§3 CALCULATIO OF STRESS

Resisting moment
G_1

	b (cm)	h (cm)	d' (cm)	d (cm)	t (cm)	(Φ32)	As (cm²)	MR (KN·m)
1	90	120	12	108	—	4	32.2	728
2	〃	〃	〃	〃	—	3	24.1	551
3	〃	〃	〃	〃	12.5	3	24.1	566
4	〃	〃	〃	〃	12.5	6	48.7	993
5	〃	〃	〃	〃	—	6	48.7	1080
6	〃	〃	〃	〃	—	7	56.3	1240
7	〃	〃	〃	〃	—	5	40.2	900
8	〃	〃	〃	〃	12.5	5	40.2	944
9	〃	〃	〃	〃	12.5	3	—	566
10	〃	〃	〃	〃	—	5	—	900
11	〃	〃	〃	〃	—	3	—	551
12	〃	〃	〃	〃	17.5	3	24.1	557
13	〃	〃	〃	〃	17.5	4	32.2	743
14	〃	〃	〃	〃	17.5	3	—	557
15	〃	〃	〃	〃	—	3	—	551
16	〃	〃	〃	〃	17.5	3	—	557
17	〃	〃	〃	〃	17.5	5	40.2	926
18	〃	〃	〃	〃	17.5	7	56.3	1257
19	〃	〃	〃	〃	17.5	5	—	926
20	〃	〃	〃	〃	17.5	3	—	557
21	〃	〃	〃	〃	—	3	—	551

$G_2 \sim 5'$

	b (cm)	h (cm)	d' (cm)	d (cm)	t (cm)		A_s (cm²)	M_R (kN·m)
1	135	120	12	108	—	5	40.2	915
2	〃	〃	〃	〃	—	3	24.1	558
3	〃	〃	〃	〃	12.5	3	24.1	568
4	〃	〃	〃	〃	12.5	6	48.7	1144
5	〃	〃	〃	〃	—	6	48.7	1100
6	〃	〃	〃	〃	—	8	64.3	1435
7	〃	〃	〃	〃	—	7	56.3	1264
8	〃	〃	〃	〃	12.5	7	56.3	1322
9	〃	〃	〃	〃	12.5	5	40.2	945
10	〃	〃	〃	〃	12.5	3	—	568
11	〃	〃	〃	〃	—	5	—	915
12	〃	〃	〃	〃	—	3	—	558
13	〃	〃	〃	〃	17.5	3	24.1	560
14	〃	〃	〃	〃	17.5	5	40.2	929
15	〃	〃	〃	〃	17.5	3	—	560
16	〃	〃	〃	〃	—	3	—	558
17	〃	〃	〃	〃	17.5	3	—	560
18	〃	〃	〃	〃	17.5	4	32.2	746
19	〃	〃	〃	〃	17.5	6	48.7	1123
20	〃	〃	〃	〃	17.5	4	—	746
21	〃	〃	〃	〃	—	4	32.2	739

G6.

	b (cm)	h (cm)	d' (cm)	d (cm)	t (cm)		As (cm²)	MR (KN·m)
1	135	120	12	108	—	5	40.2	915
2	〃	〃	〃	〃	—	3	24.1	558
3	〃	〃	〃	〃	12.5	3	24.1	568
4	〃	〃	〃	〃	12.5	7	56.3	1322
5	〃	〃	〃	〃	—	7	56.3	1264
6	〃	〃	〃	〃	—	9	72.4	1607
7	〃	〃	〃	〃	—	7	—	1264
8	〃	〃	〃	〃	12.5	7	—	1322
9	〃	〃	〃	〃	12.5	3	—	568
10	〃	〃	〃	〃	—	3	—	558
11	〃	〃	〃	〃	—	5	—	915
12	〃	〃	〃	〃	—	3	—	558
13	〃	〃	〃	〃	17.5	3	24.1	560
14	〃	〃	〃	〃	17.5	5	40.2	929
15	〃	〃	〃	〃	17.5	3	—	560
16	〃	〃	〃	〃	—	3	—	558
17	〃	〃	〃	〃	17.5	3	—	560
18	〃	〃	〃	〃	17.5	5	—	929
19	〃	〃	〃	〃	—	5	—	915
20	〃	〃	〃	〃	—	3	—	558

G_7

	b (cm)	h (cm)	d' (cm)	d (cm)	t (cm)		As (cm²)	MR (kN·m)
1	135	120	12	108	—	5	40.2	915
2	〃	〃	〃	〃	—	3	24.1	558
3	〃	〃	〃	〃	12.5	3	24.1	568
4	〃	〃	〃	〃	12.5	10	80.4	1501
5	〃	〃	〃	〃	—	10	80.4	1775
6	〃	〃	〃	〃	—	12	96.5	2111
7	〃	〃	〃	〃	—	11	88.5	1945
8	〃	〃	〃	〃	12.5	11	88.5	1511
9	〃	〃	〃	〃	12.5	9	72.4	1488
10	85	〃	〃	〃	12.5	3	24.1	566
11	〃	〃	〃	〃	—	3	24.1	549
12	〃	〃	〃	〃	—	5	40.2	897
13	135	〃	〃	〃	—	3	—	558
14	〃	〃	〃	〃	17.5	3	24.1	560
15		〃	〃	〃	17.5	5	40.2	929
16	〃	〃	〃	〃	17.5	3	—	560
17	〃	〃	〃	〃	—	3	—	558
18		〃	〃	〃	17.5	3	—	560
19	85	〃	〃	〃	17.5	4	32.2	742
20	〃	〃	〃	〃	17.5	6	48.7	1120
21	〃	〃	〃	〃	—	6	48.7	1077
22	〃	〃	〃	〃	—	4	32.2	726

Resisting shear

G1

$$V_R = V_c + \frac{A_s}{S_u} \times 0.87 f_{yv} \cdot d$$

$$= V_c + \frac{A_s}{S_u} \times 0.87 \times 41000 \times 108$$

	Vc (×10³N)		As (cm²)	Su (cm)	V_R (×10³N)
1	379	Φ16 - 2	4.02	12.5	1617
2	340	〃	〃	〃	1578
3	267	〃	〃	25	886
4	286	〃	〃	12.5	1524
5	340	〃	〃	〃	1578
6	495	〃	〃	25	1114
7	534	〃	〃	〃	1153
8	311	〃	〃	〃	930
9	354	〃	〃	〃	973
10	311	〃	〃	12.5	1549
11	427	〃	〃	〃	1665

Φ16 25 619

12.5 1238

$G_2 \sim G_5$

$$V_R = V_c + \frac{A_s}{S_v} \times 0.87 f_{yv} \cdot d$$

$$= V_c + \frac{A_s}{S_v} \times 0.87 \times 41000 \times 108$$

	V_c ($\times 10^3$N)		A_s (cm²)	S_v (cm)	V_R ($\times 10^3$N)
1	539	Φ16 − 2	4.02	25	1158
2	510	〃	〃	〃	1129
3	267	〃	〃	〃	886
4	311	〃	〃	12.5	1549
5	340	〃	〃	〃	1578
6	597	〃	〃	〃	1835
7	729	〃	〃	〃	1967
8	670	〃	〃	〃	1908
9	354	〃	〃	〃	1592
10	311	〃	〃	〃	1549
11	340	〃	〃	25	959
12	286	〃	〃	25 12.5	905 1524
13	510	〃	〃	〃	1748
14	539	〃	〃	〃	1777

619
1238

G_6

$$V_R = V_c + \frac{A_s}{S_u} \times 0.87 f_{yv} \cdot d$$

$$= V_c + \frac{A_s}{S_u} \times 0.87 \times 41000 \times 108$$

	V_c ($\times 10^3$N)		As(cm²)	Su (cm)	V_R ($\times 10^3$N)
	539	Φ16 − 2	4.02	25	1158
	311	〃	〃	〃	930
	354	〃	〃	12.5	1592
	801	〃	〃	〃	2039
	670	〃	〃	〃	1908
	354	〃	〃	〃	1592
	311	〃	〃	25	930
	539	〃	〃	〃	1158

G_1

$$V_R = V_c + \frac{A_s}{S_u} \times 0.87 f_{yv} \cdot d$$
$$= V_c + \frac{A_s}{S_u} \times 0.87 \times 41000 \times 108$$

	V_c ($\times 10^3$N)		A_s (cm²)	S_u (cm)	V_R ($\times 10^3$N)
1	539	Φ16 − 2	4.02	25	1158
2	456	〃	〃	〃	1075
3	622	〃	〃	12.5	1860
4	860	〃	〃	〃	2098
5	602	〃	〃	〃	1840
6	311	〃	〃	12.5 25	1549 930
7	504	〃	〃	〃	1123
8	459	〃	〃	〃	1078

619
1238

G_1

	b (cm)	d (cm)	As (cm^2)	P (%)	v (N/cm^2)	Vc (KN)
1	90	108	32.2	0.30	39	379
2	〃	〃	24.1	0.22	35	340
3	45	〃	24.1	0.50	55	267
4	〃	〃	32.2	0.66	59	286
5	〃	〃	48.7	1.00	70	340
6	90	〃	48.7	0.45	51	495
7	〃	〃	56.3	0.52	55	534
8	45	〃	40.2	0.83	64	311
9	〃	〃	56.3	1.16	73	354
10	〃	〃	40.2	0.83	64	311
11	90	〃	40.2	0.37	44	427

$G_2 \sim G_5$

	b (cm)	d (cm)	As (cm²)	P (%)	v (N/cm²)	Vc (KN)
1	135	108	40.2	0.28	37	539
2	〃	〃	24.1	0.17	35	510
3	45	〃	24.1	0.50	55	267
4	〃	〃	40.2	0.83	64	311
5	〃	〃	48.7	1.00	70	340
6	135	〃	48.7	0.33	41	597
7	〃	〃	64.3	0.44	50	729
8	〃	〃	56.3	0.39	46	670
9	45	〃	56.3	1.16	73	354
10	〃	〃	40.2	0.83	64	311
11	〃	〃	48.7	1.00	70	340
12	〃	〃	32.2	0.66	59	286
13	135	〃	32.2	0.22	35	510
14	〃	〃	40.2	0.28	37	539

G_6

	b (cm)	d (cm)	As (cm²)	P (%)	v (N/cm²)	Vc (KN)
1	135	108	40.2	0.28	37	539
2	45	〃	40.2	0.83	64	311
3	〃	〃	56.3	1.16	73	354
4	135	〃	72.4	0.50	55	801
5	〃	〃	56.3	0.39	46	670
6	45	〃	56.3	1.16	73	354
7	〃	〃	40.2	0.83	64	311
8	135	〃	40.2	0.28	37	539

