$

$= 1.17$ [cm]

$\delta/\text{span} = 1.17/385 = 1/330 < 1/300$ O.K.

CASE - 4. (")

D.L. $0.02 \times 0.7 = 0.014$ [t/m]

W.L. $0.14 \times 0.8 \times 0.7 = 0.078$ ["]

Span 3.85 m

$C = 100 \times 50 \times 20 - 2.3$

$$\delta = \frac{1 \times 385^4}{185 \times 2{,}100} \sqrt{\left(\frac{0.00014}{19.0}\right)^2 + \left(\frac{0.00078}{80.7}\right)^2}$$

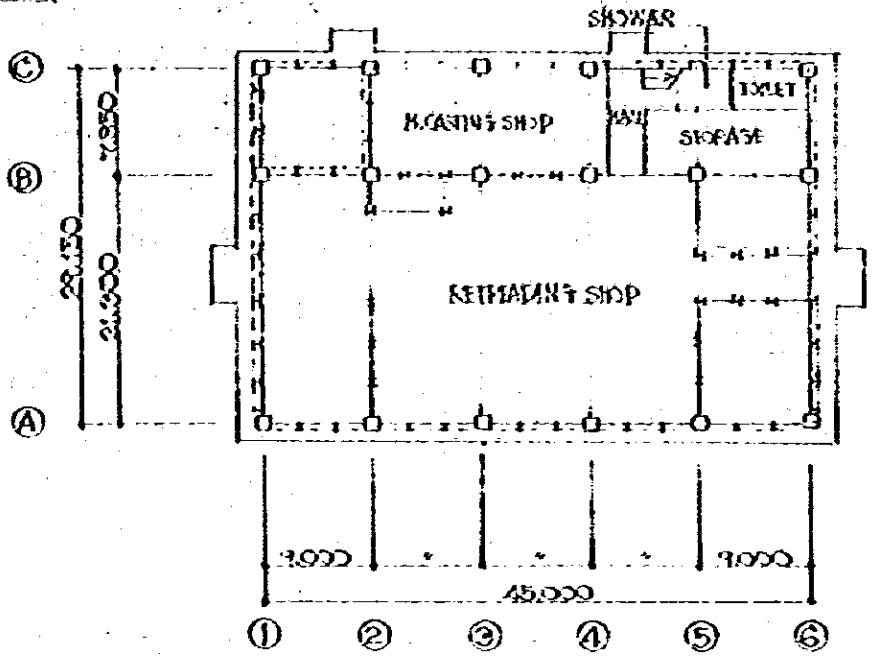
$= 0.69$ [cm]

$\delta/\text{span} = 0.69/385 = 1/560 < 1/300$ O.K.

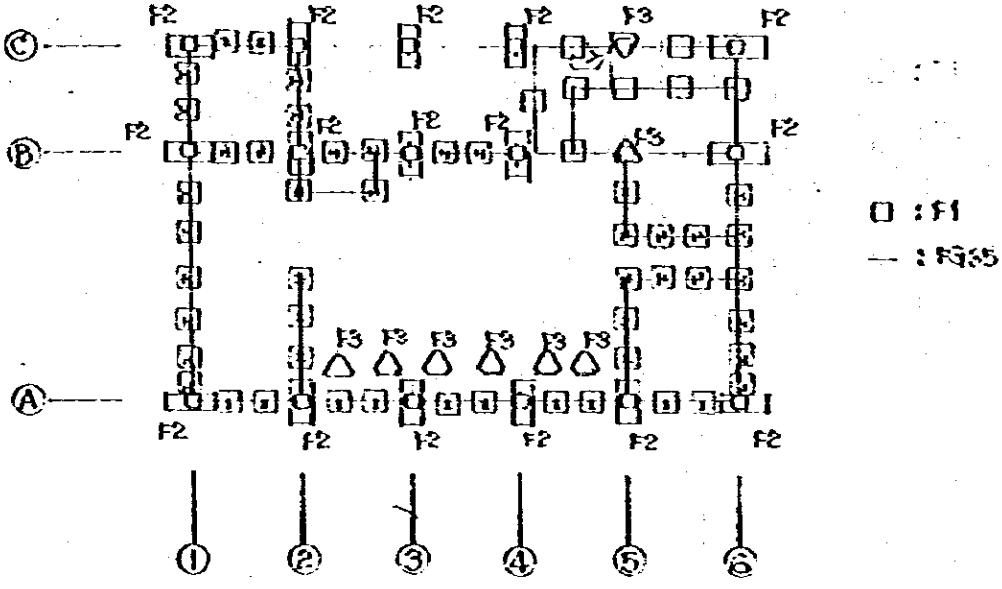
15　塗装，車体工場

RETREADING & METAL CASTING FACTORY

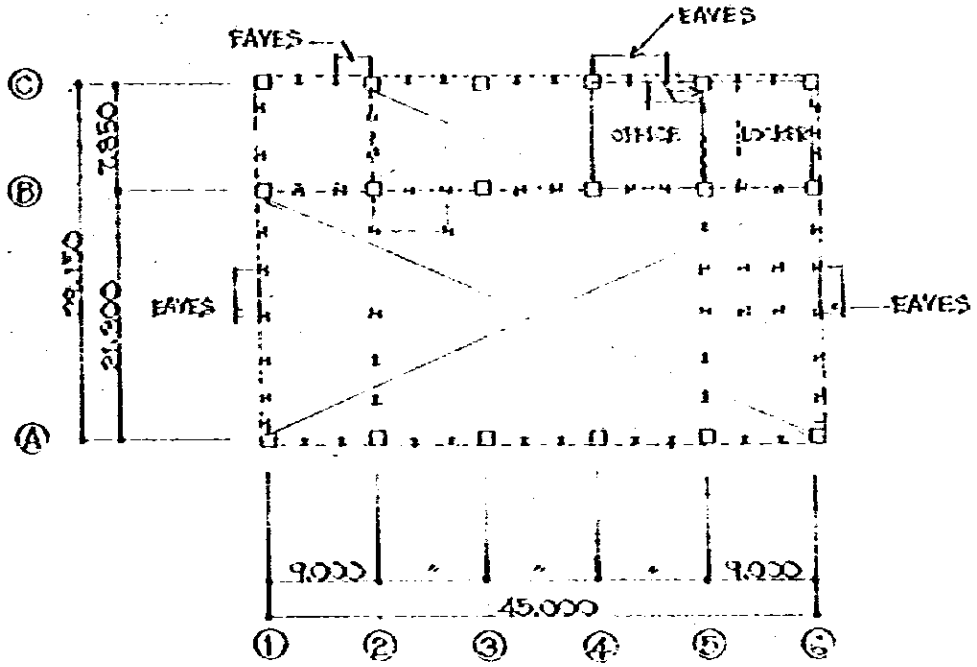
GF PLAN



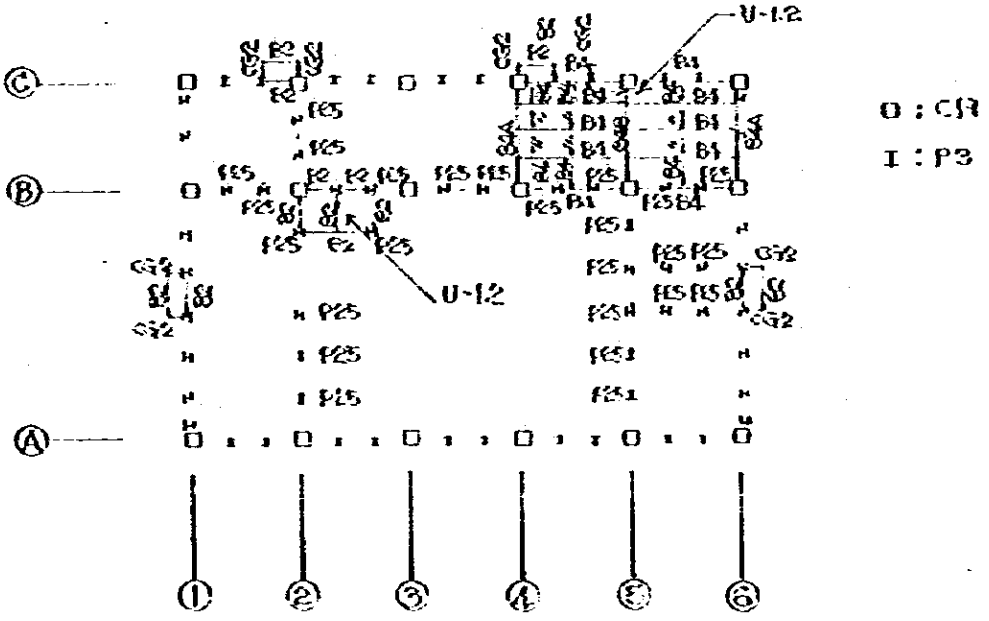
GF KEY PLAN



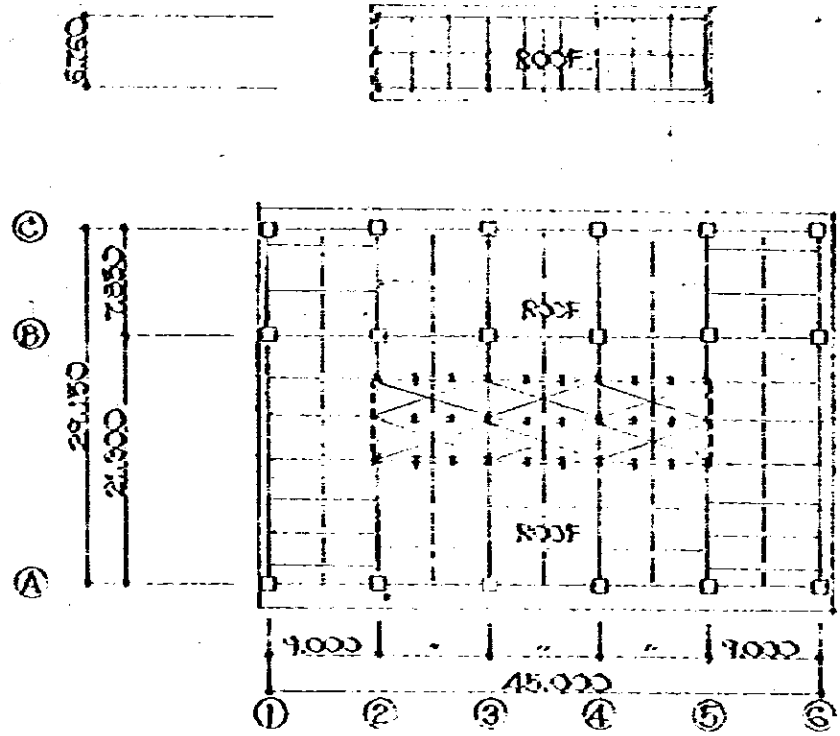
1F PLAN



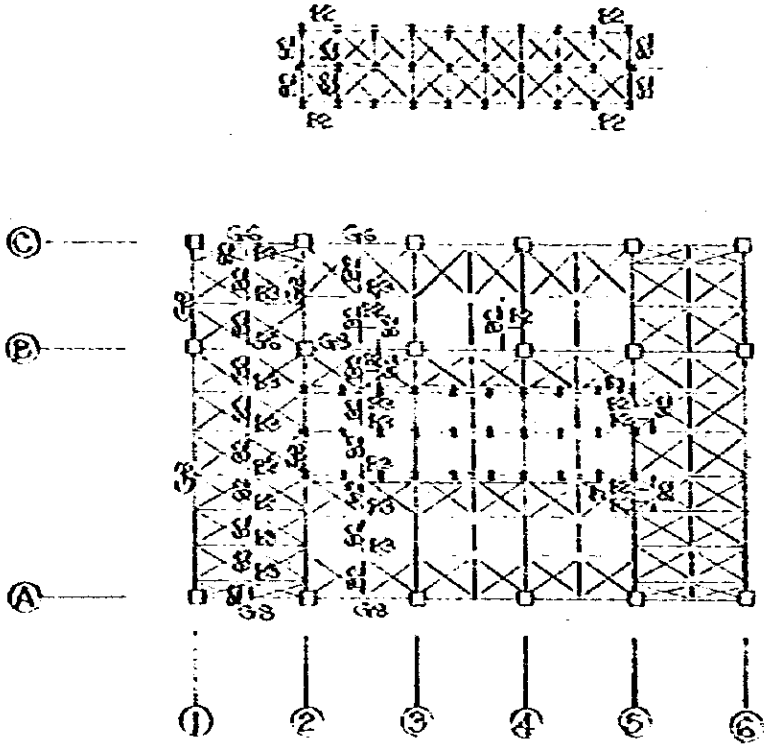
1F KEY PLAN



RF PLAN

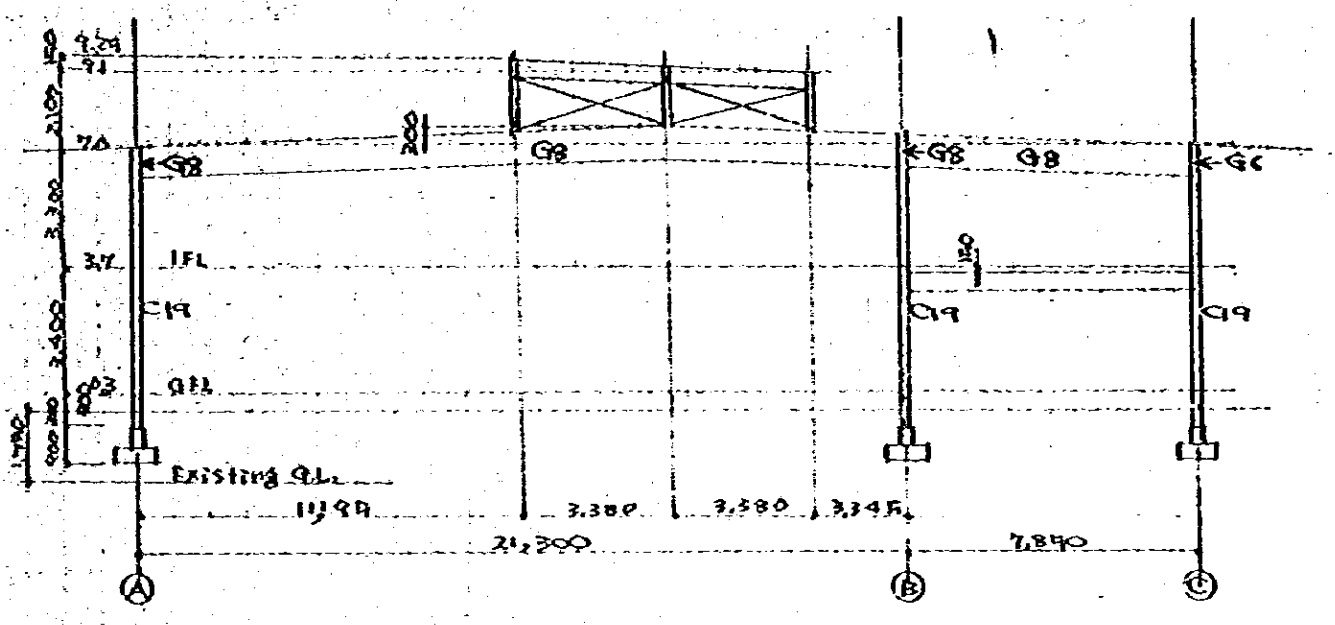


RF KEY PLAN



1 : P1

Retreading & Metal Casting Factory — Section



Unit Load

Floor

		D. L.		L. L.		T. L.
Roof		Shell type roof	0.02	S,B	0.09	0.11 (0.15)
				G,C,F	0.07	0.09 (0.13)
		Ceiling	(0.04)	K	0.03	0.05 (0.09)
			0.02 (0.06)			
Office Locker		Finish	0.13	S,B	0.30	0.31
		Deck	0.02	G,C,F	0.18	* 0.39
		Ceiling	0.04	K	0.08	0.29
			0.21			
						* With Above Ceiling 0.43
Stair case		Step	0.06	S,B	0.30	0.40
		String	0.04	G,C,F	0.13	0.28
				K	0.13	0.18
			0.10			

Beam

	t/m			t/each						
	Steleton	Finish	Σ	ℓ						
Beam G9	0.25	0	0.25							
$\overline{G9}$	0.15	0	0.15							
Subbeam	0.05	0	0.05							
Foundation Beam	1.26	0	1.26							

Column

	t/m			t/each						
	Steleton	Finish	Σ							
Column □ 400	0.20	0	0.25							
□ 350	0.13	0	0.15							
Post	0.04	0	0.05							

Wall

	t/m2			t/m						
	Steleton	Finish	Σ							
Siding	0.01	0.01	0.02							
Partition	0.01	0.07	0.08							
Sash	0.01	0.04	0.05							
Brick 11 / 24	0.49	0.11	0.60							

Wind Pressure

Velosity of Wind

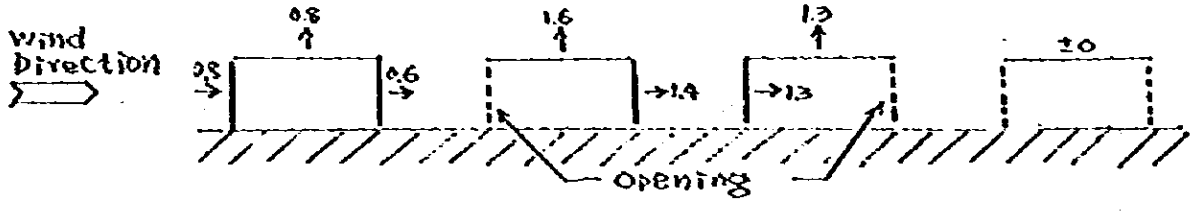
Cyclone 130 Miles/Hour = 130 × 1609.34/3,600
= 58.1 m/sec
→ 60.0 m/sec (h = 10 m)

(In 1970, At chitagon, recorded
103 m.p.h. = 46.0 m/sec)

Velosity Pressure $q = \frac{1}{2}\rho V^2 = \frac{1}{2} \times \frac{1}{8}\left(60\sqrt{\frac{h}{15}}\right)^2$
$= 60\sqrt{h}$

Block	Surface		[m] $\bar{h}$	$60\sqrt{\bar{h}}$	[kg/m²] q	[kg/m²] cq
Heavy Repair Factory	Monitor Roof	Roof Wall	12.7	214	220	
		Roof Wall	10.5, 6.9	194, 158	200, 160 140, 120	
Parts Storage	Monitor Roof	Roof Wall	9.9 – 9.29	184 – 183	180	
		Roof Wall	9.36 – 9.00	163	160 120	
Inspection Factory	Monitor Roof	Roof Wall				
		Roof Wall	9.20 – 9.10	161	160 120	
Periodical Repair Factory	Monitor Roof	Roof Wall	9.33 – 9.23	183	180	
		Roof Wall	9.23 – 9.00	161	160 120	
Paint & Body Factory	Monitor Roof	Roof Wall	9.41 – 9.31	184	180	
		Roof Wall	9.31 – 9.00	162	160 120	
Retreading & Metal Casting Factory	Monitor Roof	Roof Wall	9.35 – 9.30	184	180	
		Roof Wall	9.30 – 9.23	162	160 120	

Coefficient of Wind Pressure



Axial Force [t]

		C1		C2		C4		C5	
M_{RF}	S								
	G,B								
	C								
	W								
	Σ								
	W.L.								
	Σ'								
R_F	S	0.09 × 38.1	3.4	× 62.3	5.6	×		×	
	G,B	0.15 × 8.9	1.3	× 12.9	1.9	×		×	
	C	0.09 × 11.0	0.6	× 18.9	0.9	×	=C2	×	=C2
	FG	0.15 × 6.7	1.0	× 6.7	1.0	×	9.4	×	9.4
	W	1.26 × 2.0	2.5	× 4.2	5.3	× 80	11.3	× 8.0	11.3
		0.02 × 8	0	× 8	0	× 0	0	× 0	0
		0.08 × 0	0	× 8	0	× 13.0	1.6	× 13.0	1.0
		0.08 × 10.4	0.5	× 52.7	2.6	× 45.1	2.3	× 29.7	1.5
		0.60 × 3.0	1.8	× 6.4	3.8	× 13.1	7.9	× 26.1	15.7
	Σ		11.1		21.1		31.9		38.9
	W.L.	-0.20 × 38.1	-7.6	× 62.3	-12.5	× =C2	-12.5	× =C2	-12.5
	Σ'		3.6		8.6		19.4		26.4
1_F	S					0.43 × 17.7	7.6	× 35.3	15.2
	G,B					0.05 × 16.2	0.8	× 26.4	1.3
	C								
	W								
	Σ						40.3	8.4	55.4	16.5
	W.L.							0		0
	Σ'						27.8	8.4	42.9	16.5

		C6		B1		B2		B4	
M_{RF}	S					0.09 × 48.2	4.3	× 18.8	7.1
	G,B					0.05 × 23.6	1.2	× 40.5	2.0
	C					0.05 × 2.1	0.1	× 2.1	0.1
	W					0.02 × 0	0	× 0	0
						0.08 × 14.3	1.1	× 0	0
						0.05 × 18.9	0.9	× 37.8	1.9
	Σ						7.6		11.1	11.1
	W.L.					-0.21 × 48.2	-10.1	× 78.8	-16.5
	Σ'						-2.5		-5.4	-5.4
R_F	S	0.09 ×		× 80.2	7.2	× 102.8	9.1	× 65.4	5.9
	G,B	0.15 ×		× 19.1	2.9	× 23.6	3.5	×		
	C	0.05 ×	=C1	× 18.0	0.9	× 31.5	1.6	×	=B2	6.1
	FG	0.15 ×		× 6.7	1.0	× 6.7	1.0	×		
	W	1.26 ×	5.0	× 4.9	0.2	× 0	0	× 0	0	0
		0.02 ×	0	× 0	0	× 0	0	× 0	0	0
		0.08 ×	0	× 78	0.6	× 34.8	2.8	× 17.9	1.4
		0.05 ×	22.1	× 27.0	1.4	× 6.4	0.3	× 3.0	0.2
		0.60 ×	16.4	× 10.1	6.1	× 10.1	6.1	× 6.6	4.0
	Σ		23.5		26.3		32.0	24.4	28.7	17.6
	W.L.	-0.20 ×	38.1	-7.6	× 80.2	-16.0	× 102.8	-20.2	× 65.4	-13.1
	Σ'		15.9	15.9	9.7	9.7	1.7	4.2	-0.9	4.5
1_F	S	0.43 ×	17.7	7.6					0.43 × 17.7	7.6
	G,B	0.05 ×	15.2	0.8					0.05 × 15.2	0.8
	C									
	W									
	Σ		31.9	8.4					30.1	8.4
	W.L.			0						0
	Σ'		24.3	8.4					7.5	8.4

