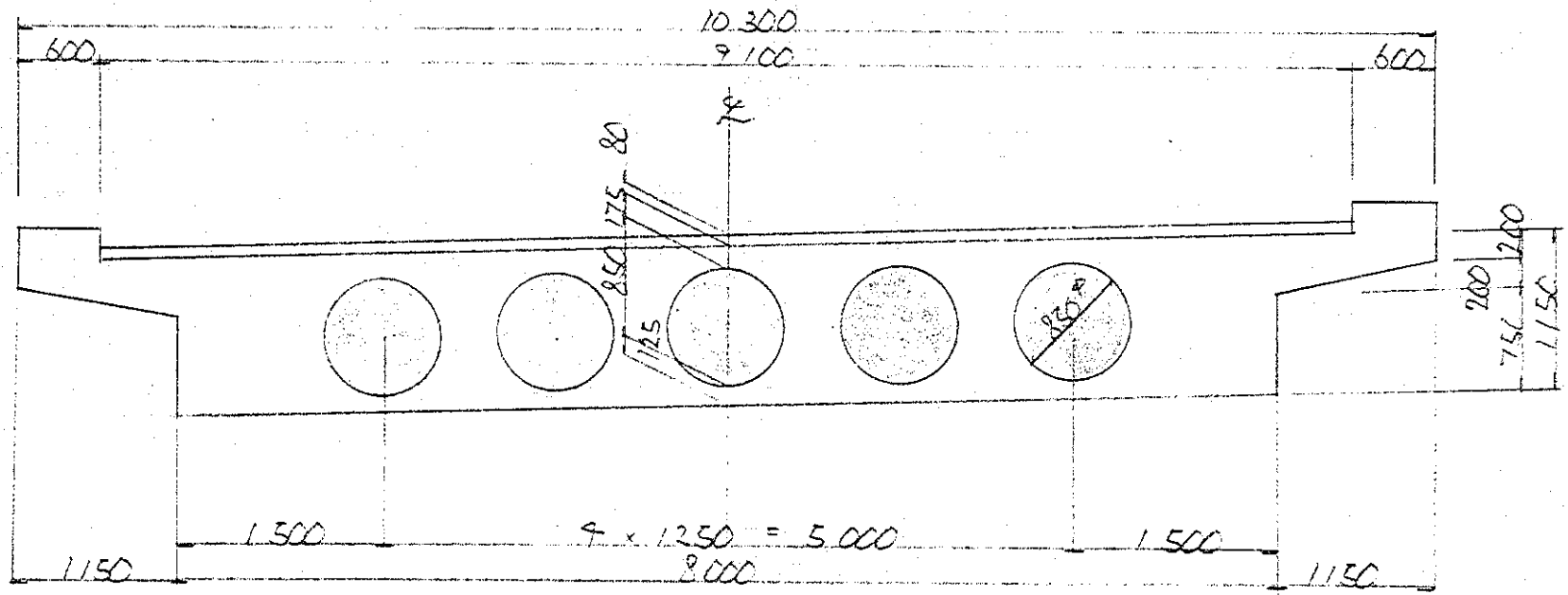
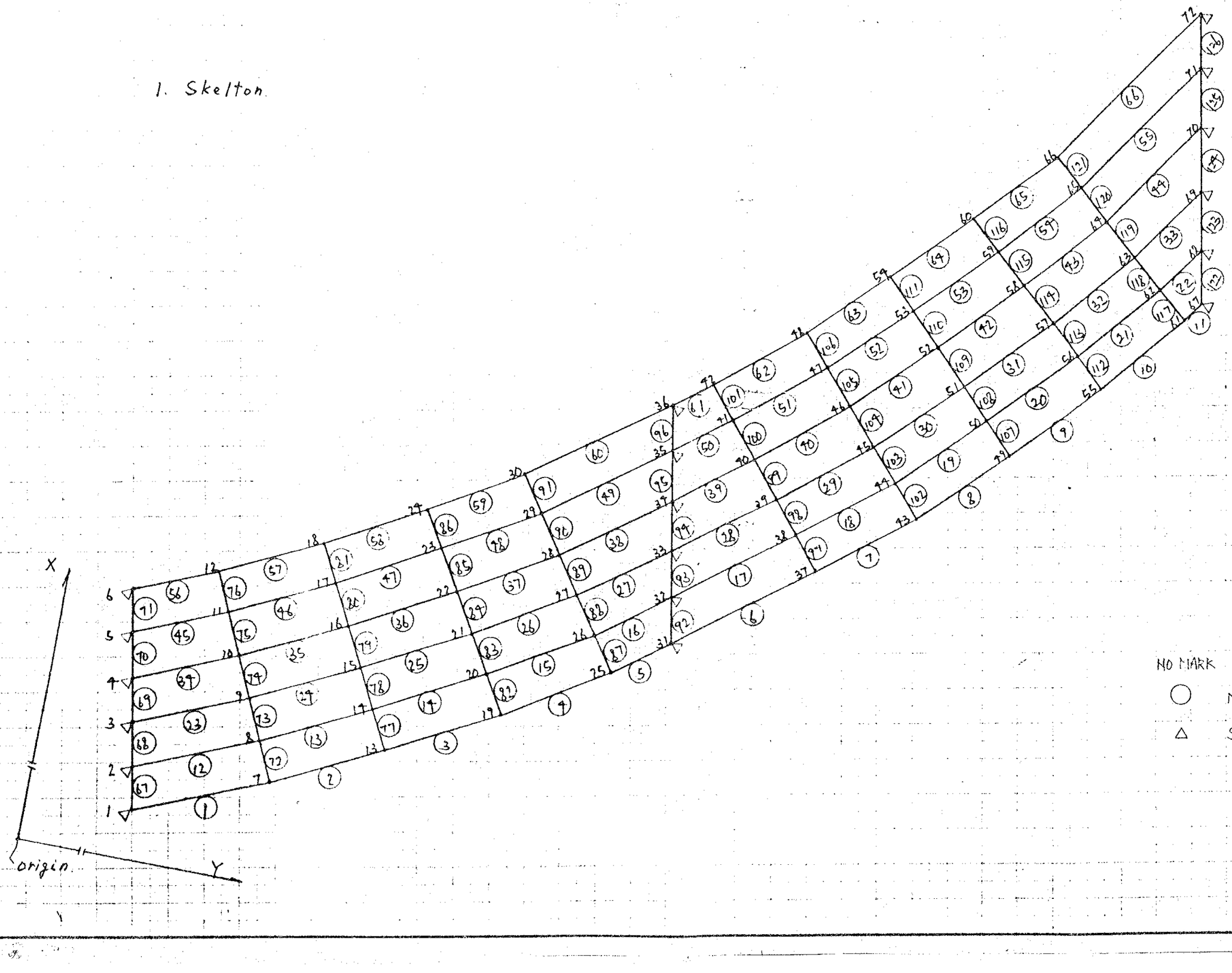
§§2 DESIGN OF MAIN SLAB

§1 PREPARATION



Typical cross section

1. Skelton



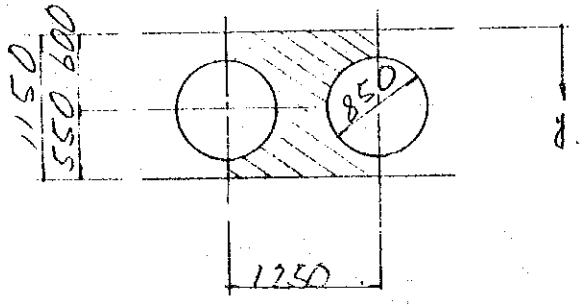
2. Co-ordinate

	X	Y		X	Y
1	23.395	79.595	31	30.168	93.991
2	24.989	79.358	32	31.890	93.685
3	26.299	79.171	33	33.253	93.982
4	27.500	78.983	34	34.623	93.278
5	28.757	78.796	35	35.999	93.073
6	30.355	78.558	36	37.757	92.811
7	24.759	83.361	37	32.943	97.956
8	26.233	82.779	38	34.213	97.009
9	27.395	82.311	39	35.213	96.259
10	28.556	81.899	40	36.213	95.509
11	29.713	81.387	41	37.213	94.755
12	31.193	82.800	42	38.989	93.802
13	26.097	86.971	43	39.959	100.501
14	27.535	85.806	44	36.179	99.985
15	28.670	85.282	45	37.134	98.685
16	29.805	89.759	46	38.095	97.835
17	30.990	89.235	47	39.055	97.085
18	32.382	83.570	48	90.275	96.069
19	27.592	89.505	49	37.092	102.939
20	28.996	88.769	50	38.259	101.862
21	30.102	88.181	51	39.177	101.019
22	31.208	87.597	52	90.096	100.166
23	32.313	87.019	53	91.019	99.319
24	33.717	86.273	54	92.180	98.292
25	29.251	92.455	55	39.352	105.265
26	30.613	91.690	56	90.962	104.130
27	31.686	90.999	57	91.336	103.236
28	32.759	90.357	58	92.211	102.343
29	33.832	89.716	59	93.089	101.999
30	35.195	88.901	60	94.199	100.319

	X	Y		X	Y
61	91.729	107.973			
62	92.779	106.282			
63	93.606	105.395			
64	94.933	104.908			
65	95.260	103.971			
66	96.311	102.280			
67	91.792	107.528			
68	93.866	107.219			
69	95.528	106.972			
70	97.219	106.720			
71	98.993	106.963			
72	51.187	106.129			

3. Flexural rigidity of main girder

Interior girder



$A = 1.25 \times 1.15 - \frac{1}{4}\pi \times 0.85^2$

$= 1.4375 - 0.5672 = 0.8703\ m^2$

$Ay = 1.4375 \times 0.575 - 0.5672 \times 0.600 = 0.4839\ m^3$

$Ay^2 = 1.4375 \times 0.575^2 - 0.5672 \times 0.600^2 = 0.2711\ m^4$

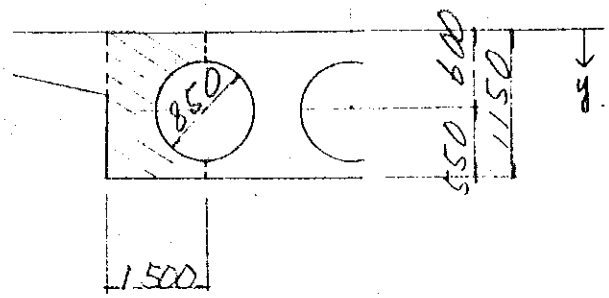
$I_o = \frac{1}{12} \times 1.25 \times 1.15^3 - \frac{1}{64}\pi \times 0.85^4 = 0.1328\ m^4$

$y = \frac{Ay}{A} = \frac{0.4839}{0.8703} = 0.556\ m$

$I = 0.2711 + 0.1328 - 0.8703 \times 0.556^2 = 0.1399\ m^4$

$I' = \frac{1}{12} \times 1.25 \times 1.15^3 = 0.1589\ m^4$

Edge girder



$A = 1.50 \times 1.15 - \frac{1}{4}\pi \times 0.85^2 \times \frac{1}{2}$

$= 1.7250 - 0.2836 = 1.7414\ m^2$

$Ay = 1.7250 \times 0.575 - 0.2836 \times 0.600 = 0.8217\ m^3$

$Ay^2 = 1.7250 \times 0.575^2 - 0.2836 \times 0.600^2 = 0.4682\ m^4$

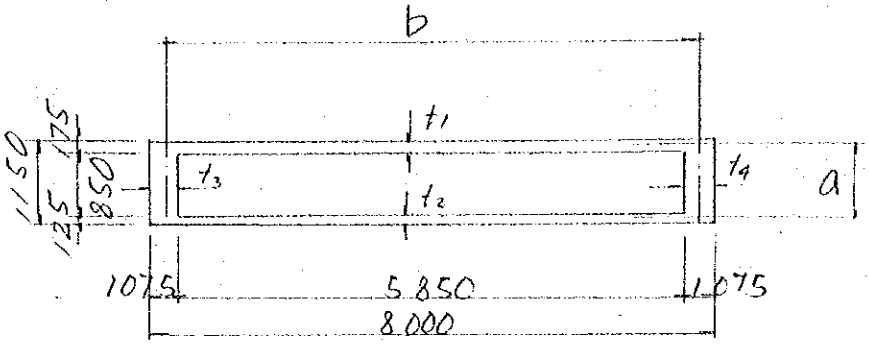
$I_0 = \frac{1}{12} \times 1.50 \times 1.15^3 - \frac{1}{64}\pi \times 0.85^4 \times \frac{1}{2} = 0.1773\ m^4$

$y = \frac{Ay}{A} = \frac{0.8217}{1.7414} = 0.570\ m$

$I = 0.4682 + 0.1773 - 1.7414 \times 0.570^2 = 0.1772\ m^4$

$I' = \frac{1}{12} \times 1.500 \times 1.15^3 = 0.1901\ m^4$

Torsional rigidity of main girder



$a = 1.000\ m \qquad b = 6.925\ m$

$t_1 = 0.175\ m \qquad t_2 = 0.125\ m \qquad t_3 = t_4 = 1.075\ m$

$$J = \Sigma C b t^3 + \Sigma C a t^3 + \frac{4a^2b^2}{\frac{b}{t_1} + \frac{b}{t_2} + \frac{a}{t_3} + \frac{a}{t_4}}$$

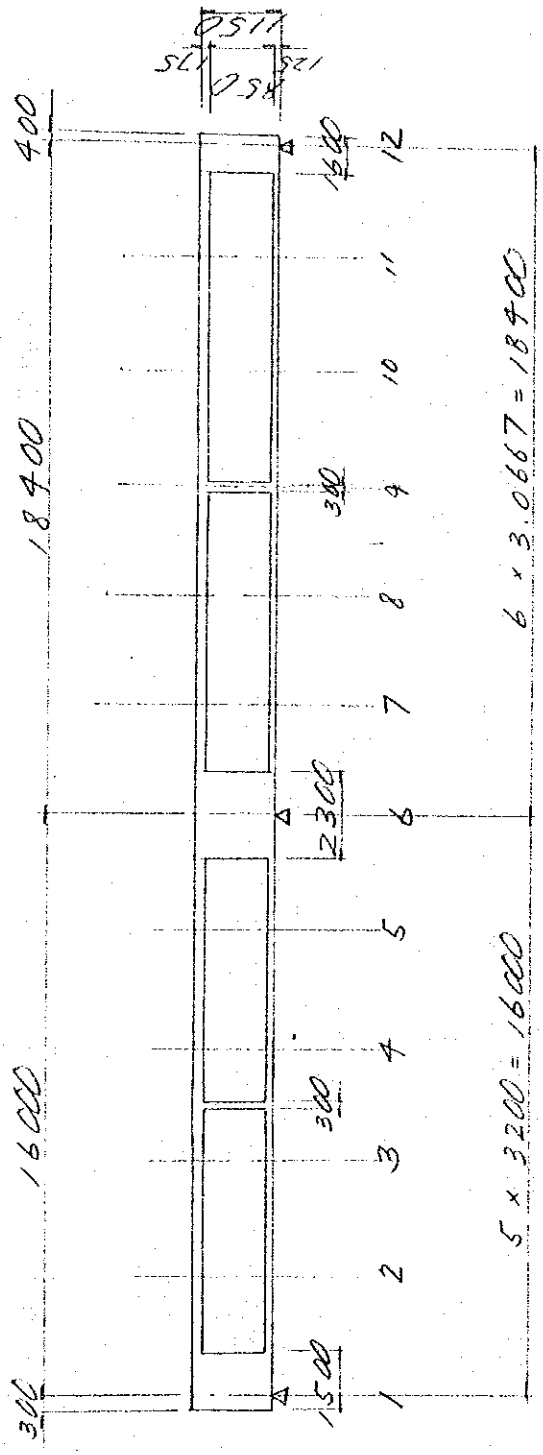
$$= 0.328 \times 6.925 \times 0.175^3 + 0.329 \times 6.925 \times 0.125^3$$
$$+ 2 \times 0.152 \times 1.075 \times 1.000^3$$
$$+ \frac{4 \times 1.000^2 \times 6.925^2}{\frac{6.925}{0.175} + \frac{6.925}{0.125} + 2 \times \frac{1.000}{1.075}}$$

$$= 0.0122 + 0.0049 + 0.3268 + 1.9810$$

$$= 2.3249\ m^4$$

$$J = \frac{2.3249}{6} = 0.3874\ m^4$$

Flexural rigidity of cross beam



List of flexural & torsional rigidity

Point	I (m^4)	J (m^4)
1	0.2193	0.5653
2	0.2349	0.9520
3	"	"
4	"	"
5	"	"
6	0.3543	0.9328
7	0.2258	0.9140
8	"	"
9	"	"
10	"	"
11	"	"
12	0.2271	0.5760

Cross beam - 1

	A	y	Ay	Ay^2	I_o
1.900 × 0.175	0.333	0.088	0.0293	0.0026	0.0008
1.500 × 0.850	1.275	0.600	0.7650	0.4590	0.0768
1.900 × 0.125	0.238	1.088	0.2589	0.2817	0.0003
	1.846		1.0532	0.7433	0.0779

$y = 0.571\ m$

$I = 0.7433 + 0.0779 - 1.846 \times 0.571^2 = 0.2193\ m^4$

Cross beam - 2.3.4.5

	A	y	Ay	Ay^2	I_o
3.200 × 0.175	0.560	0.088	0.0493	0.0043	0.0014
3.200 × 0.125	0.400	1.088	0.4352	0.4735	0.0005
	0.960		0.4845	0.4778	0.0019

$y = 0.505\ m$

$I = 0.4778 + 0.0019 - 0.960 \times 0.505^2 = 0.2349\ m^4$

Cross beam - 6

	A	y	Ay	Ay^2	I_o
3.133 × 0.175	0.548	0.088	0.0482	0.0042	0.0014
2.300 × 0.850	1.955	0.600	1.1730	0.7038	0.1177
3.133 × 0.125	0.392	1.088	0.4265	0.4640	0.0005
	2.895		1.6477	1.1720	0.1196

$y = 0.569\ m$

$I = 1.1720 + 0.1196 - 2.895 \times 0.569^2 = 0.3543\ m^4$

Cross beam - 7.8.9.10.11

	A	y	Ay	Ay^2	I_o
3.067× 0.175	0.537	0.088	0.0473	0.0042	0.0014
3.067 × 0.125	0.383	1.088	0.4167	0.4534	0.0005
	0.920		0.4640	0.4576	0.0019

$y = 0.504$ m

$I = 0.4576 + 0.0019 - 0.920 \times 0.504^2 = 0.2258\ m^4$

Cross beam - 12

	A	y	Ay	Ay^2	I_o
1.933 ×0.175	0.338	0.088	0.0297	0.0026	0.0009
1.600 ×0.850	1.360	0.600	0.8160	0.4896	0.0819
1.933 × 0.125	0.242	1.088	0.2633	0.2865	0.0003
	1.940		1.1090	0.7787	0.0831

$y = 0.572$ m

$I = 0.7787 + 0.0831 - 1.940 \times 0.572^2 = 0.2271\ m^4$

Cross beam -

	A	y	Ay	Ay^2	I_o

$y =$ m

$I =$ + . − × ^{2} = m^4

Torsional rigidity of cross beam

Span - 1

$a = 1.000\ m \qquad b = 14.975\ m$

$t_1 = 0.175\ m \quad t_2 = 0.125\ m \quad t_3 = 1.500\ m \quad t_4 = 1.150\ m$

$$J = 0.331 \times 14.975 \times 0.175^3 + 0.332 \times 14.975 \times 0.125^3 + 0.196 \times 1.500 \times 1.000^3 + 0.160 \times 1.150 \times 1.000^3 + \frac{4 \times 1.000^2 \times 14.975^2}{\frac{14.975}{0.175} + \frac{14.975}{0.125} + \frac{1.000}{1.500} + \frac{1.000}{1.150}}$$

$$= 0.0266 + 0.0097 + 0.2940 + 0.1840 + 4.3353$$

$$= 4.8496\ m^4$$

$$J = 4.8496 \times 1/16.30 = 0.2975\ m^4/m$$

Span - 2

$a = 1.000\ m \qquad b = 17.425\ m$

$t_1 = 0.175\ m \quad t_2 = 0.125\ m \quad t_3 = 1.600\ m \quad t_4 = 1.150\ m$

$$J = 0.331 \times 17.425 \times 0.175^3 + 0.332 \times 17.425 \times 0.125^3 + 0.196 \times 1.600 \times 1.000^3 + 0.160 \times 1.150 \times 1.000^3 + \frac{4 \times 1.000^2 \times 17.425^2}{\frac{17.425}{0.175} + \frac{17.425}{0.125} + \frac{1.000}{1.600} + \frac{1.000}{1.150}}$$

$$= 0.0309 + 0.0113 + 0.3264 + 0.1840 + 5.0507$$

$$= 5.6033\ m^4$$

$$J = 5.6033 \times 1/18.80 = 0.2980\ m^4/m$$

Cross beam - 1. $J = 0.2975 \times 1.900 = 0.5653\ m^4$

" - 2, 3, 4, 5. $J =$ " $\times 3.200 = 0.9520$ "

" - 6 $J = 0.2975 \times 1.600 + 0.2980 \times 1.533$

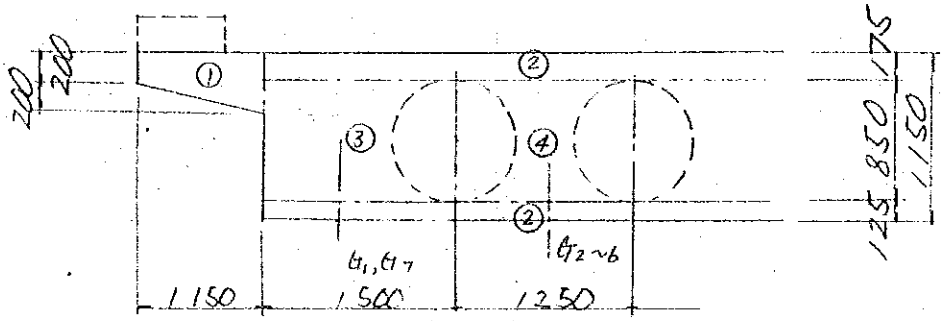
$= 0.9328$ "

" - 7, 8, 9, 10, 11 $J = 0.2980 \times 3.067 = 0.9140$ "

" - 12 $J =$ " $\times 1.933 = 0.5760$ "

1. Dead load

1) Slab



① $Wd_1 = 1/2 \times (0.20 + 0.40) \times 23.6 = 7.080$ KN/m²

② $Wd_2 = (0.175 + 0.125) \times 23.6 = 7.080$ "

③ $Wd_3 = (1.500 \times 0.85 - 1/4 \times 0.85^2 \times \pi \times 1/2) \times 23.6 = 23.394$ KN/m

$Wd_3' = 1.500 \times 0.85 \times 23.6 = 30.090$ "

④ $Wd_4 = (1.25 \times 0.85 - 1/4 \times 0.85^2 \times \pi) \times 23.6 = 11.683$ KN/m

$Wd_4' = 1.25 \times 0.85 \times 23.6 = 25.075$ "

2) Cross beam

G_1 , G_6

$$A = 1/4 \times 0.85^2 \times \pi \times 1/2 = 0.284\ m^2$$

Edge support

$$W_5 = 0.284 \times 1.20 \times 23.6 = 8.043\ KN$$

Center support

$$W_5 = 0.284 \times 2.30 \times 23.6 = 15.416\ KN$$

Center beam

$$W_5 = 0.284 \times 0.30 \times 23.6 = 2.011\ KN$$

$G_2 \sim G_5$

$$A = 1/4 \times 0.85^2 \times \pi = 0.567\ m^2$$

Edge support

$$W_5 = 0.567 \times 1.20 \times 23.6 = 16.057\ KN$$

Center support

$$W_5 = 0.567 \times 2.30 \times 23.6 = 30.777\ KN$$

Center beam

$$W_5 = 0.567 \times 0.30 \times 23.6 = 4.013\ KN$$

3) Kerb

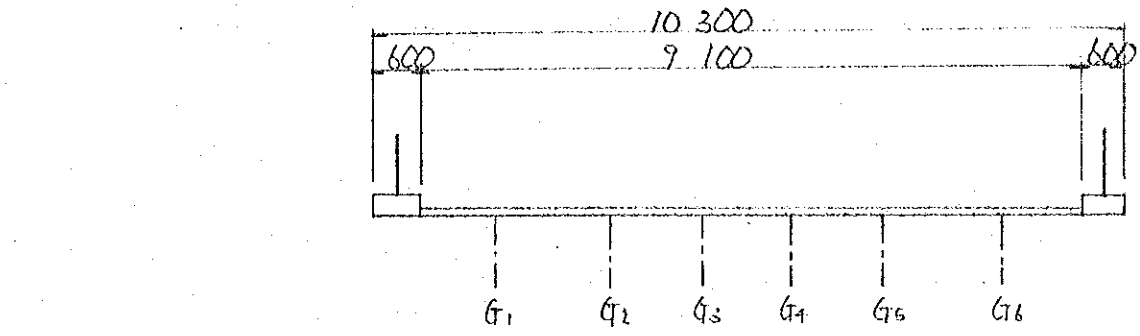
$Wd_6 = 0.60 \times 0.23 \times 23.6 = 3.257\ KN/m$