G1

	b (cm)	d (cm)	As (cm²)	P (%)	v (N/cm²)	Vc (KN)
1	135	108	40.2	0.28	37	539
2	90	〃	40.2	0.41	47	456
3	〃	〃	80.4	0.83	64	622
4	135	〃	96.5	0.66	59	860
5	90	〃	72.4	0.74	62	602
6	40	〃	48.7	1.13	72	311
7	85	〃	48.7	0.53	55	504
8	〃	〃	40.2	0.44	50	459

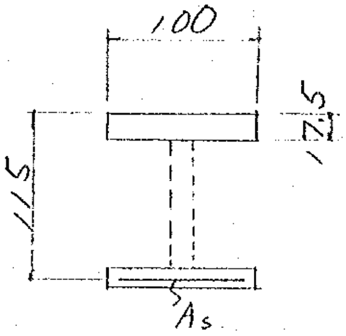
§§3 DESIGN OF CROSS BEAM

1 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/m)	HB (KN m/m)
1	138.9 -174.1	159.7 -241.6	1.757	102.8 -128.8	94.5 -143.0
2	94.5 -47.6	172.4 -87.9	2.914	42.2 -21.2	61.5 -31.4
3	92.4 -34.7	175.8 -70.6	2.914	41.2 -15.5	62.7 -25.2
4					
5	89.2 -42.0	169.9 -76.9	2.914	39.8 -18.7	60.6 -27.4
6	67.2 -77.9	127.8 -109.9	2.914	30.0 -34.8	45.6 -39.2
7	172.6 -357.1	228.4 -471.4	3.170	70.8 -146.4	74.9 -154.7
8	249.7 -252.5	349.7 -274.9	3.426	94.7 -95.8	106.2 -83.4
9	205.2 -80.3	324.5 -93.1	3.426	77.9 -30.5	98.5 -28.3
10					
11	304.4 -17.2	447.7 -33.5	3.426	115.5 -6.5	135.9 -10.2
12	433.4 -260.2	579.3 -325.8	3.426	164.5 -98.7	175.9 -98.9
13	217.9 -292.7	263.1 -409.3	2.113	134.1 -180.1	129.5 -201.5



$M = 175.9\ KN\,m$

$b = 100\,cm \quad d = 115\,cm \quad t = 17.5\,cm$

$A_s = \Phi 12\ ctc\ 12.5\,cm$

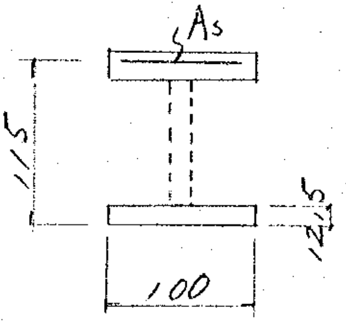
$= 9.05\,cm^2$

$P = \frac{A_s}{bd} = 0.000787 \qquad t/d = 0.152$

$K = 0.143 \qquad j = 0.952$

$\sigma_c = 197\ N/cm^2 < 1000\ N/cm^2$

$\sigma_s = 17750$ " < 23000 "



$M = 201.5\ KN.m$

$b = 100\,cm \quad d = 115\,cm \quad t = 12.5\,cm$

$A_s = \Phi 12\ ctc\ 12.5\,cm$

$= 9.05\,cm^2$

$P = 0.000787 \qquad t/d = 0.109$

$K = 0.147 \qquad j = 0.963$

$\sigma_c = 100\ N/cm^2 < 1000\ N/cm^2$

$\sigma_s = 20\,100$ " < 23000 "

7. R.C. Voided Slab Bridge (C, E-Ramp BR)

CONTENTS

§§1 DESIGN CONDITION

§ I. DESIGN CONDITION

TYPE	2 SPANS CONTINUANCE RC VOIDED SLAB BRIDE
BRIDGE LENGTH	32 550
GIRDER LENGTH	32 500
SPAN	16 200 + 15700
WIDTH	9 500
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	I.5 D + 2.5 L
		2 (D + L)
	HB LOADING	I.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. REIN FORCEMENT

HOT ROLLED YIELD BARS

SPECIFIED CHARACTERISTIC STRENGTH

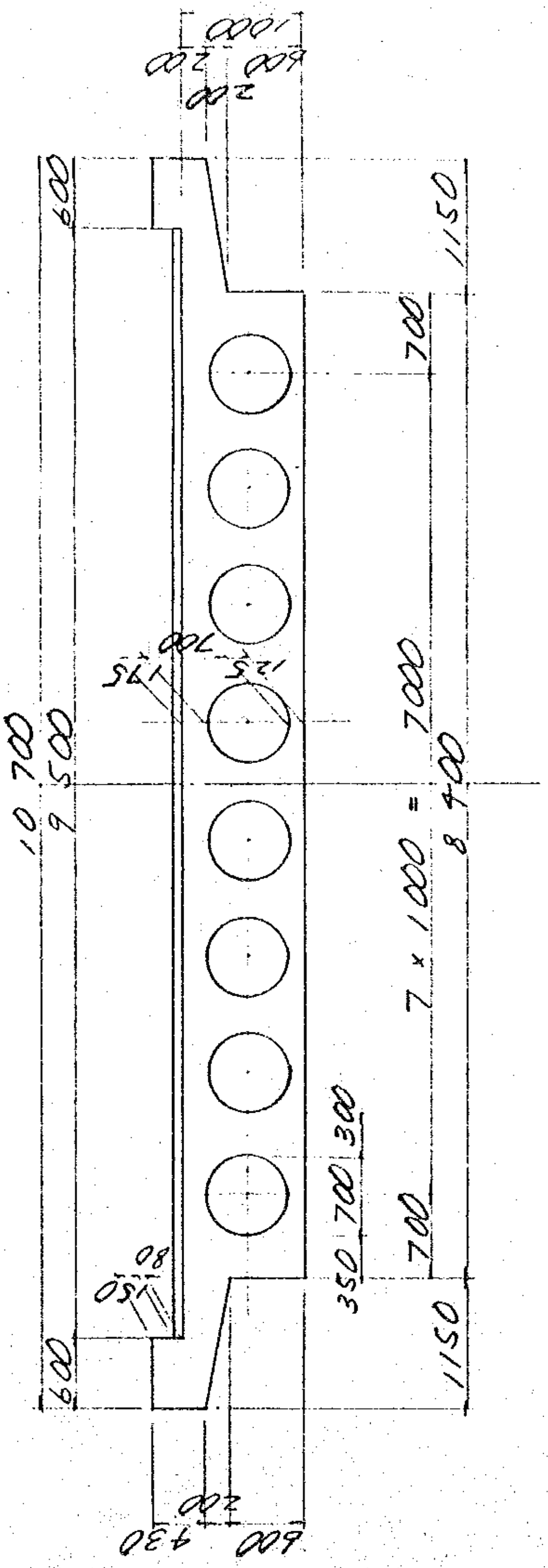
f_{su} = 410 N/m^2 (4180 kg/cm^2)