		BH		BG		A1		A2	
MRF	S	0.09 ×		×		× 29.1	6.8	× 122.9	11.1
	G,B	0.04 ×		×		× 16.2	2.3	× 19.7	3.0
	C	0.04 ×		×		× 19.5	1.0	× 31.5	1.9
	W	0.02 ×		×		× 6.7	1.0	× 6.7	1.0
		0.08 ×		×		× 3.7	4.7	× 3.0	3.8
		0.04 ×	=B2	×	=B1	× 0	0	× 0	0
	Σ		11.6						
	W.L.	-0.21 ×	=B2	×	=B1				
	Σ'		-2.5						
RF	S	0.09 ×		×		× 29.1	6.8	× 122.9	11.1
	G,B	0.18 ×		×		× 16.2	2.3	× 19.7	3.0
	C	0.04 ×	=B2	×	=B1	× 19.5	1.0	× 31.5	1.9
	FG	0.15 ×		×		× 6.7	1.0	× 6.7	1.0
	W	1.26 ×	3.0	×	4.9	× 3.7	4.7	× 3.0	3.8
		0.02 ×	0	×	0	× 0	0	× 0	0
		0.08 ×	48.7	×	20.0	× 0	0.4	× 0	0
		0.04 ×	0	×	12.7	× 14.2	1.0	× 15.6	0.8
		0.10 ×	8.7	×	9.5	× 5.6	3.4	× 4.5	2.7
	Σ		35.2		28.2		20.2		24.3
	W.L.	-0.20 ×	=B2	×	=B1	× 29.1	-15.0	× 122.9	-24.6
	Σ'		4.9		9.2		5.2		-0.3
TF	S	0.43 ×	38.3	×	17.9				
	G,B	0.04 ×	26.4	×	19.2				
	C								
	W								
	Σ		51.7		34.6				
	W.L.		0		0				
	Σ'		20.9		16.6				

		1P		2P		BP		C/B W	
MRF	S								
	G,B								
	C								
	W								
	Σ								
	W.L.								
	Σ'								
RF	S								
	G,B								
	C								
	FG								
	W								
	Σ								
	W.L.								
	Σ'								
TF	S								
	G,B								
	C	0.04 × 6.7	0.3	× 6.7	0.3	× 6.7	0.3	× 0	
	FG	1.26 × 3.4	4.3	× 3.9	4.9	× 3.0	3.8	× 1.0	1.3
	W	0.02 × 0		× 0		× 0		× 0	
		0.08 × 0		× 20.4	1.6	× 0		× 0	
		0.04 × 17.7	0.9	× 0		× 0		× 0	
		0.10 × 5.1	3.1	× 5.9	3.6	× 8.7	5.2	× 1.5	0.9
	Σ		8.6		10.3		9.3	[C/W] 2.2	2.2
	W.L.								
	Σ'								

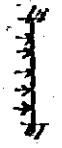
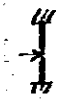
RC

CMoQ

[tm , t]

	Load			C		Mo		Q
↳ RG	9.0	(0.09×3.92)×1.2	q	0.535 × 9.0²/12	3.6	× 1/8	5.4	× 9.0/2	2.4
T.L.					3.6		5.4		2.4
〃	9.0	(1.6×0.18×1.6 −0.8×0.08×2.22 −0.07×3.92	q	−0.986 × 9.0²/12	−5.3	× 1/8	−8.0	× 9.0/2	−3.5
W.L.					−5.3		−8.0		−3.5
		5.0 × 1/6	P	0.83 × 6.9/8	0.7	× 1/4	1.4	× 1/2	0.4
↳ C	4.3			(0.1 × 1.5 | 1.1)				
K.L.					0.7		1.4		0.4
〃	4.3	(0.8~0.6×0.12 ×3.38)	q	0.324 × 6.9²/12 0.243	1.3 ~1.0	× 1/8	1.9 ~1.5	× 6.9/2	1.1 ~0.8
W.L.				(1.3 1.0 × 1.5 | 2.0 1.5) 1.3 1.0		1.9 1.5		1.1 0.8

(Ein, 4.3)

	Load			C		Mo		Q	
↑ RG	 21.0	(0.09×38.8) 0.05×9.0 $38.5 \times 5/21.0$	P	$0.917 \times 21.0^2/12$	33.7	$\times 1/8$	40.4	38.5×2.5	96
			g	$0.20 \times 21.0^2/12$	7.4	$\times 1/8$	11.0	$\times 21.0/2$	2.1
T.L.					41.1		61.6		11.7
↓	 21.0	$(-0.8 \times 0.16 - 0.07) \times 9.0$	g	$-1.152 \times 21.0^2/12$	-42.3	$\times 1/8$	-63.5	$\times 21.0/2$	-12.1
W.L.					-42.3		-63.5		-12.1
↑ RG	 9.85	$(0.09 \times 38.3$ $0.16 \times 9.0)$	P	$3.629 \times 9.85/8$	3.6	$\times 1/4$	7.1	$\times 1/2$	1.8
			g	$0.20 \times 9.85^2/12$	1.6	$\times 1/8$	1.5	$\times 9.85/2$	0.8
T.L.					4.6		8.6		2.6
↓	 9.85	$(-0.8 \times 0.16 - 0.07) \times 38.3$	P	$-6.894 \times 9.85/8$	-6.9	$\times 1/4$	-13.7	$\times 1/2$	-3.5
W.L.					-6.9		-13.7		-3.5
↑ C	 9.3	$5.0 \times 1/6$	P	$0.83 \times 6.9/8$	0.7	$\times 1/4$	1.4	$\times 1/2$	0.4
				$(0.7 \times 1.5$	1.1)				
F.L.					0.7		1.4		0.4
↓	 9.3	$(0.8 \times 0.6 \times 0.12) \times 2.94$	g	0.282 $0.212 \times 6.9/12$	1.1 0.8	$\times 1/8$	1.7 1.3	$\times 6.9/2$	1.0 0.7
				$(\frac{1.1}{0.8} \times 1.5$	1.7 $1.3)$				
W.L.					1.7 0.8		1.7 1.3		1.8 0.7

Seismic Force

[t]

			W	k	Kw	Q
MRF	S	0.05×29.5×8.96	12.0			
	B	0.05×{(29.0×3)+(6.96×7)}	6.4			
	P	0.05×2.25×18	2.0			
	W	(0.05×14.52×2.25)+(0.05×45.0×2.25)	8.8			
	Σ	w̄ = 29.2/(29.0×6.96) = 0.16 [t/m²]	29.2	0.10	2.9	3.0
RF	S	0.05×{(45.5×31.15)−(29.0×6.81)}	62.6			
	G	0.15×{(45.0×3)+(29.15×6)}	46.9			
	B	0.05×{(45.0×6)+(9.0×4)+(29.15×5)}	22.6			
	C	0.15×9.0×18/2	9.5			
	P	0.05×9.0×53/2	9.3			
	W	(0.05×58.3×3.5)+(0.05×90.0×3.3)+(0.05×10.33×3.5)	49.9			
	Σ	w̄ = 204.8/(83.0×29.15) = 0.16 [t/m²]	204.8	〃	20.5	24.0
1F	S	0.29×18.0×9.85	41.0		→ 1/2	↓ 29.0
	B	0.05×{(18.0×5)+(9.85×5)}	6.5			
	W	0.05×9.84×3.3	2.1			
	Σ	w̄ = 49.6/(18.0×9.85) = 0.35 [t/m²]	49.6	〃	5.0	

Wind Force

[t]

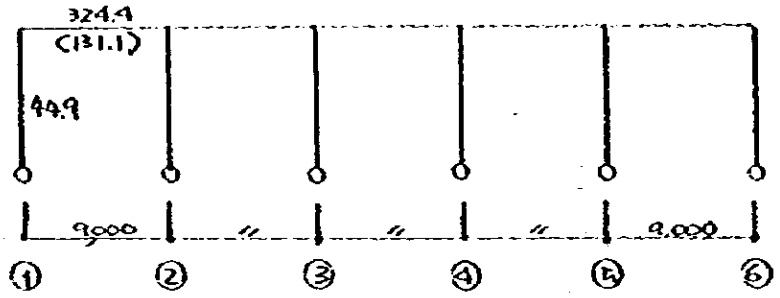
		C	q		A	H	Q	Note
↳	MRF	0.8+0.4	0.18	8.26×2.25	18.6	4.71	5.0	
	RF	〃	0.12	29.2×3.35	94.8	16.4	22.0	< K.L.
	1F							
↳	MRF	0.8+0.4	0.18	29.54×2.25	61.9	15.6	16.0	
	RF	〃	0.12	45.5×3.35	152.4	26.6	42.0	> K.L.
	1F							

Stiffness Ratio

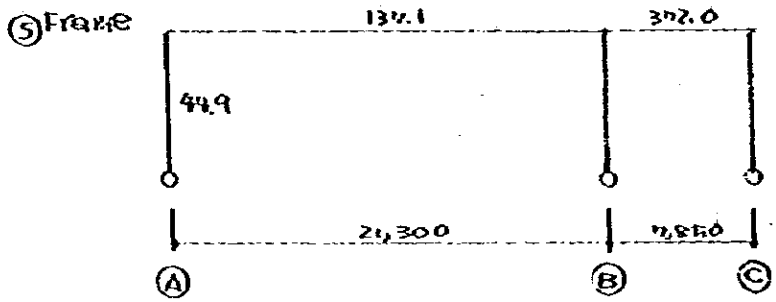
	J	ℓ/k	900	2130	185	k	630	
H - 810x308x14x26	242,000		324.4	137.1	372.0			
H - 488x300x11x18	118,000		131.1					
B - 350x350x19 ^16	46,900 ^39,300						59.9 (x0.75=44.9)	

$$Je = \mu J_{max} = 0.26 + 0.80\sqrt[3]{\left(\frac{35,300}{40,900}\right)^2} J_{max} = 0.93\ J_{max}$$

AB Frame (C)

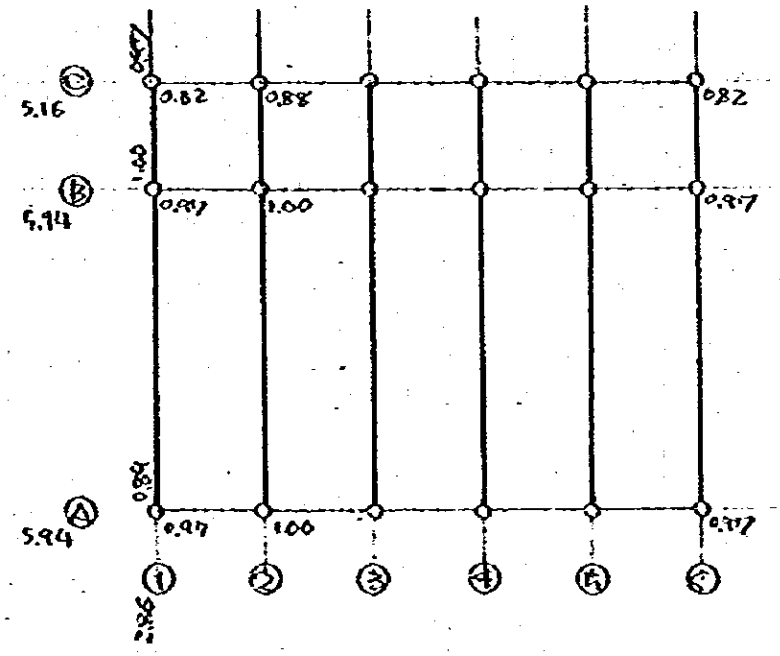


⑤ Frame



Distribution Factor & Inflection Point

	D										K.L.			W.L.		
	k_D	Σk_b	K	a	D	D'	y_0	y_1	$y_{2,3}$	Σy	h	Q	M_U	M_L	Q	M_U	M_L
↔	41.9	324.4	7.34	0.23	10.25	0.97	0			0	6.3	2.5	17.4	0	1.8	12.7	0
		(51.1)			(8.19)	(0.83)											
		488	14.68	0.24	10.69	1.00	0			0	〃	2.6	17.9	0	1.9	13.1	0
		(262.7)			(9.40)	(0.89)											
↕	449	139.1	3.10	0.22	9.52	0.89	0			0	〃	2.7	18.4	0	3.6	24.6	0
		169.1	16.04	0.24	10.72	1.00	0			0	〃	3.0	20.7	0	4.0	27.6	0
		372.0	8.42	0.24	10.43	0.97	0			0	〃	2.9	20.1	0	3.9	26.8	0



Unit Stress

Case / Dir.	K.L. Total Q	K.L. Total ΣD	K.L. Total Q/ΣD	K.L. Ⓑ/Ⓢ Frame Q	K.L. Ⓑ/Ⓢ Frame ΣD	K.L. Ⓑ/Ⓢ Frame Q/ΣD	W.L. Total Q	W.L. Total ΣD	W.L. Total Q/ΣD	W.L. Ⓑ/Ⓢ Frame Q	W.L. Ⓑ/Ⓢ Frame ΣD	W.L. Ⓑ/Ⓢ Frame Q/ΣD
↔	27.0	17.82	1.6	16.0	5.94	2.6	22.0	17.82	1.3	11.8	5.94	1.9
↕	〃	17.16	1.6	8.0	2.86	3.0	42.0	17.16	2.5	11.6	2.86	4.0

$(2.9/2)+(20.5/2)+2.5=14.2$
$(14.0/4)+(5.0/2)=4.3$

$(4.1+16.4)/2=10.6$
$(16.6/3)+(26.6/4)=10.3$

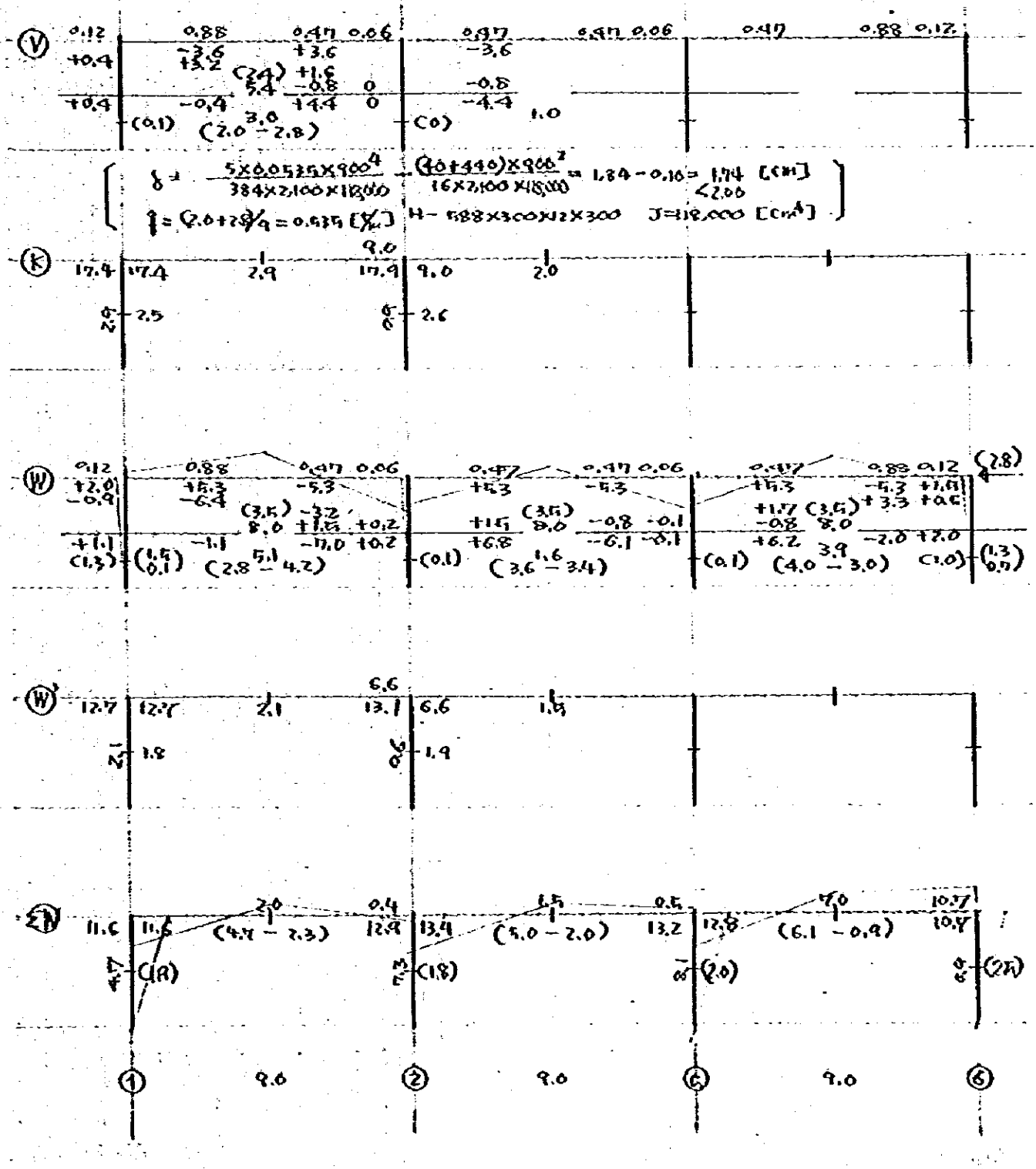
R

Deflection by Horizontal Force

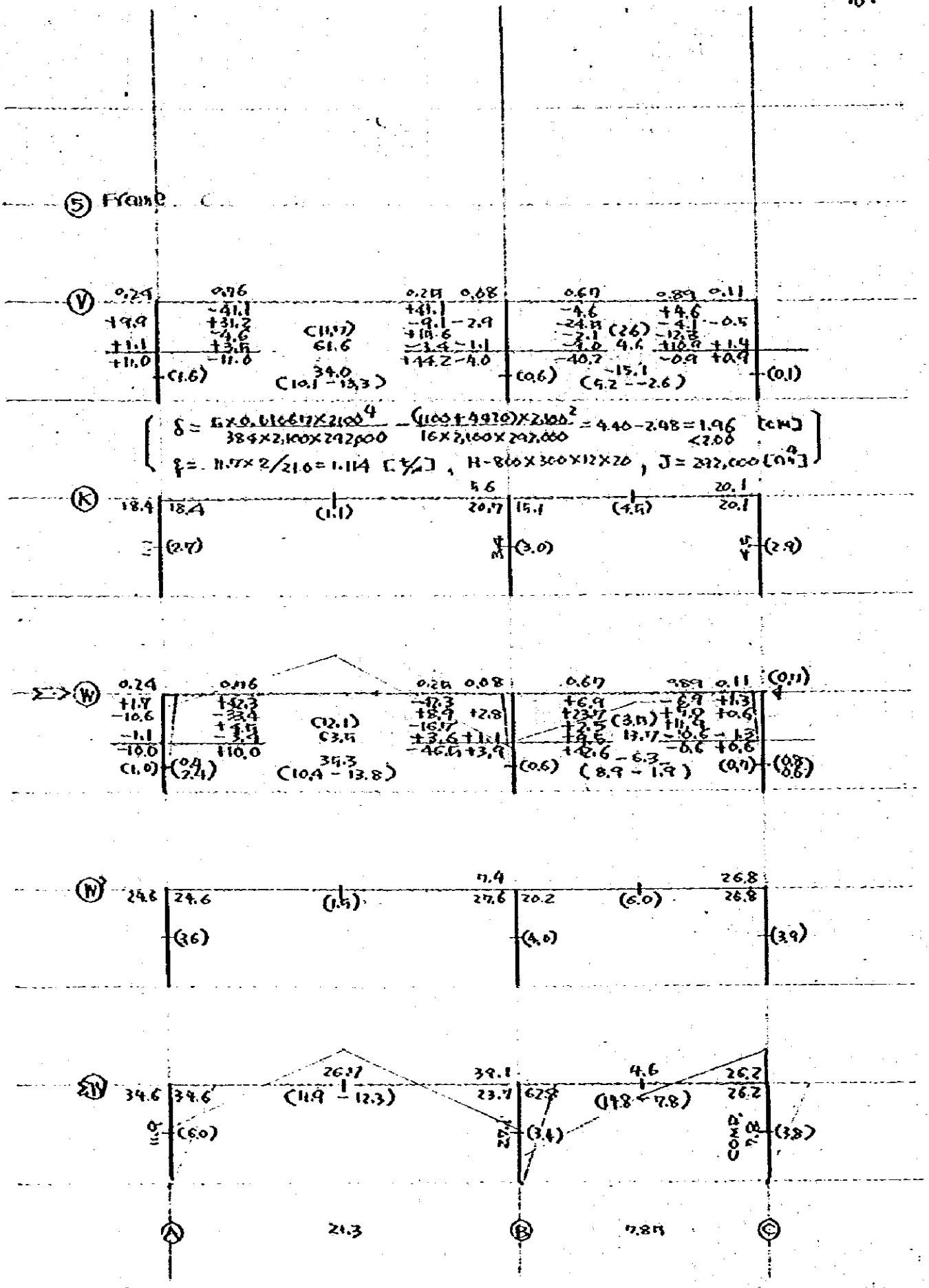
			Q	ΣD_{bo}	$h_o^2/12Eko$	δ	δ/h_o	
7	K.L.	Σ	21.0	11.04×10.69	$630^2/2\times2.100$	2.33	1/210	
	W.L.	Σ	22.0	〃	〃	1.96	1/331	
4	K.L.	Σ	21.6	17.16×10.12	〃	231	1/202	
	W.L.	Σ	42.6	〃	〃	3.60	1/175	