4) Wearing surface

$Wd_7 = 1.808\ KN/m^2$

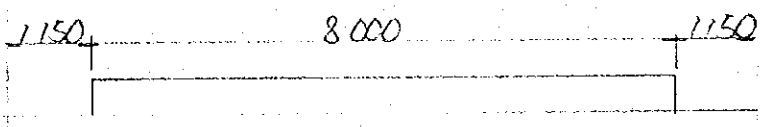
5) Rail

$Wd_8 = 1.10\ KN/m$



Slab (1)
$w = 7.080\ KN/m^2$

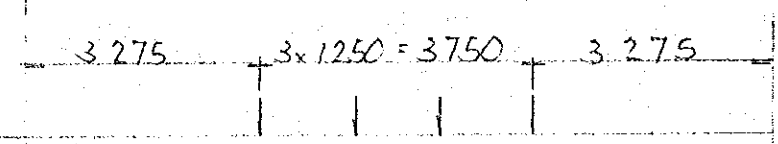
Slab (2)
$w = 7.080\ KN/m^2$



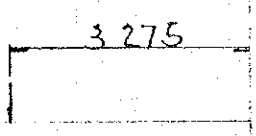
Slab (3)
$w = 23.397\ KN/m$

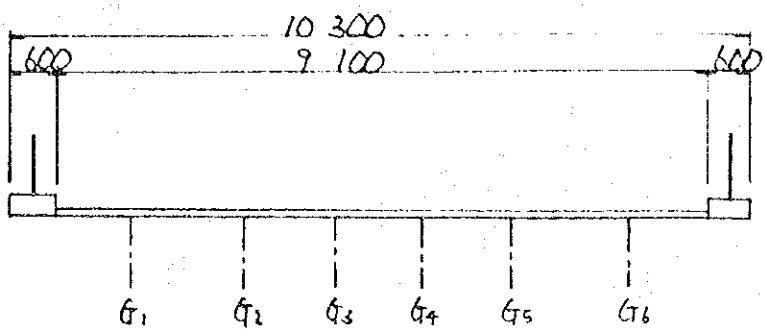
Slab (3')
$w = 30.090\ KN/m$

Slab (4)
$w = 11.683\ KN/m$



Slab (4')
$w = 25.075\ KN/m$





Cross beam (Es)
3.093 KN

1.687.5 1.687.5

Cross beam (C.s)
15.416 KN

1.687.5 1.687.5

Cross beam (C.b)
2.011 KN

1.687.5 1.687.5

Cross beam (Es)
16.057

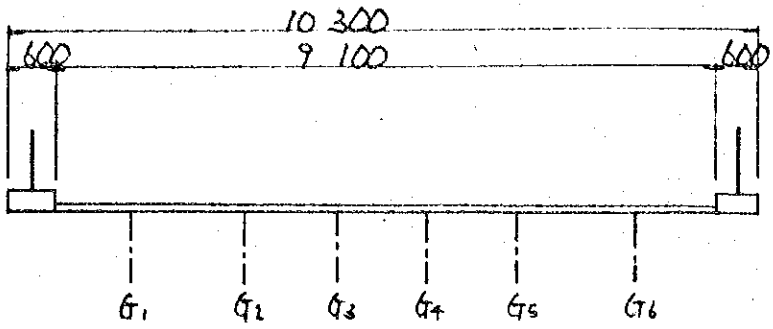
3.275 3×1250=3750 3.275

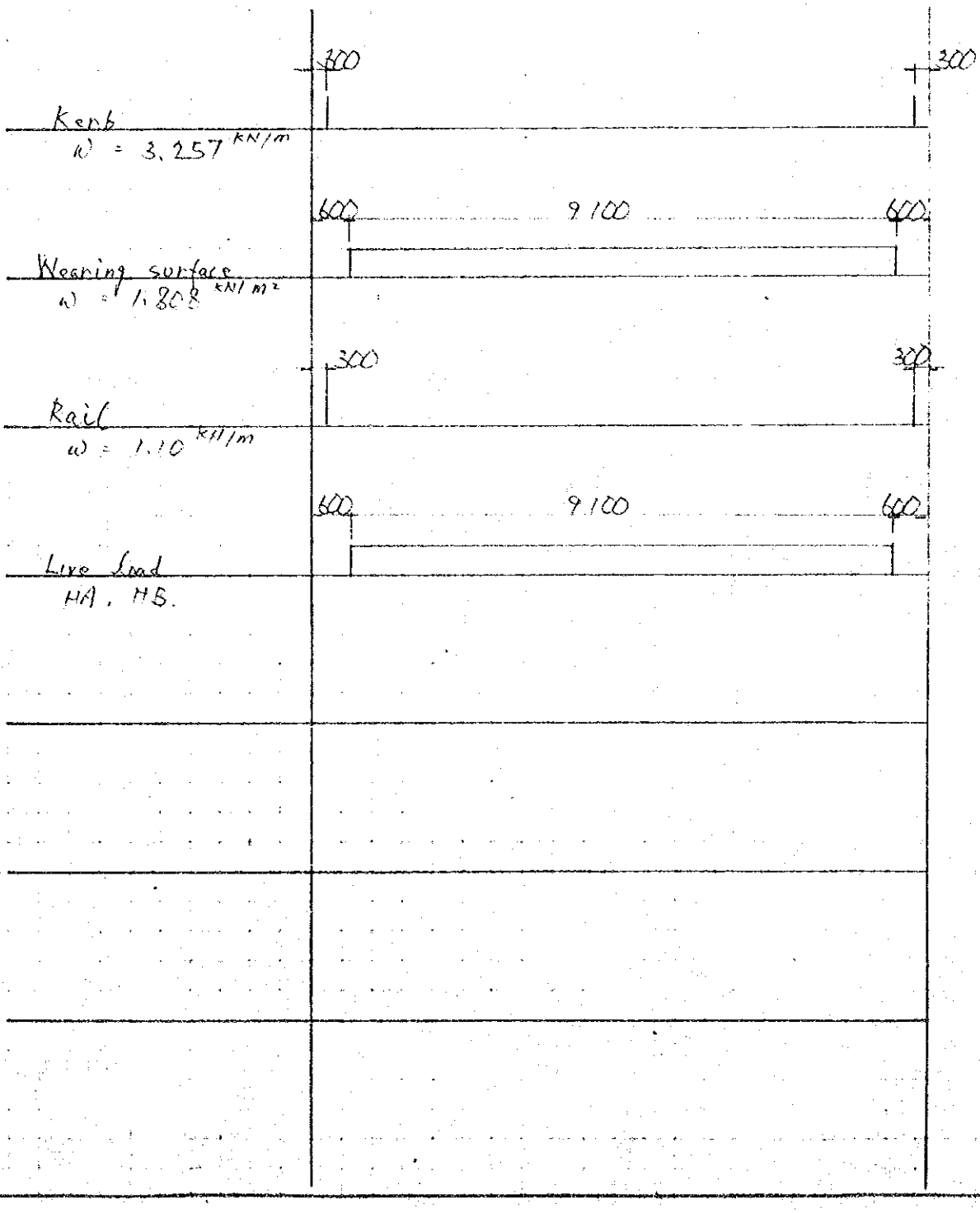
Cross beam (C.s)
30.777

3.275 3×1250=3750 3.275

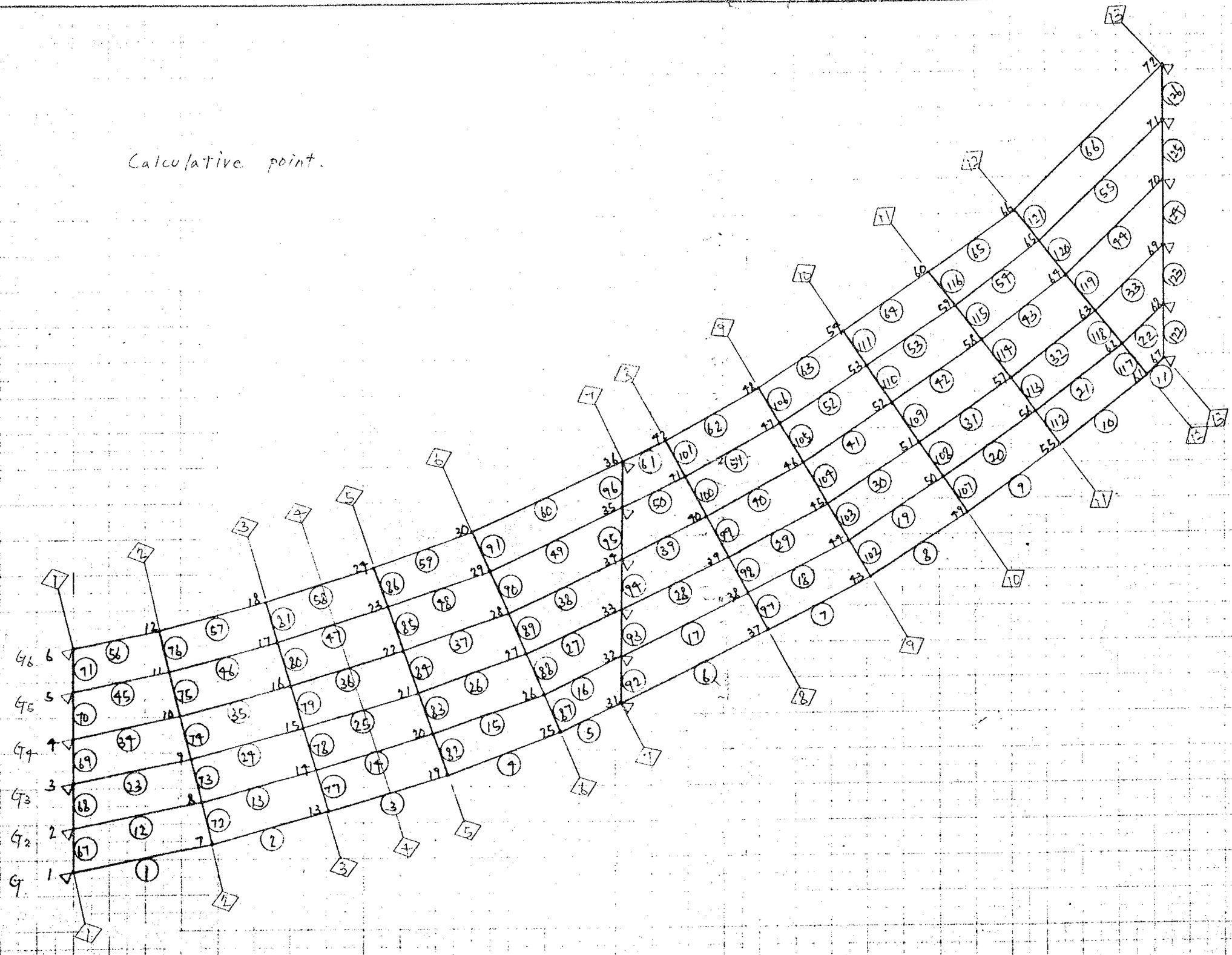
Cross beam (C.b)
4.013

3.275 3×1250=3750 3.275


10 300
600
9 100
600
G1
G2
G3
G4
G5
G6


300
300
Kerb
w = 3.257 kN/m
600
9 100
600
Wearing surface
w = 1.808 kN/m²
300
300
Rail
w = 1.10 kN/m
600
9 100
600
Live Load
HA, HB.

Calculative point.



Moment list.

(Design sectional force)

(KN·m)

	G_1		G_2		G_3		G_4		G_5		G_6	
	max	min	max	min	max	min	max	min	max	min	max	min
1	37.2	- 225.6	70.4	- 55.1	55.5	- 37.7	71.8	32.6	101.2	- 38.2	171.1	- 275.4
2	1060.7	366.3	773.9	291.1	715.5	280.6	690.3	275.4	879.0	275.6	803.5	314.5
3	1382.7	925.9	966.2	322.4	898.1	305.2	876.7	302.7	878.0	305.4	1099.8	375.9
4	1187.2	325.4	841.2	222.2	828.7	229.1	827.9	230.0	849.8	228.2	1195.7	325.8
5	1193.6	216.3	509.3	33.5	690.8	108.2	613.1	85.5	633.8	91.1	785.2	125.0
6	- 60.4	- 703.2	- 215.0	- 798.1	- 26.6	- 372.0	45.0	- 392.7	129.5	- 292.1	238.2	- 337.8
7	- 813.7	- 1769.4	- 607.8	- 1209.9	- 637.7	- 1290.3	- 653.1	- 1236.8	- 705.3	- 1358.8	- 1566.9	- 3197.0
8	279.5	- 305.0	89.3	- 300.5	- 22.2	- 905.9	- 138.4	- 554.8	- 283.3	- 769.0	- 718.1	- 1668.7
9	1159.0	260.0	691.2	190.2	587.3	102.5	527.2	74.0	455.3	38.0	298.4	136.5
10	1691.7	609.4	997.6	395.8	906.9	363.5	870.4	346.6	962.8	373.3	841.6	311.2
11	1559.9	665.2	901.4	420.1	847.5	385.4	844.1	381.4	1100.1	441.1	975.1	398.4
12	246.3	- 387.8	509.3	- 28.9	579.1	199.0	621.7	218.9	792.5	279.6	719.7	206.9
13	198.1	- 493.8	30.6	- 119.3	- 8.5	- 127.9	- 33.7	- 156.3	- 59.1	- 211.5	- 107.8	- 322.5

see page 22 for design point

DEAD + HA. or 1/1.25 (DEAD + HB)

WHICHEVER IS MORE

Moment list

(DEAD + LL)

KN·m

	G_1		G_2		G_3		G_4		G_5		G_6	
	max	min	max	min	max	min	max	min	max	min	max	min
1	14.2	-225.6	70.4	-55.1	55.5	-33.9	71.8	-32.4	101.8	-32.2	171.1	-217.2
2	1060.7	475.0	772.9	379.4	715.5	360.4	696.3	253.7	574.0	353.3	303.5	383.2
3	1382.7	565.1	966.2	423.9	898.1	402.3	876.7	392.3	878.0	401.5	1049.8	493.5
4	1187.2	441.4	841.2	309.0	788.7	312.9	827.9	313.4	849.8	311.4	1195.7	442.2
5	1193.6	330.6	509.3	73.3	649.8	119.1	613.1	135.8	633.8	193.6	735.2	192.0
6	-159.6	-703.2	-264.9	-748.1	-45.8	-372.0	11.0	-349.7	105.8	-299.1	166.1	-337.8
7	-1018.7	-1784.4	-758.9	-1309.9	-796.5	-1290.3	-819.4	-1238.8	-872.2	-1358.2	-1903.9	-3147.0
8	258.3	-305.0	72.9	-320.5	-38.4	-405.9	-165.9	-551.8	-335.1	-749.0	-857.2	-1663.7
9	1154.0	366.1	691.2	203.3	587.3	156.0	527.2	120.7	453.3	73.1	298.4	241.6
10	1691.7	792.3	997.6	512.9	906.9	471.0	870.4	449.2	963.2	493.7	841.6	396.3
11	1359.9	849.7	901.4	531.7	847.5	479.4	844.1	475.1	1000.1	553.2	975.1	499.7
12	296.3	-333.6	509.3	41.1	579.1	216.9	621.7	227.5	793.3	385.1	719.7	249.4
13	198.1	-444.7	32.6	-119.3	-11.2	-127.9	-35.6	-158.3	-59.1	-211.5	-195.4	-323.5

see page 22 for design point

Moment list

(DEAD + HS)

KN·m

	G_1		G_2		G_3		G_4		G_5		G_6	
	max	min	max	min	max	min	max	min	max	min	max	min
1	96.5	-277.9	57.7	-26.5	56.1	-47.1	97.6	-47.2	110.3	-27.6	191.9	-349.2
2	1186.2	457.9	834.0	383.9	782.3	350.7	736.3	344.3	705.5	344.5	821.4	393.1
3	1999.6	532.4	999.1	402.0	940.9	325.7	919.4	378.4	920.9	381.7	1138.7	469.9
4	1296.0	906.3	841.4	277.7	898.6	224.4	899.8	227.5	871.0	285.3	1302.6	407.3
5	1358.4	370.4	533.3	41.9	665.0	135.3	623.7	101.9	668.9	113.9	836.1	156.3
6	-75.5	-800.4	-268.7	-789.5	-33.2	-221.5	56.3	-354.1	141.9	-298.2	297.3	-325.2
7	-1017.1	-1800.4	-759.7	-1157.6	-797.1	-1122.6	-814.4	-1191.3	-883.2	-1272.5	-1958.6	-3203.0
8	349.4	-399.2	105.4	-321.3	-27.7	-402.0	-173.0	-522.2	-361.0	-725.9	-897.6	-1459.1
9	1276.3	325.0	721.2	175.2	613.2	128.1	549.3	92.5	453.9	47.5	262.5	170.6
10	1753.7	761.8	1039.4	499.7	927.7	454.4	910.7	433.3	1019.1	466.6	922.6	389.0
11	1723.0	831.5	928.3	525.1	883.4	481.8	888.1	476.8	1057.6	551.4	1085.5	498.0
12	291.1	-484.7	527.4	-36.1	624.5	184.2	768.1	272.6	876.4	349.5	850.0	358.6
13	189.2	-617.3	19.4	-131.4	-10.6	-159.7	-92.1	-180.0	-79.0	-122.6	-139.7	-453.0

see page 22 for design point

Shear force list

(Ultimate)

(kN)

	G_1		G_2		G_3		G_4		G_5		G_6	
	max	min	max	min	max	min	max	min	max	min	max	min
1	1491.9	- 748.3	775.8	- 6.6	868.1	137.9	822.1	133.9	809.1	- 7.3	1754.0	161.9
2	879.9	- 95.8	486.9	- 190.9	519.9	- 42.3	590.1	- 31.6	541.6	- 130.9	1321.9	- 17.9
3	505.8	- 412.6	263.7	- 343.3	306.0	- 191.1	320.3	- 177.2	330.7	- 359.2	869.0	- 187.9
4	- 161.1	- 1062.9	510.9	- 435.7	132.6	- 423.7	179.3	- 322.3	191.2	- 452.2	519.2	- 409.2
5	- 518.2	- 2311.8	199.8	- 706.5	130.7	- 655.7	170.9	- 568.9	512.3	- 660.2	449.2	- 581.5
7L	- 665.7	- 2705.1	30.5	- 953.6	- 252.0	- 1008.3	- 228.9	- 957.3	- 77.3	- 956.9	- 256.2	- 1719.2
7R	1633.1	268.7	925.6	50.6	947.9	213.7	967.3	203.9	963.1	49.6	3655.5	1063.1
8	1093.9	- 12.9	479.9	- 10.5	738.5	111.0	2299	154.3	1009.5	113.9	3410.9	564.5
9	651.1	- 590.9	512.1	- 121.0	577.8	23.8	642.7	58.6	745.5	41.2	1849.8	339.1
10	406.7	- 679.6	324.5	- 300.2	377.0	- 121.9	426.9	- 81.7	553.2	- 89.7	1453.7	- 197.3
11	252.6	- 1947.0	237.1	- 539.1	253.5	- 268.5	291.6	- 196.2	358.7	- 212.9	1035.1	- 6.0
12	- 228.5	- 2190.5	350.0	- 789.1	274.6	- 499.1	398.9	- 310.5	362.7	- 391.0	925.6	- 71.7
13	- 333.5	- 3198.0	121.8	- 979.7	- 99.2	- 803.1	- 127.0	- 786.1	- 81.7	- 910.1	- 253.1	- 1995.2

see page 22 for design point

1.5(DEAD) + 1.5(LIVE)

or

2.0(DEAD + LIVE)

or

{1.5(DEAD) + 2.0(LIVE)} / 1.25

} WHICHEVER IS WORSE

Shear force list

(Dead + HA)

(KN)

	G_1		G_2		G_3		G_4		G_5		G_6	
	max	min	max	min	max	min	max	min	max	min	max	min
1	1226.8	- 298.3	775.8	- 6.6	756.5	137.9	742.5	133.9	809.1	- 7.3	1472.9	193.5
2	706.9	- 93.8	466.9	- 190.9	471.8	- 42.2	429.7	- 31.6	541.6	- 120.9	1050.6	- 17.9
3	402.8	- 349.9	163.7	- 393.3	276.2	- 196.1	291.7	- 177.2	330.7	- 259.2	690.3	- 187.9
4	161.1	- 963.7	210.9	- 935.7	136.6	- 983.7	163.0	- 333.3	191.2	- 452.3	424.3	- 909.3
5	- 391.9	- 2123.8	199.8	- 706.5	130.7	- 655.5	170.9	- 518.9	213.3	- 660.2	949.2	- 521.9
7L	- 659.6	- 2507.6	30.5	- 953.6	- 253.0	- 991.2	- 228.9	- 957.3	- 77.3	- 956.9	- 356.2	- 1519.1
7R	1439.9	286.1	925.6	50.6	947.9	213.7	916.2	203.7	962.1	49.6	3631.8	1012.1
8	936.0	12.9	674.9	- 12.5	715.7	111.0	807.8	159.3	1069.5	113.9	2242.3	569.5
9	651.1	- 211.1	512.1	- 121.0	558.7	22.3	627.8	59.2	745.5	+ 1.2	1494.9	334.1
10	406.7	- 582.0	329.5	- 300.2	369.7	- 115.5	421.0	- 66.9	552.2	- 69.7	1296.9	- 197.3
11	252.6	- 1239.2	237.1	- 539.1	253.5	- 248.7	267.8	- 176.9	332.7	- 215.9	895.8	39.6
12	- 228.5	- 2822.1	250.0	- 789.1	274.6	- 999.1	298.9	- 310.5	363.9	- 392.0	793.0	- 39.3
13	- 233.5	- 2857.1	100.0	- 974.7	- 102.0	- 765.0	- 127.0	- 720.9	- 184.2	- 910.1	- 256.7	- 1269.6

see pg. 22 for design point

Shear force list

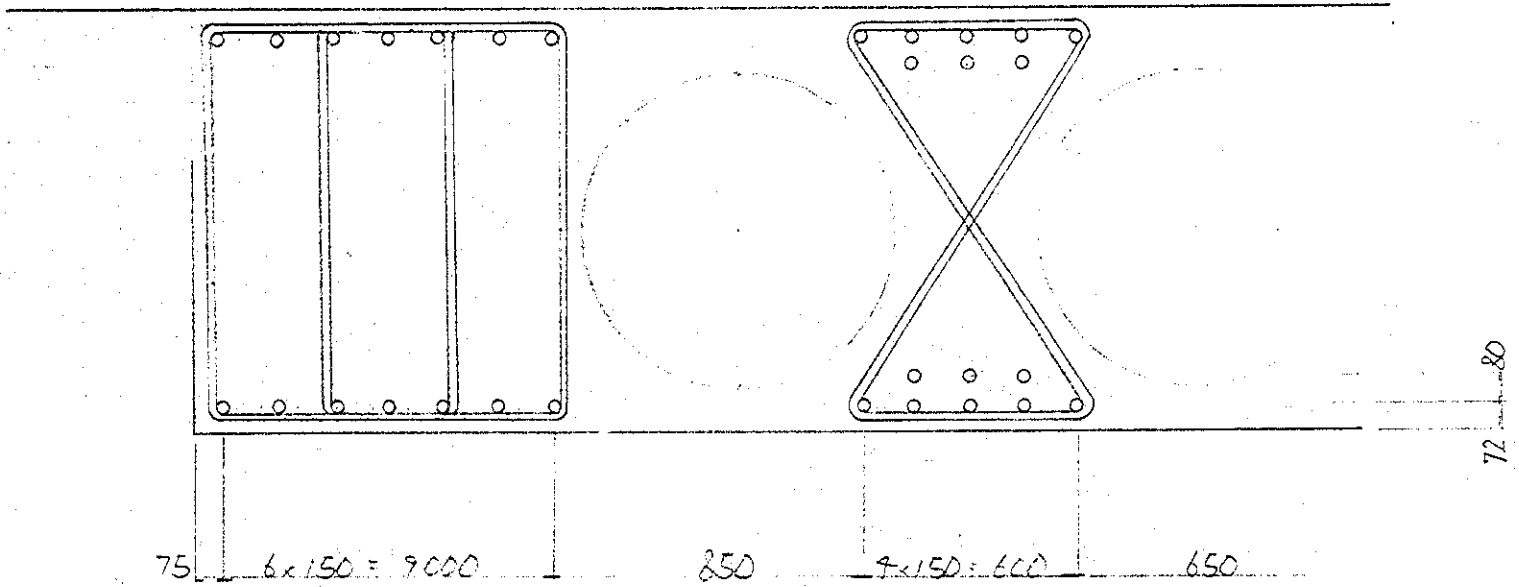
(Dead + LS)

(KN)

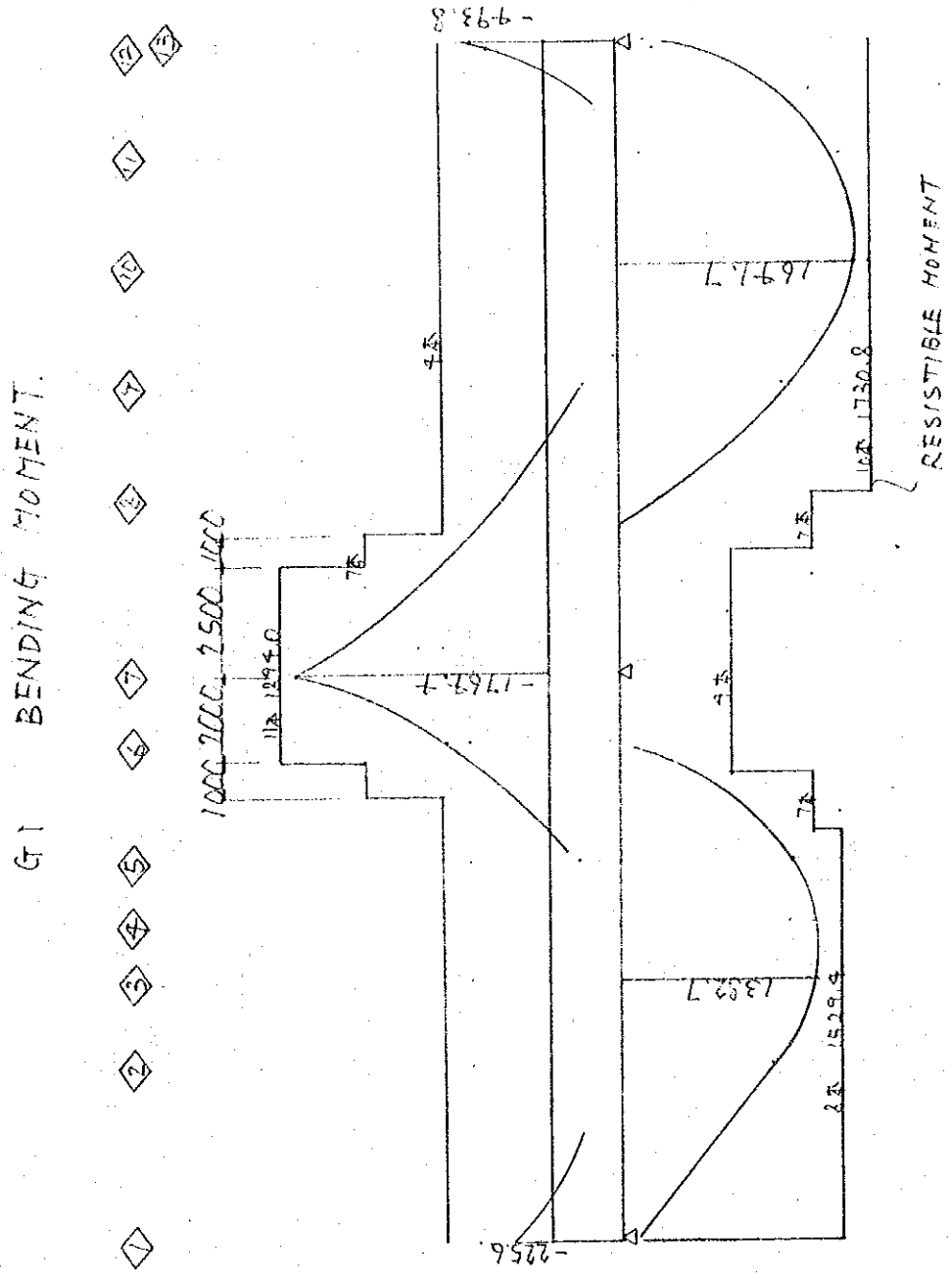
	G_1		G_2		G_3		G_4		G_5		G_6	
	max	min	max	min	max	min	max	min	max	min	max	min
1	1491.9	395.9	696.3	103.0	808.1	157.9	822.1	133.8	675.9	85.3	1756.0	161.9
2	874.9	- 58.6	321.9	- 42.9	519.9	- 17.1	540.1	- 2.3	404.0	- 16.3	1281.9	43.7
3	505.8	- 412.6	111.1	- 251.0	306.0	- 184.2	320.3	- 169.5	176.0	- 175.9	264.0	- 148.9
5	100.0	- 1062.9	30.5	- 351.8	133.8	- 490.3	179.3	- 341.9	38.1	- 353.1	519.3	- 398.6
6	- 518.2	- 2311.8	53.3	- 700.5	- 10.0	- 610.0	49.7	- 513.1	- 45.2	- 523.1	357.9	- 571.5
7L	- 665.7	- 2705.1	- 12.2	- 852.9	- 255.7	- 1008.3	- 234.3	- 999.1	- 177.8	- 313.0	366.8	- 1719.2
7R	1622.1	268.7	787.3	192.9	952.9	213.6	967.3	213.6	831.1	157.2	3655.5	1030.0
8	1093.9	30.2	499.8	85.9	738.5	136.3	839.9	177.2	857.6	225.0	2410.9	585.5
9	689.3	- 392.9	338.0	- 96.5	577.8	26.0	692.7	58.6	611.3	102.5	1899.8	350.3
10	372.7	- 674.6	193.8	- 239.6	377.0	- 121.9	426.9	- 81.7	409.3	- 22.8	1453.7	125.5
11	- 19.1	- 1417.0	7.7	- 500.0	242.5	- 268.5	291.6	- 196.3	189.0	- 158.7	1035.1	- 6.0
12	- 396.0	- 3190.5	157.7	- 621.9	119.0	- 415.8	219.9	- 301.9	140.0	- 269.1	935.6	- 71.7
13	- 300.0	- 3192.0	121.8	- 781.9	- 99.3	- 803.1	- 128.3	- 735.1	- 21.7	- 656.3	- 252.1	- 1995.8