PERMISSIBLE TENSILE STRESS

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

§§ 2 DESIGN OF MAIN SLAB

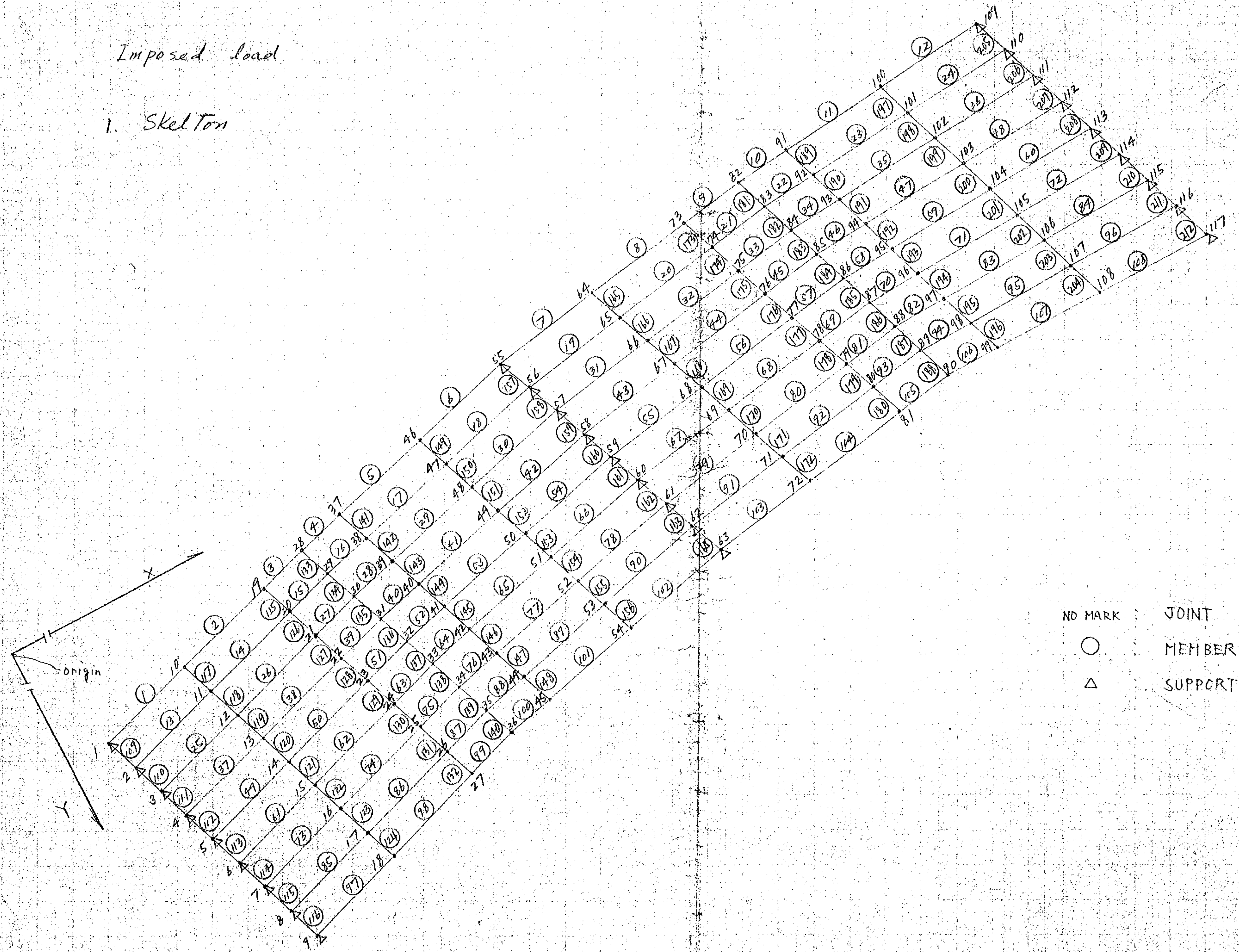
§ 1 PREPARATION



TYPICAL CROSS SECTION

Imposed load

1. SkelTon



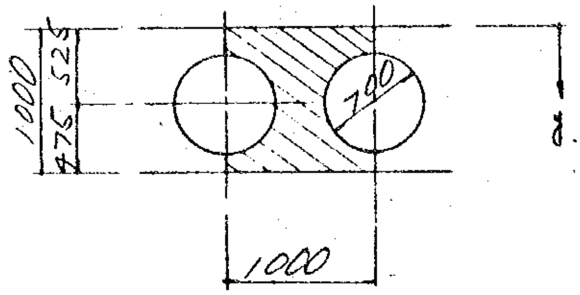
2 Co-ordinate

	X	Y		X	Y
1	19.102	49.231	31	26.789	45.559
2	19.870	49.909	32	27.541	46.223
3	20.620	50.571	33	28.293	46.888
4	21.369	51.233	34	29.045	47.552
5	22.119	51.895	35	29.798	48.217
6	22.868	52.557	36	30.569	48.898
7	23.618	53.219	37	25.642	42.459
8	24.367	53.881	38	26.414	43.141
9	25.136	54.560	39	27.167	43.806
10	21.202	46.897	40	27.920	44.471
11	21.971	47.576	41	28.673	45.136
12	22.721	48.238	42	29.426	45.801
13	23.470	48.900	43	30.180	46.467
14	24.220	49.562	44	30.933	47.132
15	24.970	50.225	45	31.705	47.814
16	25.720	50.887	46	27.965	40.350
17	26.470	51.549	47	28.740	41.034
18	27.238	52.228	48	29.495	41.701
19	23.385	44.640	49	30.251	42.368
20	24.155	45.320	50	31.007	43.036
21	24.906	45.984	51	31.763	43.704
22	25.657	46.647	52	32.519	44.371
23	26.408	47.310	53	33.276	45.039
24	27.159	47.974	54	34.051	45.724
25	27.910	48.637	55	30.350	38.312
26	28.662	49.301	56	31.128	38.999
27	29.432	49.981	57	31.887	39.669
28	24.424	43.550	58	32.646	40.339
29	25.285	44.231	59	33.406	41.010
30	26.037	44.895	60	34.165	41.681

	X	Y		X	Y
61	34.925	42.352	91	38.097	32.477
62	35.685	43.023	92	38.890	33.178
63	36.464	43.711	93	39.664	33.861
64	32.873	36.286	94	40.438	34.545
65	33.655	36.977	95	41.213	35.230
66	34.419	37.651	96	41.989	35.915
67	35.182	38.325	97	42.765	36.600
68	35.946	38.999	98	43.542	37.286
69	36.710	39.674	99	44.338	37.990
70	37.474	40.349	100	40.792	30.698
71	38.239	41.024	101	41.591	31.404
72	39.023	41.717	102	42.372	32.094
73	35.457	34.341	103	43.153	32.784
74	36.244	35.036	104	43.935	33.474
75	37.012	35.714	105	44.718	34.166
76	37.780	36.393	106	45.502	34.857
77	38.549	37.072	107	46.286	35.550
78	39.318	37.751	108	47.090	36.261
79	40.088	38.431	109	43.538	29.004
80	40.858	39.111	110	44.345	29.717
81	41.648	39.809	111	45.133	30.413
82	36.777	33.409	112	45.923	31.110
83	37.567	34.107	113	46.713	31.808
84	38.338	34.788	114	47.503	32.506
85	39.109	35.469	115	48.295	33.206
86	39.881	36.151	116	49.088	33.906
87	40.654	36.833	117	49.901	34.624
88	41.427	37.516			
89	42.200	38.199			
90	42.993	38.900			

3 Flexural rigidity of main girder

1) Interior girder



$A = 1.00 \times 1.00 - 1/4\ \pi \times 0.70^2$

$= 1.0000 - 0.3847 = 0.6153\ m^2$

$Ay = 1.000 \times 0.50 - 0.3847 \times 0.525 = 0.2980 m^3$

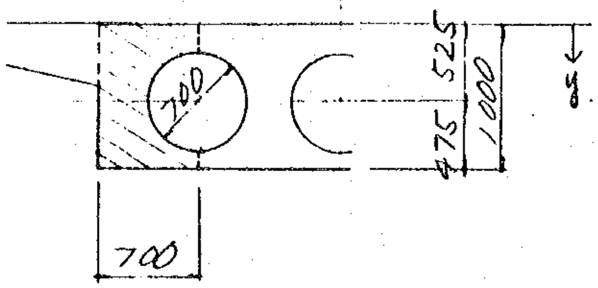
$Ay^2 = 1.000 \times 0.50^2 - 0.3847 \times 0.525^2 = 0.1440\ m^4$

$I_0 = 1/12 \times 1.00 \times 1.00^3 - 1/64\ \pi \times 0.70^4 = 0.0715\ m^4$

$y = \frac{Ay}{A} = \frac{0.2980}{0.6153} = 0.484\ m$

$I = 0.1440 + 0.0715 - 0.6153 \times 0.484^2 = 0.0714 m^4$

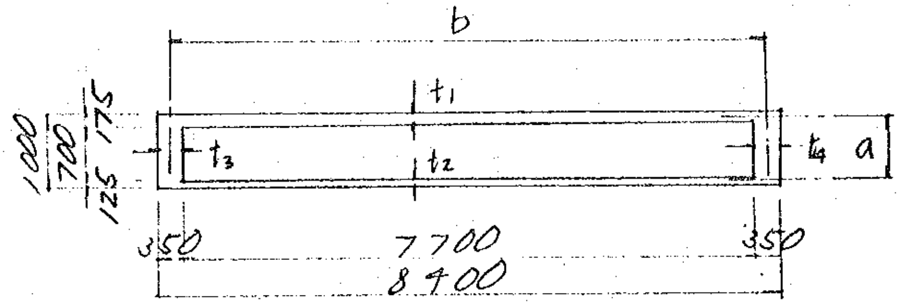
2) Edge girder



$$A = 0.70 \times 1.00 - \tfrac{1}{4}\pi \times 0.70^2 \times \tfrac{1}{2}$$
$$= 0.7000 - 0.1923 = 0.5077 \ m^2$$
$$Ay = 0.7000 \times 0.50 - 0.1923 \times 0.525 = 0.2490 \ m^3$$
$$Ay^2 = 0.7000 \times 0.50^2 - 0.1923 \times 0.525^2 = 0.1220 \ m^4$$
$$I_0 = \tfrac{1}{12} \times 0.70 \times 1.00^3 - \tfrac{1}{64}\pi \times 0.70^4 \times \tfrac{1}{2} = 0.0524 \ m^4$$
$$y = \frac{Ay}{A} = \frac{0.2490}{0.5077} = 0.490^m$$

$$I = 0.1220 + 0.0524 - 0.5077 \times 0.490^2 = \underline{\underline{0.0525 \ m^4}}$$

3) Torsional rigidity of main girder



$a = 0.850\ m \qquad b = 8.050\ m$

$t_1 = 0.175\ m \qquad t_2 = 0.125\ m \qquad t_3 = t_4 = 0.350\ m$

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

$$= 0.329 \times 8.050 \times 0.175^3 + 0.330 \times 8.050 \times 0.125^3$$

$$+ 2 \times 0.247 \times 0.850 \times 0.350^3$$

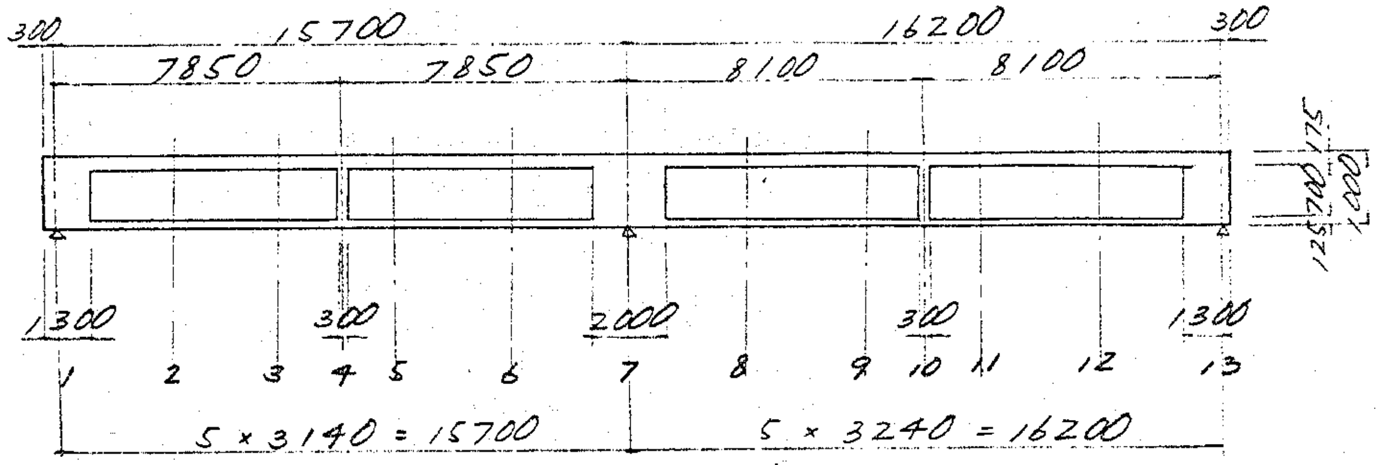
$$+ \frac{4 \times 0.850^2 \times 8.050^2}{\frac{8.050}{0.175} + \frac{8.050}{0.125} + 2 \times \frac{0.850}{0.350}}$$

$$= 0.0142 + 0.0052 + 0.0180 + 1.6249$$

$$= 1.6623\ m^4$$

$$J = \frac{1.6623}{9} = \underline{\underline{0.1847\ m^4}}$$

4) Flexural rigidity of cross beam



List of flexural & torsional rigidity

Point	I (m^4)	J (m^4)
1	0.1385	0.3974
2	0.1677	0.6673
3	0.1255	0.5004
4	0.0935	0.3336
5	0.1255	0.5004
6	0.1677	0.6673
7	0.2299	0.6780
8	0.1727	0.6888
9	0.1292	0.5166
10	0.0963	0.3444
11	0.1292	0.5166
12	0.1727	0.6888
13	0.1417	0.4082

Cross beam - 1.