Stress

Ⓑ Frame

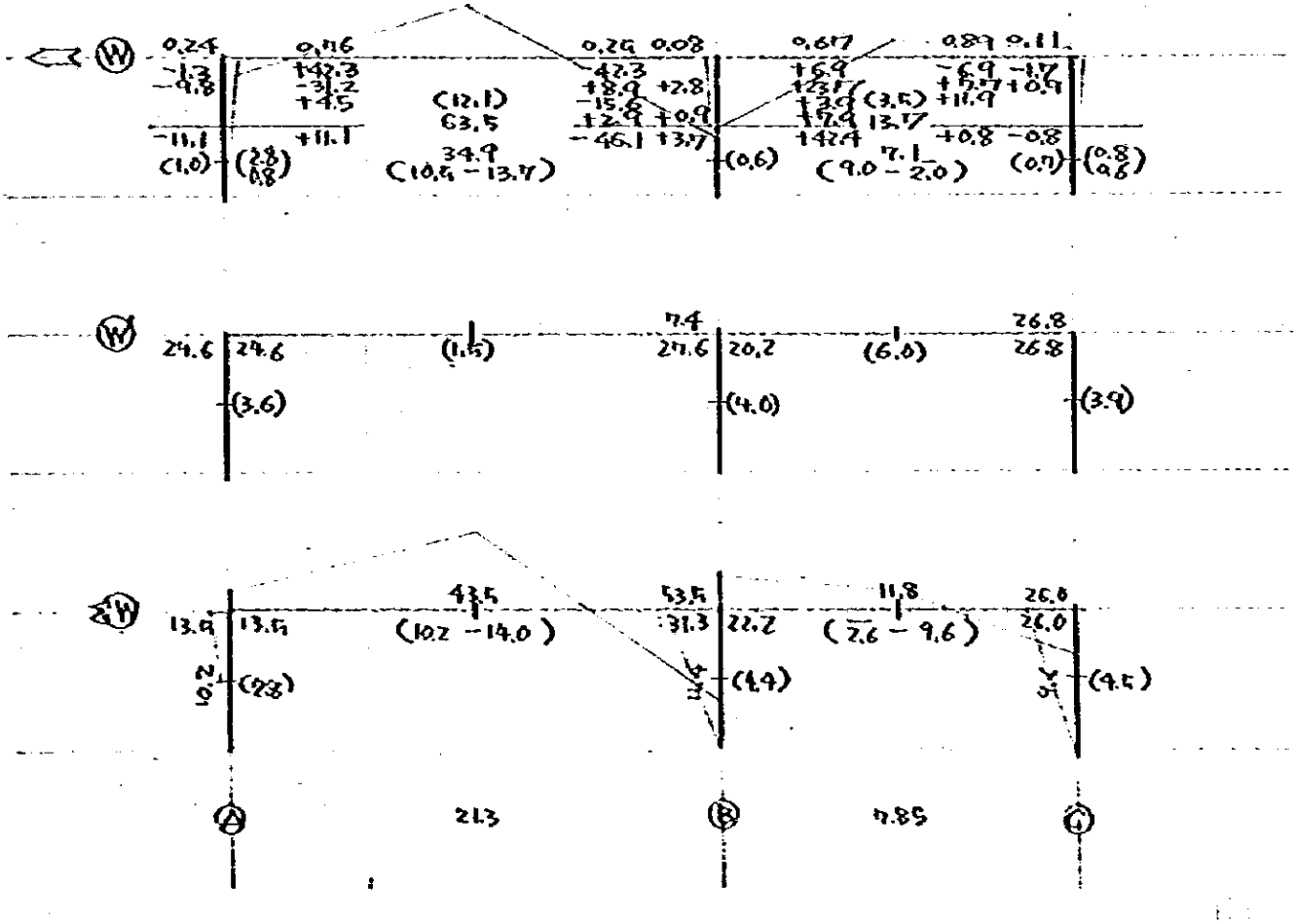


⑤ Frame

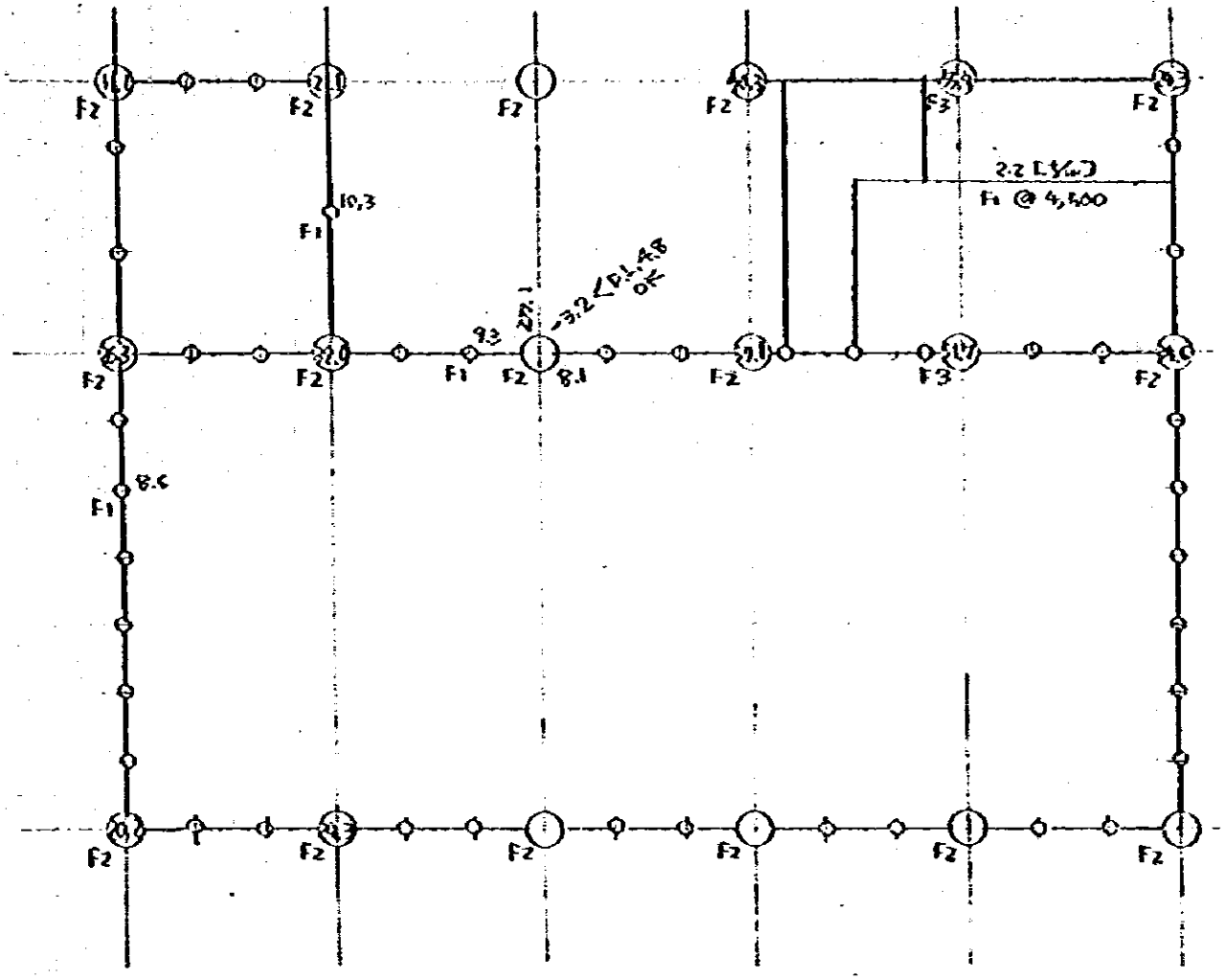


$$\left[\ \delta = \frac{5\times 0.016617\times 2100^4}{384\times 2{,}100\times 292{,}000} - \frac{(1100+4970)\times 2100^2}{16\times 2{,}100\times 292{,}000} = 4.40-2.98 = 1.96 \ [cm] < 2.00 \ \right]$$

$$\left[\ \frac{1}{r} = 11.77\times 2/21.6 = 1.114 \ [1/m] \ ,\ H\text{-}800\times 300\times 12\times 26 \ ,\ J = 292{,}000 \ [cm^4] \ \right]$$


Ⓦ
0.24
0.16
0.25
0.08
0.617
0.89
0.11
-1.3
-4.8
+42.3
-31.2
+4.5
-42.3
+8.9
+2.8
-15.6
+12.9
+0.9
-46.1
+13.7
+6.9
+23.1
+3.9
+17.4
13.7
-6.9
+5.7
-1.7
+0.5
+11.9
-11.1
+11.1
(12.1)
63.5
34.9
(10.5 - 13.7)
(1.0)
(2.8)
(0.8)
(0.6)
(3.5)
(9.0 - 2.0)
+0.8
-0.8
(0.7)
(0.8)
(0.8)
Ⓦ
24.6
24.6
(1.5)
27.4
27.6
20.2
(6.0)
26.8
26.8
(3.6)
(4.0)
(3.9)
Ⓦ
13.9
13.6
43.5
(10.2 - 14.0)
53.5
31.3
22.2
11.8
(7.6 - 9.6)
26.6
26.0
(9.8)
(4.4)
(4.5)
Ⓐ
21.3
Ⓑ
9.85
Ⓒ

Footing


F2
F2
F2
F2
F3
F2
10,3
F1
2-2 L½x3
F1 @ 4,500
9.3
F1
F2
8.1
F2
F3
F2
8.6
F1
F2
F2
F2
F2
F2
F2

Design of Piling Footing

$n \geq 2$ (R 100%)

PILE

Φ	L	R	ΔW	Re
300	12,000	25	$0.9^2 \times 1.5 \times 2.0 = 2.4$	22.6
350	〃	36	$1.05^2 \times$ 〃 $= 3.3$	26.7
400	〃	35	$1.2^2 \times$ 〃 $= 4.3$	30.7

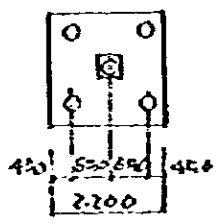
$n = 1$ (R 80%)

PILE

Φ	L	R	ΔW	Re
300	12.000	26	2.4	17.6
350	〃	24	3.3	20.7
400	〃	28	4.3	23.7

Φ = 300 type

F5



$Q_F = 22.6$ [t]

$M_F = 22.6 \times (0.65 - 0.275) = 8.5$ [tm]

2D+Q 1段 D 10 @ 543 [cm]

Qa 27.7 [cm] Q_{AL} 52.9 [t]

at 4.8 [cm²]

14-D13

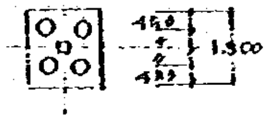
For Lift Up

$W = 2.2^2 \times 1.5 \times 2.0 = 14.5$ [t]

$(3.5^2 + 2.2^2)/2 \times 3.0 = 28.9$ [t]

Φ = 300 Type

F4



2D+a 149

Q_F = 22.6 [t]

M_F = 22.6 × (0.45 − 0.275) = 4.0 [tm]

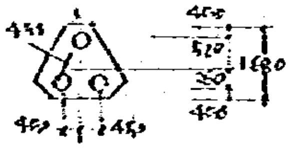
D 45 j 32.4 [cm]

q 46.5 Q_{AL} 23.5

at 0.6

12 − D13

F3



2D+a→8=90

Q_F = 22.6

M_F = 22.6 × (0.52 − 0.275) = 5.5

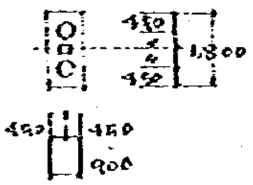
D 90 j 54.3

q 27.7 Q_{AL} 24.4

at 0.5

9 − D13

F2



B 90

Q_F = 22.6

M_F = 22.6 × (0.45 − 0.275) = 4.0

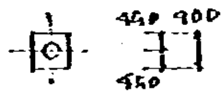
D 90 j 54.3

q 27.7 Q_{AL} 24.4

at 0.4

9 − D13

F1



D = 450

6 − D13

For
Lift Up

w = 1.5 × 2.0 = 3.0 t/m²　　D 45

F4　Q = 1.8² × 3.0/4 = 2.43　　q 5.0

M = 2.43 × 0.9 × 1/3 = 0.73　　at 0.5

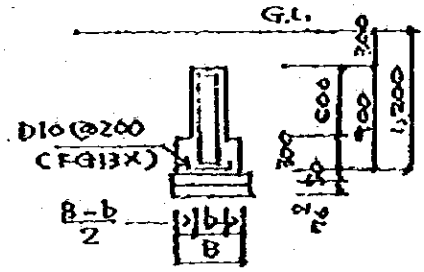
5 − D10

F2　Q = 2.43 = 2.43　　q 5.0

M = 2.43 × 0.45 = 1.09　　at 1.1

3 − D10

Design of Foundation Beam



Type	B	b		TOP R.	BTM R.	SIDE R.	Stirp.	TIE
FG_{35}	350	350		2-D19	2-D19	2-D16	□D10 @200	⊓D10 @600
45	450	〃		〃	〃	〃	〃	〃
55	550	〃		〃	〃	〃	〃	〃

For Stress Between Piling Footing

w_f = (FG35) 1.26 + (Brick Wainscot) 0.6×2.9
= 3.0 [t/m]

Span 4.5 [m]

Mo $3.0\times4.5^2/8$ 7.6 [tm] at 5.4 [cm²]) 2-D19
Q $\times4.5/2$ 6.8 [t] Qa 6.9 [cm])

b 35 D 90 j 0.9 QAL 12.4 [t] > Q

w_f = 1.26 + (0.6×1.5) + (0.08×2.9) = 2.84

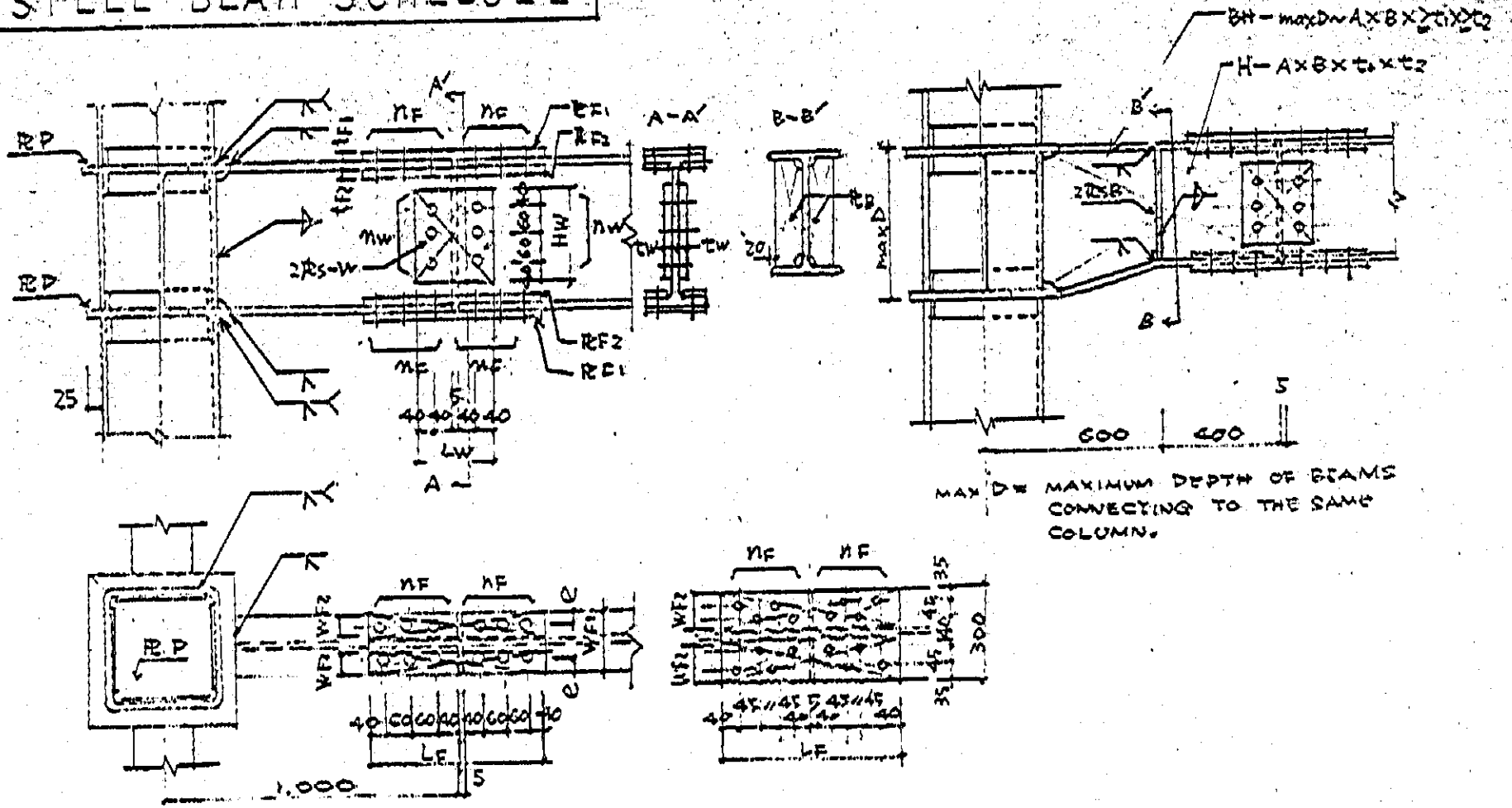
Span 5.3

Mo $2.84\times5.3^2/8$ 10.0 at 7.0 ∼ 3-D19
Q $\times5.3/2$ 7.5

Design of Beam

			V	K	W_1	W_2	1.5V	V+K	V+W_1	V+W_2	Max	Member	l_b	σ_b	λ_b	n	c	f_b	Z	σ/f	Type	Note
			Stress																			
4	M	ⓐ	0.4	17.4	14.6	10.7	0.6	17.8	11.2	11.1	17.8	H 588X300X12X20										
		CENT	3.0	4.2	2.0	7.0	4.5	7.2	5.0	4.0	7.2											
		ⓑ	4.4	9.0	0.4	12.8	6.6	13.4	4.0	8.4	13.4		450	787	57.2	7.71	1.00	1.60	4020	0.18	G6	
	Q		2.0 2.8	2.9	-4.7 -2.3	-0.9 -0.1	4.2	5.7	2.7	3.3	5.7											
	M	○										H 800X300X14X26										
		○																		//	G8	
	Q																			OK		
1	M	ⓐ	0.9	20.1	26.2	26.0	1.3	21.0	26.3	26.9	26.9	H 800X300X14X26										
		CENT.	15.1	2.5	4.6	11.8	22.7	17.6	10.5	26.9	26.9											
		ⓑ	40.2	15.1	62.8	22.2	60.3	55.3	22.6	62.4	62.4										G8	
	Q		-2.6 5.2	4.5	7.8 -14.8	-9.6 26	9.8	9.7	9.6	13.2	12.2											
	M	ⓑ	44.2	5.6	39.1	53.5	66.3	49.8	5.1	9.3	66.3	H 800X300X14X26										
		CENT.	34.0	6.4	26.7	43.5	51.0	40.4	7.3	10.5	51.0											
		ⓐ	11.0	18.4	34.6	13.5	16.5	29.4	23.6	24.5	29.4		338	780	43.3	9.00	1.00	1.60	7290	0.38	G8	
	Q		13.3 10.1	1.1	-12.3 -11.9	-14.0 -10.2	20.0	14.4	1.8	0.7	20.0											

STEEL BEAM SCHEDULE



MAX D = MAXIMUM DEPTH OF BEAMS CONNECTING TO THE SAME COLUMN.

WF	R
150	30
M6	30
200	35
250	45

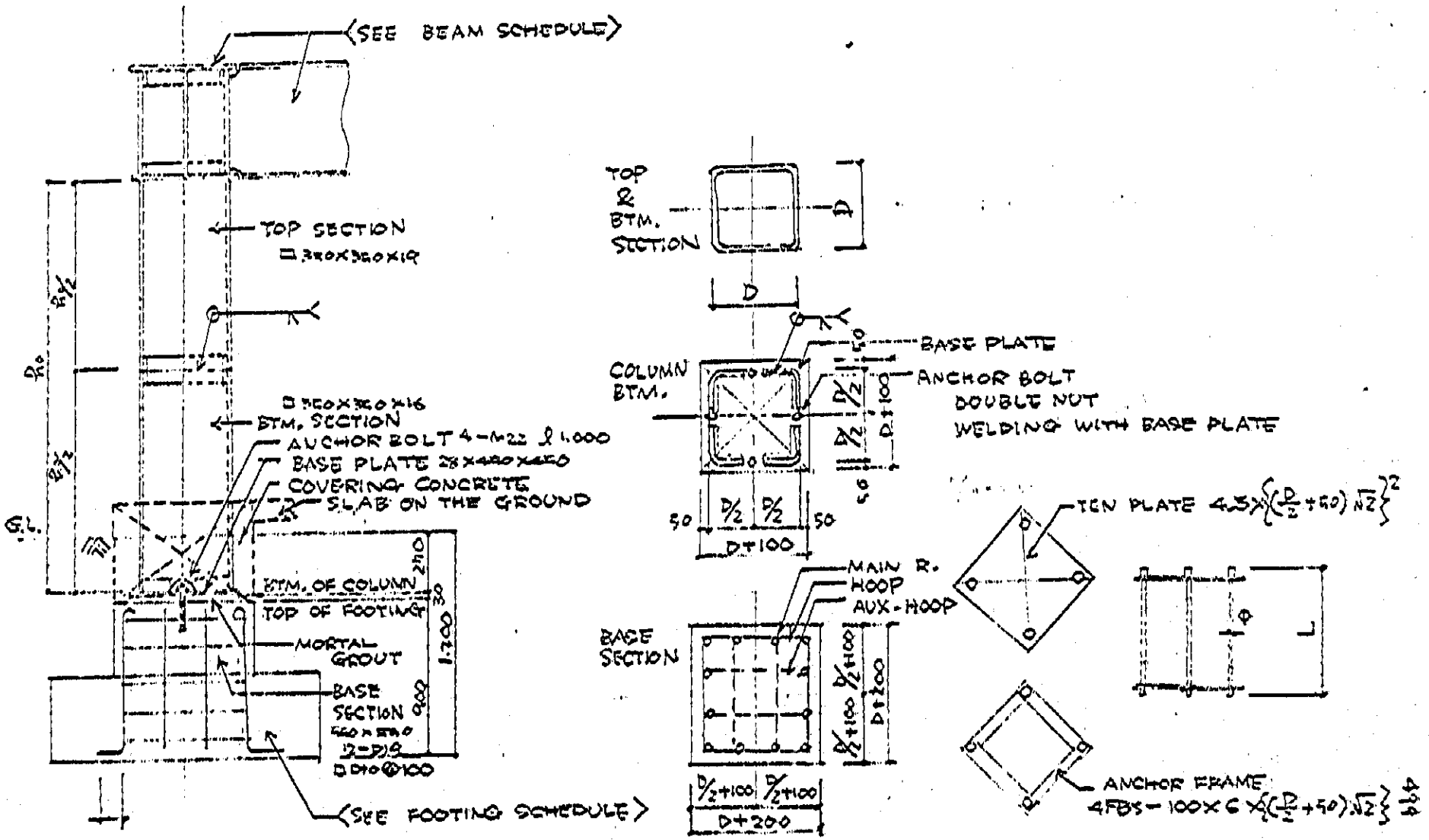
$$t_\alpha \geq \sqrt{3}\,\frac{t_F}{\ell_\alpha}$$

MARK	MEMBER	RP	RB	RF1 $t_{f1} \times L_F \times W_{F1}$	RF2 $t_{f2} \times L_F \times W_{F2}$	nF	Rw $t_w \times L_{ww} \times h_w$	nW	NOTE
G9	H 900×300×16×28	28							
G8	H 800×300×14×26	28	16	19 × 300 × 615	22 × 107 × 615	2×6-M22	12 × 165 × 620	10-M22	
G7	H 700×300×13×24	25	16	19 × 300 × 525	19 × 107 × 525	2×5-M22	9 × 165 × 560	9-M22	
G6	H 588×300×12×20	22	16	16 × 300 × 435	16 × 107 × 435	2×4-M22	9 × 165 × 440	7-M22	
G6A	H 600×200×11×17	19	16	16 × 200 × 405	16 × 73 × 405	2×3-M22	9 × 165 × 440	7-M22	
G5	H-482×300×11×15	16	16						
G5A	H 500×200×10×16	16	16	12 × 200 × 405	16 × 73 × 405	2×3-M22	9 × 165 × 380	6-M22	
G4	H 390×300×10×16	16	16						
G4A	H 400×200×8×13	16	16	9 × 200 × 285	12 × 73 × 285	2×2-M22	9 × 165 × 260	4-M22	

Design of Column

Axis			V	K	W_1	W_2	1.5V	V+K	V+W_1	V+W_2	Max	Member	σc/fb	τK/τb	λK/λb	n	C	fc/fb	A/Z	σ/f	Type
	—	N																			
		M U/L												Cf. Chart							
8		Q																			
	|	N																			
		M U/L																			
		Q																			
	←	N										□ 350x350x19 ~16									
		M U/L																			
C		Q																			
	↓	N	12.0	-4.5	7.8	-9.6	18.0	7.5	<u>19.8</u>	2.4	19.8										
		M U/L	0.9	20.1	-26.2	26.0	1.5	21.1	26.3	<u>26.9</u>	26.9										
		Q	0.1	0.1	-3.8	4.5	0.2	0.2	<u>3.7</u>	4.6	3.7									OK	C19
	←	N	24.9	0.9	8.1	/	<u>37.5</u>	25.8	33.0		37.5	□ 350x350x19 ~16									
		M U/L	0	17.9	13.2	/	0	<u>17.9</u>	13.2		17.9										
B		Q	0	2.6	2.0	/	0	<u>3.9</u>	2.0		3.9									OK	
	↓	N	24.9	-3.4	-27.1	-11.4	<u>37.5</u>	21.5	2.2	13.5	37.5										
		M U/L	4.0	20.7	27.7	31.3	6.0	24.7	27.7	<u>35.3</u>	35.3										
		Q	0.6	3.0	3.4	4.4	0.9	3.6	4.0	<u>5.0</u>	5.0									OK	C19
	←	N										□ 350x350x19 ~16									
		M U/L																			
A		Q																		OK	
	↓	N	17.8	1.1	-11.9	-10.2	<u>26.2</u>	18.9	5.9	7.6	26.2										
		M U/L	11.0	18.4	-34.6	13.5	16.5	<u>29.4</u>	24.6	24.5	29.4										
		Q	1.6	2.7	-0.0	2.8	2.4	4.3	4.4	<u>4.4</u>	4.4									OK	C19