see page 22 for design point

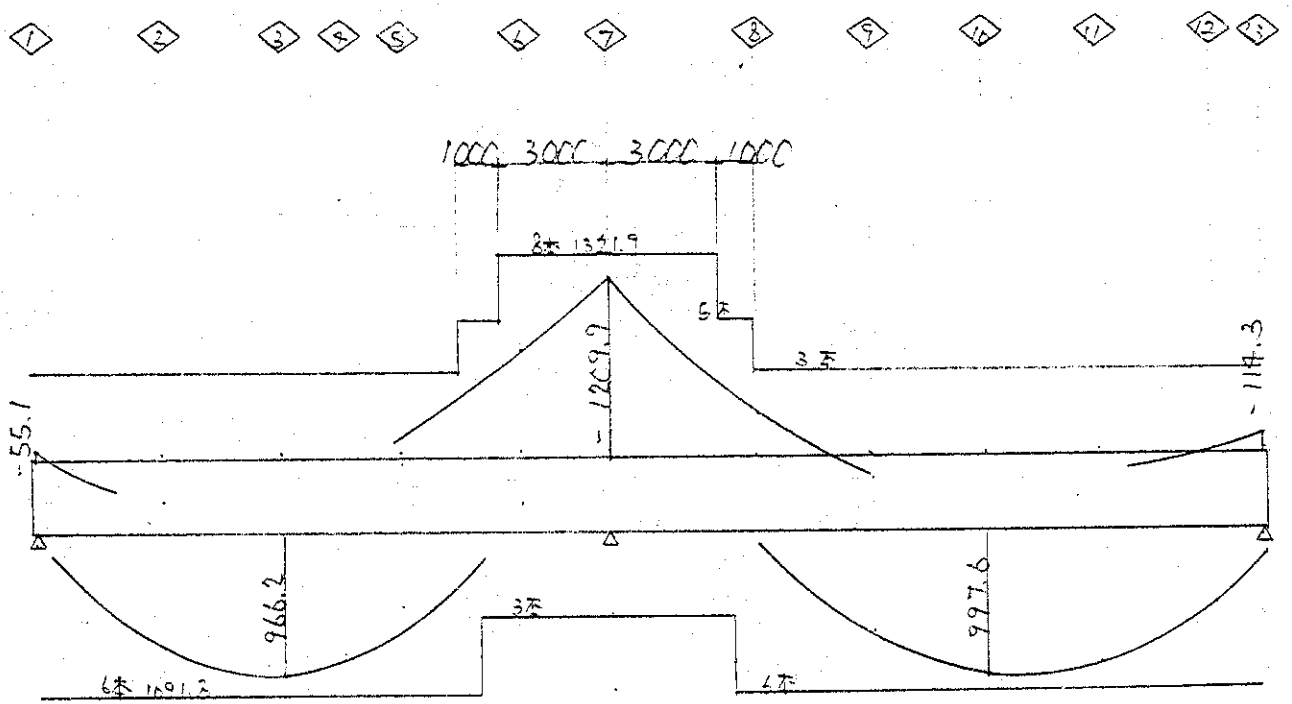
REINFORCING BAR LOCATION.



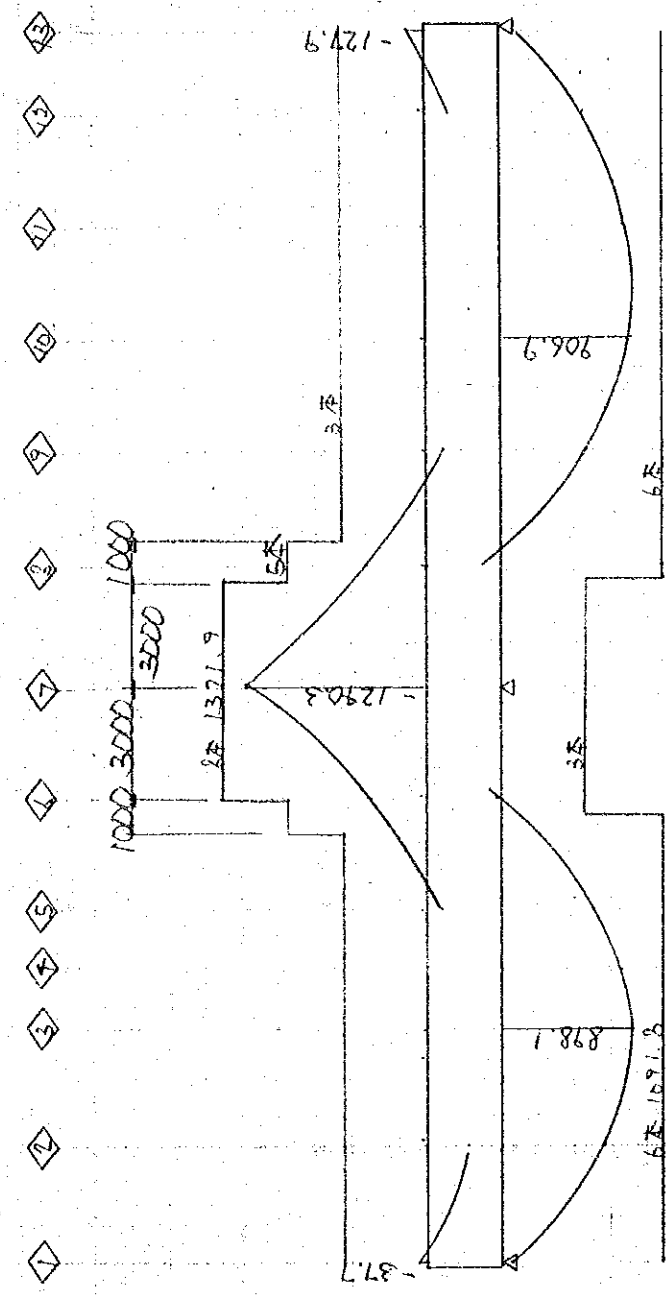
§2 DRAWING OF SECTIONAL FORCE DIAGRAM



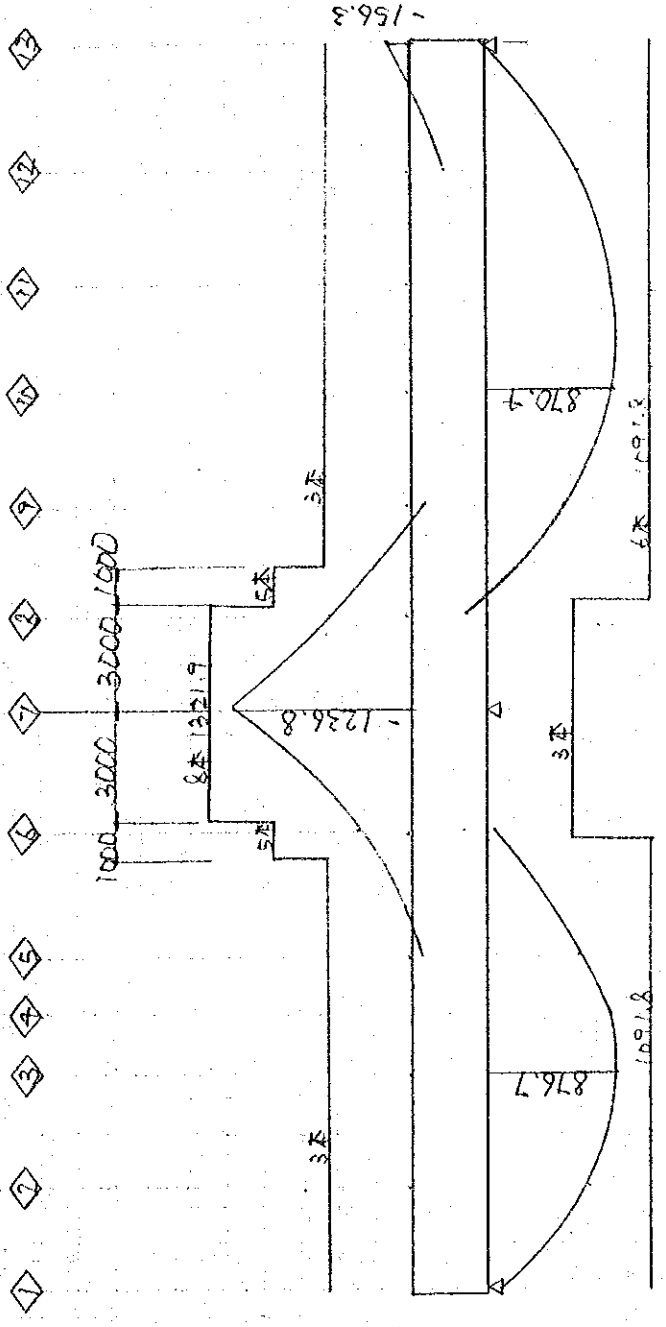
G2 BENDING MOMENT

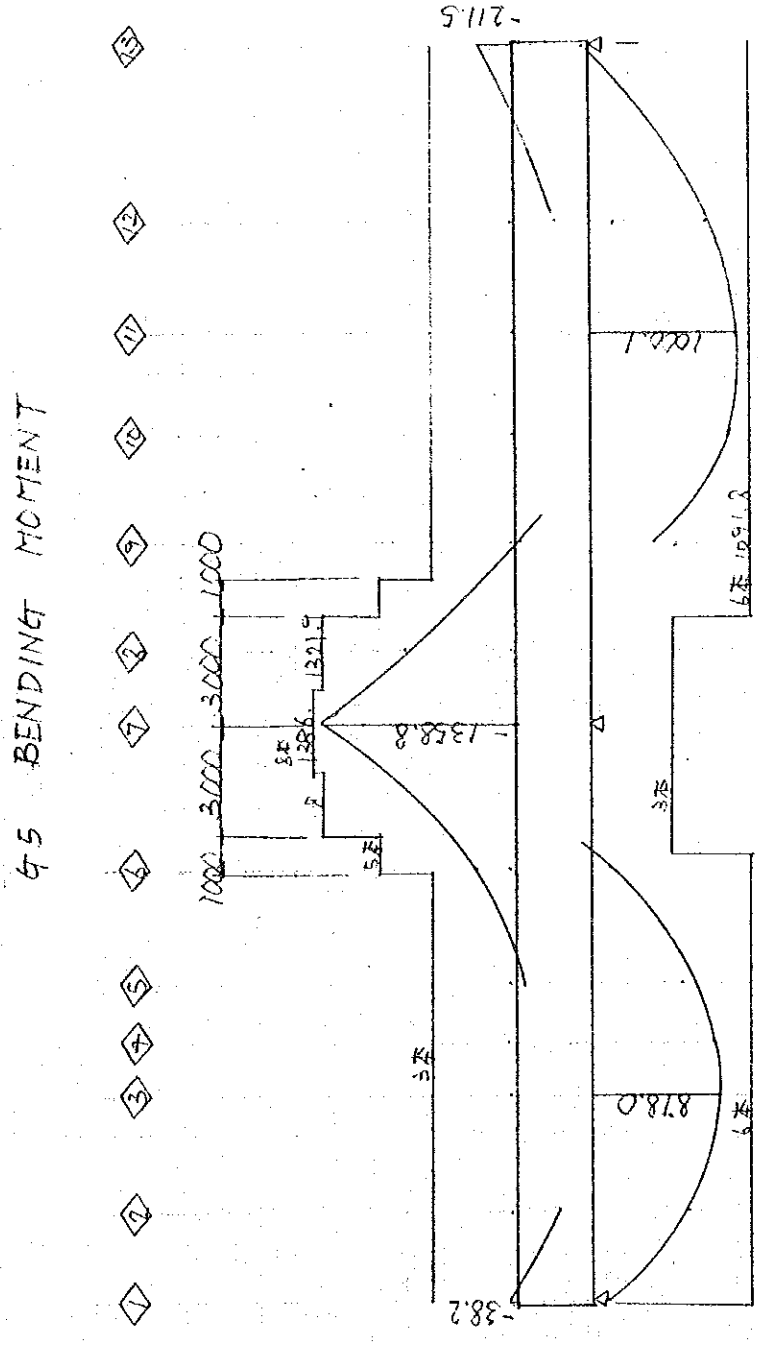


G3 BENDING MOMENT

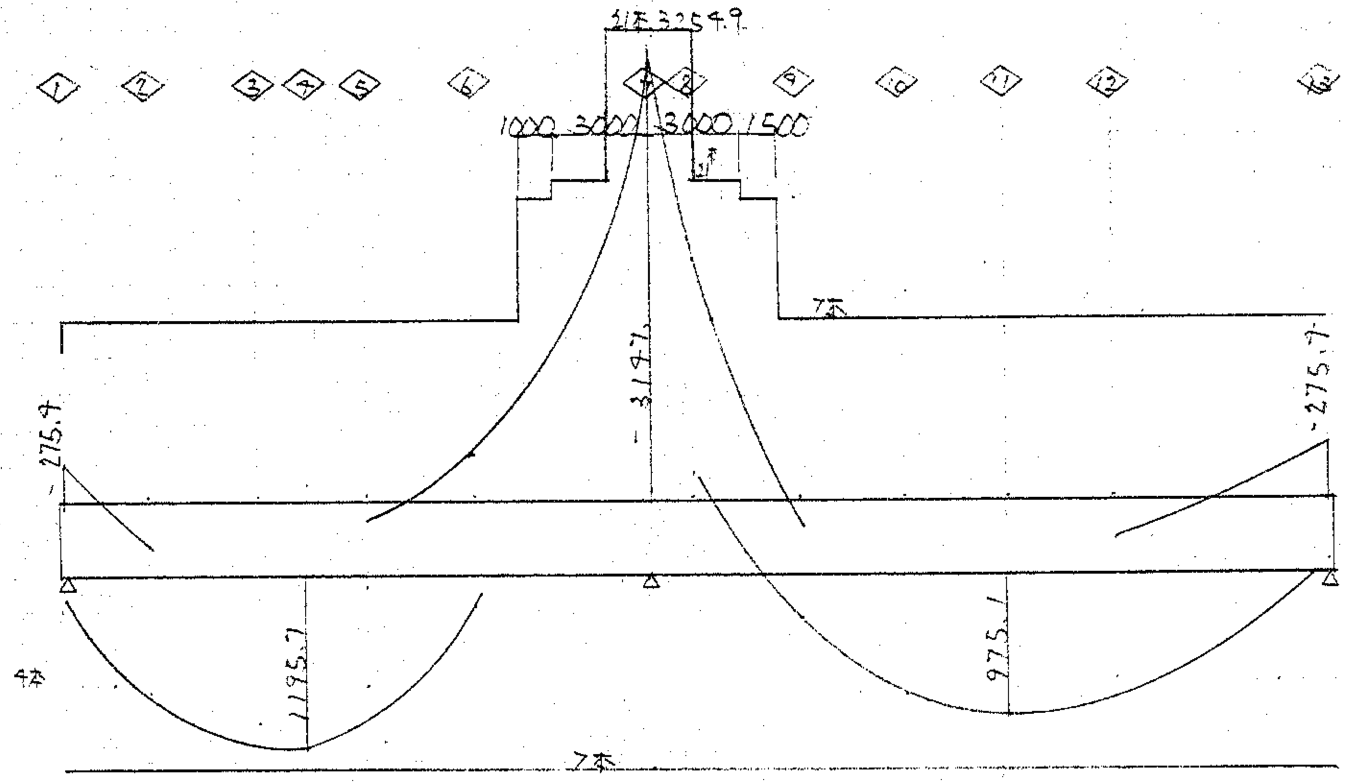


G4 BENDING MOMENT

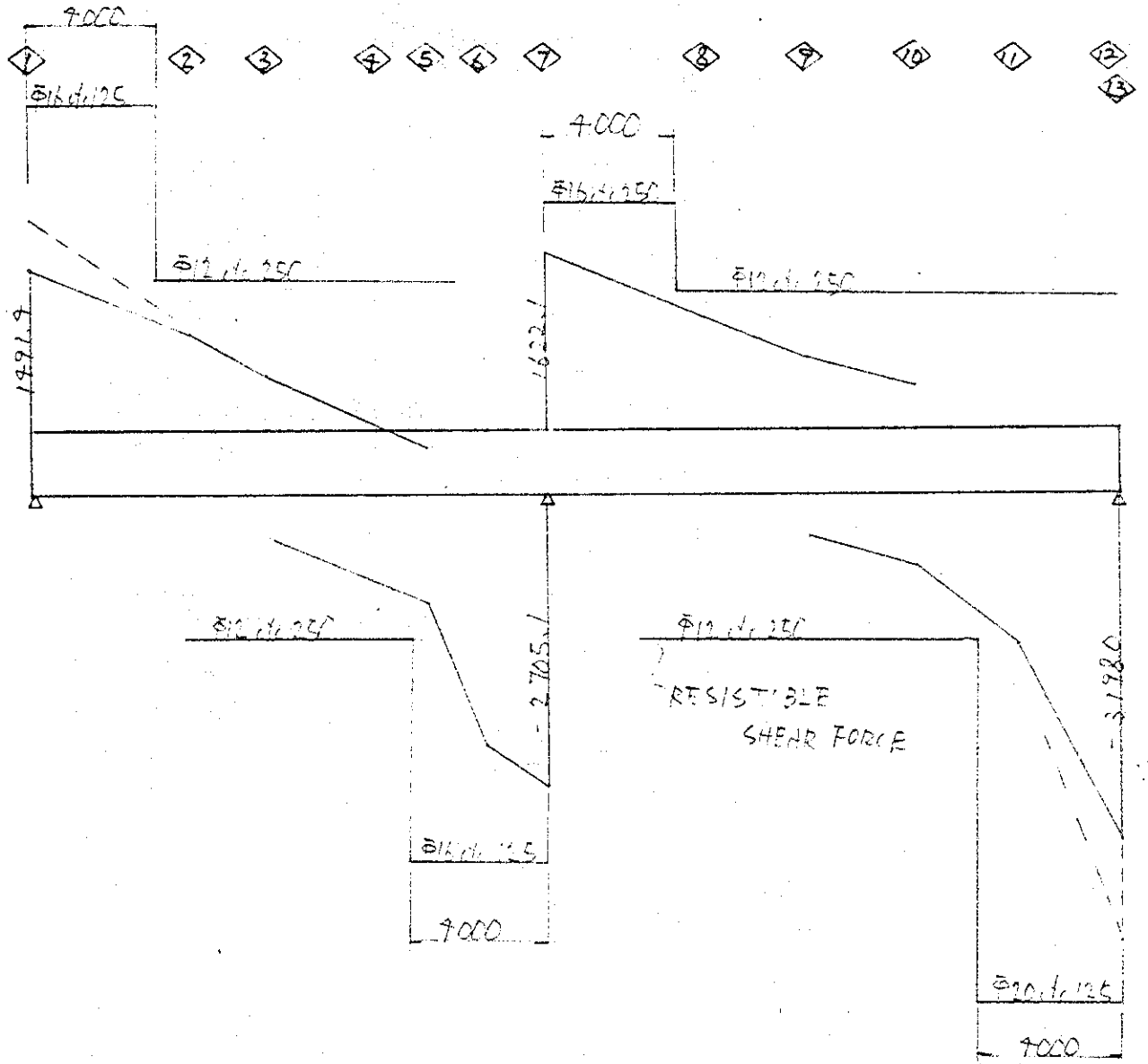



45 BENDING MOMENT
1000
3000
3000
1000
1321.7
1386
1358.8
-211.5
1000.1
678.1
818.0
-38.2

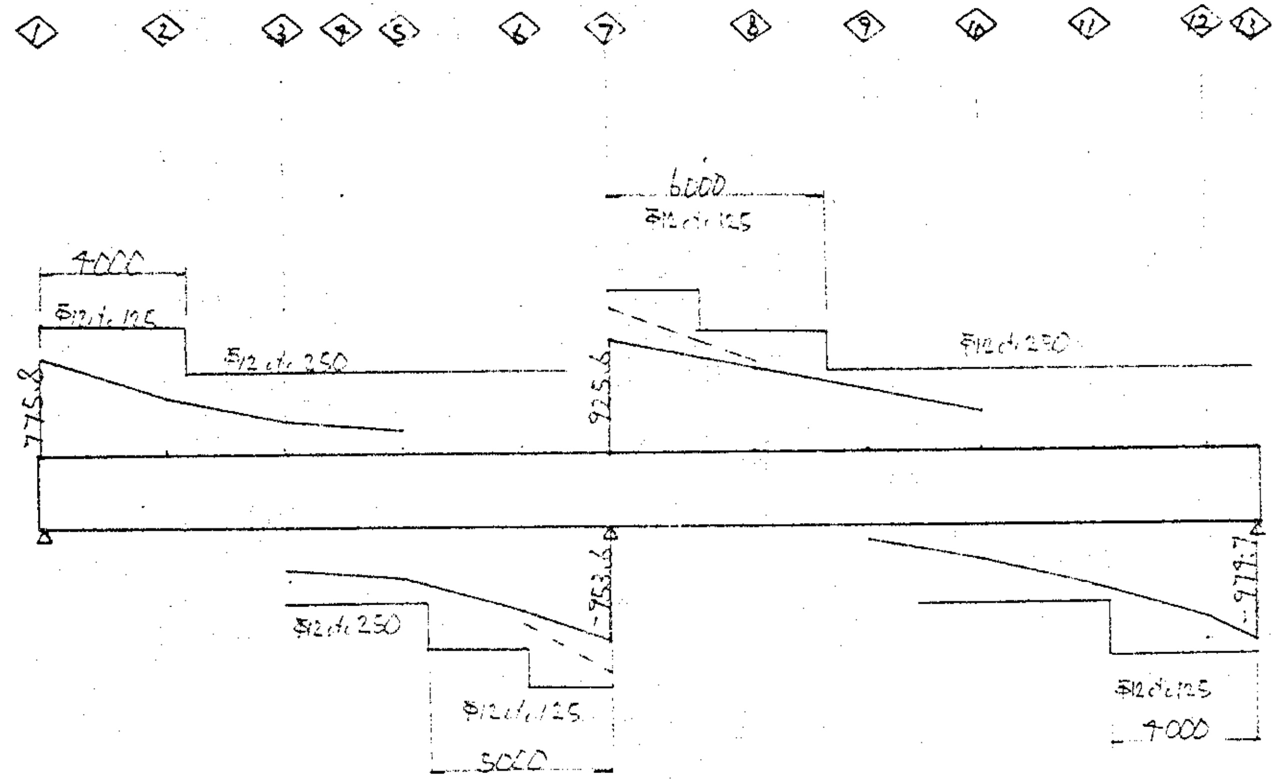
G6 BENDING MOMENT.

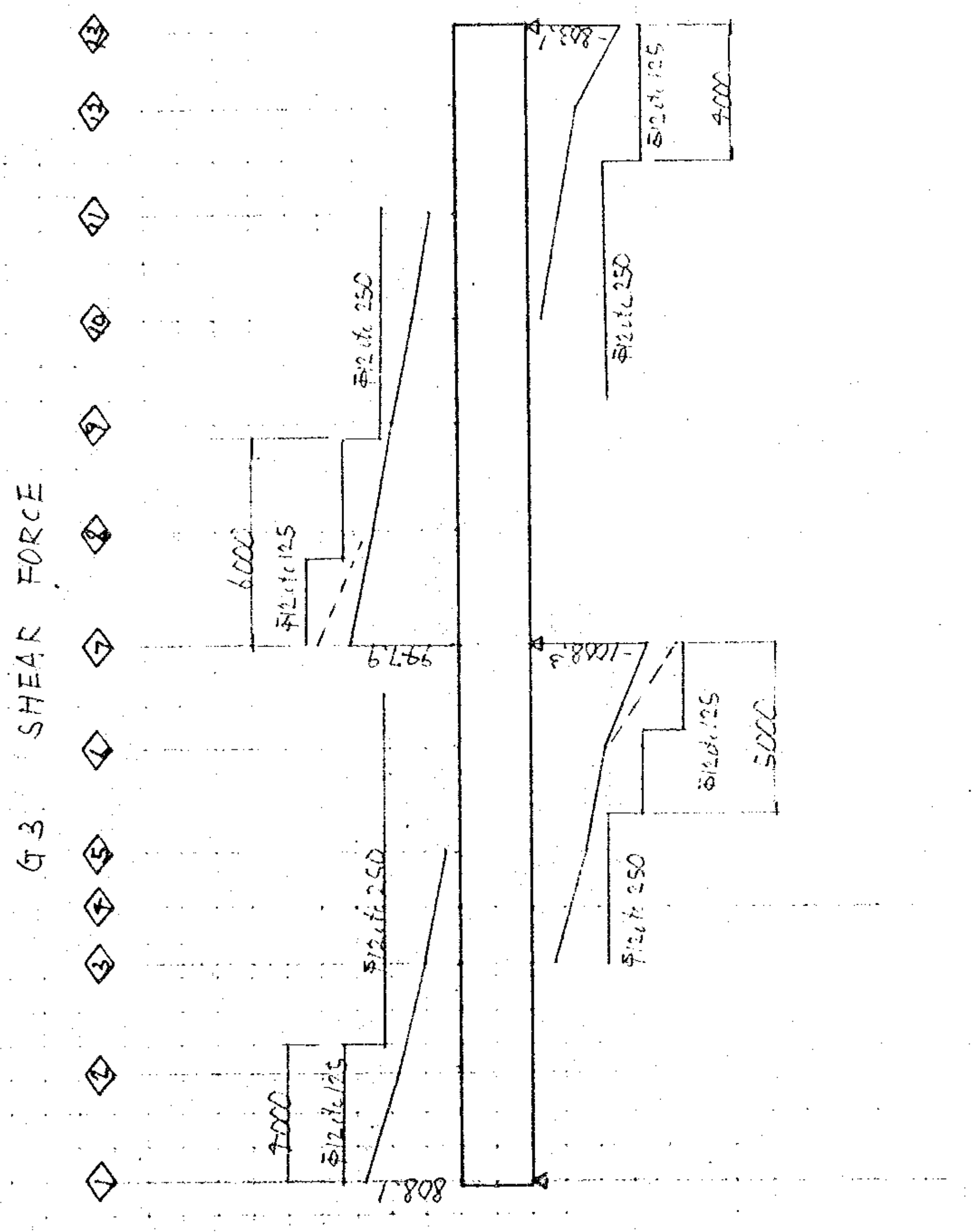


G_1 SHEAR FORCE.