	A	y	Ay	Ay²	I₀
1.870 × 0.175	0.327	0.088	0.0288	0.0025	0.0008
1.300 × 0.700	0.910	0.525	0.4778	0.2508	0.0372
1.870 × 0.125	0.234	0.938	0.2195	0.2059	0.0003
	1.471		0.7261	0.4592	0.0383

$y = 0.494$ m

$I = 0.4592 + 0.0383 - 1.471 \times 0.494^2 = 0.1385$ m⁴

Cross beam - 2.6

	A	y	Ay	Ay²	I₀
3.140 × 0.175	0.550	0.088	0.0484	0.0043	0.0014
3.140 × 0.125	0.393	0.938	0.3686	0.3457	0.0005
	0.943		0.4170	0.3500	0.0019

$y = 0.442$ m

$I = 0.3500 + 0.0019 - 0.943 \times 0.442^2 = 0.1677$ m⁴

Cross beam - 3.5

	A	y	Ay	Ay²	I₀
2.355 × 0.175	0.412	0.088	0.0363	0.0032	0.0011
2.355 × 0.125	0.294	0.938	0.2758	0.2587	0.0004
	0.706		0.3121	0.2619	0.0015

$y = 0.442$ m

$I = 0.2619 + 0.0015 - 0.706 \times 0.442^2 = 0.1255$ m⁴

Cross beam - 1.

	A	y	Ay	Ay²	I₀
1.870 × 0.175	0.327	0.088	0.0288	0.0025	0.0008
1.300 × 0.700	0.910	0.525	0.4778	0.2508	0.0372
1.870 × 0.125	0.234	0.938	0.2195	0.2059	0.0003
	1.471		0.7261	0.4592	0.0383

$y = 0.494$ m

$I = 0.4592 + 0.0383 - 1.471 \times 0.494^2 = 0.1385\ m^4$

Cross beam - 2.6

	A	y	Ay	Ay²	I₀
3.140 × 0.175	0.550	0.088	0.0484	0.0043	0.0014
3.140 × 0.125	0.393	0.938	0.3686	0.3457	0.0005
	0.943		0.4170	0.3500	0.0019

$y = 0.442$ m

$I = 0.3500 + 0.0019 - 0.943 \times 0.442^2 = 0.1677\ m^4$

Cross beam - 3.5

	A	y	Ay	Ay²	I₀
2.355 × 0.175	0.412	0.088	0.0363	0.0032	0.0011
2.355 × 0.125	0.294	0.938	0.2758	0.2587	0.0004
	0.706		0.3121	0.2619	0.0015

$y = 0.442$ m

$I = 0.2619 + 0.0015 - 0.706 \times 0.442^2 = 0.1255\ m^4$

Cross beam - 4

	A	y	Ay	Ay²	I₀
1.570 × 0.175	0.275	0.088	0.0242	0.0021	0.0007
0.300 × 0.700	0.210	0.525	0.1103	0.0579	0.0086
1.570 × 0.125	0.196	0.938	0.1838	0.1724	0.0003
	0.681		0.3183	0.2324	0.0096

$y = 0.467$ m

$I = 0.2324 + 0.0096 - 0.681 \times 0.467^2 = 0.0935$ m⁴

Cross beam - 7

	A	y	Ay	Ay²	I₀
3.190 × 0.175	0.558	0.088	0.0491	0.0043	0.0014
2.000 × 0.700	1.400	0.525	0.7350	0.3859	0.0572
3.190 × 0.125	0.399	0.938	0.3743	0.3511	0.0005
	2.357		1.1584	0.7413	0.0591

$y = 0.492$ m

$I = 0.7413 + 0.0591 - 2.357 \times 0.492^2 = 0.2299$ m⁴

Cross beam - 8, 12

	A	y	Ay	Ay²	I₀
3.240 × 0.175	0.567	0.088	0.0499	0.0044	0.0014
3.240 × 0.125	0.405	0.938	0.3799	0.3563	0.0005
	0.972		0.4298	0.3607	0.0019

$y = 0.442$ m

$I = 0.3607 + 0.0019 - 0.972 \times 0.442^2 = 0.1727$ m⁴

Cross beam - 9, 11

	A	y	Ay	Ay^2	I_o
2.430 × 0.175	0.425	0.088	0.0374	0.0033	0.0011
2.430 × 0.125	0.304	0.938	0.2852	0.2675	0.0004
	0.729		0.3226	0.2708	0.0015

$y = 0.443$ m

$I = 0.2708 + 0.0015 - 0.729 \times 0.443^2 = 0.1292$ m^4

Cross beam - 10

	A	y	Ay	Ay^2	I_o
1.620 × 0.175	0.284	0.088	0.0250	0.0022	0.0007
0.300 × 0.700	0.210	0.525	0.1103	0.0579	0.0086
1.620 × 0.125	0.203	0.938	0.1904	0.1786	0.0003
	0.697		0.3257	0.2387	0.0096

$y = 0.467$ m

$I = 0.2387 + 0.0096 - 0.697 \times 0.467^2 = 0.0963$ m^4

Cross beam - 13

	A	y	Ay	Ay^2	I_o
1.920 × 0.175	0.336	0.088	0.0296	0.0026	0.0009
1.300 × 0.700	0.910	0.525	0.4778	0.2508	0.0372
1.920 × 0.125	0.240	0.938	0.2251	0.2111	0.0003
			0.7325	0.4645	0.0384

$y = 0.493$ m

$I = 0.4645 + 0.0384 - 1.486 \times 0.493^2 = 0.1417$ m^4

Torsional rigidity of cross beam

Span - 1

$a = 0.850\ m \qquad b = 14.850\ m$

$t_1 = 0.175\ m \quad t_2 = 0.125\ m \quad t_3 = 1.300\ m \quad t_4 = 1.000\ m$

$$J = 0.331 \times 14.850 \times 0.175^3 + 0.332 \times 14.850 \times 0.125^3 + 0.198 \times 1.300 \times 0.850^3 + 0.163 \times 1.000 \times 0.850^3 + \frac{4 \times 0.850^2 \times 14.850^2}{\frac{14.850}{0.175} + \frac{14.850}{0.125} + \frac{0.850}{1.300} + \frac{0.850}{1.000}}$$

$$= 0.0263 + 0.0096 + 0.1581 + 0.1001 + 3.1064 \qquad = 3.4005\ m^4$$

$$J = 3.4005 \times 1/16.00 = 0.2125\ m^4/m$$

Span - 2

$a = 0.850\ m \qquad b = 15.350\ m$

$t_1 = 0.175\ m \quad t_2 = 0.125\ m \quad t_3 = 1.000\ m \quad t_4 = 1.300\ m$

$$J = 0.331 \times 15.350 \times 0.175^3 + 0.332 \times 15.35 \times 0.125^3 + 0.198 \times 1.000 \times 0.850^3 + 0.163 \times 1.300 \times 0.850^3 + \frac{4 \times 0.850^2 \times 15.350^2}{\frac{15.350}{0.175} + \frac{15.350}{0.125} + \frac{0.850}{1.000} + \frac{0.850}{1.300}}$$

$$= 0.0272 + 0.0100 + 0.1581 + 0.1001 + 3.2118$$

$$= 3.5072\ m^4$$

$$J = 3.5072 \times 1/16.50 = 0.2126\ m^4/m$$

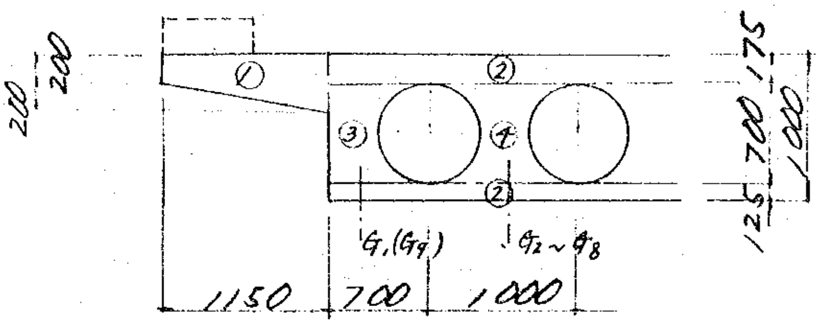
Cross beam	- 1.	J = 0.2125 × 1.870 = 0.3974 m^4
〃	- 2.6	J = 〃 × 3.140 = 0.6673 〃
〃	- 3.5	J = 〃 × 2.355 = 0.5004 〃
〃	- 4.	J = 〃 × 1.570 = 0.3336 〃
〃	- 7.	J = 0.2125 × 1.570 + 0.2126 × 1.620 = 0.6780 〃
〃	- 8. 12	J = 0.2126 × 3.240 = 0.6888 〃
〃	- 9. 11	J = 〃 × 2.430 = 0.5166 〃
〃	- 10	J = 〃 × 1.620 = 0.3444 〃
〃	- 13	J = 〃 × 1.920 = 0.4082 〃