STEEL COLUMN SCHEDULE



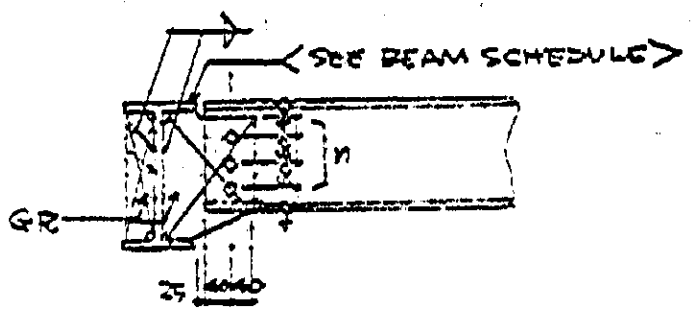
Re

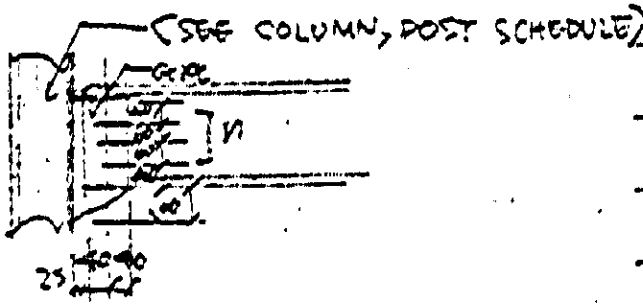
Design of Sub Beam

h	l	@	ω D.L.	ω W.L.	ω T.L.	g	Mo	Q	In	Zn	Member	J	Z	lb	ib	λb	η	C	fb	σ/f	Type
9.25	3.12	3.69	0.02	0.3×0.18	0.124	0.408	0.50	0.64	230.4	20.8	H-200×400										B2
〃	9.0	3.38	〃	〃	〃	0.369	3.74	1.66	5003.7	155.8	H-300×150	7,210	481	212	3.417	80.6	8.61	1.00	1.28	0.78	B3
7.3	9.0	3.93	〃	〃	〃	0.437	4.42	1.97	5925.8	194.4	〃										〃
7.0	〃	2.29	〃	1.6×0.18	0.268	0.553	5.60	2.49	7099	253.5	H-350×175	13,600	480								B3A
4.0	〃																				B3B
〃	3.38																				B2
3.4	7.0	1.96	0.51			4.05 (5 L 0.05)	19.85	4.93	21,357.4	1240.6	H-400×200	23,700	1,190								B4
〃	7.85	9.0	{0.51×9.0} + {(0.05+0.0417)×3.3}			5.07	39.05	19.9	59,686	2240.6	H-440×300										B4B
〃				6.09 ≈ ½		2.56	19.71	10.0	30,237.6	1321.9	H-450×200										B4A

900

STEEL SUBBEAM SCHEDULE





MARK	SECTION	GR	M
B2C	H-[illegible]	12	5-M22
B4A	H-450X200X9X14	〃	〃
B4	H-600X200X11X17	〃	4-M22
B2A	H-350X175X7X11	〃	4
B3	H-300X150X6.5X9	4	3-M22
B2A	H-250X125X6X9	9	〃
B2	H-200X100X5.5X8	〃	2-M22
B9	H-900X300X16X28	19	12-M22
B6A	H-588X300X22X20	16	17-M22
B6	H-600X200X11X17	〃	〃
B11	H-600X200X10X16	12	6-M22
B3E	H-300X[illegible]X12X19	12	2X3-M22

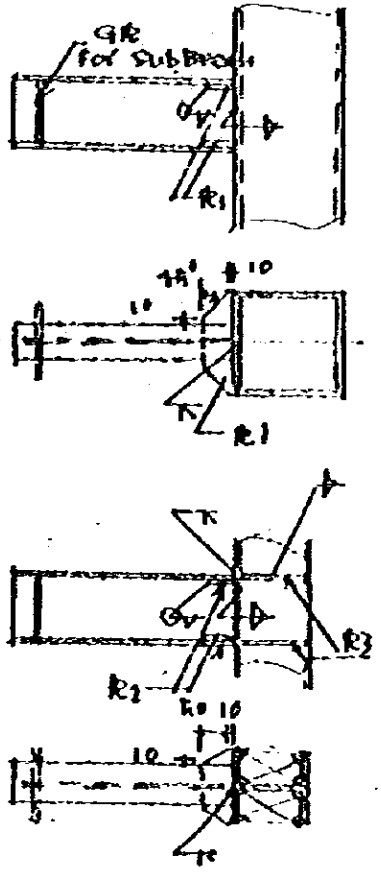
Re

Design of Cantilever

	h	l	@	w			z	M	Q	Ju	Zu	Member	J	Z	lb	Cb	λb	η	C	fb	d/t	Type
				D.L.	W.L.	T.L.																
																						CG3A
																						CG2

502

SCHEDULE OF CANTILEVER

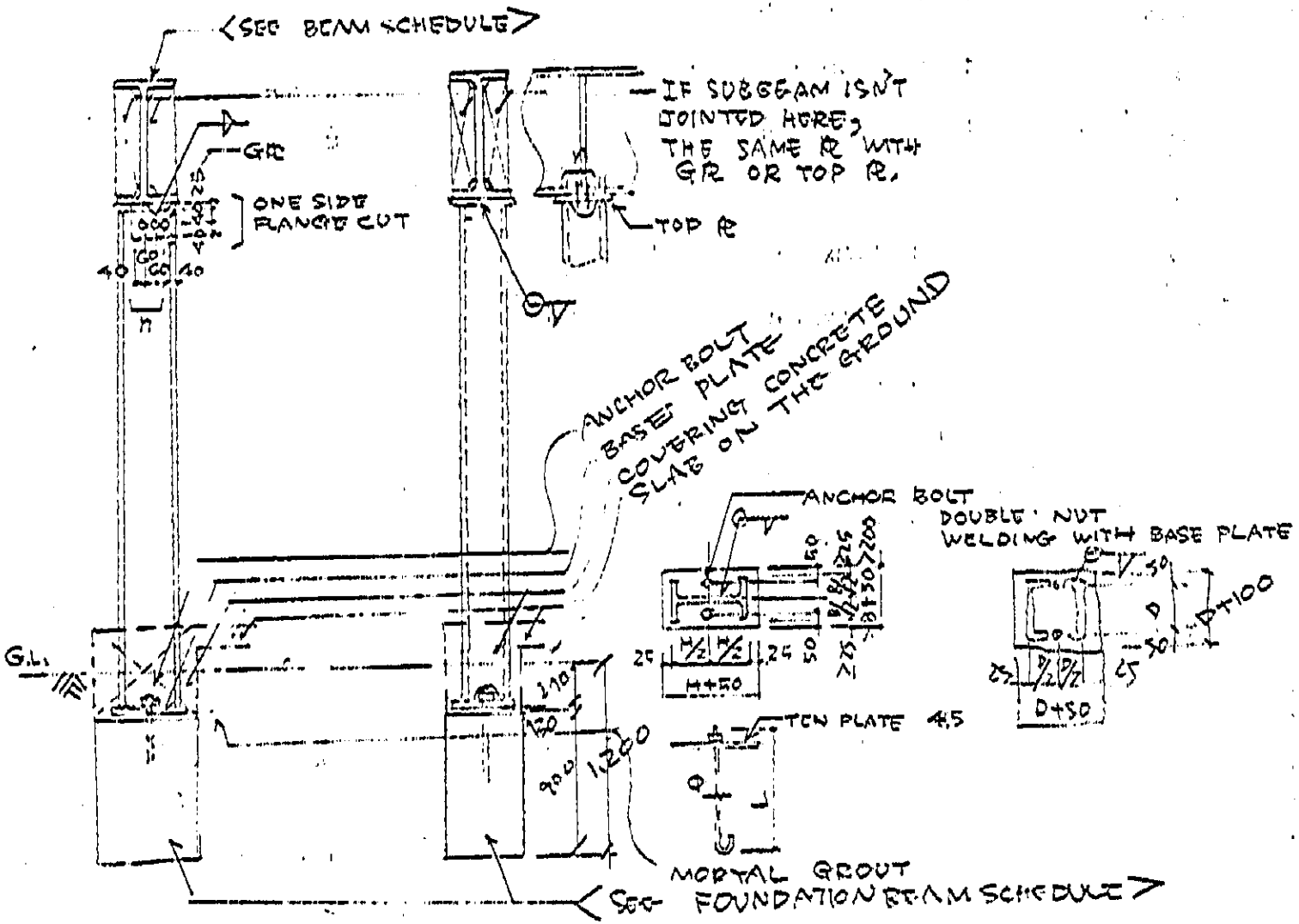


MARK	MEMBER	R1	R2	R3
CG4	H-400X200X8X13	R12	R12	R12
CG3A	H-350X175X7X11	"	"	"
CG3	H-300X150X6.5X9	R9	R9	R9
CG2	H-200X100X5.5X8	"	"	"

DESIGN OF POST

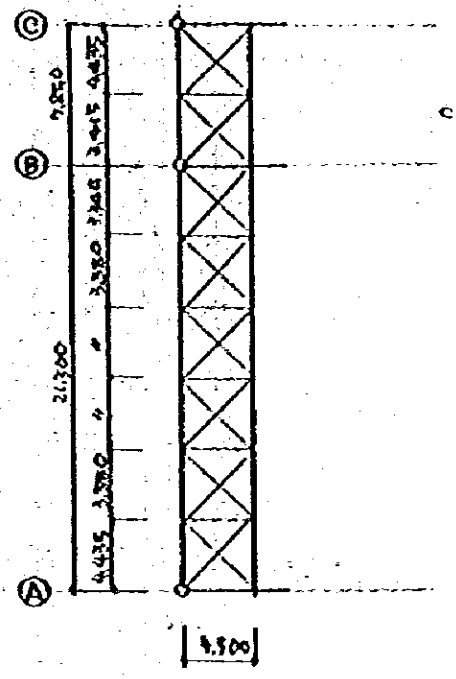
	BTM	TOP	h	ℓ	D.L. w	D.L. q	N	W.L. w	W.L. q	M	Q	Zx	Zy	Member	J	fx / fb	ix / ib	λx / λb	η / C	fc / fb	A / Z	σ/f	
	7.3	9.25	2.0	3.00	0.05	0.15	0.30	0.8x0.18	0.43	0.22	0.86	640	9.2	H-100x100	323	200	2.02	82.6	3.42	1.07	21.9		P1
																//	2.73	73.3	1.00	1.60	76.5 (ΣY/26.7)	0.35	
			7.0	~																			P3
MANAGER DOOR SIDE			4.3	1.45	0.X x 0.2	0.177						202.6	13.2	□-100x100x4	226						44.3		

STEEL POST SCHEDULE



MARK	SECTION	GR	n	BASE PLATE	ANCHOR BOLT Φ × L	NOTE
P1	H-400×100×6×8	R 9	2-M22	R 16 × 190 × 200	2-M 20 × 900	
P2	H-200×100×5.6×8	DO	〃	R 〃 × 250 × 200	2-M 〃 × 〃	
P2A	H-250×125×6.5×9	DO	3-M22	R 〃 × 300 × 200	2-M 〃 × 〃	
P3	H-300×150×6.5×9	DO	〃	R 〃 × 350 × 200	2-M 〃 × 〃	
P3A	H-350×175×7×11	R 12	4-M22	R 〃 × 400 × 225	2-M 〃 × 〃	
P4	H-400×200×8×13	DO	〃	R 〃 × 450 × 250	2-M 〃 × 〃	
P4A	H-450×200×9×14	DO	4-M22	R 〃 × 500 × 250	2-M 〃 × 〃	
P25	H-250×250×9×14	R 9	2×2-M22	R 19 × 300 × 300	〃	
P20A	□-200×200×R	TOP R 16×300×300	〃	R 16 × 250 × 300	〃	
P25A	□-250×250×R	〃 19×300×350	〃	R 19×300×350	〃	

Design of Bracing



P 7.00
@ 3.91
A $0.8 \times 0.12 \times 3.91 = 0.375$
Q $0.375 \times 7.0/2 = 1.31$
D $1.31 \times 5.96/4.5 = 1.04 \sim \times 2.6 = 4.34$ $An = 4.34/2.4 = 1.81$

$$Jn = \frac{12 \times 0.0002 \times 5.96^3 \times 300}{384 \times 2{,}100} = 209.8$$

$$Zn = \frac{3 \times 0.02 \times 5.96^2 \times 100}{8 \times 2.4} = 11.1$$

L-130×130×9
A 22.9, J 366.0, Z 38.7

$$Jn' = \frac{5 \times 0.0002 \times 2.98^3 \times 300}{384 \times 2{,}100} = 9.8$$

$$Zn' = \frac{0.02 \times 2.98^2 \times 100}{8 \times 2.4} = 0.9$$

L-75×75×6
A 8.7, J 46.1, Z 8.5

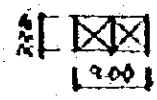
Monitor Roof

Vertical

P $1.4 \times 0.18 \times 9.0 \times 9.25/2 = 2.55$
D $2.55 \times 4.06/3.38 \times 1/2 = 1.53$ $An = 1.53/2.4 = 0.64$

L-75×75×6

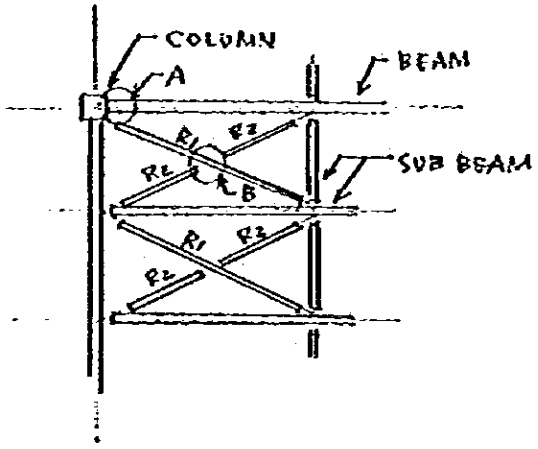
Horizontal

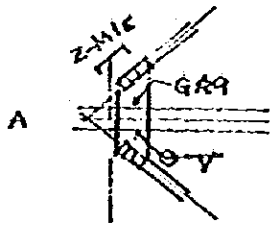


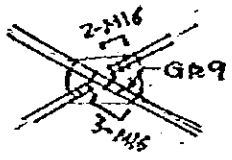
$$Jn = \frac{18 \times 0.0002 \times 5.62.8^3 \times 300}{384 \times 2{,}100} = 172.4$$

L-100×100×10
A 19.0, J 175.0, Z 24.4

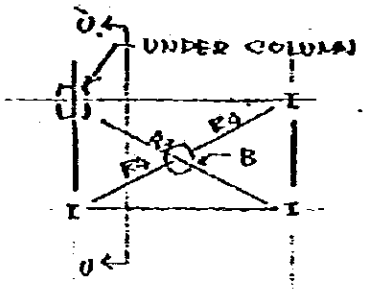
BRACING SCHEDULE

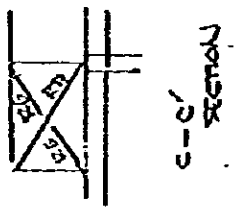






MONITOR ROOF





Mark	Member	Note
R_1	L-130×130×9	At. Paint & Body F. ~ L-130×130×12
2	L-75×75×6	
3	L-100×100×10	
4	L-75×75×6	
5	〃	
6	〃	

Design of Shell Type Roof

Bldg.	Roof Level [m]	$q = 60\sqrt{h}$	C	Cq [kg/m²]
Heavy Repair Factory	10.5 ~ 13.0	194 ~ 216	1.6	310 ~ 346
Parts Storage	7.0 ~ 9.5	168 ~ 185	〃	243 ~ 296
Inspection Factory	〃		〃	
Periodical Repair F.	〃		〃	
Paint & Body Factory	〃		〃	
Retreading & M.C. F.	〃		〃	

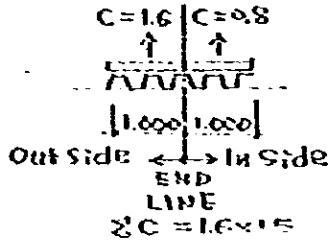
Continuous Beam Type

$$\frac{M}{Z} = \frac{\omega l^2}{8Z} \le f \quad \sim \quad l_2 \le \sqrt{\frac{8Zf}{\omega}}$$

$$\frac{5\,\omega l^4}{384\,EI} \le \frac{l}{300} \quad \sim \quad l_1 \ge \sqrt[3]{\frac{384 \times 2{,}100\, I}{300 \times 5\,\omega}}$$

S-60 0.8 A/M Use Z 61.33 [cm³/m]
I 619.94 [cm⁴/m]
Self-ω 13.5 [kg/m²]

ω	Net ω	l_2	l_1	l_{min}
1.5 × 0.346 [t/m²]	0.00492 [t/cm²]	373.6 [cm]	407.6 [cm]	373.6 [cm]
× 0.310	0.00438	396.0	423.8	396.0
× 0.296	0.00417	405.9	430.7	405.9
× 0.243	0.00343	441.1	456.3	441.1



$$l_2 \le \sqrt{\frac{8 \times 61.33 \times 1.4}{\omega}} = \sqrt{\frac{686.896}{\omega}}$$

$$l_1 \le \sqrt[3]{\frac{384 \times 2{,}100 \times 619.94}{300 \times 5 \times \omega}} = \sqrt[3]{\frac{333{,}279.9144}{\omega}}$$

Allowable Stress [kg/cm²]

	M. Roof	Roof
H.R. Factory	510	590
Generally	400	440

Cantilever Type

$$\frac{M}{Z} = \frac{\omega l^2}{2Z} \leq f \quad \sim \quad l_2 \leq \sqrt{\frac{2Zf}{\omega}}$$

$$\frac{\omega l^4}{8EI} \leq \frac{l}{250} \quad \sim \quad l_1 \leq \sqrt[3]{\frac{8 \times 2{,}100\, I}{250\,\omega}}$$

ω	Net ω	l_2	l_1	l_{min}
0.348 [t/m]	0.00333 [t/cm]	196.7 [cm]	210.9 [cm]	196.7 [cm]
0.310	0.00297	208.2	219.1	208.2
0.296	0.00283	213.3	222.7	213.3
0.253	0.00240	231.7	235.2	231.7

$$l_2 \leq \sqrt{\frac{2 \times 61.33 \times 0.80^{*} \times 1.4}{\omega}} = \sqrt{\frac{128.793}{\omega}}$$

$$l_1 \leq \sqrt[3]{\frac{8 \times 2{,}100 \times 613.94 \times 0.75^{*}}{250\,\omega}} = \sqrt[3]{\frac{31{,}244.976}{\omega}}$$

$\sim$

Allowable Span = 190 [cm]

Designed Type

0.8 ⟶ Size up to 1.0 ~~t~~

Design of Mezzanine Floor

$w = 0.01$ [t/m²]

U – 1.2 Deck Plate (AL-31) $Z = 35.5$ $J = 13.6$

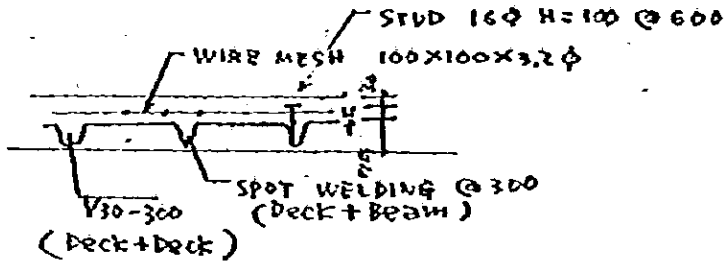
$$\frac{wl^2}{8Z} < f \sim l > \sqrt{\frac{8Zf}{w}}$$

$$= \sqrt{\frac{8 \times 35.5 \times 1.4}{0.0051}} = 279.2$$

$$\frac{5\,wl^4}{384\,EJ} < \frac{l}{350} \sim l > \sqrt[3]{\frac{384\,EJ}{1500\,w}}$$

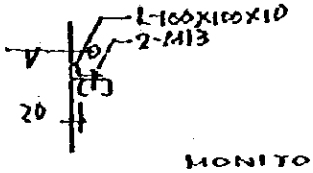
$$= \sqrt[3]{\frac{384 \times 2{,}100 \times 13.6}{1{,}500 \times 0.0051}} = 242.9$$

—— Allowable Span 240 [cm]



Design of Furring Strip

Outside Wall



MONITOR ROOF　C-120×60×25-4.5　@≒900
GENERAL　C-100×50×20-3.2　@≒900
OR　-2.3　@≒700

MONITOR ROOF ～ GENERAL WALL

	Span	@	D.L.	W.L.
H.R.F.	3.68 ～ 3.35	0.9～0.7	50	220 ～ 140
P.S.	3.50 ～ 3.60	〃	〃	180 ～ 120
I.F.	/ ～ 3.33	〃	〃	/ ～ 120
P.R.F.	3.53 ～ 3.90	〃	〃	180 ～ 120
P.B.F.	3.45 ～ 3.25	〃	〃	180 ～ 120
R.M.C.F.	3.00 ～ 3.38	〃	〃	180 ～ 120

CASE-1. (H.R.F. MONITOR ROOF)

D.L. 0.05×0.9 = 0.045 [t/m]
W.L. 0.22×0.8×0.9 = 0.158 [〃]
span 3.68 [m]

C-100×50×20-2.3

$$\frac{\delta}{f} = \frac{368^2 \times 100}{8 \times 1.4}\left(\frac{0.045}{6.05} + \frac{0.158}{16.1}\right)$$

$$= 2.08 < 2.10$$

$$\delta = \frac{5 \times 368^4}{384 \times 2100}\sqrt{\left(\frac{0.00045}{19.8}\right)^2 + \left(\frac{0.00158}{80.7}\right)^2}$$

$$= 3.49 \text{ [cm]}$$

C-100×50×20-3.2

$$\delta = \frac{5 \times 368^4}{384 \times 2100}\sqrt{\left(\frac{0.00045}{24.8}\right)^2 + \left(\frac{0.00158}{107}\right)^2}$$

$$= 2.69 \text{ [cm]}$$

C-100×50×20-4.5

$$\delta = \frac{5 \times 368^4}{384 \times 2100}\sqrt{\left(\frac{0.00045}{30.9}\right)^2 + \left(\frac{0.00158}{139}\right)^2}$$

$$= 2.10 \text{ [cm]}$$

C-120×60×25-4.5

$$= \sqrt{\left(\frac{\quad}{58.0}\right)^2 + \left(\frac{\quad}{252.0}\right)^2}$$

$$= 1.13 \text{ [cm]}$$

δ/span = 1.13/368 = 1/324 < 1/300
O.K.