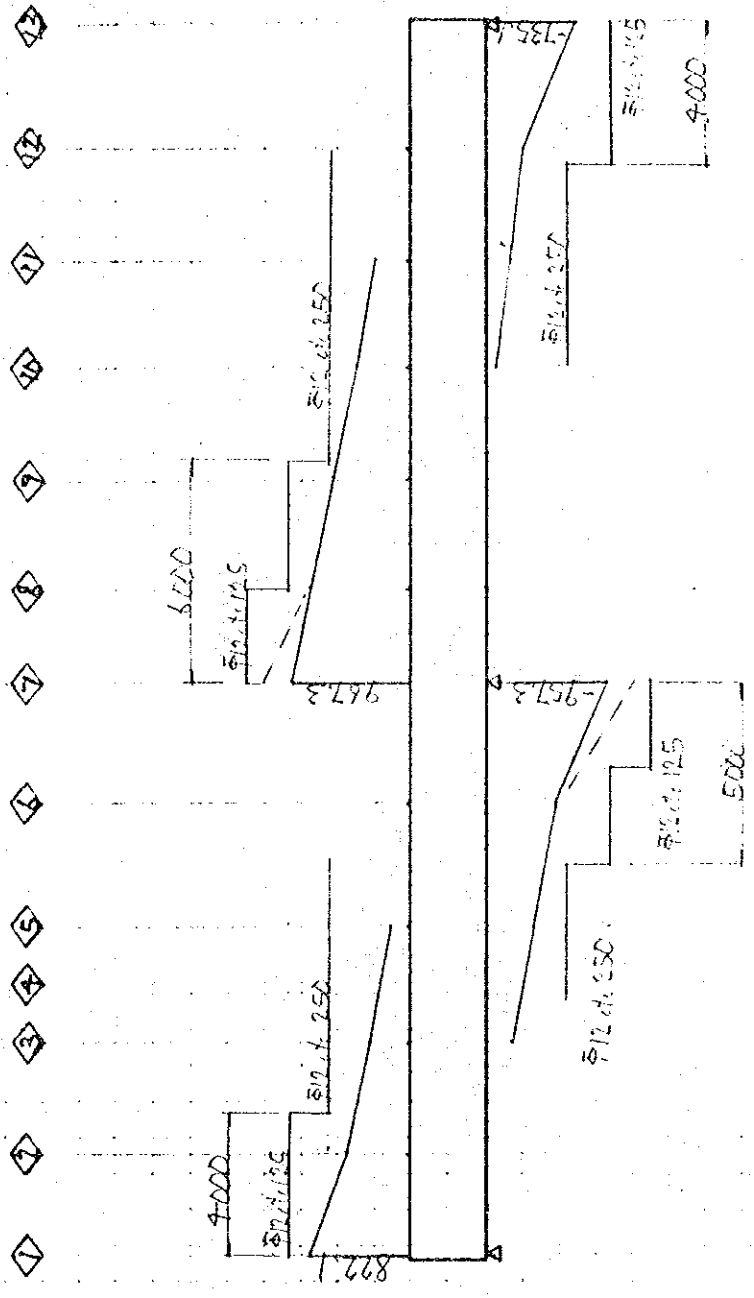


GT2 SHEAR FORCE

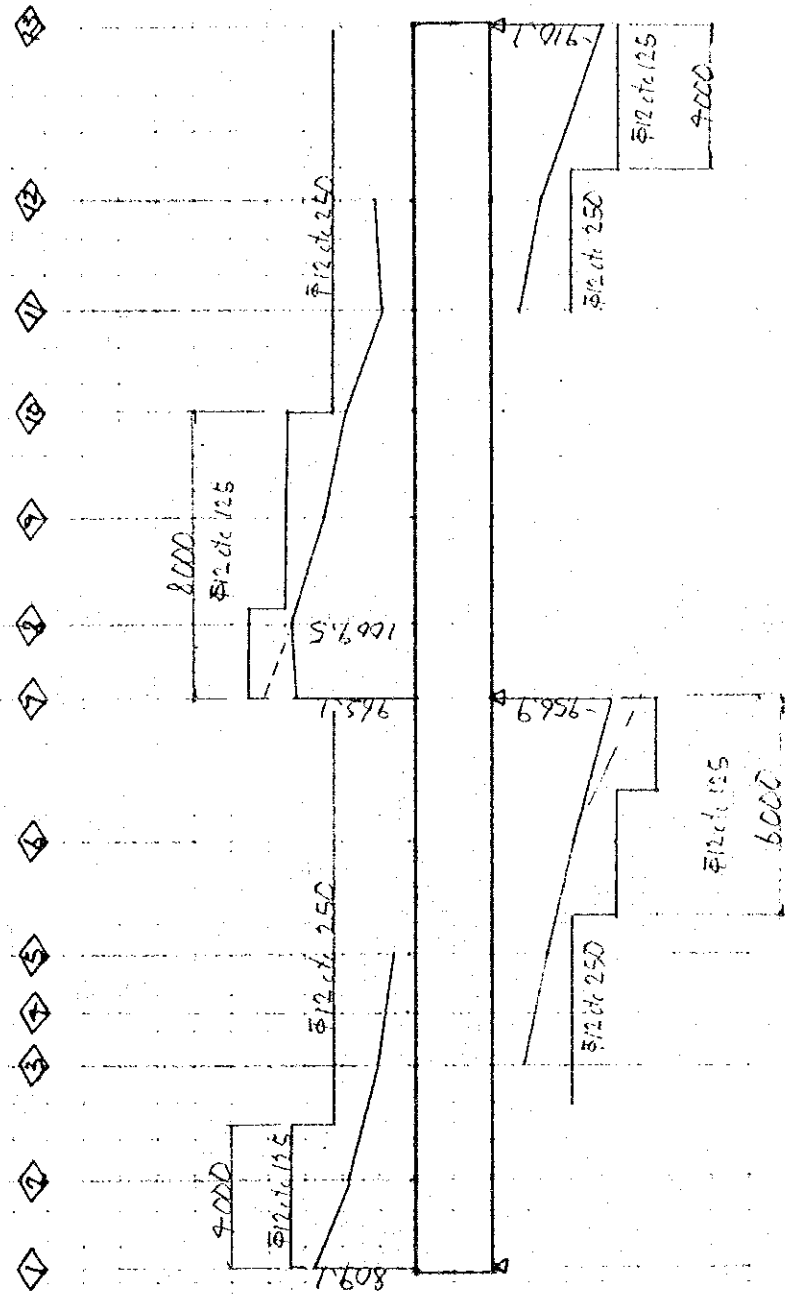



G3 SHEAR FORCE
808.1
997.9
1008.3
803.1
7000
6000
5000
4000

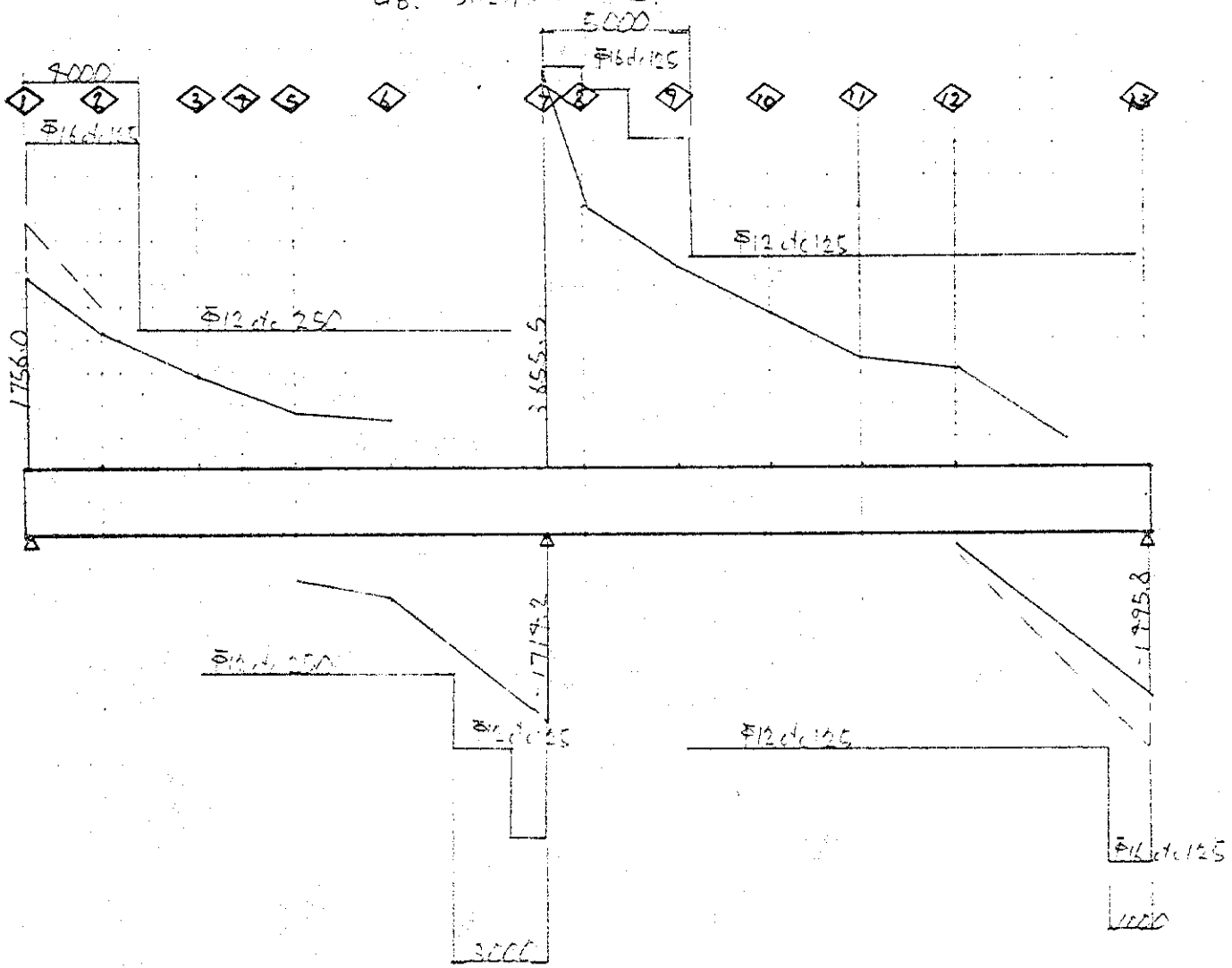
G4 SHEAR FORCE



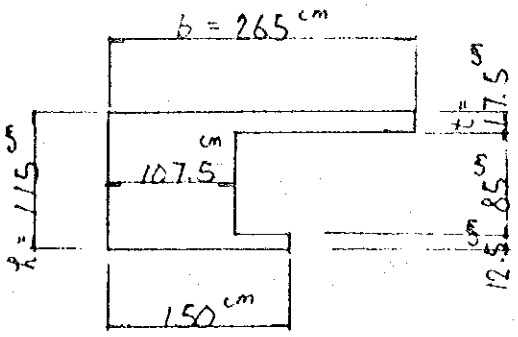
G5 SHEAR FORCE.



G6. SHEAR FORCE.



§3 CALCULATION OF STRESS
G1 AND G6 RESISTIBLE MOMENT



(FOR POSITIVE MOMENT)

$$As = 10 - \phi 32 = 10. \times 8.04 = 80.4 \ cm^2$$

$$d' = \frac{2.2 \times 7 + 15.2 \times 3}{10} = 9.6 \ cm$$

$$d = h - d' = 115.0 - 9.6 = 105.4 \ cm$$

$$np = \frac{n \cdot As}{b \cdot d} = \frac{15 \times 80.4}{265 \times 105.4} = 0.0432$$

$$x = \frac{n \cdot d \cdot As + b \cdot t^2}{n \cdot As + b \cdot t} = \frac{15 \times 105.4 \times 80.4 + 265 \times 17.5^2}{15 \times 80.4 + 265 \times 17.5} = 55.6 \ cm > 17.5 \ cm$$

NEWTRAL AXIS EXISTS AT WEB

$$k = \frac{np + \frac{1}{2}(t/d)}{np + t/d} = \frac{0.0432 + \frac{1}{2}(0.0662)^2}{0.0432 + 0.0660} = 0.916$$

$$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\frac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.066 \times \left\{\frac{3 \times 0.916 - 2 \times 0.066}{2 \times 0.916 - 0.066}\right\}$$

$$= 0.963$$

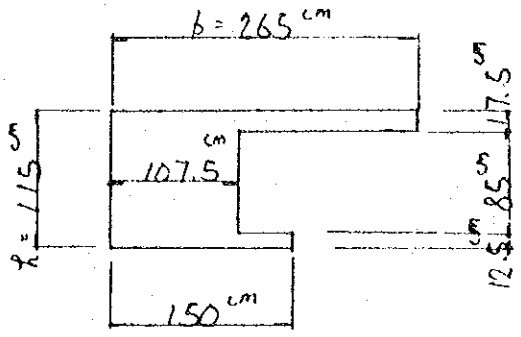
$$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.916)}{0.916} = 21.1 < \frac{23000}{1000} = 23$$

$$M_m = As \cdot j \cdot d \cdot \sigma_s = 80.4 \times 0.968 \times 105.4 \times 21.1 \times 1000$$

$$= 1730.8 \ KN \cdot m$$

G1 AND G6 RESISTIBLE MOMENT

(FOR POSITIVE MOMENT)



$A_s = 8 - \phi 32 = 8 \times 8.04 = 64.32 \ cm^2$

$d' = \dfrac{7.2 \times 7 + 15.2 \times 1}{8} = 8.2 \ cm$

$d = h - d' = 115.0 - 8.2 = 106.8 \ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 64.32}{265 \times 106.8} = 0.0341$

$x = \dfrac{n \cdot d \cdot A_s + b \cdot t^2}{n \cdot A_s + b \cdot t} = \dfrac{15 \times 106.8 \times 64.32 + 265 \times 17.5^2}{15 \times 64.32 + 265 \cdot 17.5} = 32.9 \ cm$

$> 17.5 \ cm$

NEWTRAL AXIS EXISTS AT WEB

$k = \dfrac{np + \frac{1}{2}(t/d)}{np + t/d} = \dfrac{0.0341 + \frac{1}{2}(0.066)}{0.0341 + 0.066} = 0.362$

$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\dfrac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.066 \times \left\{\dfrac{3 \times 0.362 - 2 \times 0.066}{2 \times 0.362 - 0.066}\right\}$

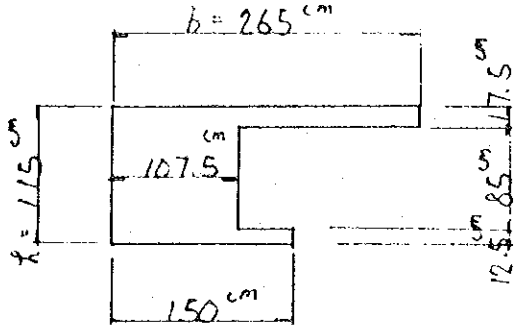
$= 0.968$

$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.362)}{0.362} = 26.4 > \dfrac{23000}{1000} = 23$

$M_{rm} = A_s \cdot j \cdot d \cdot \delta_c = 64.32 \times 0.968 \times 106.8 \times 23000$

$= 1529.7 \ kN \cdot m$

G1 AND G6 RESISTIBLE MOMENT



(FOR POSITIVE MOMENT)

$A_s = 7 - \Phi 32 = 7 \times 8.04 = 56.28 \ cm^2$

$d' = \dfrac{7.2 \times 7 + 15.2 \times 0}{7 + 0} = 7.2 \ cm$

$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 56.28}{265 \times 107.8} = 0.0296$

$x = \dfrac{n \cdot d \cdot A_s + b \cdot t^2}{n \cdot A_s + b \cdot t} = \dfrac{15 \times 107.8 \times 56.28 + 265 \times 17.5^2}{15 \times 56.28 + 265 \times 17.5} = 31.7 \ cm$

$> 17.5 \ cm$

NEWTRAL AXIS EXISTS AT WEB

$k = \dfrac{np + \frac{1}{2}(t/d)}{np + t/d} = \dfrac{0.0296 + \frac{1}{2}(0.066)}{0.0296 + 0.066} = 0.332$

$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\dfrac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.066 \times \left\{\dfrac{3 \times 0.332 - 2 \times 0.066}{2 \times 0.332 - 0.066}\right\}$

$= 0.968$

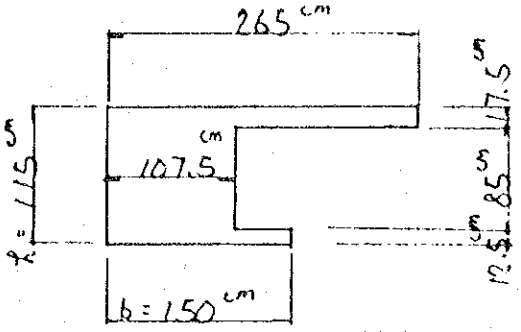
$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.332)}{0.332} = 30.2 > \dfrac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot f_s = 56.28 \times 0.968 \times 107.8 \times 23000$

$= 1350.3 \ KN \cdot m$

G1 AND G6 RESISTIBLE MOMENT

(FOR POSITIVE MOMENT)



$$A_s = 6 - \phi 32 = 6 \times 8.04 = 48.24 \ cm^2$$

$$d' = \frac{7.2 \times 4 + 15.2 \times 2}{6} = 9.9 \ cm$$

$$d = h - d' = 115.0 - 9.9 = 105.1 \ cm$$

$$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 48.24}{265 \quad 105.1} = 0.0260$$

$$x = \frac{n \cdot d \cdot A_s + b \cdot t^2}{n \cdot A_s + b \cdot t} = \frac{15 \times 105.1 \times 48.24 + 265 \times 17.5^2}{15 \times 48.24 + 265 \times 17.5} = 29.3 \ cm$$

$> 17.5 \ cm$

NEWTRAL AXIS EXISTS AT WEB

$$k = \frac{np + \frac{1}{2}(\frac{t}{d})}{np + \frac{t}{d}} = \frac{0.0260 + \frac{1}{2}(0.066)^2}{0.0260 + 0.066} = 0.306$$

$$j = 1 - \frac{1}{3} \cdot (\frac{t}{d}) \left\{ \frac{3k - 2 \cdot \frac{t}{d}}{2k - \frac{t}{d}} \right\} = 1 - \frac{1}{3} \times 0.066 \times \left\{ \frac{3 \times 0.306 - 2 \times 0.066}{2 \times 0.306 - 0.066} \right\}$$

$$= 0.968$$

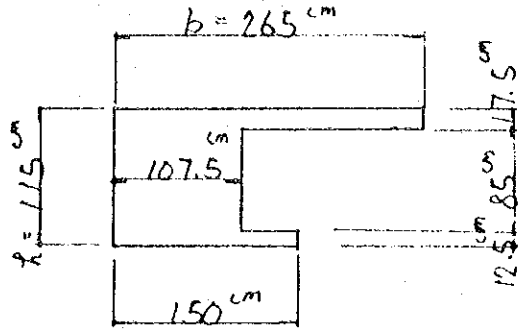
$$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.306)}{0.306} = 37.0 \qquad \frac{23000}{1000} = 23$$

$$M_{rn} = A_s \cdot j \cdot d \cdot f_s = 48.24 \times 0.968 \times 105.1 \times 23000$$

$$= 1128.8 \ KN \cdot m$$

G1 AND G6 RESISTIBLE MOMENT

(FOR POSITIVE MOMENT)



$$A_s = 5 - \phi 32 = 5 \times 8.04 = 40.2 \ cm^2$$

$$d' = \frac{7.2 \times 5 + 15.2 \times 0}{5 + 0} = 7.2 \ cm$$

$$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$$

$$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 40.2}{265 \times 107.8} = 0.0211$$

$$x = \frac{n \cdot d \cdot a_s + b \cdot t^2}{n \cdot a_s + b \cdot t} = \frac{15 \times 107.8 \times 40.2 + 265 \times 17.5^2}{15 \times 40.2 + 265 \times 17.5} = 27.9 \ cm > 17.5 \ cm$$

NEWTRAL AXIS EXISTS AT WEB

$$k = \frac{np + \frac{1}{2}(t/d)}{np + t/d} = \frac{0.0211 + \frac{1}{2}(0.066)^2}{0.0211 + 0.066} = 0.257$$

$$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\frac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.066 \times \left\{\frac{3 \times 0.257 - 2 \times 0.066}{2 \times 0.257 - 0.066}\right\}$$

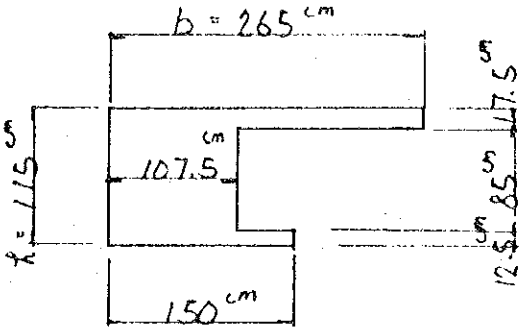
$$= 0.969$$

$$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.257)}{0.257} = 41.2 > \frac{2300}{1000} = 23$$

$$M_{rn} = A_s \cdot j \cdot d \cdot f_s = 40.2 \times 0.969 \times 107.8 \times 23\,000 \ kN \cdot m$$

$$= 965.8$$

G1 AND G6 RESISTIBLE MOMENT (FOR POSITIVE MOMENT)



$$A_s = 4 - \phi 32 = 4 \times 8.04 = 32.16 \ cm^2$$

$$d' = \frac{7.2 \times 4 + 15.2 \times}{4} = 7.2 \ cm$$

$$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$$

$$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 32.16}{265 \times 107.8} = 0.0169$$

$$x = \frac{n \cdot d \cdot A_s + b \cdot t^2}{n \cdot A_s + b \cdot t} = \frac{15 \times 107.8 \times 32.16 + 265 \times 17.5^2}{15 \times 32.16 + 265 \times 17.5} = 26.0 \ cm > 17.5$$

NEWTRAL AXIS EXISTS AT WEB

$$k = \frac{np + \frac{1}{2}(t/d)}{np + t/d} = \frac{0.0169 + \frac{1}{2}(0.066)^2}{0.0169 + 0.066} = 0.230$$

$$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\frac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.066 \times \left\{\frac{3 \times 0.230 - 2 \times 0.066}{2 \times 0.230 - 0.066}\right\}$$

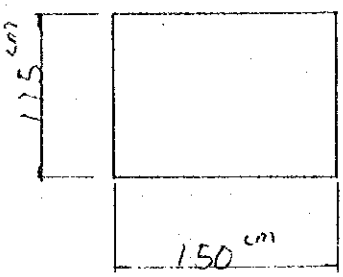
$$= 0.969$$

$$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.230)}{0.230} = 50.2 > \frac{23000}{1000} = 23$$

$$M_m = A_s \cdot j \cdot d \cdot \delta_s = 32.16 \times 0.969 \times 107.8 \times 23000$$

$$= 772.7 \ KN \cdot m$$

GT1 AND GT6 RESISTIBLE MOMENT



(FOR NEGATIVE MOMENT)

$A_s = 21 \times \Phi 32 = 21 \times 8.04 = 168.84\ (cm)^2$

$A_s' = 7 \times \Phi 32 = 7 \times 8.04 = 56.28\ "$

$d' = 7.2\ cm \quad d = 115 - 15.2 = 99.8\ (cm)$

$$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 168.84}{150 \times 99.8} = 0.1692$$

$$np' = \frac{n \cdot A_s'}{b \cdot d} = \frac{15 \times 56.28}{150 \times 99.8} = 0.0564$$

$$k = \sqrt{2\left(np + \frac{d'}{d} \cdot np'\right) + (np + np')^2} - (np + np')$$

$$= \sqrt{2(0.1692 + 0.072 \times 0.0564) + (0.1692 + 0.0564)} - (0.1692 + 0.0564) = 0.404$$

$$j = 1 - k/3 = 1 - \tfrac{1}{3} \times (0.404) = 0.865$$

$$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.404)}{0.404} = 22.1 < \frac{23000}{1000} = 23$$

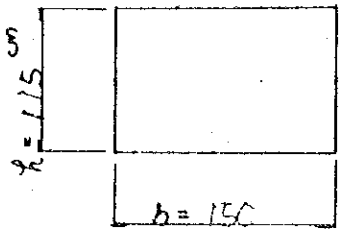
$$M_{ma} = \sigma_{ca} \cdot b \cdot d^2 \times \left(k/2 \cdot j + np'/k\left(k - \frac{d'}{d}\right)\left(1 - \frac{d'}{d}\right)\right)$$

$$= 1000 \times 150 \times 99.8 \times \{0.404/2 \times 0.865 + 0.0564 / 0.404 \times (0.404 - 0.072) \times (1 - 0.072)\}$$

$$= 3254.9\ KN \cdot m$$

G1 AND G6 RESISTIBLE MOMENT.

(FOR NEGATIVE MOMENT)



$A_s = 11 - \Phi 32 = 11 \times 8.04 = 88.44 \ cm^2$

$d' = \frac{7.2 \times 7 + 15.2 \cdot 4}{7 + 4} = 10.1 \ cm$

$d = h - d' = 115.0 - 10.1 = 104.9 \ cm$

$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 88.44}{150 \times 104.9} = 0.0893$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.0893 + (0.0893)^2} - 0.0893 = 0.335$

$j = 1 - k/3 = 1 - 1/3(0.335) = 0.888$

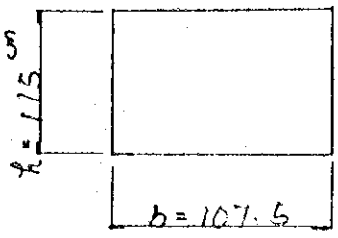
$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.335)}{0.335} = 29.8 > \frac{2300}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot \delta_s = 88.4 \times 0.888 \times 104.9 \times 23000$

$= 1894.0 \ kN \cdot m$

G1 AND G6 RESISTIBLE MOMENT.