Section force due to design load

LOADING

1. Dead load

1) Slab



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

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

③ $Wd_3 = (0.70 \times 0.70 - 1/4 \times 0.70^2 \times \pi \times 1/2)$

$\times 23.6 = 7.025 \ KN/m$

④ $Wd_4 = (0.70 \times 1.00 - 1/4 \times 0.70^2 \times \pi)$

$\times 23.6 = 7.442 \ KN/m$

2) Cross beam

G_1, G_9

$A = 1/4 \times 0.70^2 \times \pi \times 1/2 \doteq 0.192\ m^2$

Edge support

$Wd_5 = 0.192 \times 1.00 \times 23.6 = 4.531\ KN$

Center support

$Wd_5 = 0.192 \times 2.00 \times 23.6 = 9.062\ KN$

Center beam

$Wd_5 = 0.192 \times 0.30 \times 23.6 = 1.359\ KN$

$G_2 \sim G_8$

$A = 1/4 \times 0.70^2 \times \pi = 0.385\ m^2$

Edge support

$Wd_5 = 0.385 \times 1.00 \times 23.6 = 9.086\ KN$

Center support

$Wd_5 = 0.385 \times 2.00 \times 23.6 = 18.172\ KN$

Center beam

$Wd_5 = 0.385 \times 0.30 \times 23.6 = 2.726\ KN$

3) Kerb

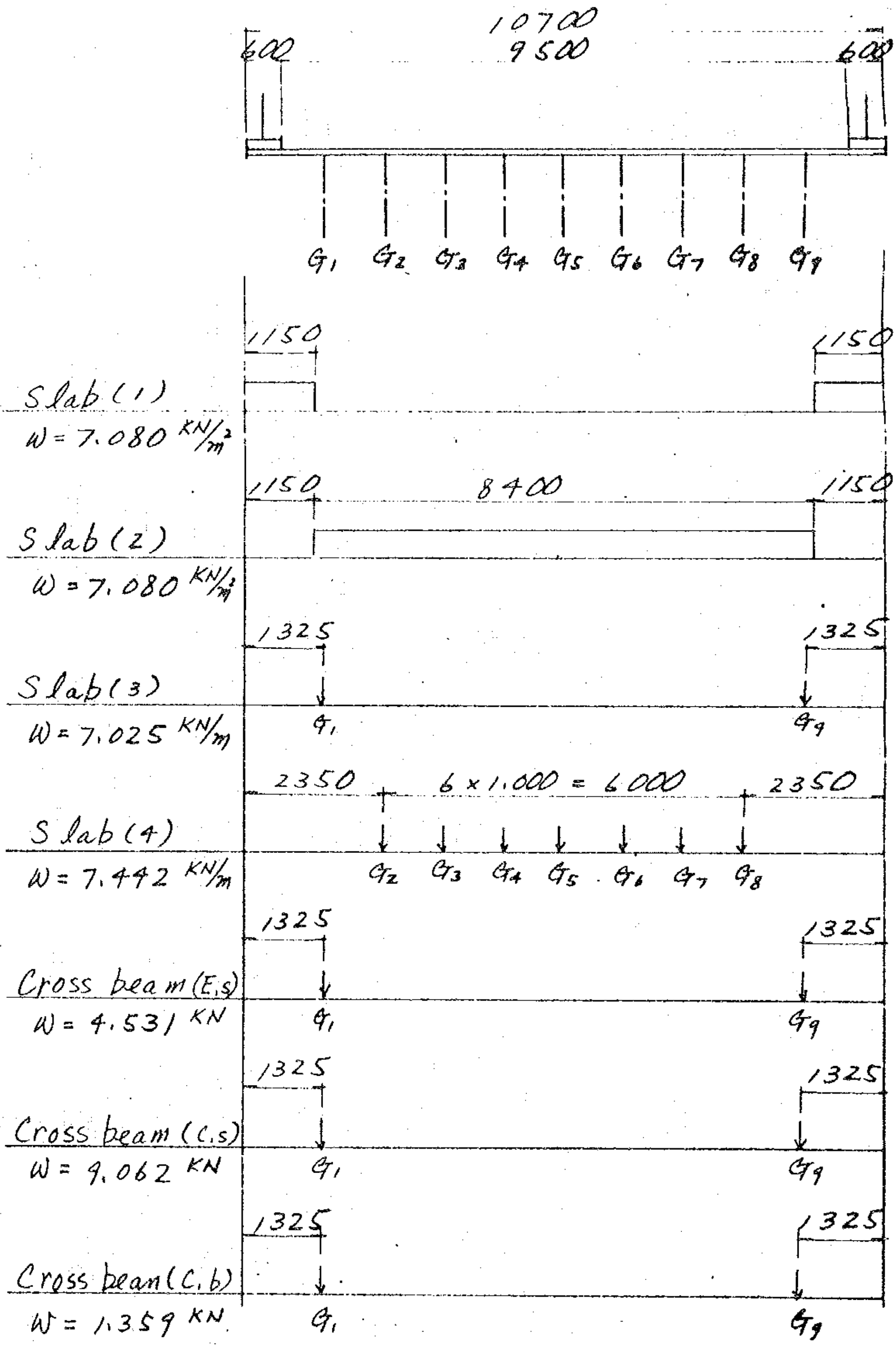
$Wd_6 = 0.60 \times 0.23 \times 23.6 = 3.257\ ^{KN}/_{m}$