CASE - 2. (H.R.F. MONITOR ROOF)

D.L. $0.05 \times 0.9 = 0.045$ [t/m]
W.L. $0.18 \times 0.8 \times 0.9 = 0.130$ [〃]
Span 3.60 [m]

C - 100 × 50 × 20 - 3.2

$$\delta = \frac{5 \times 360^4}{384 \times 2{,}100} \sqrt{\left(\frac{0.00045}{24.5}\right)^2 + \left(\frac{0.00158}{60}\right)^2}$$

$= 2.45$ [cm]

C - 100 × 50 × 20 - 4.5

$$\delta = \sqrt{\left(\frac{\quad}{36.9}\right)^2 + \left(\frac{\quad}{139}\right)^2}$$

$= 1.92$ [cm]

C - 120 × 60 × 25 - 4.5

$$\delta = \sqrt{\left(\frac{\quad}{58.0}\right)^2 + \left(\frac{\quad}{252.0}\right)^2}$$

$= 1.03$ [cm]

$\delta/\text{span} = 1.03/360 = 1/346 < 1/300$ O.K.

CASE - 3. (H.R.F. GENERAL WALL)

D.L. $0.05 \times 0.9 = 0.045$ [t/m]
W.L. $0.14 \times 0.8 \times 0.9 = 0.101$ [〃]
Span 3.85 m

C - 100 × 50 × 20 - 2.3

$$\delta = \frac{1 \times 385^4}{185 \times 2{,}100} \sqrt{\left(\frac{0.00019}{19.0}\right)^2 + \left(\frac{0.00101}{80.7}\right)^2}$$

$= 1.51$ [cm]

C - 100 × 50 × 20 - 3.2

$$\delta = \sqrt{\left(\frac{\quad}{24.5}\right)^2 + \left(\frac{\quad}{107}\right)^2}$$

$= 1.17$ [cm]

$\delta/\text{span} = 1.17/385 = 1/330 < 1/300$ O.K.

CASE - 4. (〃)

D.L. $0.02 \times 0.7 = 0.014$ [t/m]
W.L. $0.14 \times 0.8 \times 0.7 = 0.078$ [〃]
Span 3.85 m

C - 100 × 50 × 20 - 2.3

$$\delta = \frac{1 \times 385^4}{185 \times 2{,}100} \sqrt{\left(\frac{0.00014}{19.0}\right)^2 + \left(\frac{0.00078}{80.7}\right)^2}$$

$= 0.69$ [cm]

$\delta/\text{span} = 0.69/385 = 1/560 < 1/300$ O.K.

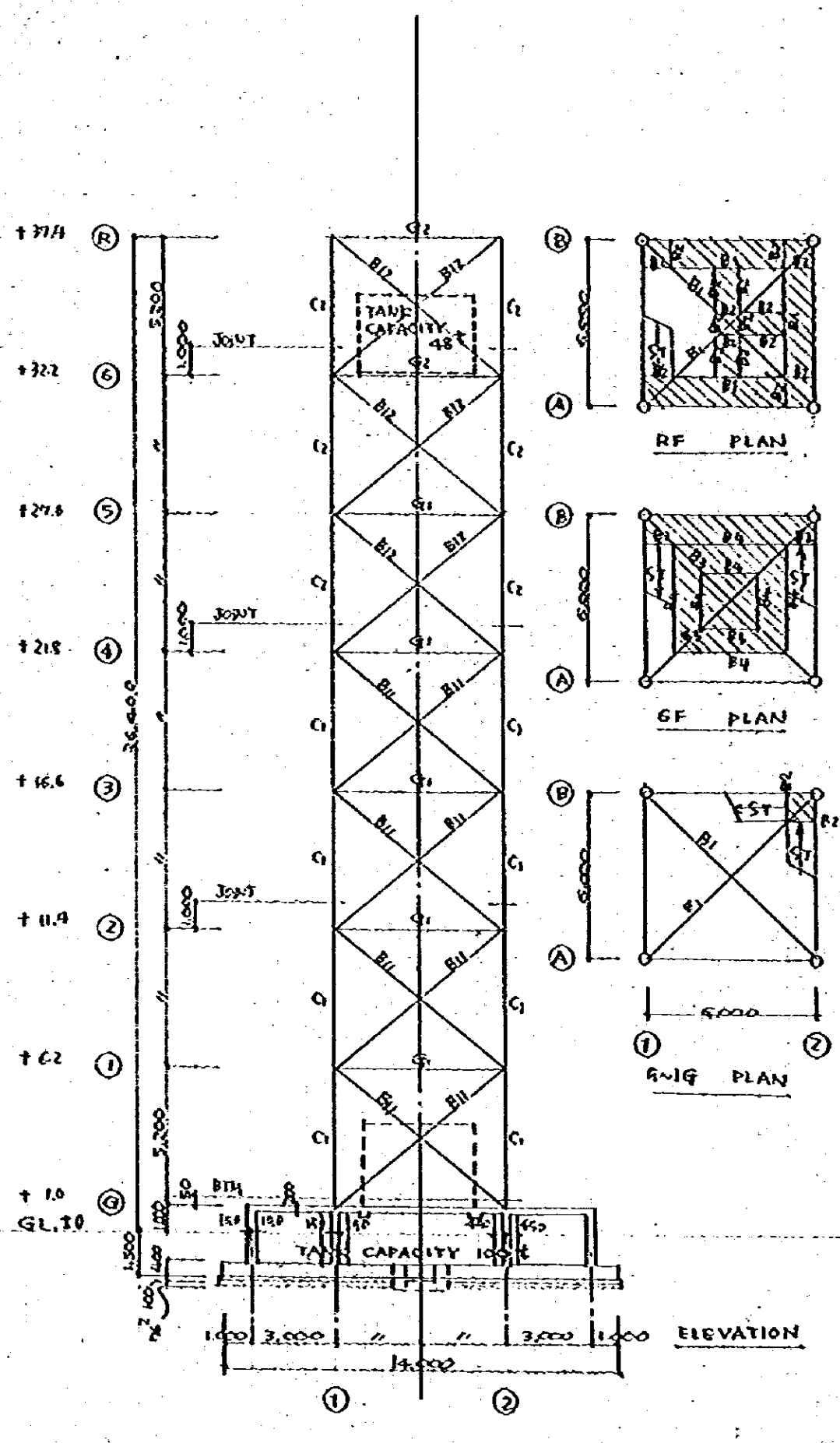
ABOVE HANGER DOOR

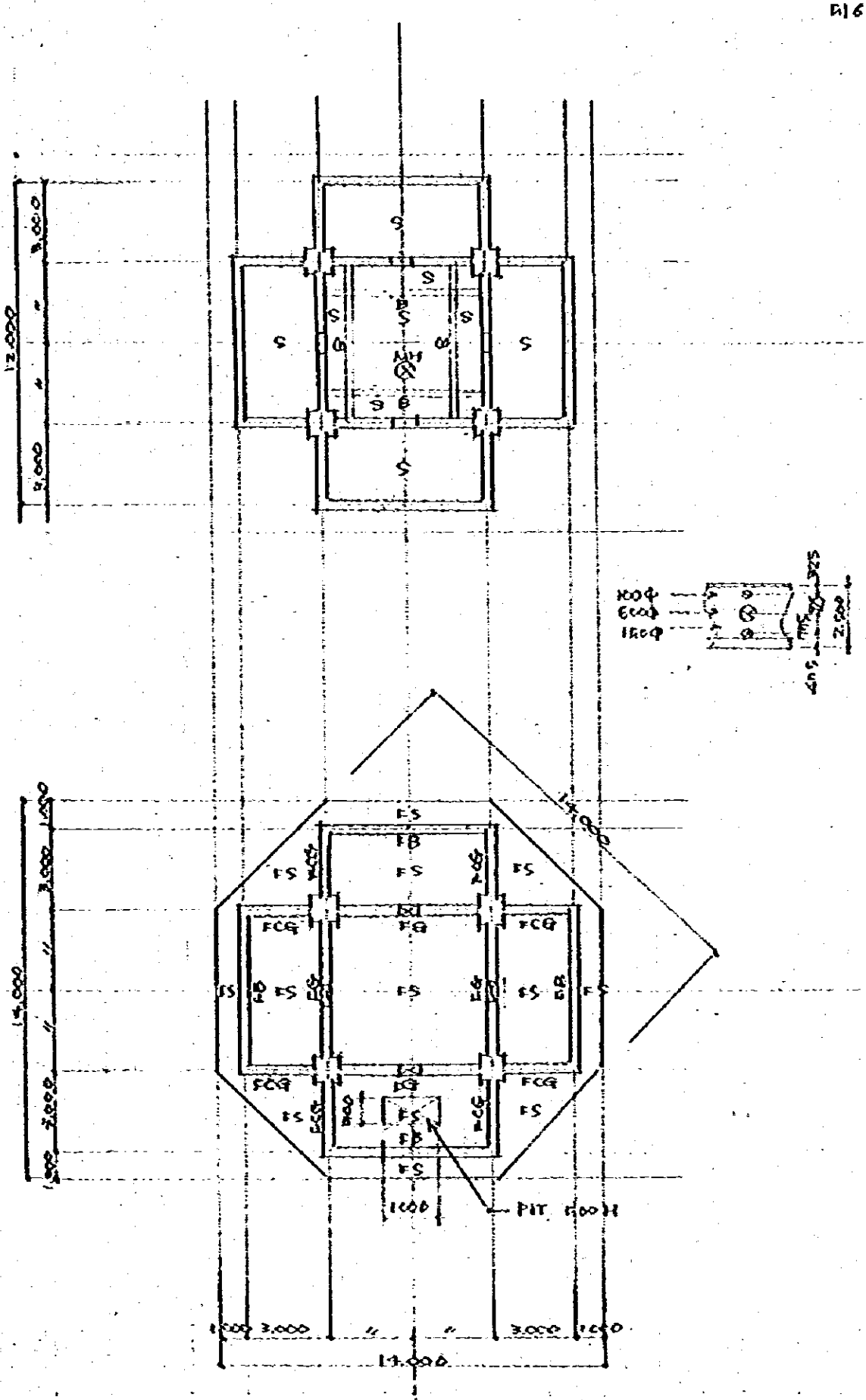
CASE-5. D.L. $0.02 \times 1 = 0.02$ @ 1.0 span 3.0
W.L. $0.8 \times 0.12 \times 1 = 0.10$
L - 125 × 125 × 9 $\quad 3x\ 219 \quad 2x\ 26.1$
$\quad 3y\ 60.4 \quad 2y\ 10.3$

$$\delta = \frac{0.02 \times 3^2 \times 100}{8 \times 26.1} + \frac{0.10 \times 3^2 \times 100}{8 \times 10.3} = 1.17 < 2.4$$

$$\delta = \frac{5 \times 300^4}{384 \times 2{,}100} \sqrt{\left(\frac{0.0002}{219}\right)^2 + \left(\frac{0.00096}{60.4}\right)^2} = 0.92 < 1.00 = \frac{1}{300}$$ O.K.

16 給 水 塔


TANK CAPACITY 48 t
JOINT
JOINT
JOINT
TANK CAPACITY 10
RF PLAN
GF PLAN
G+1F PLAN
ELEVATION


S
FS
FB
FCG
PIT
1000
3,000
13,000

Load

Tank W.L. 48.0 (δ) + D.L. 2.0 (2.0) = 50.0 (2.0) [t]

Top Floor L.L. 0.20 (δ) + D.L. 0.10 = 0.30 (0.10) [t/m²]

Staircase L.L. 0.20 (δ) + D.L. 0.10 = 0.30 (0.10) [t/m²]

Column 0.15 [t/m] (including Brace)

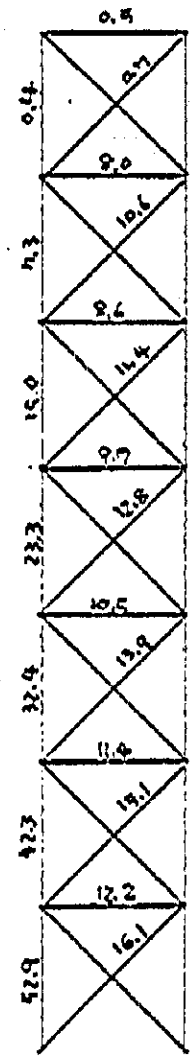
Beam 0.18 [t/m] (including Subbeam)

Wall 0.05 [t/m²]

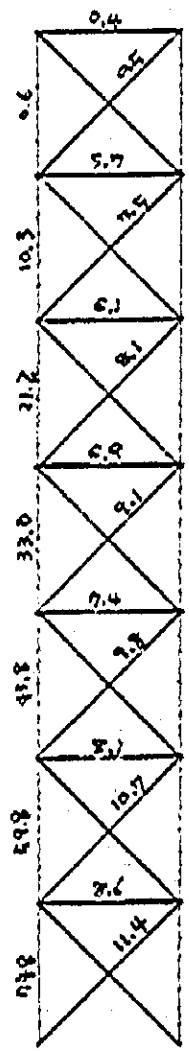
Axial Force (At Bottom)

Max	Tank	50.0 / 4	12.5
	Top Floor	0.30 × 36.0 / 4	2.7
	Staircase	0.30 × 6.0 × 6/4	2.7
	Column	0.15 × 36.4	5.5
	Beam	0.18 × 6.0 × 11	6.3
	Wall	0.05 × 5.2 × 6	1.6
		Σ	31.3 [t]
Min	Tank	2.0 / 4	0.5
	Top Floor	0.10 × 36.0/4	0.9
	Staircase	0.10 × 6.0 × 6/4	0.9
	Column	5.5	5.5
	Beam	6.3	6.3
	Wall	1.6	1.6
		Σ	15.7 [t]

Seismic Force 0° Direction



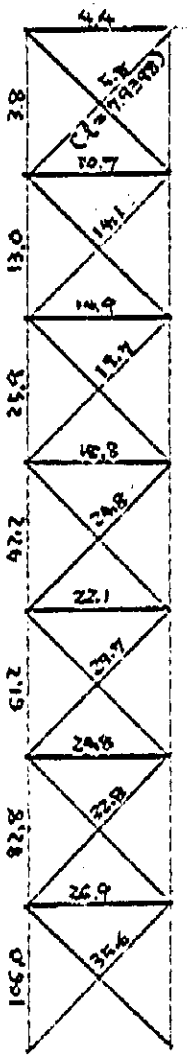
φ		W	K	H	ΣH	ΔΣ	M	ΣM	Nc	Nq	Nγ	
37.4	1.6 3.6	5.2	0.2	1.0	1.0	5.2	5.2	5.2	0.4	0.5	0.7	
32.2	5.0 10.9 3.9 3.1 3.6 1.2	74.6	〃	14.9	15.9	〃	82.7	87.9	7.3	8.0	10.6	
27.0	1.8 3.1 3.6	8.5	〃	1.7	17.6	〃	94.5	179.4	15.0	8.6	11.4	
24.8	1.8 3.1 3.6	〃	〃	〃	19.3	〃	100.4	279.8	23.3	9.7	12.8	
16.6	1.8 3.1 3.6	〃	〃	〃	21.0	〃	109.2	389.0	32.4	10.5	13.9	
11.4	1.8 3.1 3.6	〃	〃	〃	22.7	〃	118.0	507.0	42.3	11.4	15.1	
6.2	1.8 3.1 3.6	〃	〃	〃	24.4	〃	126.9	633.9	52.9	12.2	16.1	



Seismic Force 45° Direction

z_n		W	K	H	ΣH	ΔB	M	ΣM	Nc	NG	Nγ	
30.4			0.2	1.0	1.0	5.2	5.2	5.2	0.6	0.4	0.5	
32.2			〃	14.9	15.9	〃	82.7	87.9	10.3	5.7	7.5	
27.0			〃	1.7	17.6	〃	94.5	179.4	21.2	6.1	8.1	
21.8			〃	〃	19.3	〃	100.4	279.8	33.0	6.9	9.1	
16.6			〃	〃	21.0	〃	109.2	389.0	45.8	7.4	9.8	
11.4			〃	〃	22.7	〃	118.0	507.0	59.8	8.1	10.7	
6.2			〃	〃	24.4	〃	126.9	633.9	74.8	8.6	11.4	
Ratio for θ_0				1.00	1.00		1.00	1.00	$\frac{(1+\sin\theta)}{(1+\sin 45^\circ)}$	$\frac{0.5}{N_G}$		
									$=1.414$	$=0.707$	$=0.707$	

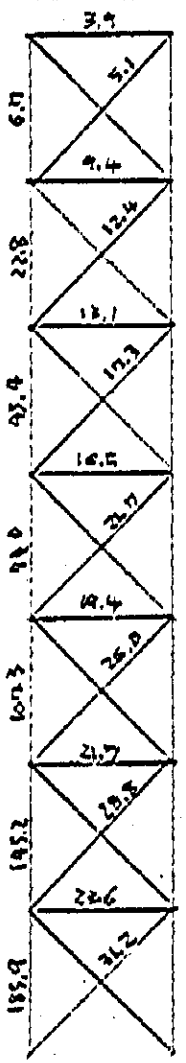
418



Wind Force 0° Direction

R	q	C	A	H	ΣH	Δp	M	ΣM	Nc	Nq	Nqr
37.4	0.37	1.4 (0.8≈0.6)	16.7	8.7	8.7	5.2	46.2	46.2	3.8	4.4	5.8
32.2	0.34	1.4 2.5	16.7 5.5	7.9 4.7	21.3	〃	110.8	156.0	13.0	10.7	14.1
27.0	0.31	2.5	11.0	9.5	29.8	〃	155.0	311.0	25.9	14.9	19.7
21.8	0.28	〃	〃	7.7	37.5	〃	195.0	506.0	42.2	18.8	24.8
16.6	0.24	〃	〃	6.6	44.1	〃	229.3	735.3	61.2	22.1	29.7
11.4	0.20	〃	〃	5.5	49.6	〃	257.9	993.2	82.8	24.8	32.8
6.2	0.15	〃	〃	4.1	53.7	〃	279.2	1272.4	106.0	26.9	35.6

Wind Force 45° Direction



Σq	q	C	A	H	ΣH	$\Delta \Sigma q$	M.	ΣM	NC	NG	NBY
30.4		1.7							6.7	3.9	5.1
32.2		1.7 3.1							22.8	9.4	12.4
29.0		3.1							45.4	18.1	17.3
21.8		//							74.0	16.5	21.7
16.6		//							107.3	19.4	26.0
11.4		//							145.2	21.7	28.8
6.2		//						1597.8	185.9	23.6	34.2
Ratio for 0°		3.1/2.4 = 1.24						1.24	$\frac{(1.24)}{(1.00)}$ = 1.754	1.754/2 = 0.877	1.754/2 = 0.877

Design of Foundation

Force from Upper Structure

Vertical Force

Max $31.3 \times 4 = 125.2$ [t]
Min $15.7 \times 4 = 62.8$ [t]

Horizontal Force

Wind Force

0° Direction
- N = ± 106.0 [t]
- H = 53.7 [t]
- M = 1,292.4 [tm]

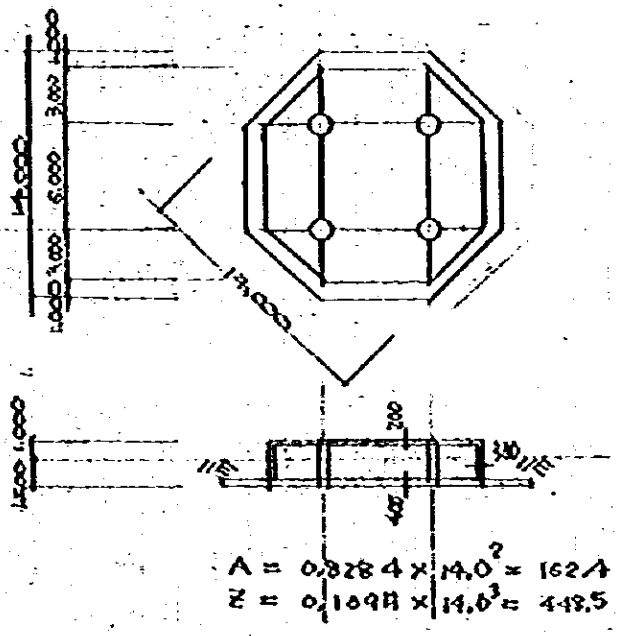
45° Direction
- N = ± 185.9 [t]
- H = 66.6 [t]
- M = 1,519.8 [tm]

Seismic Force
- N = ± 53.0 [t]
- H = 24.5 [t]
- M = 639.0 [tm]

Self Load

Pump Room: Roof $(0.10+0.46)\times 4.0\times 4.0 = 9.0$; Wall $0.46\times 2.38\times 4 = 4.3$ → 13.3

Soil	$(0.8284\times 14.0^2 - 6.0^2 - 4\times 6.3\times 3.15)\times 1.1\times 1.6$	82.7	416.6	DEAD 522.9 ~ EMPTY 429.9
Slab	$(6.0^2 + 4\times 6.3\times 3.15)\times(0.06+0.98)$	62.3		
Base	$0.8284\times 14.0^2\times(0.06+0.96)$	165.6		
Wall	$(4\times 3.9 + 4\times 10.9)\times(0.19+2.31)$	89.9		
Column	$4\times 1.9\times(0.18+1.94)$	16.1		
Water	100.0 ~ 0	100.0 ~ 0		



$A = 0.8284\times 14.0^2 = 162.4$ [m²]
$Z = 0.1098\times 14.0^3 = 448.5$ [m³]

45° Direction — Soil Reaction

$\Sigma N = (125.2 \sim 62.8) + (429.9 \sim 429.9) = 555.1 \sim 492.7$ [t]

$M = 1,577.8 + (66.6 \times 2.5) = 1,744.3$ [tm]

$\sigma_L = \frac{555.1 \sim 492.7}{162.4} = 4.03 \sim 3.03 <$ Lfe = 8.4 , $>$ W.L. max = 1.50

$\sigma_S = \frac{555.1 \sim 492.7}{162.4} \pm \frac{1,744.3}{448.5}$

$= (4.03 \sim 3.03) \pm 3.89$

$= 8.02 \sim -0.86$ $<$ Sfe = 16.8 , $> \fallingdotseq 0$

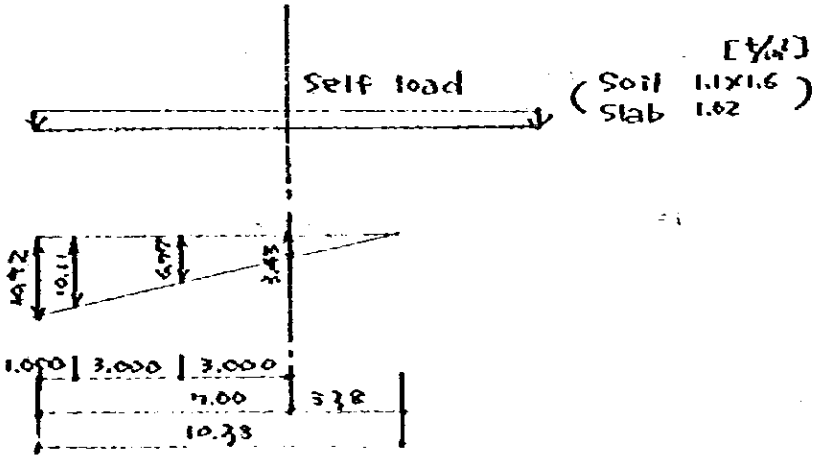
$e = \frac{1,744.3}{555.1 \sim 492.7} = 2.66 \sim 3.54$, $3\left(\frac{D}{2} - e\right) = \underset{10.38}{13.02}$ $(= x_n)$