(FOR NEGATIVE MOMENT.)



$A_s = 21 - \Phi 32 = 21 \times 8.04 = 168.84\ cm^2$

$d' = \dfrac{7.2 \times 7 + 15.2 \times 7 + 23.2}{7 + 7 + 7} = 15.2\ cm$

$d = h - d' = 115.0 - 15.2 = 99.8\ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 168.84}{107.5 \times 99.8} = 0.2361$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.2361 + (0.2361)^2} - 0.2361 = 0.990$

$j = 1 - k/3 = 1 - 1/3(0.990) = 0.837$

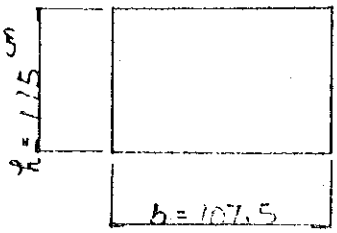
$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.990)}{0.990} = 15.6 < \dfrac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot \sigma_s = 168.84 \times 0.837 \times 99.8 \times 15.6 \times 1000$

$= 2200.2\ KN \cdot m$

G1 AND G6 RESISTIBLE MOMENT.

FOR NEGATIVE MOMENT



$A_s = 11 - \Phi 32 = 11 \times 8.04 = 88.44\ cm^2$

$d' = \frac{7.2 \times 7 + 15.3 \times 4}{7 + 4} = 10.1\ cm$

$d = h - d' = 115.0 - 10.1 = 104.9\ cm$

$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 88.4}{107.5 \times 104.9} = 0.1176$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.1176 + (0.1176)^2} - 0.1176 = 0.331$

$j = 1 - k/3 = 1 - 1/3 (0.331) = 0.873$

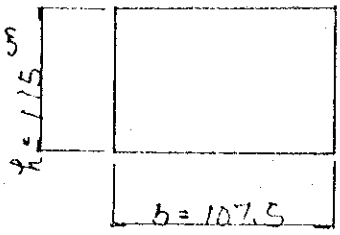
$m = \frac{n(1-k)}{k} = \frac{15.(1-0.331)}{0.331} = 29.9 > \frac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot \delta_s = 88.44 \times 0.873 \times 104.9 \times 23000$

$= 1862.9\ KN \cdot m$

GT1 AND GT6 RESISTIBLE MOMENT.

(FOR NEGATIVE MOMENT)



$As = 14 - \Phi 32 = 14 \times 8.04 = 112.56 \ cm^2$

$d' = \frac{7.2 \times 7 + 15.2 \cdot 7}{7 + 7} = 11.2 \ cm$

$d = h - d' = 115.0 - 11.2 = 103.8 \ cm$

$np = \frac{n \cdot As}{b \cdot d} = \frac{15 \times 112.56}{107.5 \times 103.8} = 0.1513$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.1513 + (0.1513)^2} - 0.1513 = 0.719$

$j = 1 - k/3 = 1 - \frac{1}{3}(0.719) = 0.860$

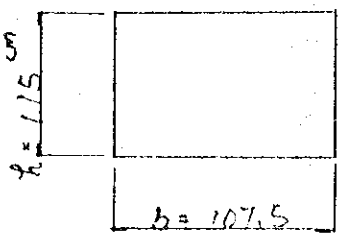
$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.719)}{0.719} = 20.8 \qquad \frac{23000}{1000} = 23$

$Mm = As \cdot j \cdot d \cdot \delta s = 112.56 \times 0.860 \times 103.8 \times 20.8 \times 1000$

$= 2090.0 \ KN \cdot m$

G1 AND G2 RESISTIBLE MOMENT

FOR NEGATIVE MOMENT



$A_s = 7 - \phi 32 = 7 \times 8.04 = 56.28 \ cm^2$

$d' = \frac{7.2 \times 7 + 15.2 \cdot}{7 +} = 7.2 \ cm$

$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$

$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 56.28}{107.5 \times 107.3} = 0.0728$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.0728 + (0.0728)^2} - 0.0728 = 0.316$

$j = 1 - k/3 = 1 - 1/3(0.316) = 0.895$

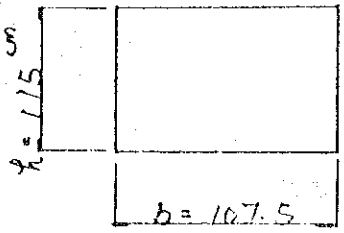
$m = \frac{n(1-k)}{k} = \frac{15 \cdot (1 - 0.316)}{0.316} = 32.5 > \frac{2300}{100} = 23$

$M_{rn} = A_s \cdot j \cdot d \cdot \delta_s = 56.28 \times 0.895 \times 107.3 \times 23000$

$= 1298.9 \ kN \cdot m$

G1 AND G6 RESISTIBLE MOMENT.

FOR NEGATIVE MOMENT



$A_s = 5 - \Phi 32 = 5 \times 8.04 = 40.2 \ cm^2$

$d' = \frac{7.2 \times 5 + 15.2 \times}{5 +} = 7.2 \ cm$

$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$

$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 40.2}{107.5 \times 107.3} = 0.0520$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.0520 + (0.0520)^2} - 0.0520 = 0.275$

$j = 1 - k/3 = 1 - 1/3(0.275) = 0.908$

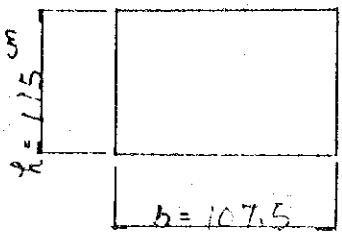
$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.275)}{0.275} = 39.5 \qquad \frac{23000}{1000} = 23$

$M_{rn} = A_s \cdot j \cdot d \cdot \delta_s = 40.2 \times 0.908 \times 107.8 \times 23000$

$= 905.0 \ kN \cdot m$

G1 AND G6 RESISTIBLE MOMENT.

FOR NEGATIVE MOMENT.



$A_s = 4 - \Phi 32 = 4 \times 8.04 = 32.16 \ cm^2$

$d' = \dfrac{7.2 \times 4 + 15.2 \times }{4 +} = 7.2 \ cm$

$d = h - d' = 115.0 - 7.2 = 107.8 \ (cm)$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 32.16}{107.5 \times 107.8} = 0.0416$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.0416 + (0.0416)^2} - 0.0416 = 0.250$

$j = 1 - k/3 = 1 - \frac{1}{3}(0.250) = 0.917$

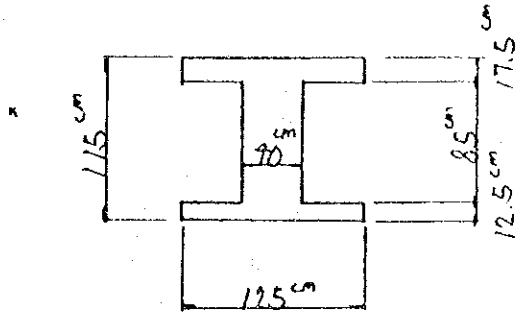
$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.250)}{0.250} = 45 > \dfrac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot \delta_s = 32.16 \times 0.917 \times 107.8 \times 23000$

$= 731.2 \ kN \cdot m$

G2 ~ G5 RESISTISLE MOMENT

(FOR POSITIVE MOMENT)



$A_s = 6 - \phi 32 = 6 \times 8.04 = 48.24\ cm^2$

$d' = \frac{7.2 \times 5 + 15.2 \times 1}{5 + 1} = 8.5\ cm$

$d = h - d' = 115.0 - 8.5 = 106.5\ cm$

$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 48.24}{125 \times 106.5} = 0.0544$

$x = \frac{n \cdot d \cdot a_s + b \cdot t^2}{n \cdot a_s + b \cdot t} = \frac{15 \times 106.5 \times 48.24 + 125 \times 17.5^2}{15 \times 48.24 + 125 \times 17.5} = 39.6\ cm > 17.5\ cm$

NEWTRAL AXIS EXISTS AT WEB

$k = \frac{np + \frac{1}{2}(t/d)}{np + t/d} = \frac{0.0544 + \frac{1}{2}(0.1693)}{0.0544 + 0.1693} = 0.310$

$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\frac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.1693 \times \left\{\frac{3 \times 0.310 - 2 \times 0.1693}{2 \times 0.310 - 0.1693}\right\}$

$= 0.928$

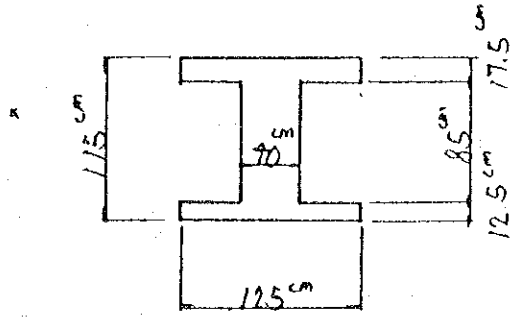
$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.310)}{0.310} = 33.4 > \frac{23000}{1000} = 23$

$M_{ra} = A_s \cdot j \cdot d \cdot f_c = 48.24 \times 0.928 \times 106.5 \times 23000$

$= 1091.8\ kN \cdot m$

G2 ~ G5 RESISTIBLE MOMENT

(FOR POSITIVE MOMENT)



$A_s = 5 - \phi 32 = 5 \times 8.04 = 40.2 \ cm^2$

$d' = \dfrac{7.2 \times 5 + 15.2 \times}{5} = 7.2 \ cm$

$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 40.2}{125 \times 107.8} = 0.0497$

$x = \dfrac{n \cdot d \cdot A_s + b \cdot t^2}{n \cdot A_s + b \cdot t} = \dfrac{15 \times 107.8 \times 40.2 + 125 \times 17.5^2}{15 \times 40.2 + 125 \times 17.5} = 37.0 \ cm > 17.5 \ cm$

NEWTRAL AXIS EXISTS AT WEB

$k = \dfrac{np + \frac{1}{2}(t/d)^2}{np + t/d} = \dfrac{0.0497 + \frac{1}{2}(0.1693)^2}{0.0497 + 0.1693} = 0.278$

$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\dfrac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.1693 \times \left\{\dfrac{3 \times 0.278 - 2 \times 0.1693}{2 \times 0.278 - 0.1693}\right\}$

$= 0.995$

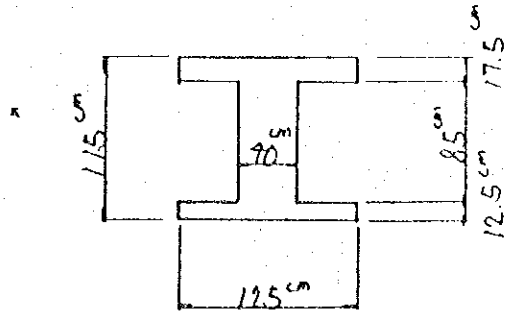
$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.278)}{0.278} = 39.0 > \dfrac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot \sigma_s = 40.2 \times 0.995 \times 107.8 \times 23000$ KN·m

$= 991.9$

G2 ~ G5 RESISTIBLE MOMENT

(FOR POSITIVE MOMENT)



$A_s = 3 - \phi 32 = 3 \times 8.04 = 24.12 \ cm^2$

$d' = \dfrac{7.2 \times 3 + 15.2 \times}{3} = 7.2 \ cm$

$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 24.12}{125 \times 107.8} = 0.0268$

$x = \dfrac{n \cdot d \cdot A_s + b \cdot t^2}{n \cdot A_s + b \cdot t} = \dfrac{15 \times 107.8 \times 24.12 + 125 \times 17.5^2}{15 \times 24.12 + 125 \times 17.5} = 30.3 \ cm > 17.5 \ cm$

NEWTRAL AXIS EXISTS AT WEB

$k = \dfrac{np + \frac{1}{2}(t/d)}{np + t/d} = \dfrac{0.0268 + \frac{1}{2}(0.1693)}{0.0268 + 0.1693} = 0.211$

$j = 1 - \frac{1}{3} \cdot (t/d) \left\{ \dfrac{3k - 2 \cdot t/d}{2k - t/d} \right\} = 1 - \frac{1}{3} \times (0.1693) \times \left\{ \dfrac{3 \times 0.211 - 2 \times 0.1693}{2 \times 0.211 - 0.1693} \right\}$

$= 0.935$

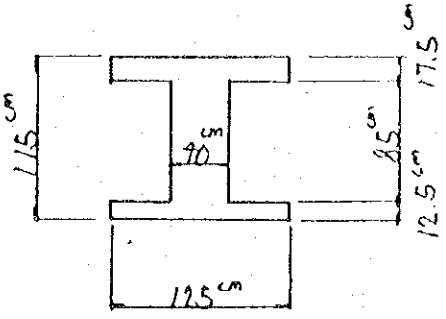
$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.211)}{0.211} = 56.1 > \dfrac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot f_s = 24.12 \times 0.935 \times 107.8 \times 23000 \ kN \cdot m$

$= 559.2$

G2 ~ G5 RESISTIBLE MOMENT

(FOR NEGATIVE MOMENT)



$A_s = 8 - \Phi 32 = 8 \times 8.04 = 64.32 \ cm^2$

$d' = \dfrac{7.2 \times 5 + 15.7 \times 3}{5 + 3} = 10.2 \ cm$

$d = h - d' = 115.0 - 10.2 = 104.8 \ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 64.32}{125 \times 104.8} = 0.0736$

$x = \dfrac{n \cdot d \cdot A_s + b \cdot t^2}{n A_s + b \cdot t} = \dfrac{15 \times 104.8 \times 64.32 + 125 \times 17.5^2}{15 \times 64.32 + 125 \times 17.5} = 47.1$

NEWTRAL AXIS EXISTS AT WEB

$k = \dfrac{np + \frac{1}{2}(\frac{t}{d})^2}{np + \frac{t}{d}} = \dfrac{0.0736 + \frac{1}{2}(0.100)^2}{0.0736 + 0.1} = 0.921$

$j = 1 - \frac{1}{3} \cdot (\frac{t}{d}) \left\{ \dfrac{3k - 2\frac{t}{d}}{2k - \frac{t}{d}} \right\} = 1 - \frac{1}{3} \times (0.100) \times \left\{ \dfrac{3 \times 0.921 - 2 \times 0.100}{2 \times 0.921 - 0.100} \right\}$

$= 0.952$

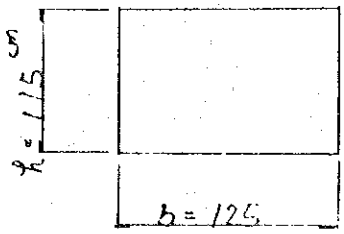
$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.921)}{0.921} = 20.6 < \dfrac{23000}{1000} = 23$

$M_{ra} = A_s \cdot j \cdot d \cdot f_s = 64.32 \times 0.952 \times 104.8 \times 20600$

$= 1321.9 \ kN \cdot m$

G2 ~ G5 RESISTIBLE MOMENT.

(FOR NEGATIVE MOMENT)



$A_s = 8 - \Phi 32 = 8 \times 8.04 = 64.32 \ cm^2$

$d' = \frac{7.2 \times 5 + 15.2 \times 3}{5 + 3} = 10.2 \ cm$

$d = h - d' = 115.0 - 10.2 = 104.8 \ cm$

$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 64.32}{125 \times 104.8} = 0.0736$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{2 \times 0.0736 + (0.0736)^2} - 0.0736 = 0.317$

$j = 1 - k/3 = 1 - 1/3(0.317) = 0.894$

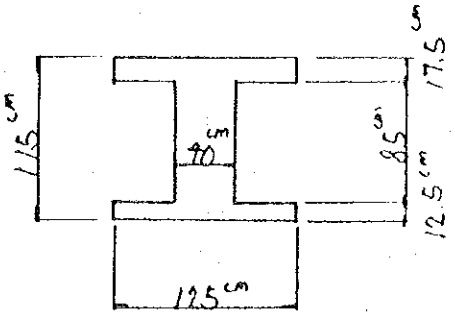
$m = \frac{n(1-k)}{k} = \frac{15 \cdot (1 - 0.317)}{0.317} = 32.3 > \frac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot \sigma_s = 64.32 \times 0.894 \times 104.8 \times 23000$

$= 1386.0 \ kN \cdot m$

G2 ~ G5 RESISTIBLE MOMENT

(FOR NEGATIVE MOMENT)



$A_s = 7 - \phi 32 = 7 \times 8.04 = 56.28 \ cm^2$

$d' = \dfrac{7.2 \times 5 + 15.2 \times 2}{5 + 2} = 9.5 \ cm$

$d = h - d' = 115.0 - 9.5 = 105.5 \ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 56.28}{125 \times 105.5} = 0.0670$

$x = \dfrac{n \cdot d \cdot A_s + b \cdot t^2}{n \cdot A_s + b \cdot t} = \dfrac{15 \times 105.5 \times 56.28 + 125 \times 12.5^2}{15 \times 56.28 + 125 \times 12.5} = 45.1 \ cm > 12.5 \ cm$

NEWTRAL AXIS EXISTS AT WEB

$k = \dfrac{np + \frac{1}{2}(t/d)}{np + t/d} = \dfrac{0.0670 + \frac{1}{2}(0.100)}{0.0670 + 0.100} = 0.921$

$j = 1 - \frac{1}{3} \cdot (t/d) \left\{ \dfrac{3k - 2 \cdot t/d}{2k - t/d} \right\} = 1 - \frac{1}{3} \times 0.100 \times \left\{ \dfrac{3 \times 0.921 - 2 \times 0.100}{2 \times 0.921 - 0.100} \right\}$

$= 0.952$

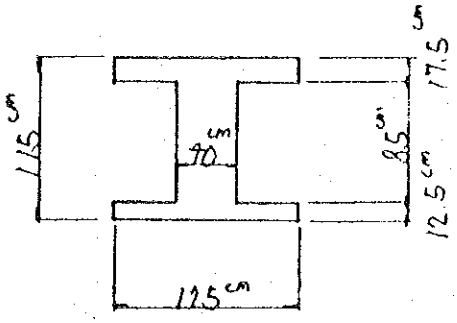
$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.921)}{0.921} = 20.6 < \dfrac{23000}{1000} = 23$

$M_{ra} = A_s \cdot j \cdot d \cdot \sigma_s = 56.28 \times 0.952 \times 105.5 \times 20.600$

$= 1169.9 \ kN \cdot m$

G2 ~ G5 RESISTIBLE MOMENT

(FOR NEGATIVE MOMENT)



$$A_s = 5 - \phi 32 = 5 \times 8.04 = 40.20 \ cm^2$$

$$d' = \frac{7.2 \times 5 + 15.2 \times}{5} = 7.2 \ cm$$

$$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$$

$$np = \frac{n \cdot A_s}{b \cdot d} = \frac{15 \times 40.2}{125 \times 107.8} = 0.0447$$

$$x = \frac{n \cdot d \cdot A_s + b \cdot t^2}{n A_s + b \cdot t} = \frac{15 \times 107.8 \times 40.2 + 125 \times 12.5^2}{15 \times 40.2 + 125 \times 12.5} = 39.0 \ cm > 12.5$$

NEWTRAL AXIS EXISTS AT WEB

$$k = \frac{np + \frac{1}{2}(t/d)}{np + t/d} = \frac{0.0447 + \frac{1}{2}(0.100)^2}{0.0447 + 0.100} = 0.343$$

$$j = 1 - \frac{1}{3}(t/d)\left\{\frac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.100 \times \left\{\frac{3 \times 0.343 - 2 \times 0.100}{2 \times 0.343 - 0.100}\right\}$$

$$= 0.953$$

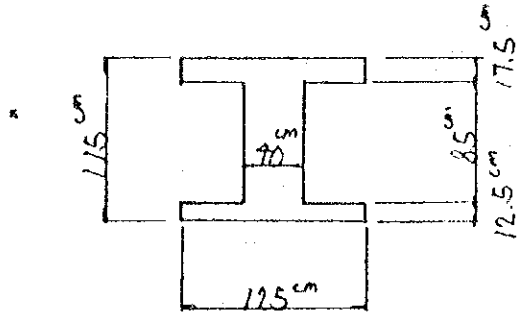
$$m = \frac{n(1-k)}{k} = \frac{15 \times (1 - 0.343)}{0.343} = 28.7 > \frac{23000}{1000} = 23$$

$$M_{ra} = A_s \cdot j \cdot d \cdot f_s = 40.2 \times 0.953 \times 107.8 \times 23000$$

$$= 949.9 \ KN \cdot M$$

G2 ~ G5 RESISTIBLE MOMENT

(FOR NEGATIVE MOMENT)



$A_s = 3 - \phi 32 = 3 \times 8.04 = 24.12 \ cm^2$

$d' = \dfrac{7.2 \times 3 + 15.2 \times}{3} = 7.2 \ cm$

$d = h - d' = 115.0 - 7.2 = 107.8 \ cm$

$np = \dfrac{n \cdot A_s}{b \cdot d} = \dfrac{15 \times 24.12}{125 \times 107.8} = 0.0268$

$x = \dfrac{n \cdot d \cdot A_s + b \cdot t^2}{n A_s + b \cdot t} = \dfrac{15 \times 107.8 \times 24.12 + 125 \times 12.5^2}{15 \times 24.12 + 125 \times 12.5} = 30.4$

NEWTRAL AXIS EXISTS AT WEB

$k = \dfrac{np + \frac{1}{2}(t/d)}{np + t/d} = \dfrac{0.0268 + \frac{1}{2}(0.100)^2}{0.0268 + 0.100} = 0.251$

$j = 1 - \frac{1}{3} \cdot (t/d)\left\{\dfrac{3k - 2 \cdot t/d}{2k - t/d}\right\} = 1 - \frac{1}{3} \times 0.100 \times \left\{\dfrac{3 \cdot 0.251 - 2 \cdot 0.100}{2 \cdot 0.251 - 0.100}\right\}$

$= 0.959$

$m = \dfrac{n(1-k)}{k} = \dfrac{15 \times (1 - 0.251)}{0.251} = 44.8 > \dfrac{23000}{1000} = 23$

$M_m = A_s \cdot j \cdot d \cdot \sigma_s = 24.12 \times 0.959 \times 107.8 \times 23000$

$= 570.5 \ KN \cdot m$

CALCULATION OF SHEAR STRESS

CHECKE FOR MAXIMUM SHEAR FORCE.

GT1, GT6

$$\nu = \frac{V}{b \cdot d}$$

$$= \frac{4157.4 \times 10^3}{1500 \times 1078} = 2.57 < 4.10.$$

GT2, ~ GT5

$$\nu = \frac{1310.2 \times 10^3}{1250 \times 1078} = 0.97 < 4.10$$

SHEAR RESISTANCE.

CALCULATION OF V_c

$$V_c = v_c \cdot b \cdot d$$

V_c ; SHEAR RESISTANCE CHARGE OF CONCRETE

v_c ; ULTIMATE SHEAR STRESS IN BEAMS

CALCULATION OF SHEAR REINFORCEMENT.

$$A_{sv} = \frac{(V - V_c) \cdot S_v}{0.87 \times f_{yv} \cdot d}$$

S_v ; SPACING OF STIRRUPS

f_{yv} ; CHARACTERISTIC STRENGTH

d ; EFFECTIVE DEPTH

GT1

$$V_c = b \cdot d \cdot \nu$$

	b (cm)	d (cm)	As (cm²)	P (%)	ν (N/cm²)	Vc (KN)
1	150.	107.8	32.16	0.20	33.0	952.8
2	107.5	106.8	64.32	0.56	56.8	652.1
3	〃	〃	〃	〃	〃	〃
4	〃	〃	〃	〃	〃	〃
5	〃	〃	〃	〃	〃	〃
6	〃	107.3	56.28	0.49	97.0	599.7
7	150.	104.9	32.94	0.56	56.8	893.7
8	107.5	107.8	56.28	0.49	97.0	599.7
9	〃	105.4	80.90	0.71	61.3	694.6
10	〃	〃	〃	〃	〃	〃
11	〃	〃	〃	〃	〃	〃
12	150	107.8	56.28	0.35	93.0	695.3
13	〃	〃	〃	〃	〃	〃

G2 ~ G5

$$V_c = b \cdot d \cdot \nu$$

	b (cm)	d (cm)	A_s (cm^2)	p (%)	ν (N/cm^2)	V_c (KN)
1	125	107.8	3-D13 29.12	0.18	25.2	339.6
2	90	106.5	6-D13 48.29	1.13	72.6	309.3
3	〃	〃	〃	〃	〃	〃
4	〃	〃	〃	〃	〃	〃
5	〃	〃	〃	〃	〃	〃
6	〃	107.8	5-D16 40.30	0.93	67.9	292.8
7	125	109.8	8-D13 49.32	0.49	47.0	615.7
8	90	106.5	6-D13 42.39	1.13	72.6	309.3
9	〃	〃	〃	〃	〃	〃
10	〃	〃	〃	〃	〃	〃
11	〃	〃	〃	〃	〃	〃
12	〃	107.8	3-D13 29.12	0.56	56.2	249.9
13	125	〃	〃	0.18	25.2	339.6

G6

$$V_c = b \cdot d \cdot v$$

	b (cm)	d (cm)	As (cm²)	p (%)	v (N/cm²)	Vc (KN)
1	150.	107.2	4 33.16	0.20	28.0	452.8
2	107.5	〃	7 56.28	0.49	47.0	544.7
3	〃	〃	〃	〃	〃	〃
4	〃	〃	〃	〃	〃	〃
5	〃	〃	〃	〃	〃	〃
6	〃	〃	〃	〃	〃	〃
7	150	99.2	11 168.29	1.13	102.6	1535.9
8	107.5	103.8	19 113.56	1.01	100.	1115.9
9	〃	107.2	7 56.28	0.49	47.0	544.7
10	〃	〃	〃	〃	〃	〃
11	〃	〃	〃	〃	〃	〃
12	〃	〃	〃	〃	〃	〃
13	150	〃	4 33.16	0.20	28.0	452.8

GT1.　　$A_{SV} = \dfrac{(V - V_c) \cdot S_V}{0.87 \cdot f_{SV} \cdot d}$　　($S_V = 100^{(cm)}$)
($f_{SV} = 425^{N/mm^2}$)

	V (KN)	V_c (KN)	d cm	$A_{SV\,req}$ cm^2	
1	1933.7	452.8	107.8	37.3	φ16 d=1.25×2 = 69.3
2	879.9	652.1	106.8	5.6	φ12 d=2.50×2 = 18.1
3	505.8	〃	〃	—	〃
5	1062.7	〃	〃	10.4	〃
6	2311.8	594.7	107.8	49.3	φ16 d=1.25×2 = 69.3
7L	2705.1	893.7	107.2	46.7	〃
7R	1622.1	〃	〃	18.8	φ16 d=2.50×2 = 32.1
8	1073.7	594.7	107.2	12.5	φ12 d=2.50×2 = 18.1
9	651.1	699.6	105.9	—	〃
10	679.6	〃	〃	—	〃
11	1417.6	〃	〃	18.5	φ20 d=1.25×2 = 110.5
12	3190.5	695.3	107.2	62.6	〃
13	4157.7	〃	〃	86.9	〃