4) Wearing surface

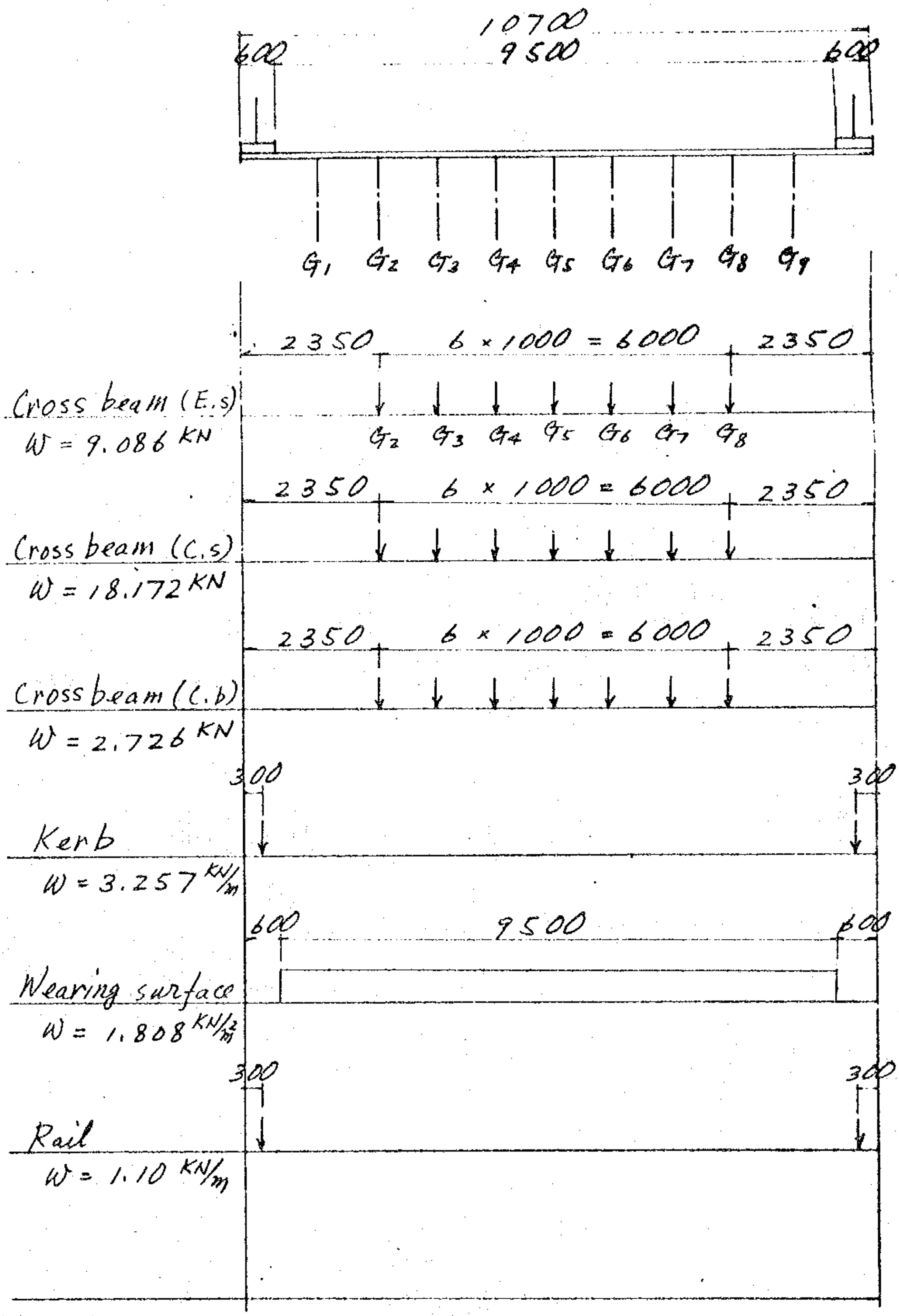
$Wd_7 = 1.808\ ^{KN}/_{m^2}$

5) Rail

$Wd_8 = 1.10\ ^{KN}/_{m}$

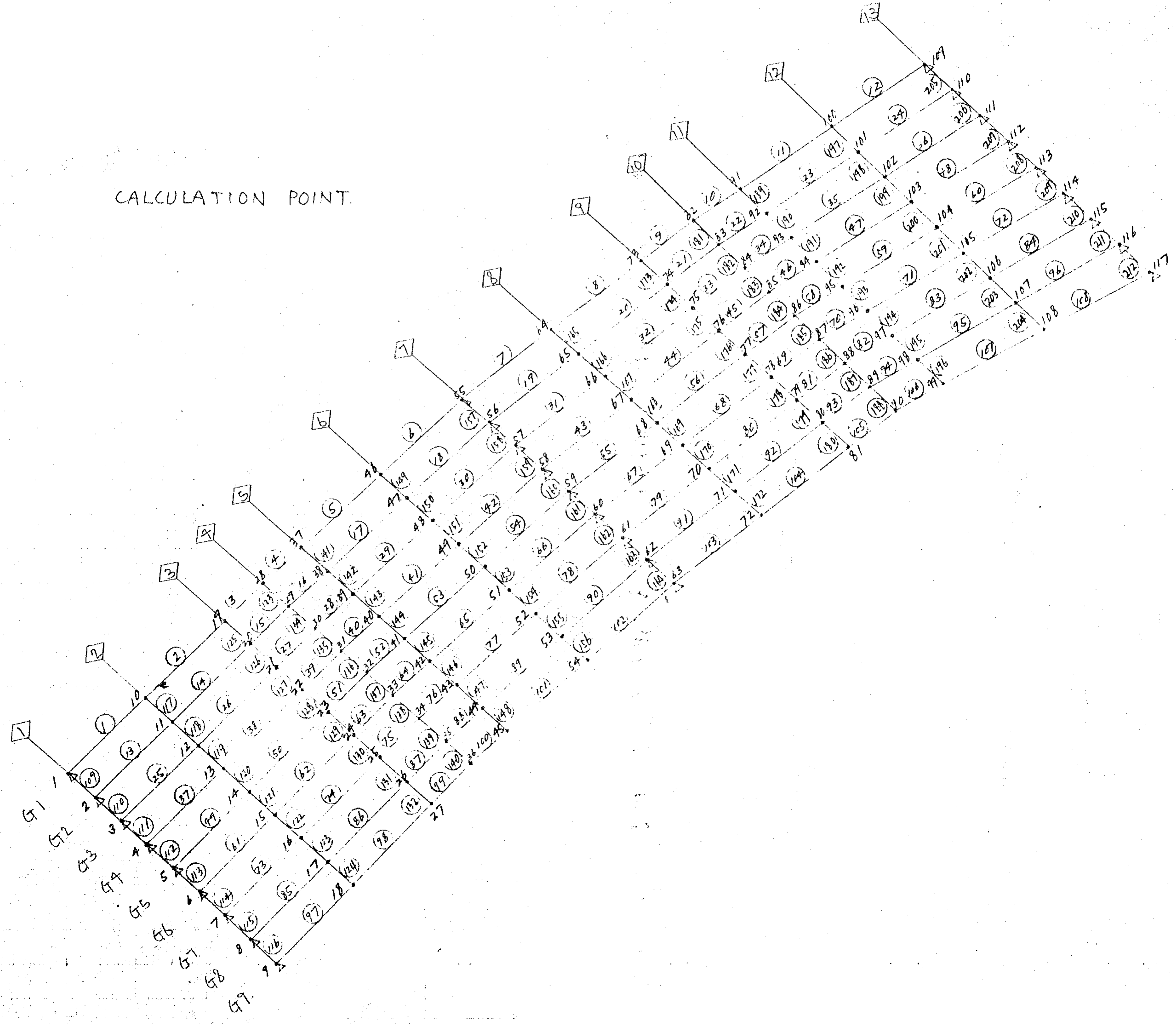


10700
9500
600
600
G1 G2 G3 G4 G5 G6 G7 G8 G9
1150
1150
Slab (1)
W = 7.080 KN/m²
1150
8400
1150
Slab (2)
W = 7.080 KN/m²
1325
1325
Slab (3)
W = 7.025 KN/m
G1
G9
2350
6 x 1.000 = 6000
2350
Slab (4)
W = 7.442 KN/m
G2 G3 G4 G5 G6 G7 G8
1325
1325
Cross beam (E.s)
W = 4.531 KN
G1
G9
1325
1325
Cross beam (C.s)
W = 9.062 KN
G1
G9
1325
1325
Cross bean (C.b)
W = 1.359 KN
G1
G9



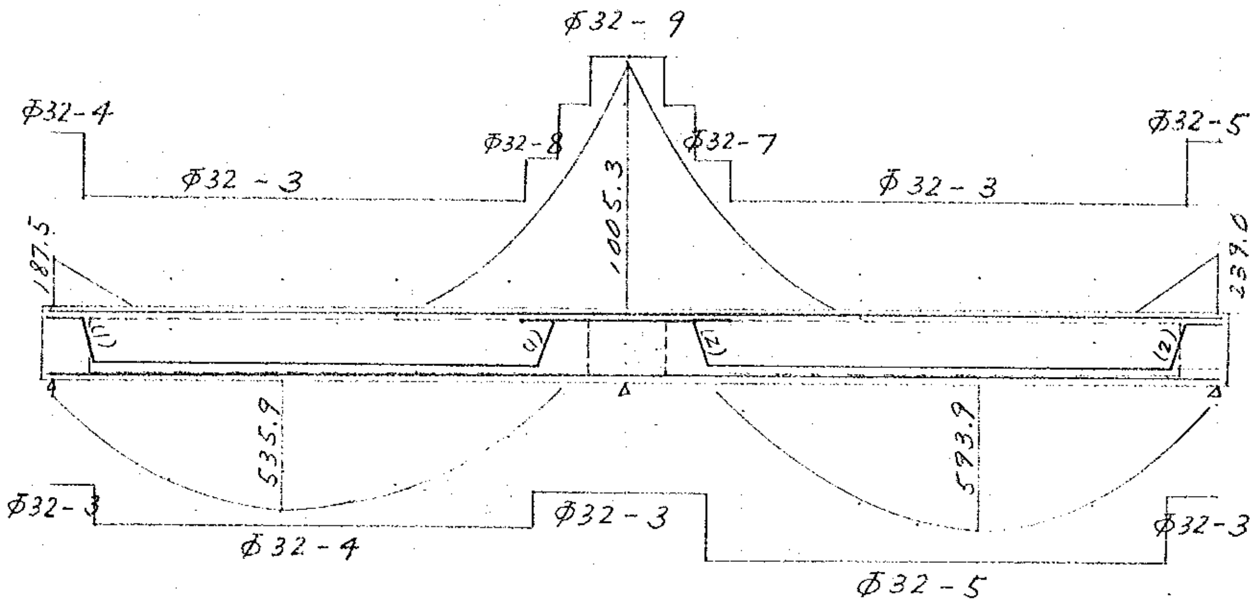
10700
9500
600
600
G1 G2 G3 G4 G5 G6 G7 G8 G9
2350
6 × 1000 = 6000
2350
Cross beam (E.s)
W = 9.086 KN
G2 G3 G4 G5 G6 G7 G8
2350
6 × 1000 = 6000
2350
Cross beam (C.s)
W = 18.172 KN
2350
6 × 1000 = 6000
2350
Cross beam (C.b)
W = 2.726 KN
300
300
Kerb
W = 3.257 KN/m
600
9500
600
Wearing surface
W = 1.808 KN/m2
300
300
Rail
W = 1.10 KN/m

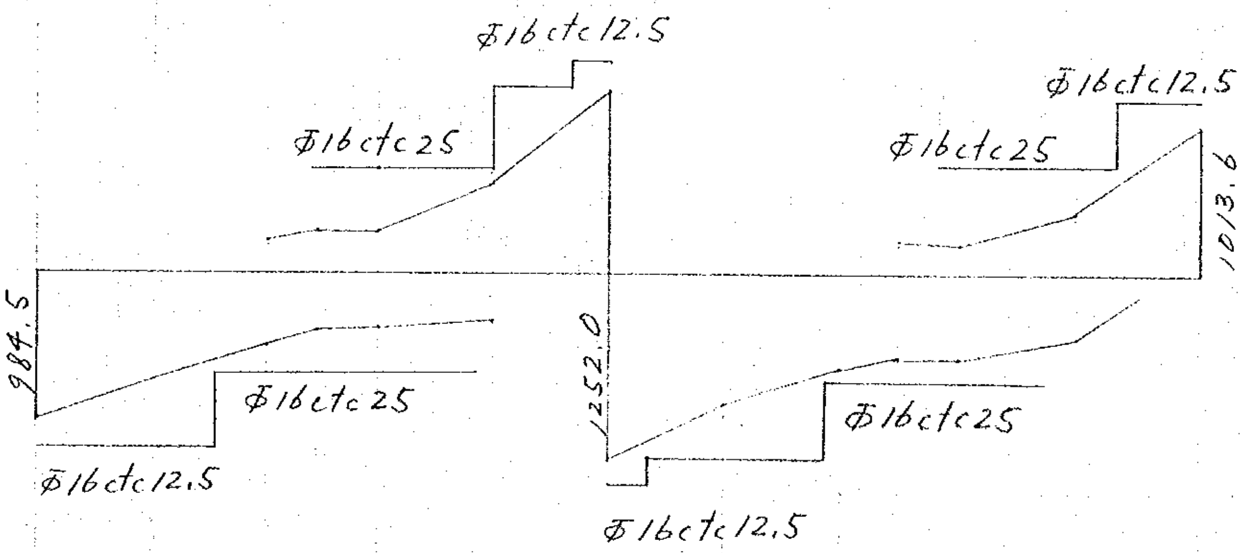
CALCULATION POINT

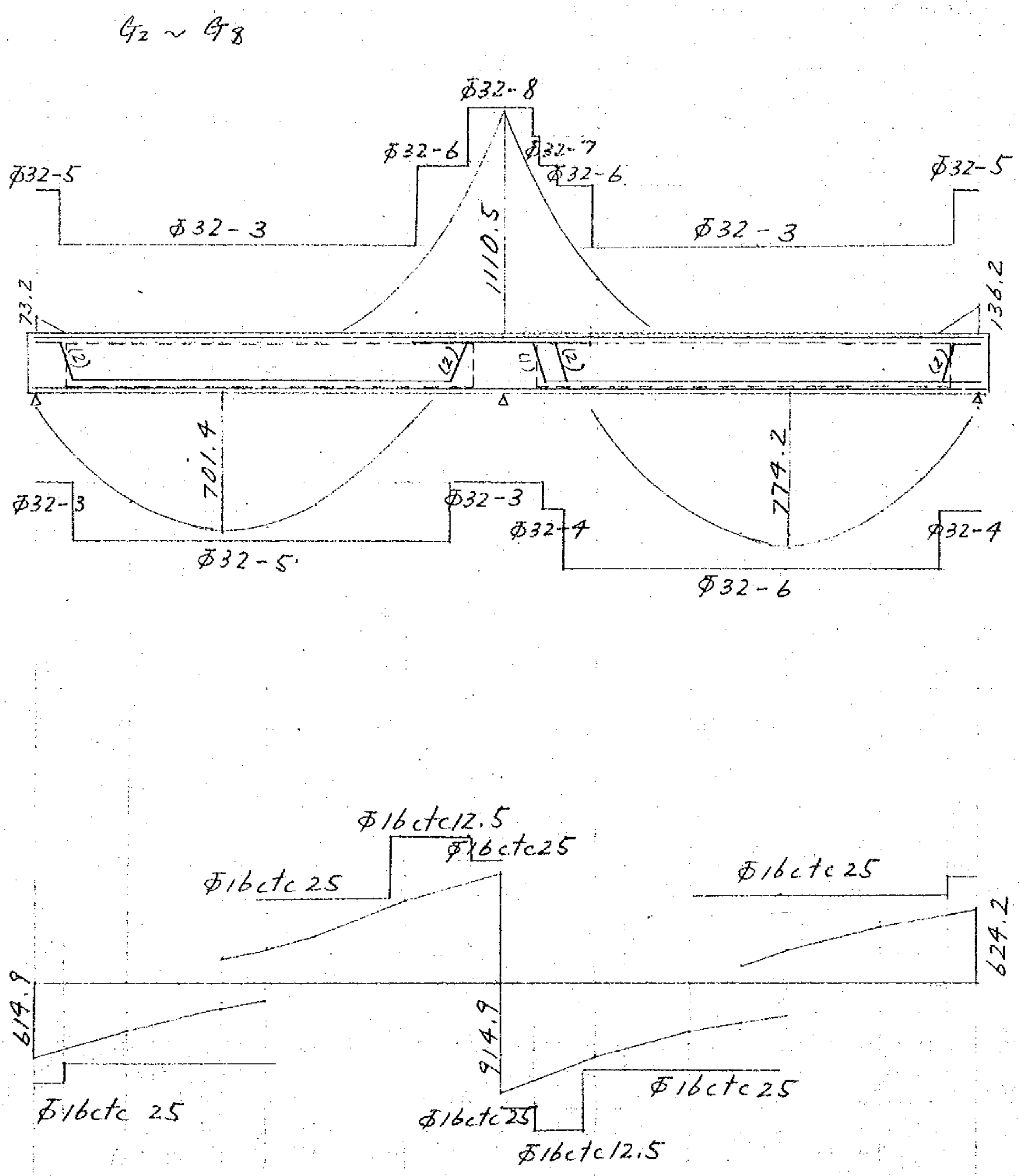


§2 DRAWING OF SECTIONAL FORCE DIAGRAM

G_1, G_9

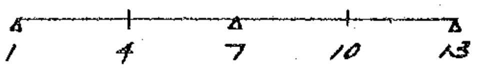





G2 ~ G8
Φ32-8
Φ32-6
Φ32-7
Φ32-6
Φ32-5
Φ32-5
Φ32-3
Φ32-3
1110.5
73.2
136.2
701.4
774.2
Φ32-3
Φ32-3
Φ32-4
Φ32-4
Φ32-5
Φ32-6
Φ16ctc12.5
Φ16ctc25
Φ16ctc25
Φ16ctc25
619.9
624.2
914.9
Φ16ctc 25
Φ16ctc25
Φ16ctc25
Φ16ctc12.5