$\frac{e}{l} = \frac{2.66 \sim 3.54}{14.0} = 0.19 \sim 0.25$

$a = 2.6 \sim 3.6$

$\sigma_S = \frac{555.1 \sim 492.7}{162.4} \times 2.6 \sim 3.6$

$= 10.99 \sim 10.92$ $<$ Sfe = 16.8



Foundation Beam

FB

$$q = \left\{\frac{(9.92+10.11)}{2} - (3.1\times1.6+1.02)\right\}\times 1.0 + \left\{\frac{(10.11+(10.11+6.77)/2)}{2} - 1.02\right\}\times 1.5$$

$$= 7.89 + 12.38$$
$$= 20.27 \quad [t/m]$$

$M_0 = 20.27\times 6.0^2/8 = 93.5$ [tm] at 14.17 [cm²] >3-D25
$Q = \times 6.0/2 = 62.3$ [t] φ 19.6 [cm]

b 30 D 250 j 211.75 QAS 54.2 [t]
α 2.0

FCG

P = from FB 62.3

$$W = \left\{\frac{(11.01+6.77)}{2} - (3.1\times1.6+1.02)\right\}\times 3.0\times 1.8/2$$
$$= 16.5$$

C = 16.5 × 3.0 = 49.5 [tm] 3-D25
Q = 16.5 [t]

FG

$$q = \left\{\frac{(10.11+6.77)/2+6.77}{2} - 1.02\right\}\times 1.5 + \left\{\frac{6.77+3.43}{2} - 1.02\right\}\times 3.0$$

$$= 9.88 + 12.24$$
$$= 22.12 \quad [t/m]$$

C = 22.12 × 6²/12 = 66.4 [tm] >3-D25
M = /8 = 99.5 [ ]
Q = C/2 = 66.4 [t]

Opening Reinforcing $Q = \frac{Q_E}{2} = 33.2$ [t]

Φ600

$$\tau = \frac{33{,}200}{211.75\times 30} = 5.25 \ [kg/cm^2]$$

$$T = 5.25\times 30\times 30\sqrt{2} = 6.65 \ [t]$$

$$p_w = \frac{Q/2}{bj\cdot 0.5\omega ft} + 0.002 = \frac{33.2/2}{30\,(95-8)\times\frac{\pi}{8}\times 1.5} + 0.002 = 0.0068$$

$a_s = 1.2$ [cm²] 2-D13
□D13-@100

Foundation Slab D 40 j 28.9

Case 1. Cantilever $\ell = 0.85 \sim 1.80$

$w_{NET_S} = 11.22 - (1.4 \times 1.6 + 1.02) = 8.44$

M	$8.44 \times 1.8^2/2$	13.07	at	15.8
Q	$\times 1.8$	15.19	ϕ	35.0

Case 2. 2 Edge Fix $\ell = 1.8$

$w_S = 8.44$

M	$8.44 \times 1.8^2 \times 0.79$	7.93
Q	$\times 1.8$	15.19

Case 3. ℓ_x 3.0 ℓ_y 6.0 $w_S = (11.01 + 6.78)/2 - 1.02 = 7.87$ λ 2

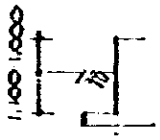
M	$7.87 \times 3.0^2 \times 0.083$	5.88
Q	$\times 3.0 \times 0.61$	12.04

Case 4. $\ell_x = \ell_y$ 6.0 λ 1 $w_L = 3.95 - 1.02 = 2.83$

M	$2.83 \times 6.0^2 \times 0.052$	5.30	at	6.1
Q	$\times 6.0 \times 0.47$	7.97	ϕ	17.2

FS (Top D13 – @ 150 c/c
Btm D19 – @ 150 c/c

Soil Pressure for Outside Beam



$w_{max} = K_s \gamma (C_s + \theta)$
$= 0.8 \times 1.6 (0.3 + 1.1)$
$= 1.12$ [t/m²]

$Q = 1.12 \times 1.4/2 = 0.78$ [t/m] Q_t 1.9 [cm]
$M = 1.12 \times 1.4^2/6 = 0.37$ [tm/m] a_t 1.0 [cm²]

D 30 j 19.25 ⇒ D13 – @150

Upper Slab

L.L. 030
D.L. 0.06 Finish + 0.48 Slab = 0.54
T.L. 0.84

$\ell x = \ell y = 6.0$ $\lambda = 1$ D 20 ℓ 14.4

M $0.84 \times 6^2 \times 0.052$ 1.57 at 5.5 D10 - @150 D.C.
Q $\times 6 \times 0.141$ 2.22 φ 7.3

Column

N $(31.3 \sim 15.7) \pm 185.9$ = MAX 217.2 [t]
MIN −170.2

$b = D = 90$ $\sigma t = 217{,}200/8{,}100$
$= 26.8 < fc = 100$ $(Fc = 180)$
[kg/cm²]

$a_s = \frac{170.2}{3.0}$
$= 56.7$ 12 − D25

p_g 0.8
a_g 64.8 16 − D25
□ D13 @100

If Beam isn't considerd,

N = 217.2 ∼ −170.2 N/bD 26.8 ∼ −21.0
Q = 26.9/2 = 13.5
M = 13.5 × (1.0 + 1.1) = 28.4 M/bD^2 3.9

QAS 60.2 > 15.5 p_t 0.50
a_t 40.5
8 − D25

Total 28-D25

Pump Roof

Roof D=150 D10 @ 200 D.C ($M = 0.86 \times 4^2/16 = 0.86$ at 2.6 D 15 ℓ 10.9)
Wall 〃 〃

Beam 480 / 250 • D19 W = $0.84 \times 6 \times \frac{3}{2}$ 11.56 D 4n ℓ 3n b 2n
M = 9.56 × 6 × 0.104 = 4.8 at 6.9 3 − D19
Q = 9.56/2 = 3.78 φ 5.1 QAL 6.1

Column

C1 (+1.000 Level) Φ 406.4 × 9.9

N=(31.3 ~15.7)± 185.9 = 217.2 ~ -170.2

C = 0.7 , q = 0.28 , A = 0.4 < qA = 0.0784 [t/m]

M₀ 0.0784 × 4.8²/8 = 0.226 [tm]

A 98.9 , i 14.1 , ℓk 520 , λ 36.9 , fc 1.48 [t/cm²]

$$\frac{\sigma_c}{f} = \frac{217.2}{98.9 \times (1.48 \times 1.5)} = 0.99$$

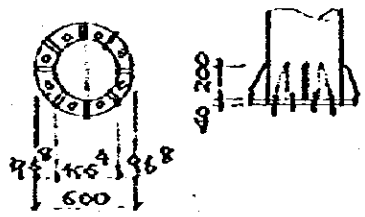
$$\frac{\sigma_t}{f} = \frac{170.2}{98.9 \times 2.4} = 0.72$$

$$\left.\begin{array}{l}\\ \\ \end{array}\right\} \quad 1.00 \leq 1.00$$

Z 1,140 $\quad \frac{\sigma_b}{f} = \frac{22.6}{1,140 \times 2.4} = 0.01$

Joint N = (31.3 ~ 15.7) ± 107.3 = 138.6 ~ -91.6

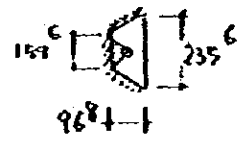
$$\sigma_c = \frac{107,300}{\frac{\pi}{4} \times 60^2} = 37.9 \ [kg/cm^2]$$



H.T.B. $AT = \frac{91.6}{8} = 11.5$ [t]

< M24 R = 21.0

B.R.



Bk 40×60×9

8RIBRS 9×200

8-M24

fx 9.7 fy 19.8 λ 2.0 ω 37.9

M 37.9 × 9.7² × 0.28 998.5 [kg cm/cm]

Q × 9.7 × 1.00 367.6 [kg/cm]

AT 11.5

M (11.5 × 9.7/2)/9.7 5.58 [tcm/cm]

Q 11.5/9.7 1.19 [t/cm]

M_Z $\frac{5.575}{2.4} = 2.36$

M_t $\sqrt{6 \times 2.36} = 3.79 \rightarrow$ R 40

∴ Welding

R = 0.79 × 2.4 = 1.90 [t/cm] > Q = 1.19

Rib Bk

Q = 37.9 × 9.7² = 3,566.0 [kg]

M = 3,566.0 × 9.7 × 2/3 = 23,060.2 [kgcm]

$$nZ = \frac{23,060.2}{2,400} = 9.61$$

$$nt = \frac{6 \times 9.61}{20^2} = 0.14 \rightarrow Pt\,9$$

Welding

$$Z = \frac{(2\pi \times 0.7(\times 2) \times 20^2}{6} = 65.3$$

$$A = 0.7 \times 0.7 \times 2 \times 20 = 19.6$$

$$\sigma_M = 23,060.2 / 65.3 = 353.1$$
$$\sigma_Q = 3,566.0 / 19.6 = 181.9$$

$$\sqrt{353.1^2 + 3 \times 181.9^2} = 443.2 < f = 1,200\ [kg/cm^2]$$

Bottom $N = 217.2 \sim -170.2$, $Q = 11.8$

$$\sigma_c = \frac{217,200}{\frac{\pi}{4} \times 68^2} = 65.5 < f_c = 100\ [kg/cm^2]$$

A.B. $AT = \frac{170.2}{16} = 10.6$ [t]

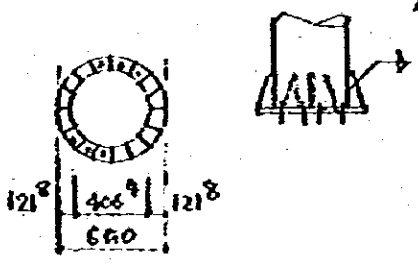
$$An = \frac{10.6}{1.8} = 5.9$$

$$\phi_n = \sqrt{4 \times 5.9/\pi} = 2.74 \rightarrow 36\phi$$

$$\tau = \frac{11.8/16}{(\frac{\pi \times 3.6^2}{4})} = 0.017 < f_s = 1.35\ [kg/cm^2]$$

$$f_{ts} = 1.4 f_{to} - 1.6\tau$$
$$= 1.4 \times 1.8 - 1.6 \times 0.017$$
$$= 2.41\ [kg/cm^2] \rightarrow f_{to} = 1.8$$

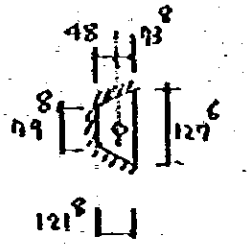
$$\frac{\sigma}{f} = \frac{10.6}{(\frac{\pi \times 3.6^2}{4}) \times 1.8} = 0.58 < 1.00$$



Bt 40×650φ
S Rib Rs 9×300
AB. 16-36φ

Anchoring $f_b = \frac{6 \times 15}{100} Fc = 13.5\ [kg/cm^2]$

$$l_n = \frac{10,600}{\pi \times 3.6 \times 13.5} = 69.4 \rightarrow 120\ [cm]$$



Bt

ℓx 12.2 ℓy. $\times$ 1.0 w = 65.5

M $65.5 \times 12.2^2 \times 0.085 = 826.7$ [kgcm/cm]

Q $\times 12.2 \times 0.5 = 399.6$ [kg/cm]

AT 10.6

M $(10.6 \times 48)/99.88 = 6.38$ [tcm/cm]

Q $10.6/99.8 = 1.33$ [t/cm]

Mz $6.38/2.4 = 2.66$

nt $\sqrt{6 \times 2.66} = 3.99 \rightarrow Pt\,40$

Welding

$$R = 0.7 \times 2.4 = 1.90\ [kg/cm] > Q = 1.33$$

Rib PL

$\sigma_c = 65.5 \quad \left(\sigma_t = \frac{170{,}200}{\frac{\pi}{4}(a^2 - 40.0^2)} = 84.2 \right)$

$Q = 84.2 \times 12.2^2 = 12{,}532.3 \quad [kg]$
$M = 12{,}532.3 \times 12.2 \times 2/3 = 101{,}929.6 \quad [kgcm]$

$nZ = \frac{101{,}929.6}{2{,}400} = 42.47$
$nt = \frac{6 \times 42.47}{20^2} = 0.64 \longrightarrow PL\,9$

Welding
$Z = \frac{(0.7 \times 6.7 \times 2) \times 32^2}{6} = 147.0$
$A = 0.7 \times 0.7 \times 2 \times 25 = 29.4$
$\sigma_M = 101{,}929.6 / 147.0 = 693.4$
$\sigma_Q = 12{,}532.3 / 29.4 = 426.3$

$\sqrt{693.4^2 + 3 \times 426.3^2} = 1{,}012.9 < f = 1{,}200 \quad [kg/cm^2]$

C2 (+21,800 level) Φ 406.4 × 6.4

$N \fallingdotseq (31.3 \sim 15.7) \pm 45.4 = 76.7 \sim -29.7\ (t)$

$C = 0.7$, $\ell = 0.37$, $A = 0.4$ $\quad C\,\ell A = 0.1036 \quad [t/m]$
$M_0 \quad 0.1036 \times 4.8^2/8 = 0.298 \quad [tm]$
A 80.4 , i 14.1 , ℓ_k 520, λ 36.9 , fc 1.48

$\frac{\sigma_c}{f} = \frac{76.7}{80.4 \times (1.48 \times 1.0)} = 0.43$
$\frac{\sigma_t}{f} = \frac{29.7}{80.4 \times 2.4} = 0.15$ $\quad$ 0.45 < 1.00
$Z \quad 967 \qquad \frac{\sigma_b}{f} = \frac{29.8}{967 \times 2.4} = 0.02$

Joint
$\sigma_c = \frac{76{,}700}{\frac{\pi}{4} \times 60^2} = 27.1$

H.T.B.
$\Delta T = \frac{29.7}{8} = 3.7$
$< M20 \quad R = 14.6$
$M = (3.7 \times 9.7/2)/9.7 = 1.85 \quad [tcm/cm]$
$nZ = 1.85/2.4 = 0.77$
$nt = \sqrt{6 \times 0.77} = 2.15 \longrightarrow PL\,25$

Rib PL $\qquad$ 8PL$_s$ − 9×200

Beam

G1 H-400×200×8×13 (Y=16)

Nmax 26.9 [t]

Self Load 0.10 [t/m] Mo 0.10×5.6²/8 0.39 [t·m]
Q ×5.6/2 0.28 [t]

Wind Force for Surface
C = 2.0 q = 0.31 A = 0.2 ~ 0.4
C·q·A = 0.124 ~ 0.248

Mo 0.124 ~ 0.248 × 5.6²/8 0.49 ~ 0.99
Q × 5.6/2 0.35 0.69

λx 123.3 fc 0.63 A 84.1
λy 47.4 λb 106.5 η 8.09 C 1.00 fb 1.10 Zx 1,190 Zy 174

$$\frac{\sigma}{f} = \frac{26.9}{84.1\times(0.63\times1.5)} + \frac{39+49}{1,190\times(1.10\times1.5)} + \frac{97}{174\times(1.10\times1.5)}$$
$$\fallingdotseq 0.34 + 0.04 + 0.34$$
$$= 0.72 < 1.00$$

$$\delta = \frac{5\times560^4}{384\times2,100}\sqrt{\left(\frac{0.001+0.00124}{23,700}\right)^2+\left(\frac{0.00248}{1,740}\right)^2}$$
Jx 23,700 Jy 1,740
$$= 0.87 \text{ [cm]}$$
$$\delta/\text{span} = 0.87/560 \fallingdotseq 1/644$$

Joint 2BS 9×165×260 4-M22

G2 H-390×300×10×16 (Y=22)

Nmax 10.7 [t]

C = 0.8 q = 0.37 A = 1.5×2.8 0.8×0.37×1.5~2.8 = 0.444 ~ 0.829
Mo 0.444 ~ 0.829 × 5.6²/8 1.74 ~ 3.25
Q × 5.6/2 1.24 2.32

λx 96.9 fc 1.13 A 136.0
λy 71.8 λb 69.1 η 6.68 C 1.00 fb 1.60 Zx 1,980 Zy 481

$$\frac{\sigma}{f} = \frac{10.7}{136.0\times(1.13\times1.5)} + \frac{39+174}{1,980\times(1.6\times1.5)} + \frac{325}{481\times(1.6\times1.5)}$$
$$= 0.38 < 1.00$$

$$\delta = \frac{5\times560^2}{384\times2,100}\sqrt{\left(\frac{0.001+0.000444}{38,400}\right)^2+\left(\frac{0.00829}{7,210}\right)^2}$$
$$= 0.71 \text{ [cm]}$$
$$\delta/\text{span} \times 0.71/560 = 1/798$$

Sub Beam

B1 ↓ D.L.

w 0.05 [t/m]
P $0.05 \times 7.9/2 = 0.20$ [t]

W.L.

C 2.0 γ 0.31 A 0.2
w $2.0 \times 0.31 \times 0.2 = 0.124$ [t/m]
P $0.124 \times 7.9/2 = 0.49$ [t]

T.L.

w $0.05 + 0.124 = 0.174$ [t/m]
P $0.20 + 0.49 = 0.69$ [t]

M_0 $0.174 \times 7.9^2/8 + 0.69 \times 7.9/4 = 2.92$ [tm]
Q $0.174 \times 7.9/2 + 0.69/2 = 1.03$ [t]

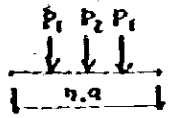
$Z_n = 292/2.4 = 113.3$ [cm³]

$$J_n = \frac{5 \times 0.00174 \times 790^3 \times 300}{384 \times 2{,}100} + \frac{0.69 \times 790^2 \times 300}{48 \times 2{,}100} = 2{,}877.4 \text{ [cm}^4\text{]}$$

H - 400 × 200 × 6.0 × 9.0 (r = 0) Zx 602, Jx 16,500

B2 H - 400 × 200 × 4.5 × 6.0 Zx 438, Jx 11,500

B3



$P_1 = P_2 = (0.10 \times 9.0) + 12.5 = 13.0$
t/t tank

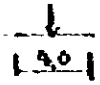
$M_0 = 13.0 \times 7.9/2 = 51.35$ [tm]
$Q = 13.0 \times 1.5 = 19.5$ [t]

$Z_n = 5{,}135/1.6 = 3{,}209.4$ [cm³]

$$J_n = \frac{19 \times 13.0 \times 790^3 \times 300}{384 \times 2{,}100} = 57{,}348.5 \text{ [cm}^4\text{]}$$

H - 400 × 400 × 13 × 21 Zx 3,030, Jx 66,600

B4



$P = (0.10 \times 4.0) + 12.5 \times 13.0$

$Z_n = \frac{13.0 \times 4.0 \times 100}{4 \times 1.6} = 812.5$

$J_n = \frac{13.0 \times 400^3 \times 300}{48 \times 2{,}100} = 6{,}190.5$

H - 400 × 200 × 8 × 13 Zx 1,190, Jx 23,700

B5

$w = 0.30 \times 0.5 = 0.15$

$Z_n = 0.15 \times 4^2 \times 100/8 \times 1.6 = 18.8$
$J_n = 5 \times 0.0015 \times 400^3 \times 300/384 \times 2{,}100 = 178.6$

H - 400 × 200 × 4.5 × 6.0

Bracing

B11 ϕ 165.2 × 5.0 (A 25.16, J 808, $\bar{x}$ 7.3)

N max 35.6 [t] HTB $35.6/14.1 \approx 3$-M22 ($\widetilde{14.1}$) 3-M20 $A_n = 35.6/2.4 = 14.8$ → PL 12×200

Self load 0.02 [t/m] Mo $0.02 \times 5.6^2/8$ 0.08 [t·m]; Q $\times 5.6/2$ 0.06 [t]

Wind force for Side Surface

$C = 0.7$ $q = 0.28$ $A = 0.1652$

$CqA = 0.0324$ [t/m]

$P = 0.0324 \times 7.3/2 = 0.1182$ [t]

Mo $0.0324 \times 7.3^2/8 + 0.1182 \times 7.3/4 = 0.4315$ [t·m]

Q $\times 7.3/2 + \times 1/2 = 0.1994$ [t]

$$\frac{\sigma}{f} = \frac{35.6}{25.16 \times 2.4} \pm \frac{(8.0 \pm 43.15)}{98.3 \times 2.4}$$

$$= 0.59 + 0.22$$

$$= 0.81 \quad < 1.00$$

($V_{0.5 \times 0.7 \times 1.2} = 0.42$, $\ell = 35.6/0.42 \times 2 = 42.4 \rightarrow$ 25×2)

$$\delta = \frac{5 \times 0.000324 \times 730^4}{384 \times 2{,}100 \times 808} + \frac{0.1182 \times 730^3}{48 \times 2{,}100 \times 808}$$

$$= 0.71 + 0.56$$

$$= 1.27 \quad [cm]$$

$$\delta/span = 1.27/730 \approx 1/575$$

B12 ϕ 139.8 × 4.5 (A 19.13, J 438, $\bar{x}$ 62.7)

N max 19.7 [t] HTB $19.7/14.1 \approx 2$-M22 ($\widetilde{14.1}$) 2-M20 $A_n = 19.7/2.4 = 8.2$ → PL 9×150

D.L. 0.02 Mo 0.08 Q 0.06

CqA $0.7 \times 0.37 \times 0.1398 = 0.0362$

P $0.0362 \times 7.3/2 = 0.1322$

Mo $0.0362 \times 7.3^2/8 + 0.1322 \times 7.3/4 = 0.4824$

Q $\times 7.3/2 + \times 1/2 = 0.1982$

$$\frac{\sigma}{f} = \frac{19.7}{19.13 \times 2.4} \pm \frac{8 + 48.2}{62.7 \times 2.4}$$

$$= 0.43 + 0.37$$

$$= 0.80 \quad < 1.00$$

$$\delta = \frac{5 \times 0.00362 \times 730^4}{384 \times 2{,}100 \times 438} + \frac{0.1322 \times 730^3}{48 \times 2{,}100 \times 438}$$

$$= 1.46 + 1.16$$

$$= 2.62 \quad [cm]$$

$$\delta/span = 2.62/730 = 1/279$$

Stair Case

Step CH 4.5

ω 0.30 [t/m²]

↳ ℓ 30 [cm]

$$z_n = \frac{0.3 \times 0.3^2 \times 100}{8 \times 1.6} = 0.211$$

$$t_n = \sqrt{6 \times 0.211 / 100} = 0.11$$

$$J_n = \frac{5 \times 0.003 \times 30^3 \times 300}{384 \times 2{,}100} = 0.151$$

$$t_n = \sqrt[3]{12 \times 0.151 / 100} = 0.26$$

↳ ℓ 10 [cm] ↳ = 0.3 × 0.15 = 0.045

$$z_n = \frac{0.045 \times 0.1^2 \times 100}{8 \times 1.6} = 0.112$$

$$t_n = 6 \times 0.112 / 5^2 = 0.04$$

$$J_n = \frac{5 \times 0.00045 \times 10^3 \times 300}{384 \times 2{,}100} = 0.287$$

$$t_n = 12 \times 0.287 / 5^3 = 0.03$$

String R6

↳ 0.3 × 0.35 = 0.105 [t/m]

$$z_n = \frac{0.105 \times 4^2 \times 100}{8 \times 1.6} = 13.125$$

$$t_n = 6 \times 13.125 / 20^2 = 0.09$$

$$J_n = \frac{5 \times 0.00105 \times 400^3 \times 300}{384 \times 2{,}100} = 125.0$$

$$t_n = 12 \times 125.0 / 30^3 = 0.06$$

Q 0.105 × 2 = 0.21

Sub Beam B5

H-200×100×5.5×8

(END)

2. 冷房・換気設計計算書

目　次

1. 概 要.