G2

	V (kN)	V_c (kN)	d cm	$A_{sv_{req}}$ cm²	
1	775.8	339.6	107.2	10.9	φ12 d.c 125 = 18.1
2	466.9	309.3	106.5	7.0	φ12 d.c 250 = 9.0
3	393.3	〃	〃	6.9	〃
5	435.7	〃	〃	3.1	〃
6	766.5	393.8	107.2	10.9	φ12 d.c 125 = 18.1
7L	1239.7	615.7	109.8	16.1	〃
7R	1203.3	〃	〃	15.2	〃
8	679.7	309.3	106.5	9.3	〃
9	512.1	〃	〃	5.2	φ12 d.c 250 = 9.0
10	329.5	〃	〃	0.9	〃
11	539.1	〃		5.7	〃
12	729.1	299.9	107.2	13.5	φ12 d.c 125 = 18.1
13	979.7	339.6	〃	15.9	〃

G3

	V (KN)	V_c (KN)	d cm	A_{sv} cm²	
1	808.1	339.6	107.8	11.8	本15, ctc125 = 18.1
2	514.9	309.3	106.5	5.3	本13 ctc250 = 9.0
3	366.0	〃	〃	——	〃
5	488.7	〃	〃	7.6	〃
6	655.7	293.8	107.8	9.1	本12 ctc125 = 12.1
7L	1310.8	615.7	109.8	17.9	〃
7R	1233.3	〃	〃	15.9	〃
8	732.5	293.8	107.8	11.2	〃
9	577.8	309.3	106.5	6.8	本13 ctc250 = 9.0
10	377.0	〃	〃	6.9	〃
11	262.5	〃	〃	——	〃
12	799.1	〃	〃	1.7	〃
13	803.1	339.6	107.2	11.6	本12 ctc125 = 12.1

G4

	V (KN)	V_c (KN)	d cm	$A_{SV_{R\&L}}$ cm^2	
1	822.1	339.6	107.8	12.1	4-12 ct. 125 = 12.1
2	590.1	309.6	106.5	5.9	4-12 ct. 250 = 9.0
3	320.3	〃	〃	0.3	〃
5	333.3	〃	〃	1.9	〃
6	568.9	293.8	107.8	6.9	〃
7_L	1249.5	615.7	107.8	16.2	4-12 ct. 125 = 12.1
7_R	1257.5	〃	〃	16.6	〃
8	829.9	293.8	107.8	13.5	〃
9	692.7	309.6	106.5	8.5	4-12 ct. 250 = 9.0
10	426.9	〃	〃	1.2	〃
11	291.6	〃	〃	—	〃
12	310.5	〃	〃	—	〃
13	735.1	339.6	107.8	13.5	4-12 ct. 125 = 12.1

GT5

	V (kN)	V_c (kN)	d cm	$A_{sv_{req}}$ cm^2	
1	809.1	339.6	107.8	11.8	有12@125 = 18.1
2	591.6	309.6	106.5	9.7	有12@250 = 9.0
3	330.7	〃	〃	0.5	〃
5	452.3	〃	〃	3.6	〃
6	660.2	292.8	107.8	9.2	有12@125 = 18.1
7L	1299.0	615.7	109.8	16.2	〃
7R	1250.7	〃	〃	16.9	〃
8	1009.5	292.8	107.2	18.0	〃
9	795.5	309.6	106.5	11.1	〃
10	552.2	〃	〃	6.2	有12@250 = 9.0
11	338.7	〃	〃	0.7	〃
12	393.0	〃	〃	3.1	〃
13	910.1	339.6	107.8	14.3	有12@125 = 18.1

G6

	V (kN)	V_c (kN)	d cm	$A_{SV_{req}}$ cm^2	
1	2282.8	952.8	107.8	45.9	φ16 ctc 125 × 2 = 69.3
2	1231.9	599.7	〃	12.5	〃
3	869.0	〃	〃	2.1	φ13 ctc 250 × 2 = 12.1
5	517.3	〃	〃	—	〃
6	581.5	〃	〃	0.9	〃
7_L	1719.2	1353.9	99.8	7.8	φ12 ctc 125 × 2 = 36.1
7_R	3655.6	〃	〃	62.9	φ16 ctc 125 × 2 = 69.3
8	3910.9	1115.9	103.8	33.7	〃
9	1349.8	599.7	107.8	35.7	〃
10	1453.7	〃	〃	22.8	φ12 ctc 125 × 2 = 36.1
11	1035.1	〃	〃	13.3	〃
12	935.6	〃	〃	9.6	〃
13	1999.5	952.2	〃	57.9	φ16 ctc 125 × 2 = 69.3

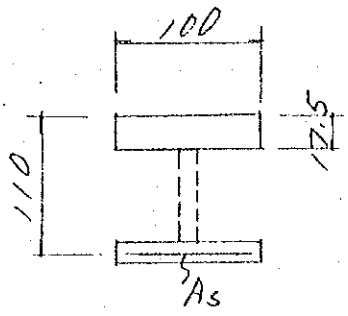
§§ 3. DESIGN OF CROSS BEAM.

Moment list

HA × 1/b × 1.3

HB × 1/b × 1.3 × 1/1.25

	HA (KN·m)	HB (KN·m)	b (m)	HA (KN/m)	HB (KN/m)
1	129.4 - 236.5	188.1 - 347.9	1.900 "	85.1 - 161.8	103.0 - 190.4
2	128.6 - 186.4	179.9 - 176.4	3.200 "	52.2 - 75.7	97.1 - 57.3
3	129.1 - 250.9	159.9 - 226.7	" "	52.4 - 101.9	53.0 - 73.7
5	160.8 - 238.1	189.4 - 238.5	" "	65.3 - 96.7	61.6 - 77.5
6	283.2 - 373.3	315.1 - 392.9	" "	115.1 - 151.7	102.4 - 127.7
7	325.5 - 829.0	393.0 - 990.6	3.133 "	135.1 - 345.0	130.5 - 328.8
8	521.2 - 518.4	570.1 - 509.2	3.067 "	220.9 - 219.7	193.3 - 172.7
9	218.0 - 158.4	279.0 - 108.7	" "	92.4 - 67.1	94.6 - 36.9
10	151.4 - 198.4	183.0 - 166.1	" "	64.2 - 84.1	62.1 - 56.3
11	197.9 - 190.5	251.9 - 208.5	" "	83.9 - 80.7	85.4 - 70.7
12	352.9 - 297.4	383.2 - 323.6	" "	149.6 - 126.1	129.9 - 109.4
13	358.6 - 983.9	412.7 - 691.3	1.933 "	241.2 - 325.4	222.0 - 345.0



$M = 291.2\ KNm$

$b = 100\ cm \quad d = 110\ cm \quad t = 17.5\ cm$

$A_s = \Phi 16\ c/c\ 12.5\ cm$

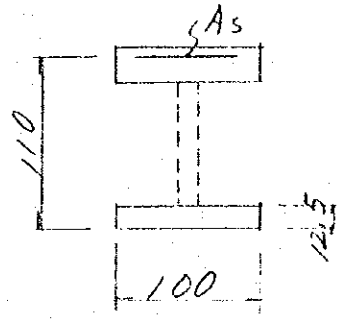
$= 16.08\ cm^2$

$P = \frac{A_s}{bd} = 0.00146 \quad t/d = 0.159$

$K = 0.191 \quad j = 0.939$

$\sigma_c = 2.29\ N/cm^2 < 1000\ N/cm^2$

$\sigma_s = 19522\ " < 23000\ "$



$M = -345.\ KNm$

$b = 100\ cm \quad d = 110\ cm \quad t = 12.5\ cm$

$A_s = \Phi 16\ c/c\ 12.5\ cm$

$= \begin{matrix}(9.05)\\16.1\end{matrix}\ cm^2$

$P = 0.00146 \quad t/d = 0.114$

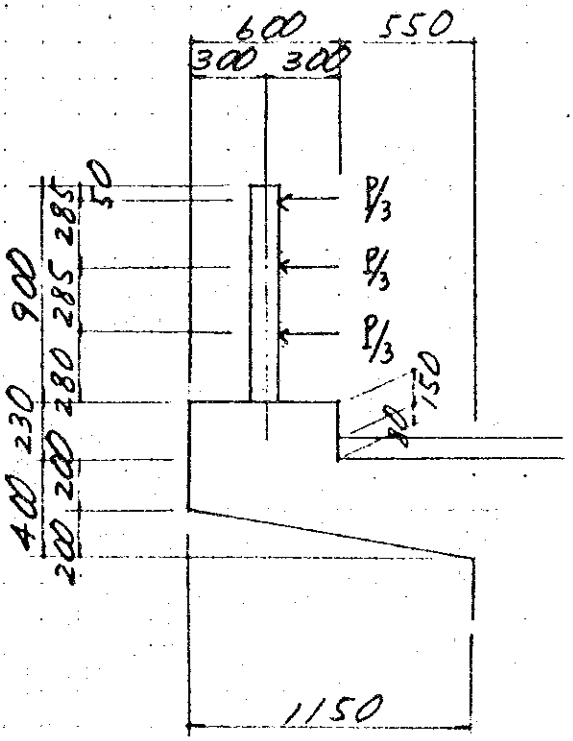
$K = 0.209 \quad j = 0.930$

$\sigma_c = 369\ N/cm^2 < 1000\ N/cm^2$

$\sigma_s = 20997\ " < 23000\ "$

§§ 4 DESIGN OF CANTILEVER SRAB

1 Calculation of bending moment



Bending moment due to dead load

Rail	1.10 × 0.85	=	0.935 KN/m/m
Kerb	3.257 × 0.85	=	2.768 "
Wearing surface	½ × 1.808 × 0.55²	=	0.273 "
Slab	⅙ × 1.15² × (2 × 4.72 + 9.44)	=	4.161 "
		Md =	8.137 KN/m/m

Bending moment due to collision load

$$C = 1 + \frac{1050 - 850}{450} = 1.444$$

$$C.P = 1.444 \times 45 = 65.0 \ KN$$

$$Mc = 65.0/3 \times (0.71 + 0.995 + 1.28) = 64.68 \ KNm$$

Interval of post 2.0 m

$$Mc = 64.68/2.0 = 32.34 \ KNm/m$$

Bending moment due to live load

$$M_l = \frac{P}{\pi} \times \frac{1}{1 + (\frac{y}{U})^4}$$

$$P = 112.5 \ KN/m$$

$$y = 0 \ m$$

$$\therefore M_l = \frac{112.5}{\pi} = 35.81 \ KNm/m$$

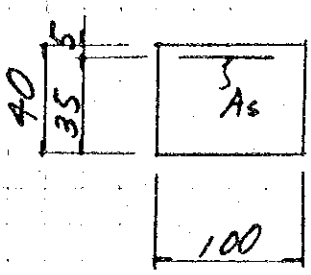
Total

$$M = Md + Mc + Ml$$

$$= 8.14 + 32.34 + 35.81$$

$$= 76.29 \ KNm/m$$

2 Calculation of bending stress



$M = 76.29$ KN.M

$b = 100$ cm $h = 40$ cm $d' = 5$ cm

$d = 35$ cm

$A_s = \Phi\ 12$ cte 12.5 cm

$= 9.05\ cm^2$

$$P = \frac{A_s}{bd} = 0.00226$$

$K = 0.229$ $\beta' = 0.923$

$\sigma_c = 517\ N/cm^2 < 1000 \times 1.25 = 1250\ N/cm^2$

$\sigma_s = 26100\ " < 23000 \times 1.25 = 28750\ "$

6. R.C. Voided Slab Bridge (M.J. G-Ramp BR)

CONTENTS

§§ 1 DESIGN CONDITION

§ 1. DESIGN CONDITION

TYPE	2 SPANS CONTINUANCE RC VOIDED SLAB BRIDE
BRIDGE LENGTH	32 350
GIRDER LENGTH	32 300
SPAN	14 570 + 17 030
WIDTH	7 800
LIVE LOAD	BS 153
	HA LOADING
	HB LOADING 37.5 UNITS
	FOOTWAY LOADING 5 KN/m^2
	VEHICLE COLLISION WITH GUARDRAIL
	ACCORDING TO NAARSA

ULTIMATE LOAD FACTORS

HA LOADING	1.5 D + 2.5 L
	2 (D + L)
HB LOADING	1.5 D + 2.0 L

§ 2. MATERIAL STRENGTH AND PERMISSIBLE STRESS

1. CONCRETE

MAIN SLAB

SPECIFIED WORKS CUBE STRENGTH

AT 28 DAYS — 30 N/mm^2 (306 kg/cm^2)

PERMISSIBLE COMPRESSIVE STRESS

BENDING COMPRESSION — 10 N/mm^2 (101 kg/cm^2)

SHEAR — 0.87 N/mm^2 (8.9 kg/cm^2)

2. REINFORCEMENT

HOT ROLLED YIELD BARS

SPECIFIED CHARACTERISTIC STRENGTH

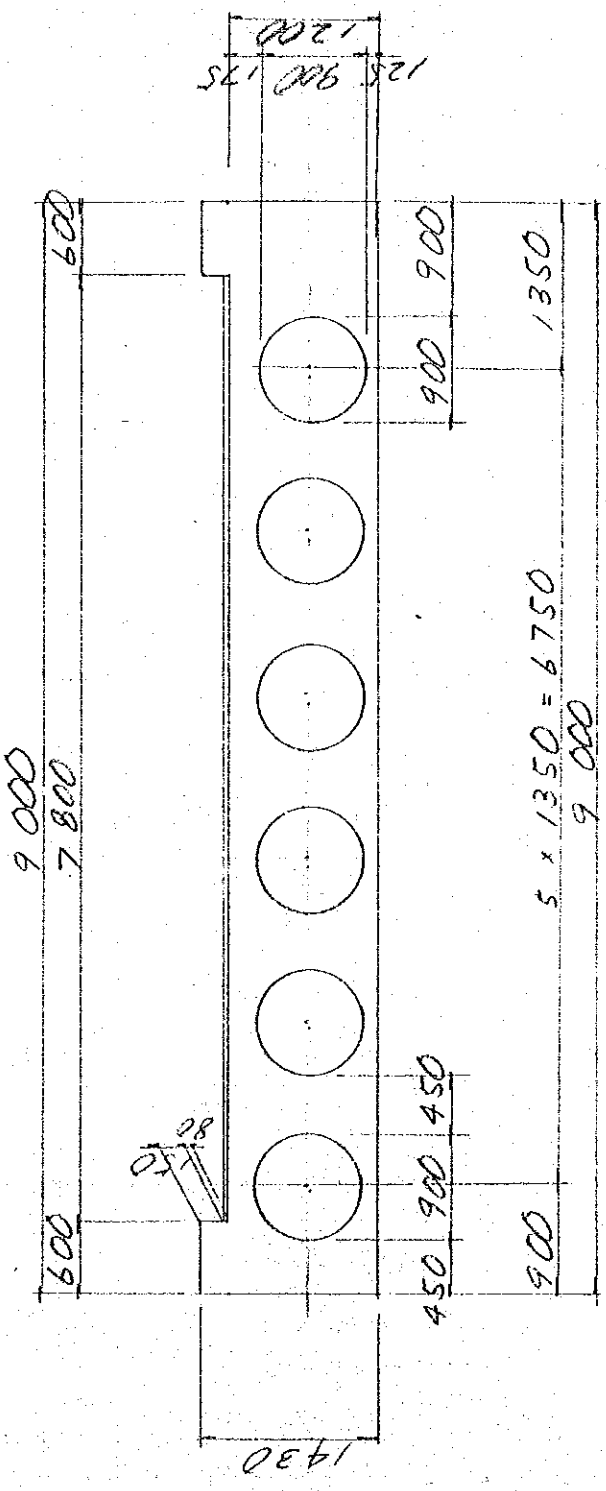
f_{su} = 410 N/m^2 (4180 kg/cm^2)

PERMISSIBLE TENSILE STRESS

f_{so} = 230 N/mm^2 (2340 kg/cm^2)

§§ 2 DESIGN OF MAIN SLAB

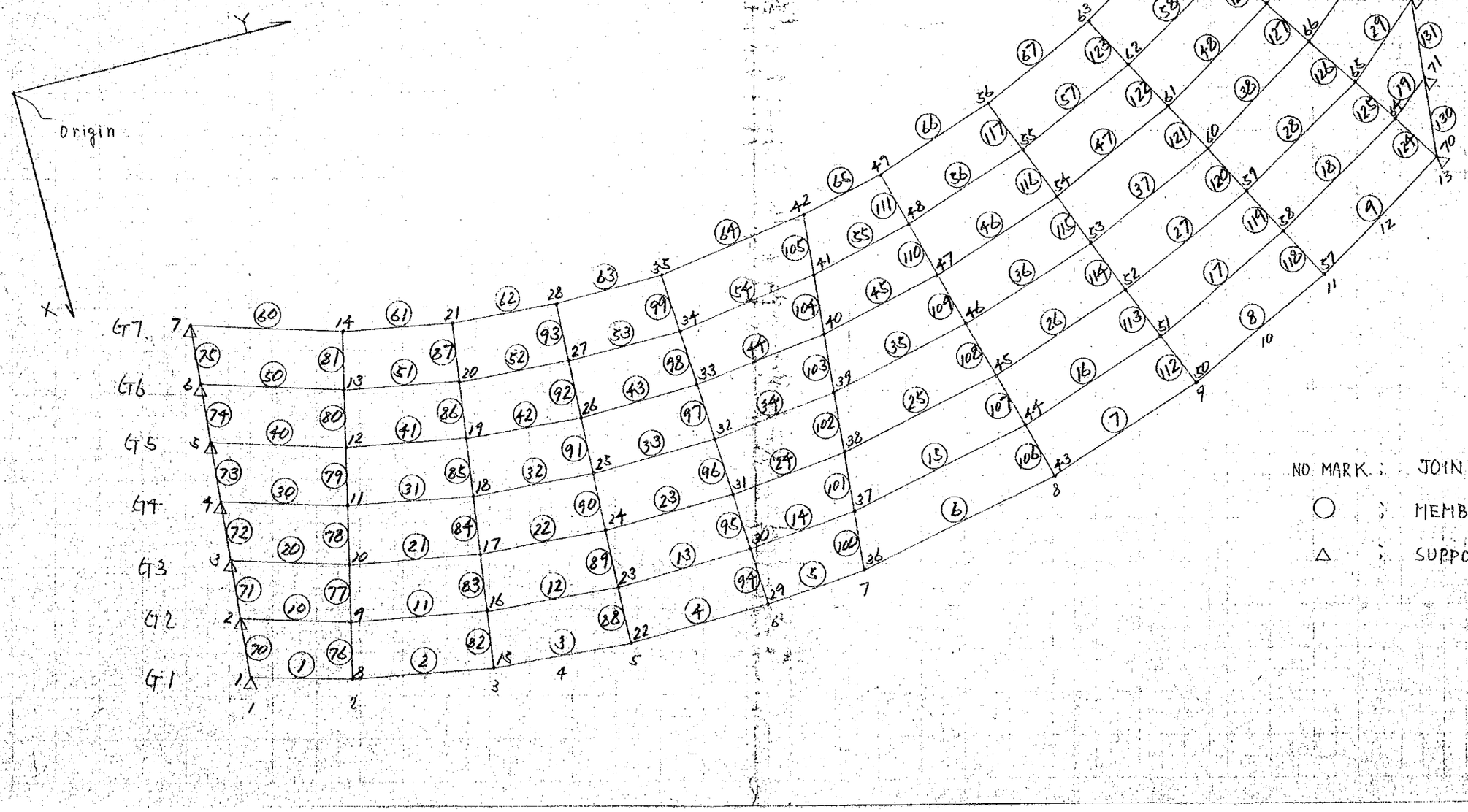
§ 1 PREPARATION



Typical cross section

MG-RAMP

1 Skelton



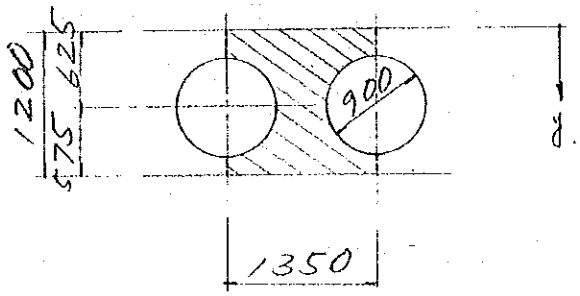
2.Co-ordinate

	X	Y		X	Y
1	59.574	68.510	31	55.362	79.740
2	58.211	68.276	32	54.079	79.322
3	56.845	68.041	33	52.795	78.904
4	55.476	67.806	34	51.511	78.487
5	54.104	67.570	35	50.251	78.077
6	52.726	67.334	36	57.147	82.732
7	51.370	67.100	37	55.785	82.498
8	59.597	70.793	38	54.420	82.263
9	58.248	70.761	39	53.052	82.028
10	56.898	70.730	40	51.680	81.792
11	55.548	70.699	41	50.304	81.556
12	54.199	70.668	42	48.948	81.323
13	52.849	70.637	43	54.989	87.157
14	51.525	70.606	44	53.821	86.479
15	59.360	74.102	45	52.654	85.801
16	58.019	73.940	46	51.486	85.124
17	56.679	73.778	47	50.319	84.446
18	55.339	73.616	48	49.151	83.768
19	53.999	73.454	49	48.005	83.103
20	52.658	73.292	50	52.844	90.411
21	51.343	73.134	51	51.760	89.605
22	58.802	77.373	52	50.677	88.800
23	57.484	77.082	53	49.594	87.994
24	56.166	76.791	54	48.510	87.189
25	54.847	76.500	55	47.427	86.383
26	53.529	76.209	56	46.364	85.592
27	52.211	75.917	57	50.369	93.388
28	50.917	75.632	58	49.378	92.472
29	57.930	80.575	59	48.387	91.555
30	56.646	80.157	60	47.396	90.638

	X	Y		X	Y
61	46.405	89.721			
62	45.414	88.804			
63	44.442	87.904			
64	46.726	95.062			
65	45.832	94.051			
66	44.937	93.039			
67	44.043	92.028			
68	43.148	91.017			
69	42.270	90.025			
70	50.369	93.388			
71	46.726	95.062			
72	45.832	94.051			
73	44.937	93.039			
74	44.043	92.028			
75	43.148	91.017			
76	42.270	90.025			

3. Flexural rigidity of main girder

Interior girder



$$A = 1.35 \times 1.20 - \frac{1}{4}\pi \times 0.90^2$$

$$= 1.6200 - 0.6359 = 0.9841 \ m^2$$

$$Ay = 1.6200 \times 0.600 - 0.6359 \times 0.625 = 0.5746 \ m^3$$

$$Ay^2 = 1.6200 \times 0.600^2 - 0.6359 \times 0.625^2 = 0.3348 \ m^4$$

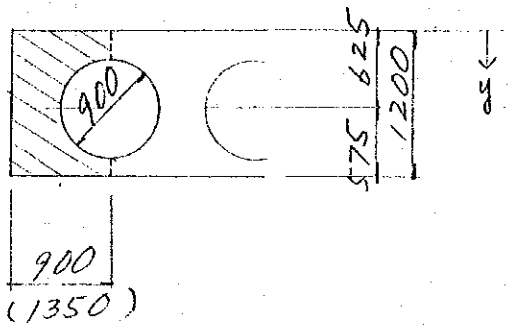
$$I_o = \frac{1}{12} \times 1.35 \times 1.20^3 - \frac{1}{64}\pi \times 0.90^4 = 0.1622 \ m^4$$

$$y = \frac{Ay}{A} = \frac{0.5746}{0.9841} = 0.584 \ m$$

$$I = 0.3348 + 0.1622 - 0.9841 \times 0.584^2 = \underline{0.1614 \ m^4}$$

$$I' = \frac{1}{12} \times 1.35 \times 1.20^3 = \underline{0.1944 \ m^4}$$

Edge girder



G1

$A = 0.90 \times 1.20 - \frac{1}{4}\pi \times 0.90^2 \times \frac{1}{2}$

$= 1.0800 - 0.3179 = 0.7621\ m^2$

$Ay = 1.0800 \times 0.600 - 0.3179 \times 0.625 = 0.4493\ m^3$

$Ay^2 = 1.0800 \times 0.625^2 - 0.3179 \times 0.625^2 = 0.2977\ m^4$

$I_0 = \frac{1}{12} \times 0.90 \times 1.20^3 - \frac{1}{64}\pi \times 0.90^4 \times \frac{1}{2} = 0.1135\ m^4$

$y = \frac{Ay}{A} = \frac{0.4493}{0.7621} = 0.590\ m$

$I = 0.2977 + 0.1135 - 0.7621 \times 0.590^2 = \underline{0.1459\ m^4}$

G7

$A = 1.35 \times 1.20 - \frac{1}{4}\pi \times 0.90^2 \times \frac{1}{2}$

$= 1.6200 - 0.3179 = 1.3021\ m^2$

$Ay = 1.6200 \times 0.600 - 0.3179 \times 0.625 = 0.7733\ m^2$

$Ay^2 = 1.6200 \times 0.600^2 - 0.3179 \times 0.625^2 = 0.4590\ m^4$

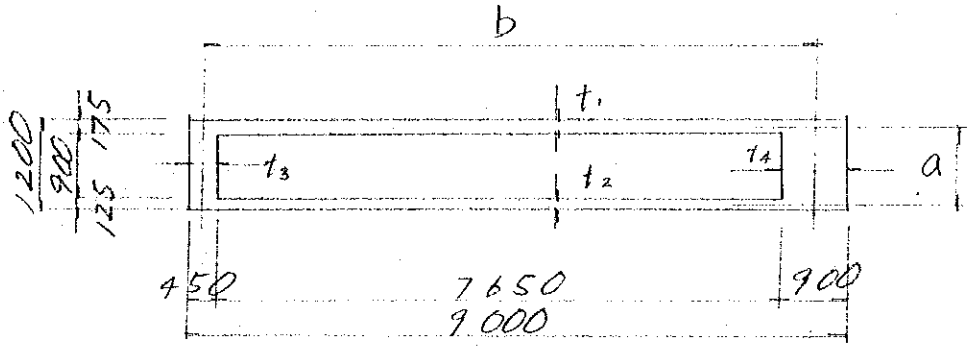
$I_0 = \frac{1}{12} \times 1.35 \times 1.20^3 - \frac{1}{64}\pi \times 0.90^4 \times \frac{1}{2} = 0.1783\ m^4$

$y = 0.594\ m$

$I = 0.4590 + 0.1783 - 1.3021 \times 0.594^2 = 0.1779\ m^4$

$I' = \frac{1}{12} \times 1.35 \times 1.20^3 = \underline{0.1944\ m^4}$

Torsional rigidity of main girder



$a = 1.050\ m \quad b = 8.325\ m$

$t_1 = 0.175\ m \quad t_2 = 0.125\ m \quad t_3 = 0.450\ m \quad t_4 = 0.900\ m$

$$J = \Sigma c b t^3 + \Sigma c a t^3 + \frac{4a^2b^2}{\frac{b}{t_1} + \frac{b}{t_2} + \frac{a}{t_3} + \frac{a}{t_4}}$$