Moment list

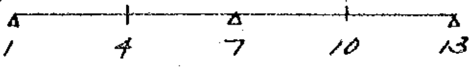
Mmax
Mmin



HA-LOADING or 1/1.25·HB-LOADING WHICHEVER IS MORE

	G1	G2	G3	G4	G5	G6	G7	G8	G9
1	34.2	49.3	44.2	49.1	51.5	53.2	53.2	67.7	61.4
	-187.5	-73.2	-37.9	-28.9	-22.4	-25.9	-29.9	-58.3	-163.8
2	357.5	517.9	517.9	515.1	508.1	516.9	525.3	544.8	402.2
	94.9	177.8	179.5	180.9	181.5	182.0	183.6	192.2	122.3
3	504.4	701.4	687.5	673.1	659.4	667.3	679.6	697.9	535.9
4	474.2	676.3	654.5	635.3	618.8	626.0	636.1	648.7	507.2
5	422.7	566.4	534.2	511.1	495.4	500.7	514.7	550.0	408.9
	54.1	84.6	73.7	66.3	60.5	56.5	54.9	62.4	33.2
6	225.6	161.8	65.1	54.2	46.6	35.4	57.8	107.2	110.6
	-131.6	-207.6	-243.7	-265.7	-273.6	-276.5	-278.8	-278.0	-246.6
7	-349.2	-473.4	-477.0	-474.2	-474.5	-480.5	-497.5	-525.5	-450.0
	-816.0	-995.0	-971.0	-964.0	-948.8	-976.4	-1014.5	-1110.5	-1005.3
8	16.2	34.2	27.6	39.9	42.7	57.6	74.0	117.8	108.2
	-264.9	-263.5	-253.1	-248.7	-244.1	-237.6	-223.9	-210.3	-200.2
9	348.1	508.1	519.6	516.4	514.8	531.5	553.5	594.2	484.9
	30.6	66.6	72.8	78.6	84.6	91.6	100.6	117.3	97.2
10	456.3	644.4	649.5	642.0	639.6	656.0	673.8	702.0	569.9
11	487.8	697.9	689.9	681.4	681.8	692.9	718.7	774.2	593.9
12	487.0	593.8	539.7	525.7	526.0	529.3	549.1	592.8	450.8
	133.8	201.4	188.2	184.2	183.8	185.7	190.2	205.8	143.3
13	64.2	69.3	51.0	46.4	38.8	26.8	18.5	20.9	22.6
	-239.0	-136.2	-77.9	-64.8	-56.3	-54.4	-59.8	-67.7	-170.7

HA - loading



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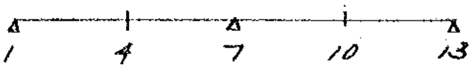
DEAD + HA-LIVE

	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9
1	17.6	41.3	43.8	49.1	51.5	53.2	53.2	63.2	50.4
	-166.1	-59.8	-37.9	-28.9	-22.4	-25.9	-29.9	-41.8	-137.9
2	357.5	517.9	517.9	515.1	508.1	516.9	525.3	541.8	402.2
	116.0	230.0	231.4	233.5	234.6	235.5	237.9	249.7	156.1
3	504.4	701.4	687.5	673.1	657.4	667.3	679.6	697.9	535.9
	183.1	273.1	268.9	266.7	264.7	263.0	263.0	268.7	198.5
4	424.2	676.3	654.5	635.3	618.8	626.0	636.1	648.7	507.2
	148.8	225.2	218.0	213.1	208.9	205.7	203.9	206.2	152.3
5	422.7	566.4	534.2	511.1	495.4	500.7	514.7	550.0	408.9
	83.2	127.0	113.5	105.1	98.6	94.3	92.8	102.4	59.4
6	122.3	135.3	64.9	36.1	23.1	26.2	31.1	63.2	44.0
	-131.9	-207.6	-243.7	-265.7	-273.6	-276.5	-278.8	-278.0	-246.6
7	-437.9	-590.2	-596.0	-592.8	-592.2	-598.3	-618.6	-652.0	-549.6
	-816.0	-995.0	-971.0	-964.0	-948.8	-976.4	-1014.5	-1110.5	-1005.3
8	16.2	29.0	27.6	37.6	41.9	57.6	24.0	117.8	108.2
	-264.9	-263.5	-253.1	-248.7	-244.1	-237.6	-223.9	-210.3	-200.2
9	348.1	508.1	519.6	516.4	514.8	531.5	553.5	594.2	484.9
	54.4	103.5	111.8	119.5	127.1	135.8	146.9	167.6	138.0
10	456.3	644.4	649.5	642.0	639.6	656.0	673.8	702.0	562.9
	137.7	216.1	223.4	228.9	234.4	241.1	249.0	263.2	209.4
11	487.8	692.9	689.9	681.4	681.8	692.9	718.7	774.2	593.9
	159.9	274.1	276.7	280.8	284.2	289.6	299.4	325.5	242.0
12	428.9	593.8	539.7	525.7	526.0	529.3	549.1	522.8	440.2
	172.7	259.9	242.9	237.8	237.1	239.3	244.8	264.0	182.7
13	49.0	58.8	43.0	43.1	35.9	26.8	18.5	13.0	8.2
	-204.4	-102.9	-73.7	-64.8	-56.3	-54.4	-59.8	-67.6	-157.0

HB-loading

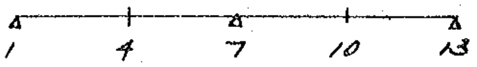


+
−

DEAD + HB-LIVE

	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9
1	42.7	61.6	55.3	55.7	55.2	61.4	66.4	84.6	76.7
	-234.4	-91.5	-33.6	-28.3	-27.2	-25.0	-26.2	-72.9	-204.8
2	366.3	583.6	555.8	561.2	546.4	560.4	563.2	610.0	408.5
	118.6	222.2	224.4	226.1	226.9	227.5	229.5	240.3	152.9
3	564.9	762.2	724.7	705.3	702.6	697.0	721.9	764.8	596.5
	172.6	258.4	254.1	251.7	249.3	247.3	247.1	252.4	185.1
4	525.3	715.3	673.1	644.1	638.6	632.4	654.8	690.0	557.1
	136.8	206.5	199.5	194.3	139.7	186.0	184.0	186.0	136.7
5	423.1	640.2	562.7	537.9	524.5	535.6	551.4	629.9	480.3
	67.6	105.7	92.1	82.9	75.6	70.6	68.6	78.0	41.5
6	282.0	202.3	81.4	67.8	58.2	44.3	22.2	134.0	138.2
	-154.5	-240.7	-276.1	-294.3	-299.1	-303.9	-310.3	-310.5	-269.3
7	-436.5	-591.8	-596.3	-592.8	-593.1	-600.6	-621.9	-656.9	-562.5
	-839.1	-1016.8	-946.5	-906.7	-908.2	-915.3	-988.0	-1118.6	-1038.7
8	7.4	42.7	33.5	42.9	53.4	59.9	76.3	136.3	93.8
	-243.5	-283.4	-279.6	-268.4	-265.2	-261.6	-253.6	-233.5	-193.3
9	400.0	569.2	549.2	552.2	556.7	561.2	603.3	663.9	542.3
	38.3	83.2	91.0	98.3	105.8	114.5	125.8	146.6	121.5
10	506.7	683.5	664.1	659.3	661.7	664.8	704.6	752.2	621.7
	124.1	198.5	205.5	211.1	216.7	223.6	231.8	246.1	196.0
11	549.0	763.9	714.3	701.9	705.8	737.9	763.4	862.3	661.2
	150.9	260.1	262.4	266.4	269.9	275.4	285.4	311.4	231.0
12	608.7	678.8	586.3	580.7	576.2	592.8	636.6	703.6	563.5
	167.2	251.8	235.2	230.2	229.7	232.1	237.8	257.3	179.1
13	80.3	86.6	63.8	58.0	48.5	23.1	11.8	26.1	28.2
	-298.8	-170.2	-97.4	-63.2	-65.7	-64.8	-46.1	-84.6	-213.4