工事名称　バングラデシュ 自動車修理工場
衛生・空調設備工事

延面積　18.000 m²

位 置　国名：バングラデシュ
北緯　23°45′
東経　90°15′
海抜　8m.

2 設計条件

気候条件

夏季設計外気温度 (4月)		37.2°C (D.B)
	平均湿度	78 %
	デイリーレンジ	10°C
冬季設計外気温度 (2月)		10°C (D.B)
最高外気温	40.5°C	(4月)
最低外気温	6.6°C	(2月)
年間雨量	2012 mm/年	
24時間の最大雨量	236 mm/日	
雨期	4～10月	
風	2.2 m/s	

参考「アジアの気候」

3 冷房計算

冷房設備を必要とする部屋は次の3部屋である。

(1) 「INJ. PUMP SHOP」 HEAVY REPAIR FACTORY

(2) 「GENERAL MANAGER ROOM」 GENERAL OFFICE BLDG.(1F)

(3) 「ADVISOR'S OFFICE ROOM」 GENERAL OFFICE BLDG.(2F)

部屋の構造体が (1) と (2),(3) と違う。

(1) 「INJ. PUMP SHOP」の冷房負荷計算

外気　37.2°C (D.B.)　78%

室内　26.0°C (D.B.)　55%

構造体熱貫流率　(KCAL/M²hr·°C)

外壁	1.6	(床上 1.5m まで)
	0.5	(〃 以上)
間仕切壁	1.4	(床上 1.5m まで)
	0.4	(〃 以上)
屋根	1.0	
床	安全サイドなので計算しない。	

温度差

外壁の相当温度差 I　(°C)

	10:00	12:00
N	6.9	7.2
E	11.2	11.0

外壁の相当温度差 II　(°C)

	10:00	12:00
N	9.5	15.0
E	26.8	18.8

屋根の相当温度差　(°C)

	10:00	12:00
H	34	42.5

間仕切の温度差　$37.2 - \frac{37.2+26.0}{2} = 5.6$ °C

室内発生熱

照明　20W/M²

人員　3人　71 kcal/Hr·人 SHG.
152 kcal/Hr·人 LHG

隙間風　両開き1ヶ所　30 M³/Hr 人

(2) 「GENERAL MANAGER ROOM」,「ADVISOR'S OFFICE ROOM」の
冷房負荷計算

室内　26.0°C (D.B)　78%

外気　37.2°C (D.B)　55%

構造体熱損流率　(KCAL/M²Hr·°C)

外壁	1.6
窓	5.5
間仕切壁	2.5
床	1.7
天井	1.2
屋根	1.4

温度差及び日射量

外壁の相当温度差 (°C)

	16:00	18:00
N	5.7	6.2
S	8.8	9.6
W	9.3	13.1

普通ガラスを通過する日射量 (KCAL/M²Hr)

	16:00	18:00
N	29	16
S	31	5
W	436	153

屋根の相当温度差 (°C)

	16:00	18:00
H	20.8	22.8

非冷房仕様との温度差　　37.2 − $\frac{35.2+26.0}{2}$ = 5.6

室内発生熱

照明　　20 W/M²

人員　　1人　　50 kcal/Hr人　S.H.G

60 kcal/Hr人　L.H.G

隙間風　　室容積 × 0.7回/Hr

（空調ハンドブックより）

集計　　単位 KCAL/Hr

	S.H.G.	L.H.G.	TOTAL
INJ. PUMP SHOP	7,510	1,810	9,320
GENERAL MANAGER RM.	6,020	1,370	7,390
ADVISOR'S OFFICE RM.	7,840	1,570	9,410

「INJ. PUMP. SHOP」は OA を入れるのでパッケージ型を，「GENERAL MANAGER. ROOM」と「ADVISOR'S OFFICE RM」の様な小さいウインドクーラーを考えることにする。

4 換気計算

換気設備を必要とする個所は、窓のない便所と給湯室，厨房および工場関係（塗装，溶接，熱発生個所，セメントなど）と部品倉庫である。次のページに必要換気回数から計算した換気風量の表をのせる。

必要換気回数（Hr）

塗装工場　30～60回/Hr　溶接工場　15～25回/Hr

倉庫　　5回/Hr

厨房　　40～80回/Hr　便所　15 回/Hr　など

建物名称	階	部屋名	室容積	換気回数(回)	換気風量(m³/H)
			m^3	回/Hr	m^3/Hr
PARTS STORAGE	GF	PARTS ROOM	11,270	5	56400
PAINT & BODY FACTORY	GF	PAINT SHOP	3570	45	160650
RETREADING & METAL CASTING FACTORY	GF	METAL CASTING SHOP	1,044	20	20,900
	GF	BOILER	379	30	11,400
	GF	HOT WATER SYSTEM	592	20	11,800
	GF	CEMENT ROOM	164	20	3,280
CHECK GATE	GF	KETTLE ROOM	12	7	84
CAFETERIA	GF	KITCHEN	467	60	28,020
	GF	TOILET	12	14	168
DORMITORY	GF	KITCHEN	139	60	8,340
GENERAL OFFICE BUILDING	GF	SANITARY CLOSET	24	—	360
	1F	KETTLE ROOM	15	—	360

第1種換気を必要とする個所は PARTS STORAGE だけで 他は第3種換気を行なう。

5 冷房機器

(1) 「INJ. PUMP SHOP」

機器 AIR COOLED SPLIT TYPE AIR CONDITIONER 2台

SHG 3760 kcal/hr

LHG 910 kcal/hr

OA風量 150 m³/2 = 75 m³/hr

OA負荷 240 kcal/hr

SUPPLY風量 (吹出温度 17°C)

$\frac{3760}{0.29 \times 9}$ = 1443 m³/hr

24 m³/min

機器仕様

室内機器 三菱重工 DP-34 V1

冷房能力 7,100 kcal/hr (外気 37.2°C)

SUPPLY風量 1,440 m³/hr

冷 媒 R-22

消費電力 3φ × 415V × 50Hz × 3.3kW

(2) 「GENERAL MANAGER ROOM」

機器 WINDOW TYPE AIRCONDITIONER × 2台.

室内冷房負荷 7390 kcal/hr/2 = 3700 kcal/hr/台

機器仕様

参考機器 トショウ CW-171PS235T

冷房能力 4,020 kcal/hr (外気 37.2°C)

排気可能型

冷媒 R-22

消費電力 1φ × 240V × 50Hz × 2.4 kW

(3) 「ADVISOR'S OFFICE ROOM」

機器 WINDOW TYPE AIRCONDITIONER × 2台.

室内冷房負荷 9410 kcal/hr/2 = 4710 kcal/hr/台

機器仕様

参考機器 トショウ CW-291PS235T

冷房能力 5.560 kcal/hr (外気 37.2°C)

排気可能型

冷媒 R-22

消費電力 1φ × 240V × 50Hz × 3.9 kW

6 換気機器

(1) DOUBLE SUCTION CENTRIFUGAL FAN

PARTS STORAGE の給気に用いる。

FAN ROOM と DECKに1ヶ所 MONITOR ROOF

に2ヶ所 設ける。

機器仕様

a) FAN ROOM (DECK)

参考機器 エバラ DRM NO4

送風量 27000 M^3/HR (450 M^3/MIN)

静圧 45 mmAg

消費電力 $3\phi \times 415^V \times 50^{HZ} \times 7.5^{KW}$

b) FAN ROOM (MONITOR ROOF 2ヶ所)

参考機器 エバラ DRM NO3 × 2台

送風量 16,200 M^3/HR (270 M^3/MIN)

静圧 40 mmAg

消費電力 $3\phi \times 415^V \times 50^{HZ} \times 5.5^{KW}$

(2) TUBULAR ROOF FAN

2ヶ所ある厨房でフードからの直接排気に使う。

機器仕様

a): CAFETERIA フード 3600 x 2400

参考機器 アサヒ RTFKV-75

排気風量 15,000 M³/HR

静圧 30 mm Ag

消費電力 3φ x 415V x 50HZ x 3.7KW

b) CAFETERIA フード 2800 x 2400

参考機器 アサヒ RTFKV-55

排気風量 13,000 M³/HR

静圧 30 mm Ag

消費電力 3φ x 415V x 50HZ x 3.7KW

c) DORMITORY フード 2,000 x 1400

参考機器 アサヒ RTFKV-70

排気風量 8,400 M³/HR

静圧 30 mm Ag

消費電力 3φ x 415V x 50HZ x 2.2KW

3機種共 耐気耐油仕様 とする

(3) ROOF FAN

工場の排気は 次の3種類のルーフ.ファンを使う。

機器仕様

a) PAINT SHOP

参考機器　カマクラ　RF-42H

排気風量　37,200 M³/Hr

消費電力　3Φ×415V×50HZ×2.2KW

b) METAL CASTING SHOP, BOILER, HOT WATER SYSTEM

参考機器　カマクラ　RF-24H

排気風量　11,700 M³/Hr

消費電力　3Φ×415V×50HZ×0.75KW

c) CEMENT ROOM

参考機器　カマクラ　RF-16H

排気風量　2,580 M³/Hr

静圧　10 mmAq

消費電力　3Φ×415V×50HZ×0.25KW

(4) CEILING TYPE VENTILATING FAN

窓がなく，外壁に面していない便所，湯沸室等の排気に使う。

機器仕様

a) KETTLE ROOM ; CHECK GATE

参考機器　ナショナル　FY-14 BFT

排気風量　84 M³/Hr

静圧　5 mmAq (ダクト＋ベントキャップ)

消費電力　1φ×240V×50Hz×0.023KW

b) TOILET ; CAFETERIA

参考機器　ナショナル　FY-18 BFT

排気風量　168 M³/Hr

静圧　5 mmAq (ダクト＋ベントキャップ)

消費電力　1φ×240V×50Hz×0.038KW

c) KETTLE ROOM, SANITARY CLOSET ; GEIERAL OFFICE ROOM.

参考機器　ナショナル　FY-20 BFT

排気風量　360 M³/Hr

静圧　5 mmAq (ダクト＋ベントキャップ)

消費電力　1φ×240V×50Hz×0.05KW

(5) FILTER 類

a) OA. FILTER

ガラリからの給気に フィルターを つける。

フィルター通過風速を 2m/s で選んだ。

フィルター 仕様

フィルタリン ユニット型エアフィルター VA-25型
500^W × 500^H × 25^T

FAN ROOM1 (ウエスト)

$$\frac{27000\ (m^3/hr)}{3600 \times 2\ (m/s) \times 0.25\ (m^2)} = 15\ (台)$$

3段 5列

FAN ROOM2.3 (MONITOR ROOF)

$$\frac{16200\ (m^3/hr)}{3600 \times 2 \times 0.25} = 9\ (台)$$

3段 3列

b) GREASE FILTER

厨房のフードには グリースフィルターを つける。

フィルター通過風速を 1.5m/s ~ 2m/s で選んだ。

フィルター 仕様

フィルター フィルター FN2020 , FN1625

FN2020 500^W × 500^H × 45^T

FN1625 400^W × 630^H × 45^T

フード 3600×2400

FN2020 × 12枚 静圧 21mmAq

フード 2800×2400

FN2020 × 10枚 静圧 22mmAq

フード 2000×1400

FN1625 × 6枚 静圧 24mmAq

LOAD ESTIMATING SHEET (B) NO. 549-44

STORIES		ROOM NAME	INJ. PUMP SHOP	ROOM AREA	W×L=Am² 87.5	ROOM VOLUME	A×H=Vm³ 350	SYSTEM	

SENSIBLE HEAT LOAD					SUMMER				WINTER		
I. SOLAR & TRANS. GAIN THRU STRUCTURES					SUN TIME 12 H		SUN TIME 10 H		SENSIBLE HEAT LOSS		
	DIREC.	W×H	AREA	K	TEMP. DIFF.	HEAT GAIN	TEMP. DIFF.	HEAT GAIN	DIREC. FACTOR	TEMP. DIFF.	HEAT LOSS
		m×m	m²	Kcal/h·m²·℃	℃	Kcal/h	℃	Kcal/h		℃	Kcal/h
WALL	N		16.0	1.6	7.2	180	6.9	180			
			55.0	0.5	15.0	410	9.5	260			
	E		12.5	1.6	11.0	220	11.2	220			
			43	0.5	18.8	400	26.8	580			
GLASS											
PARTITION			28.5	1.4	5.6	220	5.6	220			
			47.0	0.4	5.6	110	5.6	110			
FLOOR											
CEILING											
ROOF			37.5	1.0	42.5	3720	39	2980			
SUB TOTAL (I)						5260		4450	SUB TOTAL		
II. SOLAR GAIN THRU GLASS				F	Ks		Ls		INFILTRATION		
GLASS									m³×	R/h×0.288	
									×		
SUB TOTAL (II)									TOTAL (SH)		

III. INTERNAL HEAT GAIN				LATENT HEAT LOSS		
INCANDE. LIGHT	KW× 860			INFILTRATION		
FLUORE. LIGHT	20W/m² × 87.5 KW×1.000		1750	m³×	R/h×715	
				×		
PEOPLE	WALKING 3 × 37		210			
	SEATED ×			TOTAL (LH)		
INFILTRATION	90 m³× R/h×0.288	11.2	290	GRAND TOTAL		
SUB TOTAL (III)			2250	REMARKS:		
TOTAL OF SENSIBLE HEAT LOAD (I+II+III)			7510	DESIGN CONDITION		
IV LATENT HEAT LOAD				(A) 26.0°C 55%		
PEOPLE	WALKING 3 × 152		460			
	SEATED ×			(O) 37.2°C 78%		
INFILTRATION	90 m³× R/h×715	0.0326 0.2116	1350			
TOTAL OF LATENT HEAT LOAD (IV)			1810			
GRAND TOTAL OF HEAT GAIN			9320			
SENSIBLE HEAT FACTOR %						
SUPPLY AIR QUANTITY m³/h						
OUTDOOR AIR QUANTITY m³/h						
REMARKS:						

LOAD ESTIMATING SHEET (B)

NO. 53V 75

STORIES		ROOM NAME	GENERAL MANAGER ROOM	ROOM AREA	W×L=A m²	ROOM VOLUME	A×H=V m³	SYSTEM	
					41.7		125		

SENSIBLE HEAT LOAD					SUMMER				WINTER		
I. SOLAR & TRANS. GAIN THRU STRUCTURES					SUN TIME 16 H		SUN TIME 18 H		SENSIBLE HEAT LOSS		
	DIREC.	W×H	AREA	K	TEMP. DIFF.	HEAT GAIN	TEMP. DIFF.	HEAT GAIN	DIREC. FACTOR	TEMP. DIFF.	HEAT LOSS
		m×m	m²	Kcal/h·m²·℃	℃	Kcal/h	℃	Kcal/h		℃	Kcal/h
WALL	W		26.8	1.6	9.3	400	13.1	560			
	S		16.0	1.6	8.8	230	9.6	250			
	N		4.6	1.6	5.7	40	6.2	50			
GLASS	W		5.8	5.5	11.2	360	11.2	360			
	S		5.8	5.5	11.2	360	11.2	360			
PARTITION			25.5	2.5	5.6	360	5.6	360			
FLOOR			41.7	1.7	5.6	400	5.6	400			
CEILING											
ROOF											
SUB TOTAL (I)						2150		2340	SUB TOTAL		
II. SOLAR GAIN THRU GLASS				F	Le		Le				
GLASS									INFILTRATION		
	W		5.8 m²		436	2530	153	890	m³×	R/h×0.288	
	S		5.8		31	180	5	30	×		
SUB TOTAL (II)						2710		920			
III. INTERNAL HEAT GAIN									TOTAL (SH)		
INCANDE. LIGHT		KW× 860							LATENT HEAT LOSS		
FLUORE. LIGHT		20 W/m² × 41.7	KW×1,000			830			INFILTRATION		
									m³×	R/h× 715	
									×		
PEOPLE		WALKING ×									
		SEATED 1 × 50				50			TOTAL (LH)		
INFILTRATION		125 m³× 0.7	R/h×0.288		11.2	280			GRAND TOTAL		
SUB TOTAL (III)						1160			REMARKS:		
TOTAL OF SENSIBLE HEAT LOAD (I + II + III)						6020			DESIGN COND.		
IV LATENT HEAT LOAD									26.0°C 55% (R.H.)		
PEOPLE		WALKING ×							32.2°C 28% (0.7)		
		SEATED 1 × 60				60					
INFILTRATION		125 m³× 0.7	R/h×715	0.0126 / 0.0116		1310					
TOTAL OF LATENT HEAT LOAD (IV)						1370					
GRAND TOTAL OF HEAT GAIN						7390					
SENSIBLE HEAT FACTOR				%							
SUPPLY AIR QUANTITY				m³/h							
OUTDOOR AIR QUANTITY				m³/h							
REMARKS:											

LOAD ESTIMATING SHEET (B)

NO. 551/46

STORIES		ROOM NAME	ADVISORS OFFICE ROOM	ROOM AREA	W×L=A m² 48.1	ROOM VOLUME	A×H=V m³ 144	SYSTEM	

SENSIBLE HEAT LOAD					SUMMER				WINTER		
I. SOLAR & TRANS. GAIN THRU STRUCTURES					SUN TIME 16 H		SUN TIME 13 H		SENSIBLE HEAT LOSS		
	DIREC.	W×H	AREA	K	TEMP. DIFF.	HEAT GAIN	TEMP. DIFF.	HEAT GAIN	DIREC. FACTOR	TEMP. DIFF.	HEAT LOSS
		m×m	m²	Kcal/h m²·℃	℃	Kcal/h	℃	Kcal/h		℃	Kcal/h
WALL	W		26.8	1.6	9.3	400	13.1	560			
	S		16.0	1.6	8.8	230	9.6	250			
	N		16.0	1.6	5.7	150	6.2	160			
GLASS	W		5.8	5.5	11.2	360	11.2	360			
	S		5.8	5.5	11.2	360	11.2	360			
	N		5.8	5.5	11.2	360	11.2	360			
PARTITION			25.5	2.5	5.6	360	5.6	360			
FLOOR											
CEILING											
ROOF			48.1	1.5	20.3	1400	22.8	1560			
SUB TOTAL (I)						3620		3950	SUB TOTAL		
II. SOLAR GAIN THRU GLASS			m²	F	Ks		Ks				
GLASS									INFILTRATION		
	W		5.8		436	2530	153	890	m³×	R/h×0.288	
	S		5.8		31	180	5	30	×		
	N		5.8		29	170	6	90			
SUB TOTAL (II)						2880		1010			
III. INTERNAL HEAT GAIN									TOTAL (SH)		
INCANDE. LIGHT		KW × 860							LATENT HEAT LOSS		
FLUORE. LIGHT		20W/m² × 48.1 m² × 1.00				960			INFILTRATION		
									m³×	R/h× 715	
									×		
PEOPLE		WALKING ×									
		SEATED 1 × 50				50			TOTAL (LH)		
INFILTRATION		144 m³ × 0.7 R/h×0.288			11.2	330			GRAND TOTAL		
SUB TOTAL (III)						1340			REMARKS:		
TOTAL OF SENSIBLE HEAT LOAD (I + II + III)									DESIGN COND.		
IV LATENT HEAT LOAD									26.0℃ 55% (ROOM)		
PEOPLE		WALKING ×							37.2℃ 78% (OUT)		
		SEATED 1 × 60				60					
INFILTRATION		144 m³ × 0.7 R/h×715			0.33 g/kg' 0.31 g/kg'	1510					
TOTAL OF LATENT HEAT LOAD (IV)						1570					
GRAND TOTAL OF HEAT GAIN						2910					
SENSIBLE HEAT FACTOR				%							
SUPPLY AIR QUANTITY				m³/h							
OUTDOOR AIR QUANTITY				m³/h							
REMARKS:											

S-071114

3. 給排水設備設計計算書

目　次

1. オイルタンク

燃料　C重油

ボイラの燃料使用量　200kg/Hr

タンク容量　200kg/Hr ×8Hr/日×10日 /0.9kg/l = 17800 l

→ 1800φ× 6800L　有効容積 16580 l

コロッケ式

2. オイルサービスタンク

(1) C重油系統

タンク容量

1時間分とする。

200kg/0.9 = 220 l

→ 750×750×850H　フロートスイッチ、蒸気ヒータ付.

(2) A重油系統

ボイラのたき始めのみに用いる。

500×500×650H

3. オイルギアポンプ（C重油系統）

ボイラ燃料使用量の3倍とすると

200kg/Hr×3÷60÷0.9 = 11 l/MIN.

→ 参考型番

エバラ GPE　15φ×10 l/MIN ×3kg/cm² ×0.4kW

4. 排水ポンプ

4-1. HEAVY REPAIR FACTORY の STEAM CLEANER 廃排水ポンプ

4-1-1 水量

槽大きさを 1500^{L}×1000^{W} とし ON, OFF 間の水位差を 600 とする。 この水量を5分で排出するものとすると

1.5×1×0.6×1000÷5=180ℓ/MIN → 250ℓ/MIN

(スチームクリーナ 1600ℓ/HR×3÷60=80ℓ/MIN)

4-1-2 揚程

実揚程 1.4M

配管、バルブ等 2.0M

3.4M → 4M AQ.

参考型番

エバラ 50DSS 5.75 水中雑排水ポンプ

50^{φ}×250ℓ/MIN×4M AQ×0.75kW ×2台

4-2. INSPECTION FACTORY 及 RETREADING 用排水ポンプ

4-2-1 水量.