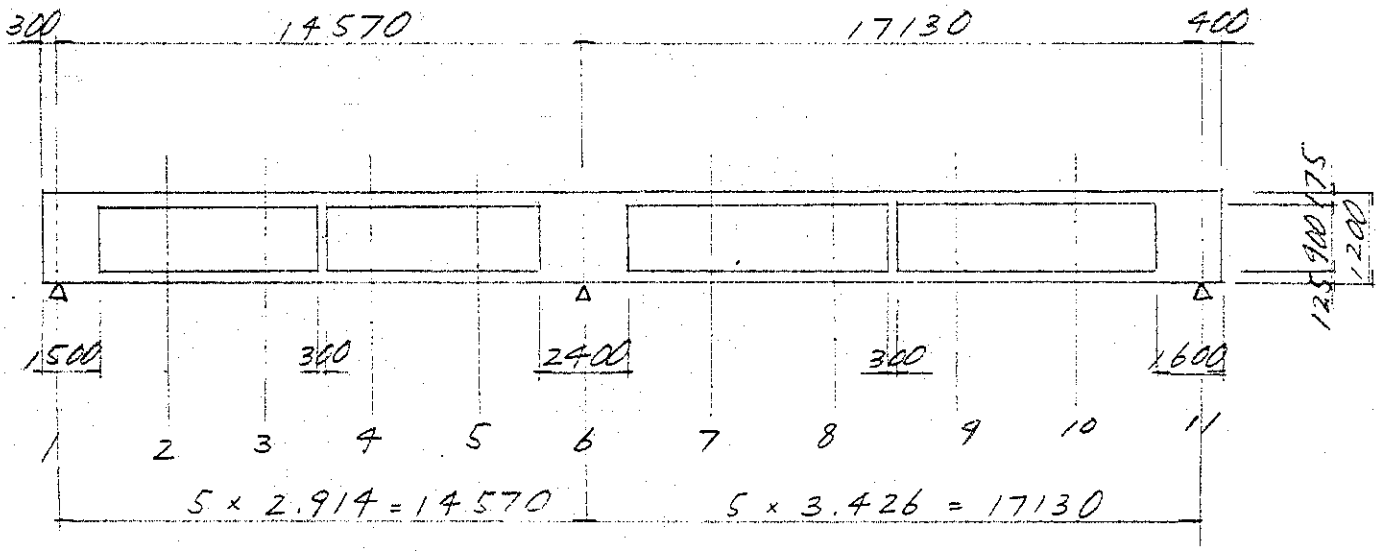
$$= 0.329 \times 8.325 \times 0.175^3 + 0.330 \times 8.325 \times 0.125^3$$
$$+ 0.243 \times 1.050 \times 0.450^3 + 0.162 \times 1.050 \times 0.900^3$$
$$+ \frac{4 \times 1.050^2 \times 8.325^2}{\frac{8.325}{0.175} + \frac{8.325}{0.125} + \frac{1.050}{0.450} + \frac{1.050}{0.900}}$$

$$= 0.0147 + 0.0054 + 0.0233 + 0.1240 + 2.5974$$

$$= 2.7648\ m^4$$

$$J = \frac{2.7648}{7} = \underline{\underline{0.3950\ m^4}}$$

Flexural rigidity of cross beam



List of flexural & torsional rigidity

Point	I (m^4)	J (m^4)
1	0.2380	0.5782
2	0.2363	0.9590
3	〃	〃
4	〃	〃
5	〃	〃
6	0.4073	1.0444
7	0.2777	1.1299
8	〃	〃
9	〃	〃
10	〃	〃
11	0.2715	0.6969

Cross beam - 1

	A	y	Ay	Ay²	I₀
1.757 × 0.175	0.307	0.088	0.0270	0.0024	0.0008
1.500 × 0.900	1.350	0.625	0.8438	0.5274	0.0911
1.757 × 0.125	0.220	1.138	0.2504	0.2850	0.0003
	1.877		1.1212	0.8148	0.0922

$y = 0.597\ m$

$I = 0.8148 + 0.0922 - 1.877 \times 0.597^2 = 0.2380\ m^4$

Cross beam - 2.3.4.5

	A	y	Ay	Ay²	I₀
2.914 × 0.175	0.510	0.088	0.0449	0.0040	0.0013
2.914 × 0.125	0.364	1.138	0.4142	0.4714	0.0005
	0.874		0.4591	0.4754	0.0018

$y = 0.525\ m$

$I = 0.4754 + 0.0018 - 0.874 \times 0.525^2 = 0.2363\ m^4$

Cross beam - 6

	A	y	Ay	Ay²	I₀
3.170 × 0.175	0.555	0.088	0.0488	0.0043	0.0014
2.400 × 0.900	2.160	0.625	1.3500	0.8438	0.1458
3.170 × 0.125	0.396	1.138	0.4506	0.5128	0.0005
	3.111		1.8494	1.3609	0.1477

$y = 0.595\ m$

$I = 1.3609 + 0.1477 - 3.111 \times 0.595^2 = 0.4073\ m^4$

Cross beam - 7.8.9.10

	A	y	Ay	Ay^2	I_o
3.426 × 0.175	0.600	0.088	0.0528	0.0046	0.0015
3.426 × 0.125	0.428	1.138	0.4871	0.5543	0.0006
	1.028		0.5399	0.5589	0.0021

$y = 0.525$ m

$I = 0.5589 + 0.0021 - 1.028 \times 0.525^2 = 0.2777$ m^4

Cross beam - 11

	A	y	Ay	Ay^2	I_o
2.113 × 0.175	0.370	0.088	0.0326	0.0029	0.0009
1.600 × 0.900	1.440	0.625	0.9000	0.5625	0.0972
2.113 × 0.125	0.264	1.138	0.3004	0.3419	0.0003
	2.074		1.2330	0.9073	0.0984

$y = 0.595$ m

$I = 0.9073 + 0.0984 - 2.074 \times 0.595^2 = 0.2715$ m^4

Cross beam -

	A	y	Ay	Ay^2	I_o

$y =$ m

$I =$ + − × ^{2} = m^4

Torsional rigidity of cross beam

Span - 1

$a = 1.050\ m \qquad b = 13.520\ m$

$t_1 = 0.175\ m \quad t_2 = 0.125\ m \quad t_3 = 1.500\ m \quad t_4 = 1.200\ m$

$$J = 0.331 \times 13.520 \times 0.175^3 + 0.332 \times 13.520 \times 0.125^3 + 0.189 \times 1.500 \times 1.050^3 + 0.160 \times 1.200 \times 1.050^3 + \frac{4 \times 1.050^2 \times 13.520^2}{\frac{13.520}{0.175} + \frac{13.520}{0.125} + \frac{1.050}{1.500} + \frac{1.050}{1.200}}$$

$$= 0.0240 + 0.0088 + 0.3282 + 0.2223 + 4.3109$$

$$= 4.8942\ m^4.$$

$$J = 4.8942 \times 1/14.87 = 0.3291\ m^4/m$$

Span - 2

$a = 1.050\ m \qquad b = 16.130\ m$

$t_1 = 0.175\ m \quad t_2 = 0.125\ m \quad t_3 = 1.200\ m \quad t_4 = 1.600\ m$

$$J = 0.331 \times 16.130 \times 0.175^3 + 0.332 \times 16.130 \times 0.125^3 + 0.160 \times 1.200 \times 1.050^3 + 0.199 \times 1.600 \times 1.050^3 + \frac{4 \times 1.050^2 \times 16.130^2}{\frac{16.130}{0.175} + \frac{16.130}{0.125} + \frac{1.050}{1.200} + \frac{1.050}{1.600}}$$

$$= 0.0286 + 0.0105 + 0.2223 + 0.3686 + 5.1511$$

$$= 5.7811\ m^4$$

$$J = 5.7811 \times 1/17.53 = 0.3298\ m^4/m$$

Cross beam - 1. $J = 0.3291 \times 1.757 = 0.5782\ m^4$

" - 2.3.4.5 $J =$ " $\times 2.914 = 0.9590$ "

" - 6 $J = 0.3291 \times 1.457 + 0.3298 \times 1.713$

$= 1.0444$ "

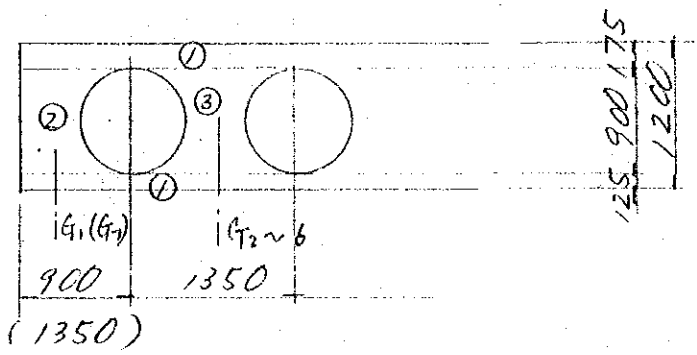
" - 7.8.9.10 $J = 0.3298 \times 3.426 = 1.1299$ "

" - 11 $J =$ " $\times 2.113 = 0.6969$ "

LOADING

1. Dead load

1) Slab



① $Wd_1 = (0.175 + 0.125) \times 23.6 = 7.080$ KN/m²

② $Wd_2 = (0.90 \times 1.20 - 1/4 \times 0.90^2 \times \pi \times 1/2) \times 23.6 = 17.985$ KN/m (G1)

$Wd_2 = (1.35 \times 1.20 - 1/4 \times 0.90^2 \times \pi \times 1/2) \times 23.6 = 30.729$ KN/m (G7)

$Wd_2' = 1.35 \times 1.20 \times 23.6 = 38.232$ " (G7)

③ $Wd_3 = (1.35 \times 1.20 - 1/4 \times 0.90^2 \times \pi) \times 23.6 = 23.226$ KN/m

$Wd_3' = 1.35 \times 1.20 \times 23.6 = 38.232$ "

2) Cross beam

G_1 , G_7

$$A = 1/4 \times 0.90^2 \times \pi \times 1/2 = 0.318 \ m^2$$

Edge support

$$W_4 = 0.318 \times 1.20 \times 23.6 = 9.006 \ KN$$

Center support

$$W_4 = 0.318 \times 2.40 \times 23.6 = 18.012 \ KN$$

Center beam

$$W_4 = 0.318 \times 0.30 \times 23.6 = 2.251 \ KN$$

$G_2 \sim G_6$

$$A = 1/4 \times 0.90^2 \times \pi = 0.636 \ m^2$$

Edge support

$$W_4 = 0.636 \times 1.20 \times 23.6 = 18.012 \ KN$$

Center support

$$W_4 = 0.636 \times 2.40 \times 23.6 = 36.023 \ KN$$

Center beam

$$W_4 = 0.636 \times 0.30 \times 23.6 = 4.503 \ KN$$

3) Kerb

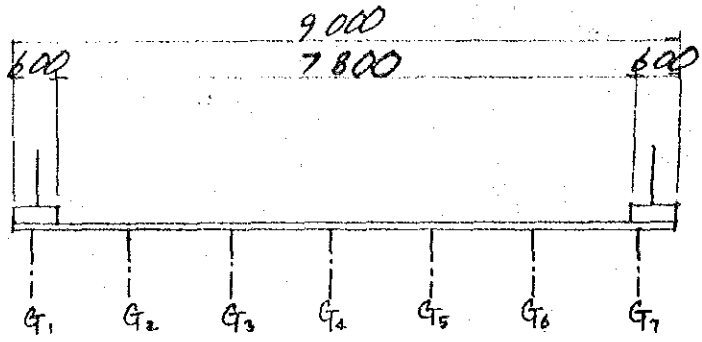
$W_{d6} = 0.60 \times 0.23 \times 23.6 = 3.257\ KN/m$

4) Wearing surface

$W_{d7} = 1.808\ KN/m$

5) Rail

$W_{d8} = 1.10\ KN/m$



9000

Slab(1)
W = 7.080 KN/m²

225
Slab(2)
W = 17.985 KN/m
G1

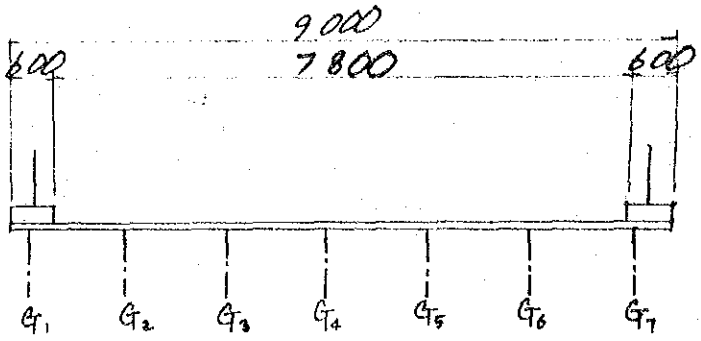
450
Slab(2)
W = 30.729 KN/m
G7

450
Slab(2')
W = 38.232 KN/m
G7

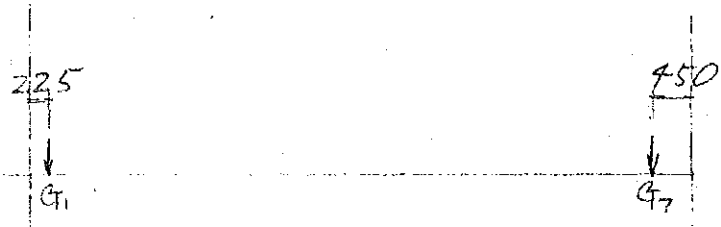
1575 4×1350 = 5400 2025
Slab(3)
W = 23.226 KN/m
G2 G3 G4 G5 G6

2025
Slab(3')
W = 38.232 KN/m
G6

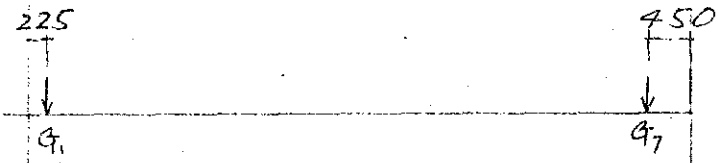
225 450
Cross beam(E_s)
W = 9.006 KN
G1 G7