1-1に同じ (250ℓ/MIN)

4-2-2 揚程

実揚程 3.2M

配管バルブ等 2.0M

5.2M → 6M AQ

参考型番

エバラ 50 DSS 5.75 水中雑排水ポンプ

50^{φ}×250ℓ/MIN×6M AQ×0.75kW ×2台 ×2SETS

5. コンプレッサー用冷却塔

40ℓ/MIN × 6台 = 240ℓ/MIN

水温　50℃/40℃ (IN/OUT)

外気　35℃　40%　WB 33.5℃

参考型番　SBC-20　0.4kW

6. 冷却水ポンプ

水量 240ℓ/MIN

揚程

実揚程	2MAq
摩擦	3
COMP	6
配管等	3
	14MAq

参考型番

エバラ　50LPD5 1.5　ラインポンプ

50Φ, 240ℓ/MIN × 14MAq, 1.5kW

7. HEAVY REPAIR FACTORY シャワー用電気ボイラ

1. 型式

工場全体で湯の出るシャワーは1ヶ所しか無いので多数の人が、連続的に使用する事が予想される。

→ しゅん間式とする。

2. 能力

13ℓ/MIN の水を 15°C から 45°C に上昇させ得るものとする。

$$出力 = 13ℓ/MIN \times (45 - 15°C) \times \frac{60}{860} \times \underset{(ロス)}{1.05} \fallingdotseq 28.6^{kW}$$

参考型番

日本イトミック EI-30　30kW

1050H × 770W × 190D　瞬間式、復管式

8 給水設備

8-1 予想給水量

〔SENTRAL WORK SHOP〕

生活用水

1日予想給水量	$750^{人} \times 10^{l/d\cdot 人} = 75,000^{l/d}$
時間平均給水量	$75,000^{l/d} \div 8^{h} = 11.875^{l/h}$
時間最大給水量	$11,875^{l/h} \times 2 = 23,750^{l/h}$
瞬時最大給水量	$\frac{11,875^{l/h} \times 3}{60^{min/h}} = 594^{l/min}$

洗車用水

1日予想給水量	$30^{台/d} \times 3500^{l/台} = 105,000^{l/d}$
時間平均給水量	$105,000^{l/d} \div 8^{l/d} = 13,125^{l/h}$
時間最大給水量	〃
瞬時最大給水量	$13,125^{l/h} \div 60 = 219^{l/min}$

床洗浄用水

1日予想給水量	$50^{台} \times 30^{l/min} \times 5^{min} = 7500^{l/d}$
時間平均給水量	〃
時間最大給水量	〃
瞬時最大給水量	$7500^{l/min} \div 5^{min} = 1500^{l/min}$

スチームクリーナー

1日予想給水量	$12^{台} \times 10^{l/min} \cdot 60^{min} \times 8^{h} = 57,600^{l/d}$
時間平均給水量	$57,600^{l/d} \div 8^{l/d} = 7,200^{l/h}$
時間最大給水量	〃
瞬時最大給水量	$7,200^{l/h} \div 60^{min/h} = 120^{l/min}$

RETRGADING

1日予想給水量	2500 L/人 × 8 人 =	20,000 L/日
時間平均給水量		2,500 L/h
時間最大給水量		2,500 L/h
瞬時最大給水量	2500 L/h ÷ 60 min =	42 L/min

(TRAINING INSTITUTE)

生活用水

1日予想給水量	80人×200 L/人·日 + 30人×100 L/人·日 =	19,000 L/日
時間平均給水量	19,000 L/日 ÷ 8 h =	2,375 L/h
時間最大給水量	2,375 L/h × 2 =	4,750 L/h
瞬時最大給水量	2,375 L/h × 3 ÷ 60 min/h =	119 L/min

TRAINING RM 洗浄用水

1日予想給水量	5人×30 L/min×5 min =	750 L/日
時間平均給水量		
時間最大給水量		
瞬時最大給水量	750 L/日 ÷ 5 min/日 =	150 L/min

〔合 計〕

1日予想給水量	95,000+103,000+7,500 +57,600+20,000+18000+750 =	304,850 L/日
時間平均給水量	11,875+13,125+7500 +7200+2,500+2375+750 =	45,325 L/h
時間最大給水量	23,750+13,125+7500 +7,200+2,500+4750+750 =	59,575 L/h
瞬時最大給水量	594+219+1500+120 +42+119+150 =	2744 L/min

8-2 高架水槽

容量　$V_E = (Q_P - Q_{PU}) T_3 + Q_{PU} \cdot T_4$

Q_P：瞬時最大給水量　(2,744 ℓ/min)

Q_{PU}：揚水ポンプの揚水量 (950 ℓ/min)

T_3：瞬時最大給水量の継続時間　(20 min)

T_4：揚水ポンプの最短運転時間　(15 min)

$V_E = (2744 - 950) \times 20 + 950 \times 15 = 50,130$ ℓ

∴ 高架水槽容量は50 m³とする。

高さ　$H = H_1 + H_2 + H_3$

H_1：実揚程　(12.8 m)

H_2：損失水頭　(9.0 m)

H_3：吐出水頭　(10.0 m)

$H = 12.8 + 9.0 + 10.0 = 31.8$ m

8-3 受水槽　時間平均給水量の2時間分とする。

43.113 × 2 = 86.226 ℓ

∴ 100 m³とする。

8-4 揚水ポンプ

揚水量　(950 ℓ/min)

揚程　$H = (H_1 + H_2 + H_3) \times 1.1$

H_1：実揚程　(35.0 m)

H_2：損失水頭　(2.0 m)

H_3：吐出水頭　(3.0 m)

$H = (35.0 + 2.0 + 3.0) \times 1.1 = 44$ m

ポンプ仕様　100A × 4段 × 950 ℓ/min × 44 m × 15 kW

2台 自動交互運転

8-5 井水ポンプ（水中ポンプ）

揚水量　時間平均給水量を揚水量とする。

(45,325 l/d ÷ 60 min)　≒ 755 l/min

揚程　静水位 6 m であるが水位低下を考慮し 35 m とする。

ポンプ仕様

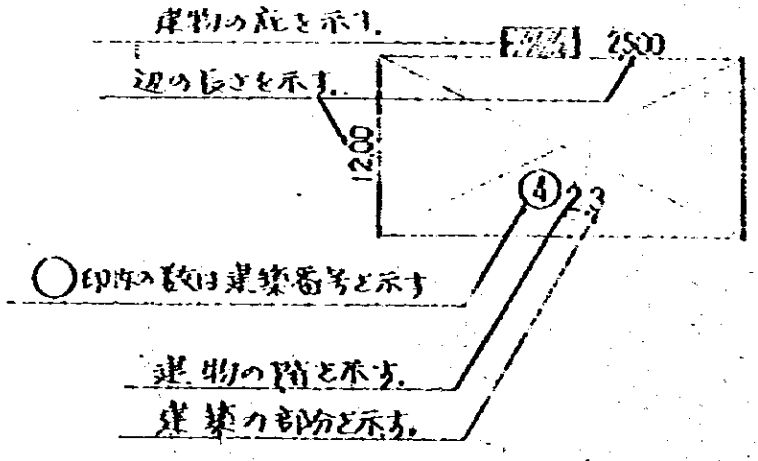
100 A × 3段 · 755 l/min · 35 m · 11 kW

4. 建築床面積計算書

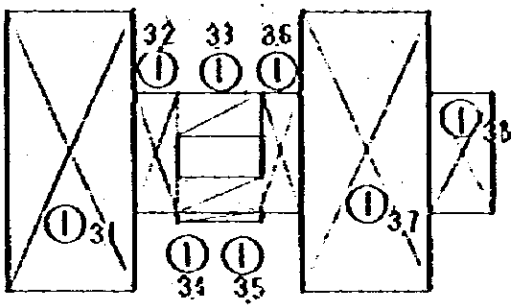
建築面積表

建築物		建築床面積 (㎡)			
NO	建築名称	1階	2階	3階	合計
①	事務所	473.94	461.29	461.29	1396.52
②	教室棟	565.15	491.56		1056.71
③	宿舎	590.24	283.55	287.55	1161.34
④	食堂	754.95			754.95
⑤	実習棟	1,161.33			1161.38
⑥	守衛所	129.92			129.92
⑦	エアコンプレッサー室	88.94			88.94
⑧	貯油庫	136.74			136.74
⑨	変電所	117.50			117.50
⑩	重整備工場	4,003.62	192.39	87.45	4283.46
⑪	部品倉庫	1.717.20			1,717.20
	揚水ポンプ室	16.00			16.00
	さくせんポンプ室	5.41			5.41
⑫	検査場	636.00	53.00		689.00
⑬	定期点検整備工場	2,003.40	121.90		2125.30
⑭	塗装.車体工場	1,508.00	145 75		1,653.75
⑮	灯油再生.鋳鉄造工場	1311.75	141.30		1,453.05
		15,220.11	1,894.74	836.29	17,951.17

凡例

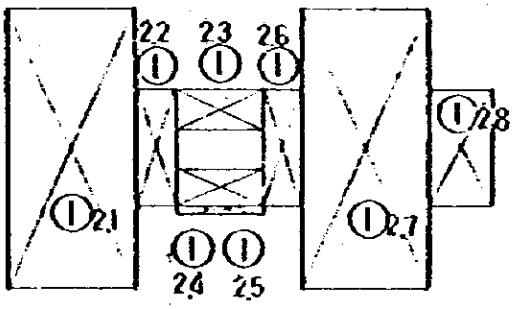


① 事務所　　1:500



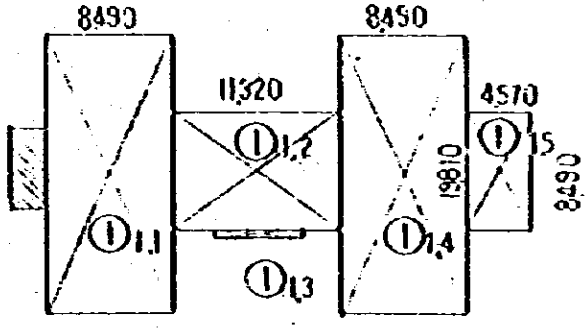
3 F.L

①31	19810 × 8490	=168.1869
①32	8490 × 2830	= 24.0267
①33	2830 × 6550	= 18.5365
①34	3730 × 6550	= 24.4315
①35	470 × 5660	= 2.6602
①36	8490 × 1940	= 16.4706
①37	19810 × 8490	=168.1869
①38	8490 × 4570	= 38.7933
		461.2386



2 F.L

①2.1	19810 × 8490	=168.1869
①2.2	8490 × 2830	= 24.0267
①2.3	2830 × 6550	= 18.5365
①2.4	3730 × 6550	= 24.4315
①2.5	470 × 5660	= 2.6602
①2.6	8490 × 1940	= 16.4706
①2.7	19810 × 8490	=168.1869
①2.8	8490 × 4570	= 38.7933
		461.2986

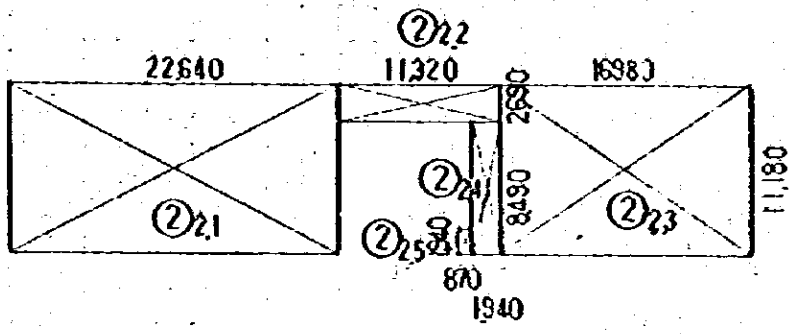


1 F.L

①1.1	19810 × 8490	=168.1869
①1.2	8490 × 11320	= 96.1098
①1.3	470 × 5660	= 2.6602
①1.4	19810 × 8490	=168.1869
①1.5	8490 × 4570	= 38.7933
		473.9402

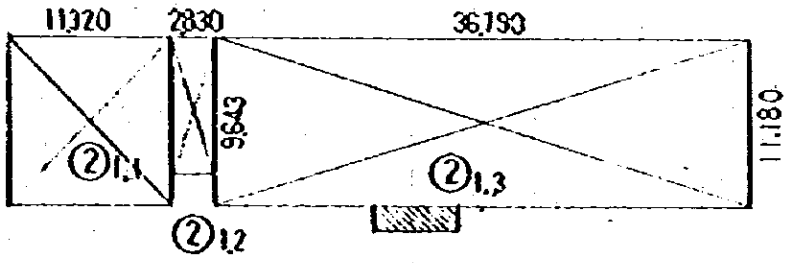
1396.52

② 教室棟　　1:500



2 F.L

②2.1	11.180 × 22640	= 253.1152
②2.2	2690 × 11.320	= 30.4508
②2.3	11.1800 × 16.980	= 183.8364
②2.4	8.490 × 1.940	= 16.4706
②2.5	1.940 × 870	= 1.6878
		491.5608

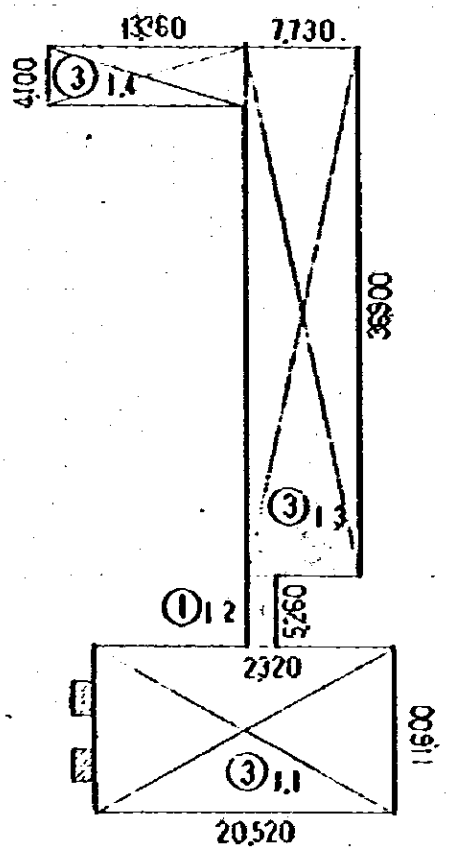


1 F.L

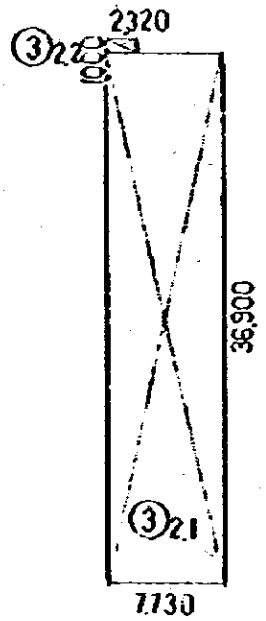
②1.1	11.180 × 11.320	= 126.5576
②1.2	9643 × 2830	= 27.2831
②1.3	11.180 × 36.790	= 411.3128
		565.1535

1056.71

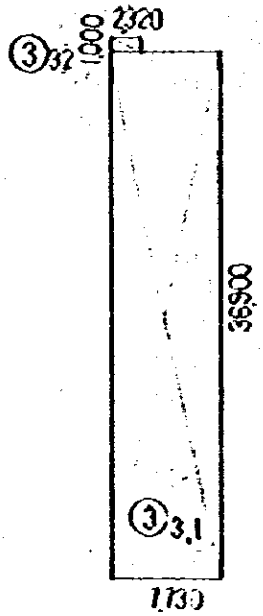
③ 宿　舎　　1：500



1 F.L



2 F.L



3 F.L

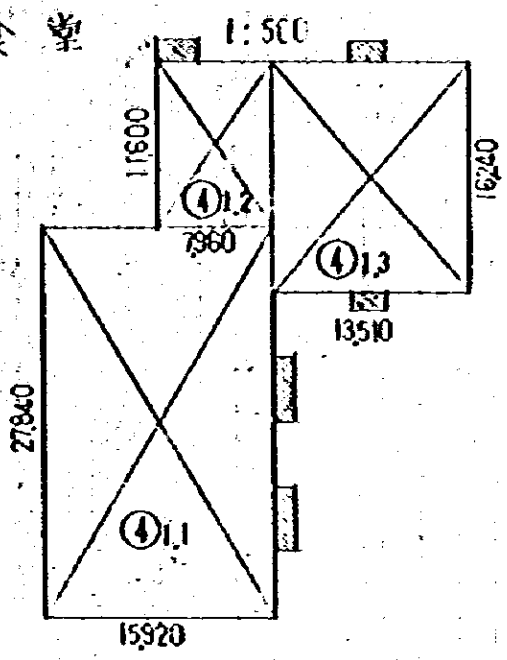
③1.1　11600×20520=2380320
③1.2　2320×　5260=　122032
③1.3　36900×　7730=285.2370
③1.4　4100×13360=　54776.0
590.2182

③2.1　36900×7730=285.2370
③2.2　1000×2320=　23200
287.5570

③3.1　36900×7730=285.2370
③3.2　1000×2320=　23200
287.5570

1165.34

④ 食堂

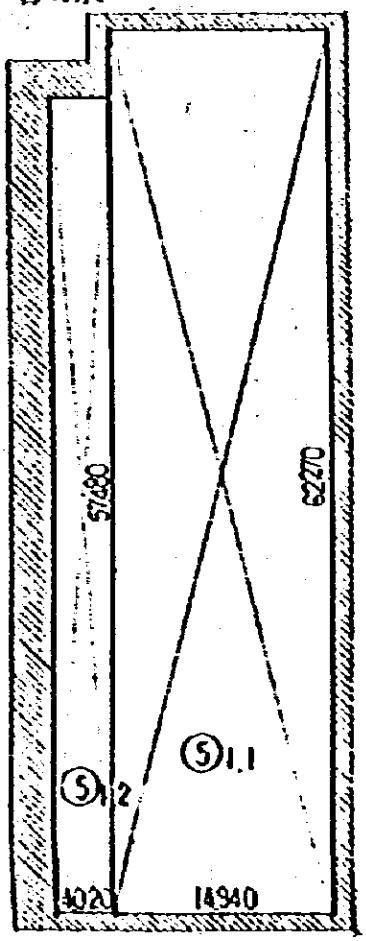


1 F.L

④1.3 16240×13510 = 219.4024
④1.2 11600× 7960 = 92.3360
④1.1 27840×15920 = 443.2128
754.9512

754.95

⑤ 東習棟

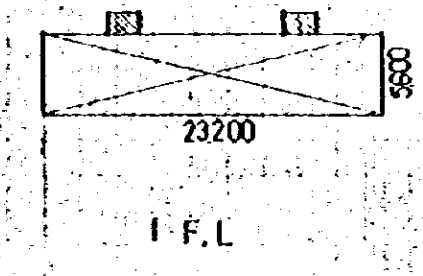


1 F.L

⑤1.2 4020×57480=231.0696
⑤1.1 14940×62270=930.3139
1161.3834

1161.38

⑥ 守衛所　1:500

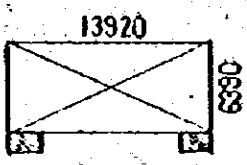


1 F.L

⑥　5600 × 23200 = 1299200

123.92

⑦ エアコンプレッサー室　1:500

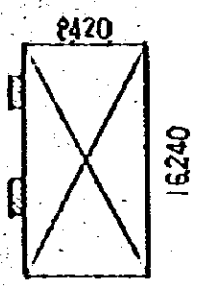


1 F.L

⑦　6390 × 13920 = 88,9488

88.94

⑧ 貯油庫　1:500

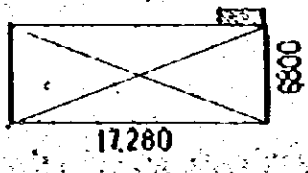


1 F.L

⑧　16240 × 8420 = 1367408

136.74

⑨ 変電所　1:500

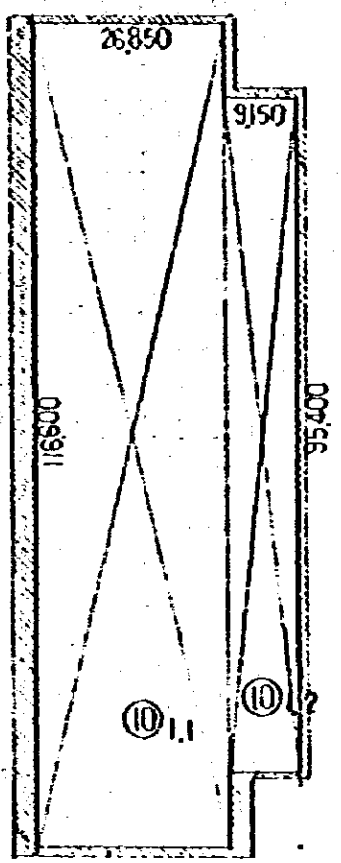


1 F.L

⑨　6800 × 17230 = 1175040

117.50

⑩ 重整備工場　　1:1000

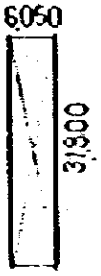


1 F. L

⑩1.1 116800×26850=3130.7100

⑩1.2 9540×9150= 872.9100

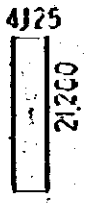
4003.6200



2 F. L

⑬2.1 31800×6050=192.3900

192.3900



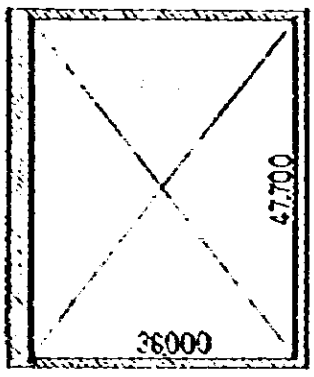
3 F. L

⑩3.1 21200×4125=87.4500

87.4500

4283.46

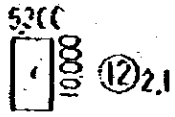
⑪ 部品倉庫　　1:1000



47700 × 36000 = 1717.2000

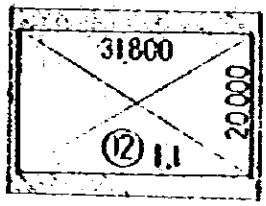
1717.20

⑫ 検 査 場　　1:100



2 F.L

⑫2.1　10.000×5300=53000

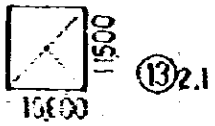


1 F.L

⑫1.1　20000×31800=636000

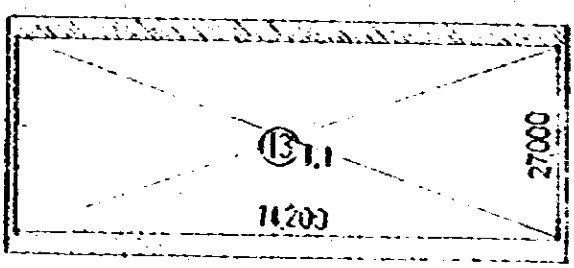
635.00

⑬ 定期点検整備工場　　1:1000



2 F.L

⑬2.1　11.500×10600 = 121900

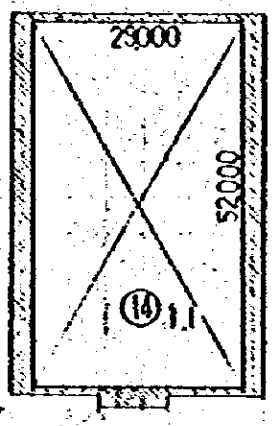


1 F.L

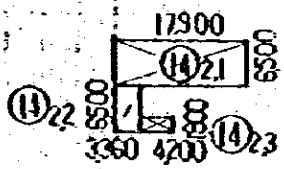
⑬1.1　27000×74200 = 2003400

212550

⑭ 塗装，車体工場　　1:100



1 F.L



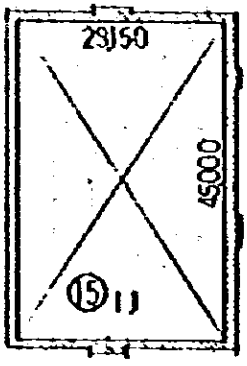
2 F.L

⑭1.1　52000×29000=1508000
1,508.0000

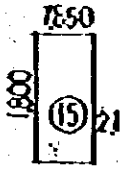
⑭2.1　17900×6500=116.3500
⑭2.2　6500×3360=21.8400
⑭2.3　1800×4200=7.5600
145.7500

1,653.75

⑮ タイヤ再生，鋳鉄工場　　1:100



1 F.L



2 F.L

⑮1.1　29150×45000=1311.7500

⑮2.1　1800×7850=141.3000

1453.05

揚水ポンプ室　1:500

4000×4000 = 160000

16,00

さくせんポンプ室　1:500

2032×2667 = 5419.0
5,419.0

5,41

JICA