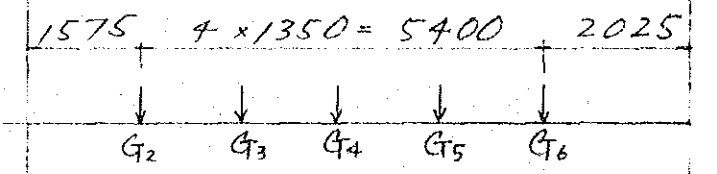
Cross beam (C.s)
$W = 18.012\ KN.$



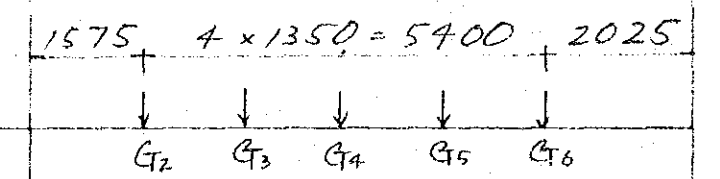
Cross beam (C.b)
$W = 2.251\ KN$



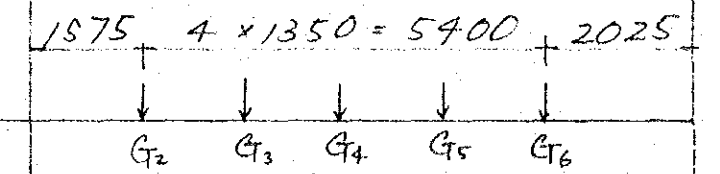
Cross beam (Es)
$W = 18.012\ KN$

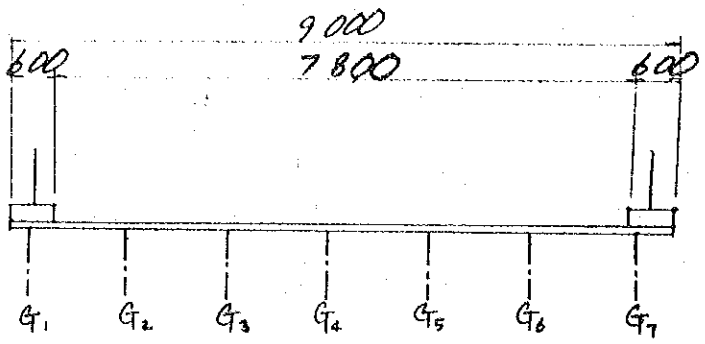


Cross beam (C.s)
$W = 36.023\ KN$



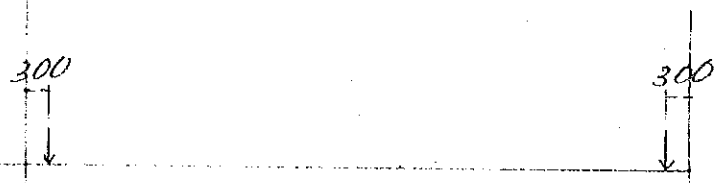
Cross beam (C.b)
$W = 4.503\ KN.$





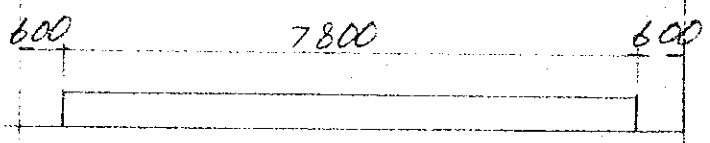
Kerb

$w = 3.257\ KN/m$



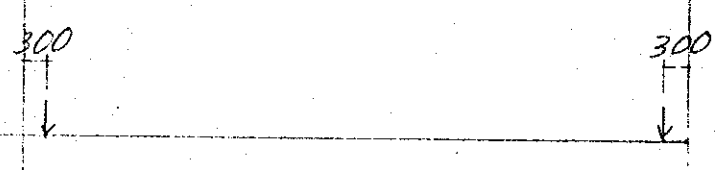
Wearing surface

$w = 1.808\ KN/m^2$

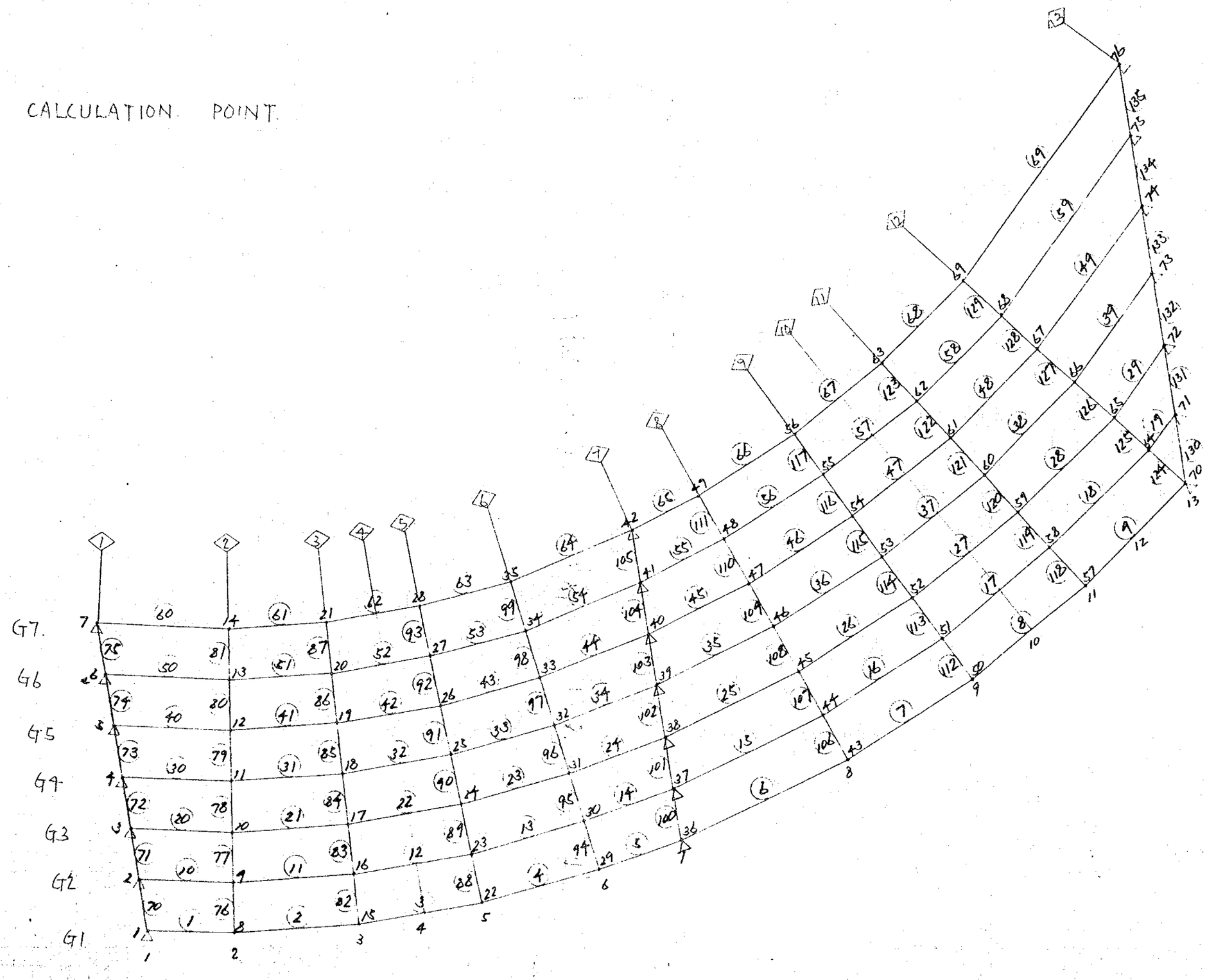


Rail

$w = 1.10\ KN/m$

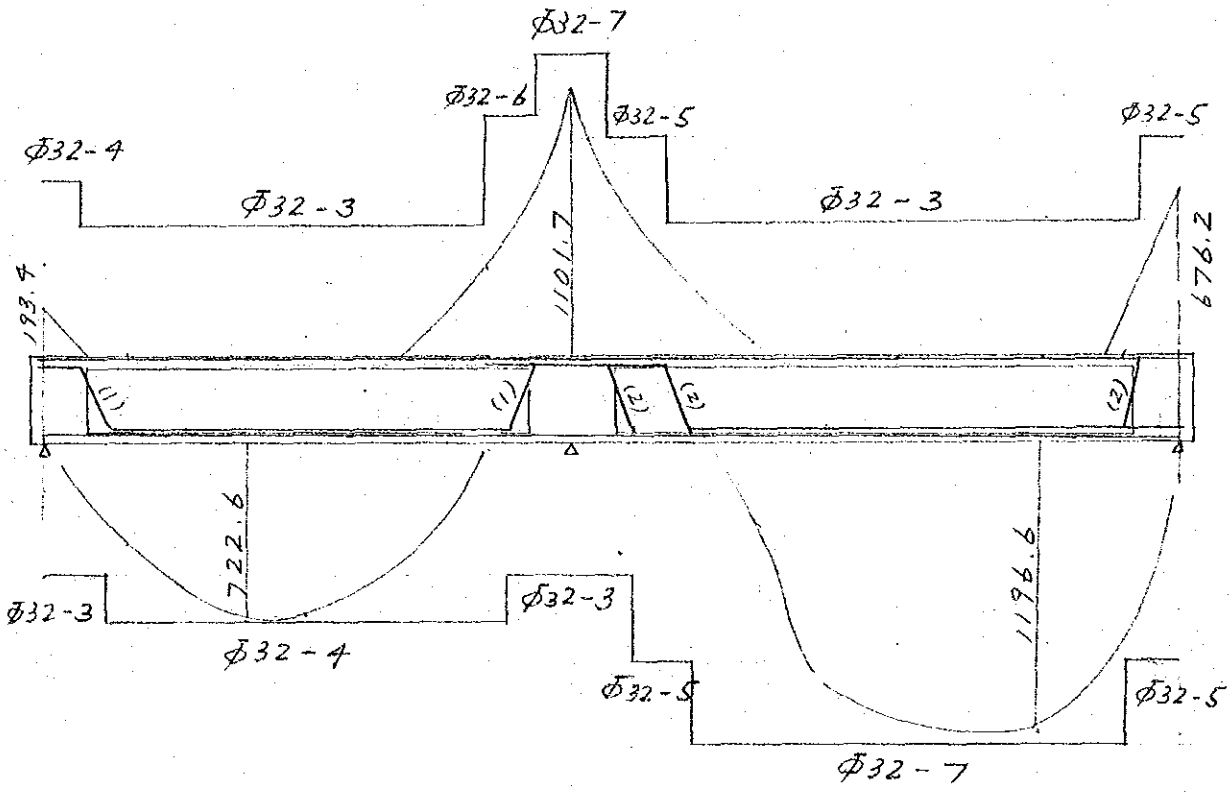


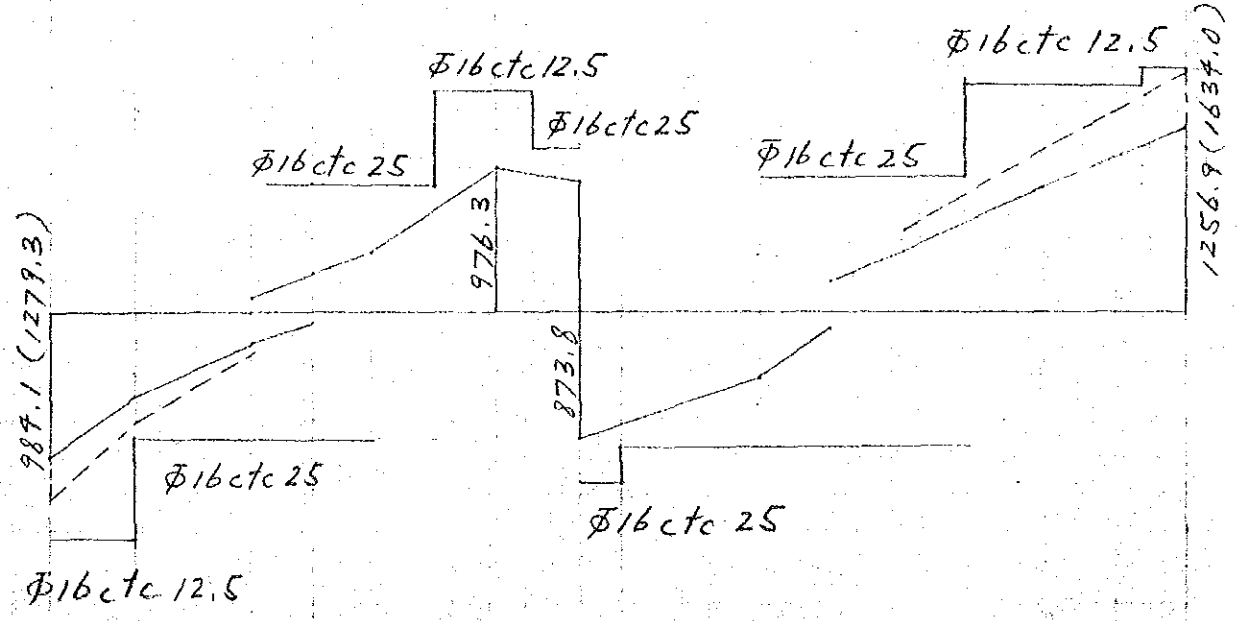
CALCULATION POINT



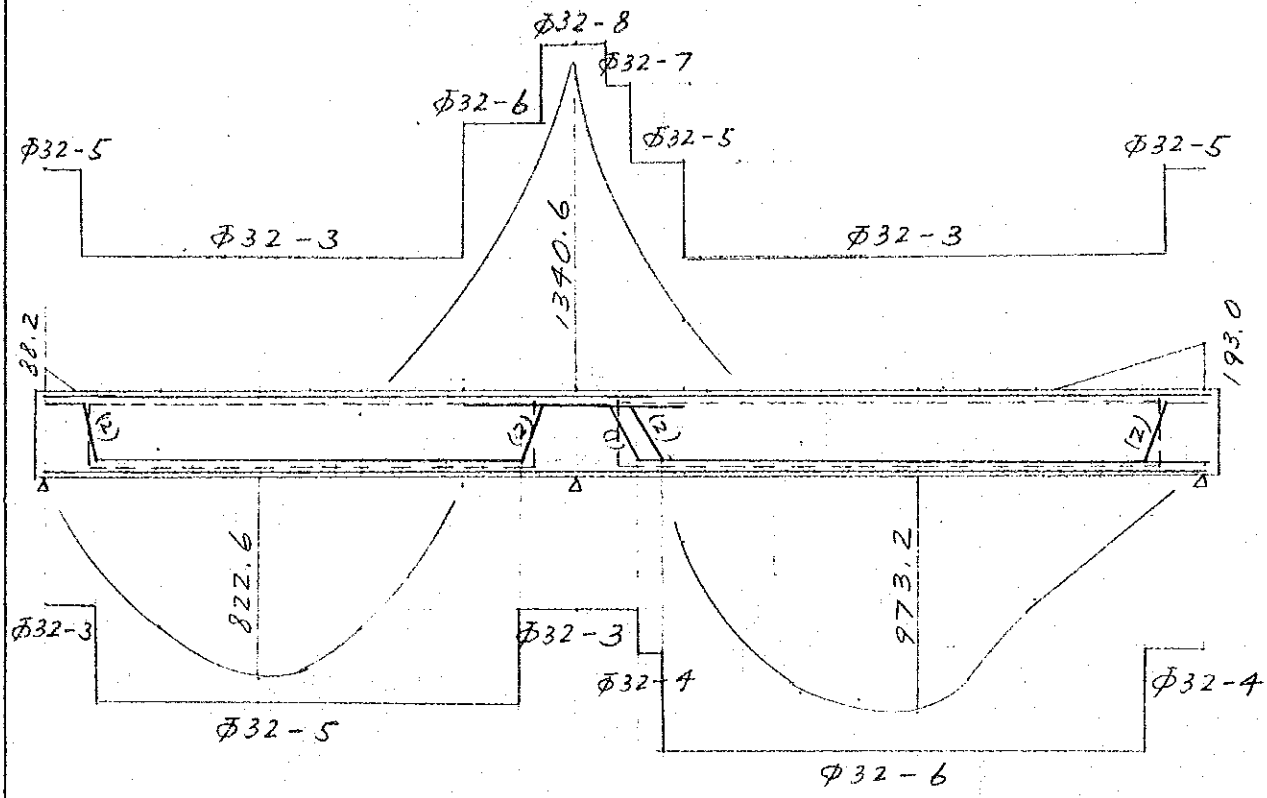
§2 DRAWING OF SECTIONAL FORCE DIAGRAM

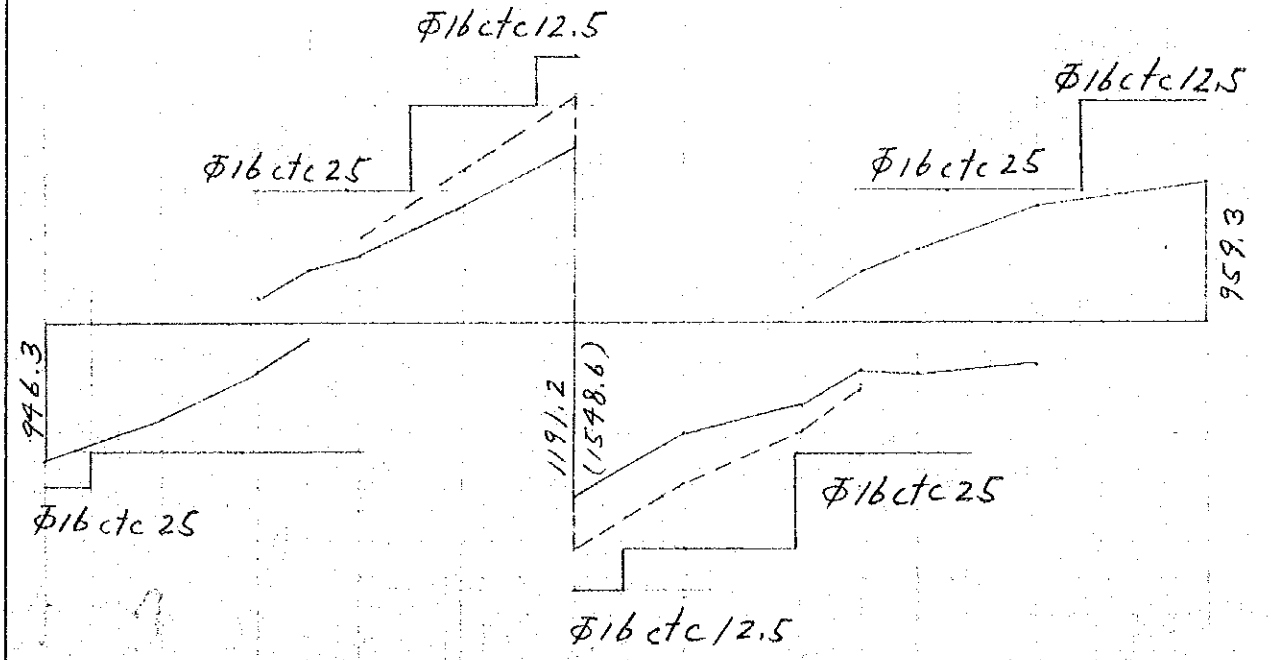
G1.



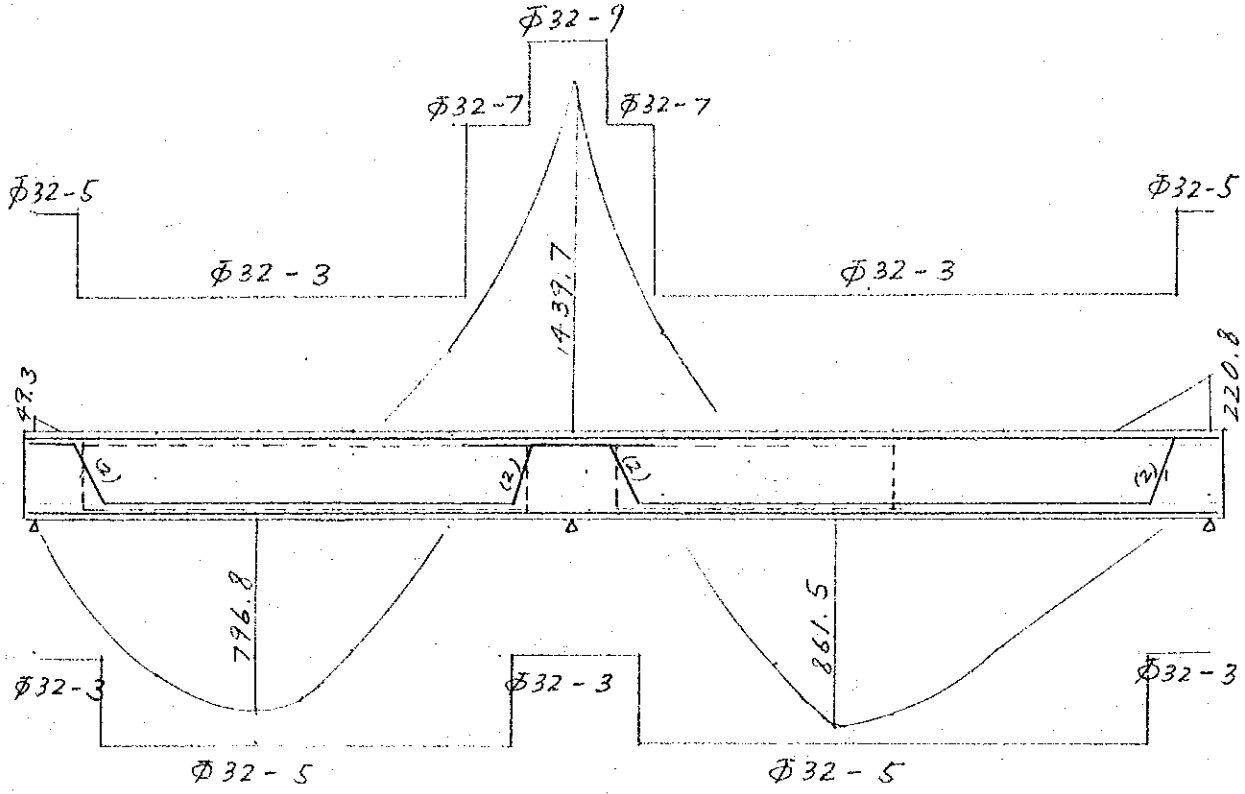


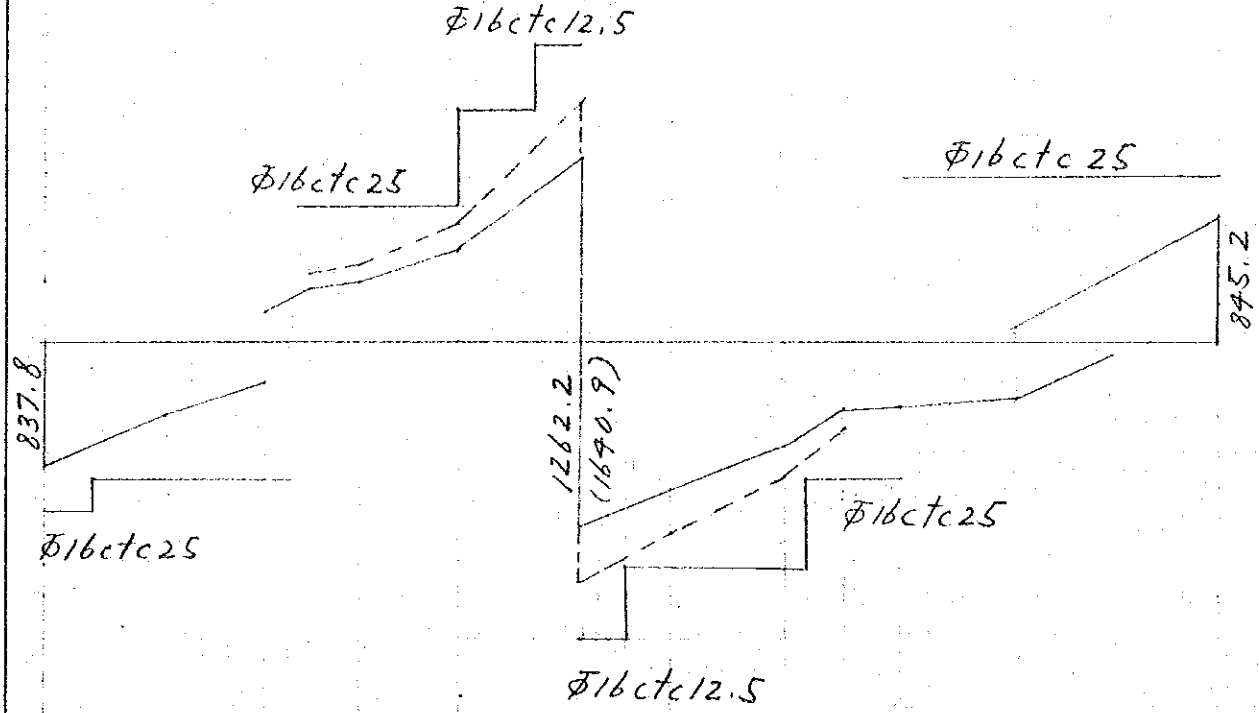
Gr2 ~ Gr5

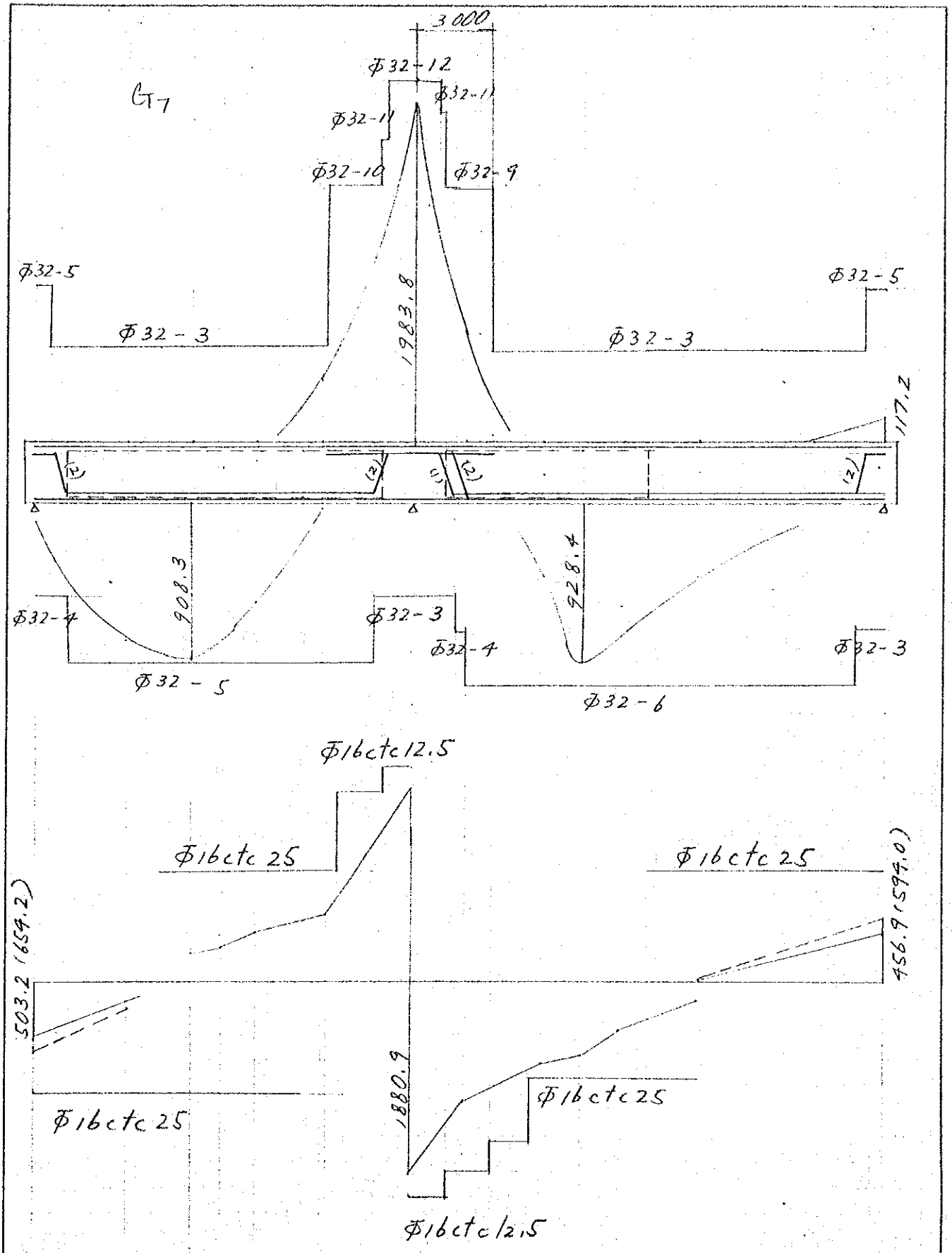

Φ32-8
Φ32-7
Φ32-6
Φ32-5
Φ32-5
Φ32-5
Φ32-3
Φ32-3
1340.6
88.2
193.0
822.6
973.2
Φ32-3
Φ32-3
Φ32-4
Φ32-4
Φ32-5
Φ32-6


Φ16ctc12.5
Φ16ctc12.5
Φ16ctc25
Φ16ctc25
959.3
946.3
1191.2
(1548.6)
Φ16ctc25
Φ16ctc25
Φ16ctc12.5

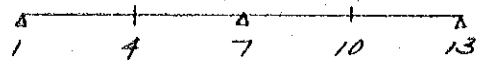
G1b.


Φ32-9
Φ32-7
Φ32-7
Φ32-5
Φ32-5
Φ32-3
Φ32-3
1439.7
220.8
97.3
796.8
861.5
Φ32-3
Φ32-3
Φ32-3
Φ32-5
Φ32-5


Φ16ctc12.5
Φ16ctc25
Φ16ctc25
845.2
837.8
1262.2
(1640.9)
Φ16ctc25
Φ16ctc25
Φ16ctc12.5


3000
G1
Φ32-12
Φ32-11
Φ32-10
Φ32-9
Φ32-5
Φ32-3
Φ32-5
Φ32-3
1983.8
117.2
908.3
928.4
Φ32-4
Φ32-3
Φ32-4
Φ32-3
Φ32-5
Φ32-6
Φ16ctc12.5
Φ16ctc25
Φ16ctc25
503.2 (654.2)
456.9 (594.0)
1880.9
Φ16ctc25
Φ16ctc25
Φ16ctc12.5

Moment list

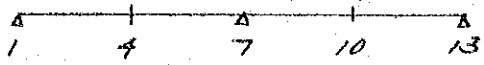


Mmax
Mmin

HA-LOADING or 1.25 : HB-LOADING (KN.m)

	G_1	G_2	G_3	G_4	G_5	G_6	G_7		
1	-10.5	14.7	12.1	-5.2	-1.8	16.9	107.8		
	-193.4	-88.2	-63.7	-73.4	-61.9	-49.3			
2	415.8	541.8	575.0	598.4	616.0	638.4	791.5		
	165.7	240.1	259.9	270.2	276.2	285.5			
3	722.6	822.6	817.2	803.0	797.7	796.8	908.3		
4	705.2	787.2	769.2	747.0	738.7	730.8	782.6		
5	589.5	622.5	591.9	564.8	554.6	539.9	579.9		
	139.8	151.2	134.7	119.1	105.5	96.2	107.8		
6	25.0	-58.1	-31.8	0	19.3	33.8	29.3		
	-351.5	-405.6	-383.1	-355.8	-336.2	-329.8	-358.0		
7	-655.6	-756.0	-775.0	-787.9	-804.0	-857.0	-1167.4		
	-1101.7	-1278.5	-1298.5	-1312.6	-1340.6	-1439.7	-1983.8		
8	318.8	259.2	174.3	96.3	0.4	-102.3	-256.2		
	-49.8	-88.2	-130.9	-194.9	-286.0	-401.5	-620.9		
9	993.9	886.4	786.0	716.6	663.9	580.4	419.8		
	414.6	368.0	321.1	284.3	251.9	207.2	177.1		
10	828.6	918.0	881.5	862.7	856.5	861.5	928.4		
11	1196.6	973.2	829.5	765.2	729.7	805.6	591.5		
	596.4								
12		326.6	459.7	505.0	478.8	512.4	424.6		
		21.1	188.6	238.4	235.9	253.7	177.0		
13	-216.8	-29.4	-57.9	-76.4	-83.4	-96.0	-45.7		
	-676.2	-138.6	-169.0	-193.0	-190.0	-220.8	-117.2		

Moment list (HA loading)



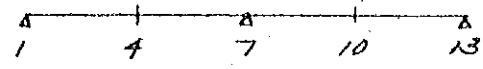
M(+)
M(−)

DEAD + HA-LIVE (KN.m)

	G1	G2	G3	G4	G5	G6	G7		
1	-54.4	-4.3	-4.6	-5.2	-10.9	12.5	105.9		
	-166.7	-68.8	-48.6	-52.4	-43.1	-31.5	35.9		
2	415.8	541.8	575.0	598.4	616.0	638.4	791.5		
	218.8	312.0	337.2	350.7	359.4	372.8	473.9		
3	722.6	822.6	817.2	803.0	797.7	796.8	908.3		
	383.8	447.0	443.0	433.2	423.5	420.0	486.3		
4	705.2	787.2	769.2	747.0	738.7	730.8	782.6		
	358.1	382.3	370.9	357.1	343.7	333.3	358.1		
5	589.5	622.5	591.9	564.8	554.6	539.9	579.9		
	218.5	232.5	211.3	192.3	176.5	165.2	182.0		
6	-82.9	-131.7	-109.0	-75.0	-53.2	-58.8	-85.9		
	-351.5	-405.6	-383.1	-355.8	-336.2	-329.8	-358.0		
7	-824.0	-945.0	-968.8	-984.9	-1005.0	-1070.3	-1448.3		
	-1101.7	-1278.5	-1298.5	-1312.6	-1340.6	-1439.7	-1983.8		
8	306.1	230.1	148.1	62.9	-25.9	-133.4	-325.6		
	-15.9	-66.8	-123.5	-194.9	-286.0	-401.5	-620.9		
9	993.9	886.4	786.0	716.6	663.9	580.4	419.8		
	550.0	488.5	429.3	383.5	343.6	287.1	177.1		
10	828.6	918.0	881.5	862.7	856.5	861.5	928.4		
	525.0	563.0	538.8	521.6	509.8	507.2	551.7		
11	1196.6	973.2	829.5	765.2	729.7	805.6	591.5		
	766.4	637.4	541.4	488.5	458.7	505.4	371.1		
12		326.6	459.7	505.0	478.8	508.5	406.4		
		93.9	256.9	308.1	302.5	325.7	235.0		
13	-278.8	-49.5	-74.7	-94.9	-106.1	-121.1	-67.9		
	-627.4	-131.2	-156.1	-178.9	-180.5	-201.2	-112.7		

Moment list (HB loading)

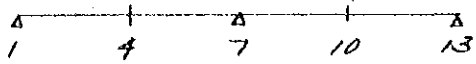
M(+)
M(-)



DEAD + HB- LIVE (KN m)

	G1	G2	G3	G4	G5	G6	G7		
1	-13.1	18.4	15.1	-10.2	-2.3	21.1	134.7		
	-241.8	-110.3	-79.6	-91.8	-77.4	-61.6	18.7		
2	473.8	624.3	646.4	670.5	706.3	739.2	914.2		
	207.1	300.1	324.9	337.7	345.2	356.9	451.2		
3	840.3	940.5	908.3	893.8	889.8	906.7	1031.1		
	361.0	420.7	415.9	404.9	393.6	388.4	448.1		
4	805.7	894.2	849.5	831.0	820.0	829.2	883.1		
	325.3	345.9	334.5	320.6	307.0	296.2	316.7		
5	725.4	723.0	661.2	640.3	630.9	633.4	723.0		
	174.7	189.0	168.6	148.9	131.9	120.2	134.7		
6	31.3	-72.6	-39.8	-0.0	24.1	42.2	36.6		
	-438.5	-476.8	-444.2	-412.1	-385.6	-379.2	-411.0		
7	-819.5	-945.0	-968.8	-984.9	-1005.0	-1071.3	-1459.3		
	-1223.4	-1389.3	-1354.6	-1368.3	-1372.9	-1481.8	-2147.2		
8	398.5	324.0	217.9	120.4	0.5	-127.9	-320.3		
	-62.3	-110.2	-163.6	-231.4	-316.5	-415.8	-654.1		
9	1110.8	986.5	872.7	795.4	748.8	664.8	471.5		
	518.3	460.0	401.4	355.4	314.9	259.0	159.1		
10	938.7	1035.9	972.6	950.0	967.0	989.4	1059.8		
	507.2	542.9	518.5	500.9	488.5	484.7	525.2		
11	1373.6	1063.1	889.7	843.3	824.3	922.9	706.8		
	745.5	622.0	528.2	475.8	445.9	491.0	361.2		
12		369.5	543.6	622.4	588.7	640.5	530.8		
		26.4	235.8	298.0	294.9	317.1	221.3		
13	-271.0	-36.8	-72.4	-95.5	-104.2	-120.0	-57.1		
	-845.3	-173.3	-211.2	-241.3	-237.5	-276.0	-146.5		

Shear list



KN

+
−

1.5(DEAD)+2.5(HA-LIVE) or 2.0(DEAD+HA-LIVE) or {1.5(DEAD)+2.0(HB-LIVE)}×1.25

	G_1	G_2	G_3	G_4	G_5	G_6	G_7		
1	984.1	946.3	864.5	894.9	842.2	837.8	503.2		
	399.3	307.7	280.3	272.5	262.2	241.4	164.8		
2	575.2	654.8	557.3	578.8	520.1	498.2	190.1		
	191.0	104.0	67.6	53.2	29.5	11.2	-66.6		
3	216.2	346.8	294.9	329.6	277.1	267.6	-27.8		
	-90.5	-150.9	-149.2	-163.2	-167.4	-195.3	-260.8		
4	63.8	114.1	84.4	98.8	72.7	71.0	-83.3		
	-244.0	-339.3	-322.1	-346.7	-333.0	-356.2	-316.5		
5	-102.3	46.4	42.2	96.5	55.7	53.9	-203.4		
	-406.3	-442.7	-398.1	-394.9	-386.2	-403.6	-464.8		
6	-420.3	-208.0	-209.2	-135.2	-141.0	-126.1	-313.3		
	-976.3	-790.1	-699.6	-671.4	-632.6	-610.9	-634.0		
7	873.8	1163.4	1110.7	1191.2	1176.7	1262.2	1880.9		
	432.2	495.8	519.5	539.4	555.2	606.2	960.3		
8	458.0	720.4	734.5	834.8	860.1	1011.3	1160.3		
	154.4	199.8	238.1	280.6	324.3	409.3	579.7		
9	103.6	424.6	462.8	559.5	572.9	703.7	793.5		
	-206.3	-80.5	-0.5	47.1	92.5	176.7	386.3		
10	-42.2	173.3	219.3	289.6	332.1	460.2	710.2		
	-420.3	-316.7	-202.9	-168.1	-99.3	-1.3	320.4		
11	-227.6	68.4	199.3	344.0	355.3	442.5	468.1		
	-851.3	-486.3	-269.3	-168.3	-103.5	-43.7	209.2		
12		-91.4	-11.3	206.4	297.1	392.7	169.9		
		-789.0	-503.5	-305.9	-173.6	-98.1	-2.5		
13	-534.1	-218.7	-301.4	-273.9	-255.4	-265.2	-210.9		
	-1256.9	-959.3	-875.4	-834.7	-824.4	-845.2	-456.9		