Shear list



1.5(DEAD)+2.5(HA-LIVE) or 2.0(DEAD+HA-LIVE) or {1.5(DEAD)+2.0(HB-LIVE)}·1/1.25

	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9
1	984.5	605.7	614.9	604.3	598.2	602.1	607.7	587.3	961.9
	182.5	136.1	146.2	139.0	136.5	136.9	139.9	115.8	149.0
2	739.9	385.5	399.0	399.5	389.9	397.1	385.8	355.0	692.4
	50.1	-31.4	-14.3	-14.3	-6.3	-18.7	-24.8	-62.4	1.1
3	485.7	185.9	209.9	222.4	212.2	218.2	207.1	181.6	364.5
	-116.1	-197.3	-156.3	-150.1	-150.7	-153.8	-159.4	-209.4	-216.5
4	391.8	113.7	134.8	148.9	139.5	145.6	134.4	109.7	263.7
	-186.0	-271.3	-234.9	-227.5	-220.4	-230.1	-236.3	-276.9	-297.5
5	367.9	68.5	82.3	108.7	109.8	106.0	77.5	48.5	329.5
	-259.7	-367.3	-319.4	-306.2	-294.4	-306.7	-321.9	-389.7	-279.0
6	238.6	-31.1	16.4	67.7	92.2	74.4	30.2	7.8	332.5
	-602.9	-673.9	-522.0	-484.8	-463.6	-480.2	-500.0	-606.3	-449.0
7	1048.8	777.8	797.2	810.0	796.8	822.1	856.0	914.9	1252.0
	222.4	246.3	280.2	287.5	289.8	301.4	319.8	328.9	365.4
8	885.9	582.8	593.2	603.1	594.7	602.1	591.4	567.9	836.5
	164.0	133.8	151.3	155.4	161.2	151.1	148.9	105.1	130.9
9	650.4	408.6	402.9	414.9	402.8	406.5	398.3	356.0	428.2
	44.8	2.8	17.9	22.1	15.7	16.5	13.5	-59.4	-137.8
10	574.2	329.0	321.0	332.4	318.5	320.2	309.6	264.8	313.6
	-26.2	-62.8	-51.5	-53.2	-60.0	-56.8	-63.4	-143.7	-237.8
11	574.9	266.9	259.4	275.4	271.7	260.5	228.5	181.5	410.6
	-77.5	-168.3	-117.2	-123.0	-128.5	-127.7	-158.4	-258.3	-197.0
12	445.7	153.5	171.9	211.3	229.3	209.8	159.5	132.2	420.8
	-407.9	-457.6	-318.1	-303.1	-301.7	-294.4	-327.5	-425.6	-313.6
13	-141.3	-114.5	-138.5	-136.2	-136.8	-200.8	-146.5	-129.6	-168.3
	-1013.6	-624.2	-617.4	-611.7	-606.5	-607.6	-621.4	-580.1	-952.3

§3 CALCULATION OF STRESS

Resisting moment

G1 . G9.

	b (cm)	h (cm)	d' (cm)	d (cm)	t (cm)	Φ32	As (cm²)	MR (KN·m)
1	70	100	12	88	—	4	32.20	581
2	"	"	"	"	—	3	24.10	440
3	"	"	"	"	12.5	3	24.10	456
4	"	"	"	"	12.5	8	64.30	626
5	"	"	"	"	12.5	9	72.40	849
6	"	"	"	"	—	9	72.40	1023
7	"	"	"	"	12.5	9	—	849
8	"	"	"	"	12.5	7	56.30	621
9	"	"	"	"	12.5	3	—	456
10	"	"	"	"	—	3	24.10	440
11	"	"	"	"	—	5	40.20	717
12	"	"	"	"	—	3	—	440
13	"	"	"	"	17.5	3	24.10	447
14	"	"	"	"	17.5	4	32.20	595
15	"	"	"	"	17.5	3	—	447
16	"	"	"	"	—	3	—	440
17	"	"	"	"	17.5	3	—	447
18	"	"	"	"	17.5	5	40.20	736
19	"	"	"	"	17.5	3	—	447
20	"	"	"	"	—	3	—	440

$G_2 \sim G_8$

	b (cm)	h (cm)	d' (cm)	d (cm)	t (cm)	Φ32	As (cm²)	MR (KN·m)
1	100	100	12	88	—	5	40.20	730
2	〃	〃	〃	〃	—	3	24.10	447
3	〃	〃	〃	〃	12.5	3	24.10	457
4	〃	〃	〃	〃	12.5	6	48.30	850
5	〃	〃	〃	〃	—	6	48.30	869
6	〃	〃	〃	〃	—	8	64.30	1140
7	〃	〃	〃	〃	—	7	56.30	1005
8	〃	〃	〃	〃	12.5	7	56.30	863
9	〃	〃	〃	〃	12.5	5	40.20	760
10	〃	〃	〃	〃	12.5	3	—	457
11	〃	〃	〃	〃	—	3	—	447
12	〃	〃	〃	〃	—	5	—	730
13	〃	〃	〃	〃	—	3	—	447
14	〃	〃	〃	〃	17.5	3	24.10	449
15	〃	〃	〃	〃	17.5	5	40.20	744
16	〃	〃	〃	〃	17.5	3	—	449
17	〃	〃	〃	〃	—	3	—	447
18	〃	〃	〃	〃	17.5	3	—	449
19	〃	〃	〃	〃	17.5	4	32.20	597
20	〃	〃	〃	〃	17.5	6	48.30	892
21	〃	〃	〃	〃	17.5	4	—	597
22	〃	〃	〃	〃	—	4	32.20	590

Resisting shear

G_1, G_9

$$V_R = V_c + \frac{A_s}{S_u} \times 0.87\, f_{yv} \cdot d$$

$$= V_c + \frac{A_s}{S_u} \times 0.87 \times 41000 \times 88$$

	V_c ($\times 10^3$ N)		A_s (cm^2)	S_u (cm)	V_R ($\times 10^3$ N)
1	338	Φ16 - 2	4.02	12.5	1347
2	283	〃	〃	〃	1292
3	194	〃	〃	〃	1203
4	218	〃	〃	25	722
5	277	〃	〃	12.5	1286
6	280	〃	〃	〃	1289
7	449	〃	〃	〃	1458
8	280	〃	〃	〃	1289
9	264	〃	〃	〃	1273
10	234	〃	〃	25	738
11	194	〃	〃	12.5	1203
12	283	〃	〃	〃	1292
13	363	〃	〃	〃	1372

$G_2 \sim G_8$

$$V_R = V_c + \frac{A_s}{S_u} \times 0.87\, f_{yu} \cdot d$$

$$= V_c + \frac{A_s}{S_u} \times 0.87 \times 41000 \times 88$$

	V_c ($\times 10^3$N)		A_s (cm²)	S_u (cm)	V_R ($\times 10^3$N)
1	448	Φ16 − 2	4.02	25	952
2	316	〃	〃	〃	820
3	176	〃	〃	〃	680
4	211	〃	〃	〃	715
5	227	〃	〃	12.5	1236
6	242	〃	〃	25	746
7	536	〃	〃	〃	1040
8	519	〃	〃	〃	1023
9	237	〃	〃	12.5	1246
10	227	〃	〃	25	731
11	195	〃	〃	〃	699
12	387	〃	〃	〃	891
13	448	〃	〃	〃	952

G1 . G9

$$V_c = b d v$$

	b (cm)	d (cm)	As (cm²)	P (%)	v (N/cm²)	Vc (KN)
1	70	88	32.20	0.52	55	338
2	〃	〃	24.10	0.39	46	283
3	35	〃	24.10	0.78	63	194
4	〃	〃	32.20	1.05	71	218
5	〃	〃	64.30	2.09	90	277
6	〃	〃	72.40	2.35	91	280
7	70	〃	72.40	1.18	73	449
8	35	〃	72.40	—	—	280
9	〃	〃	56.30	1.83	86	264
10	〃	〃	40.20	1.31	76	234
11	〃	〃	24.10	—	—	194
12	70	〃	24.10	—	—	283
13	〃	〃	40.20	0.65	59	363

$G_2 \sim G_8$

	b (cm)	d (cm)	As (cm²)	P (%)	v (N/cm²)	Vc (KN)
1	100	88	40.20	0.46	51	448
2	〃	〃	24.10	0.27	36	316
3	30	〃	24.10	0.91	67	176
4	〃	〃	40.20	1.52	80	211
5	〃	〃	48.30	1.83	86	227
6	〃	〃	64.30	2.44	92	242
7	100	〃	64.30	0.73	61	536
8	〃	〃	56.30	0.64	59	519
9	30	〃	56.30	2.14	90	237
10	〃	〃	48.30	—	—	227
11	〃	〃	32.20	1.22	74	195
12	100	〃	32.20	0.37	44	387
13	〃	〃	40.20	—	—	448

§§ 3 DESIGN OF CROSS BEAM

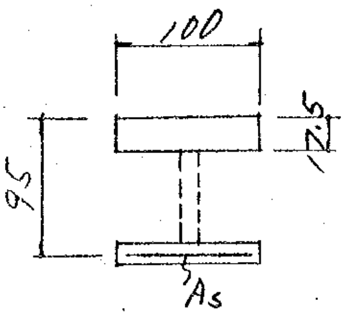
1 Moment list

HA × 1/b

HB × 1/b × 1/1.25

	HA (KN·m)	HB (KN·m)	b (m)	HA (KNm/m)	HB (KNm/m)
1	66.6 -116.2	99.0 -160.1	1.870	35.6 -62.1	42.4 -68.5
2	86.3 -184.0	110.5 -198.2	3.140	27.5 -58.6	28.2 -50.5
3	74.0 -180.6	96.0 -186.0	2.355	31.4 -76.7	32.6 -63.2
4	48.3 -141.0	61.2 -135.4	1.570	30.8 -89.8	31.2 -69.0
5	84.4 -190.6	106.6 -191.6	2.355	35.8 -80.9	36.2 -65.1
6	124.6 -214.4	157.5 -202.6	3.140	39.7 -68.3	40.1 -51.6
7	140.9 -228.1	167.6 -275.2	3.190	44.2 -71.5	42.0 -69.0
8	148.6 -193.9	191.1 -171.3	3.240	45.9 -59.9	47.2 -42.3
9	117.2 -173.0	149.3 -174.5	2.430	48.2 -71.2	49.2 -57.5
10	70.4 -135.2	90.3 -132.2	1.620	43.5 -83.5	44.6 -65.3
11	104.8 -189.6	137.7 -191.6	2.430	43.1 -78.0	45.3 -63.1
12	167.7 -222.4	226.2 -235.4	3.240	51.8 -68.6	55.9 -58.1
13	101.6 -240.8	111.8 -333.8	1.920	52.9 -125.4	46.6 -139.1

2. Calculation of stress



$M = 55.9$ KNm

$b = 100$ cm $d = 95$ cm $t = 17.5$ cm

$A_s = \Phi 12$ ctc 12.5 cm

$= 9.05$ cm²

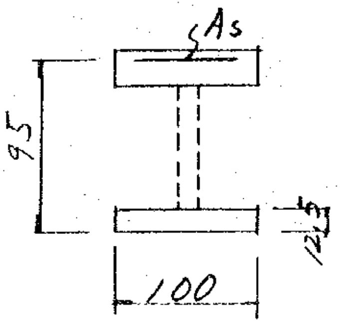
$P = \frac{A_s}{bd} = 0.000953$ $t/d = 0.184$

$K = 0.155$ $j = 0.948$

$\sigma_c = 84$ N/cm² < 1000 N/cm²

$\sigma_s = 6860$ " < 23000 "

$M = 139.1$ KNm



$b = 100$ cm $d = 95$ cm $t = 12.5$ cm

$A_s = \Phi 12$ ctc 12.5 cm

$= 9.05$ cm²

$P = 0.000953$ $t/d = 0.132$

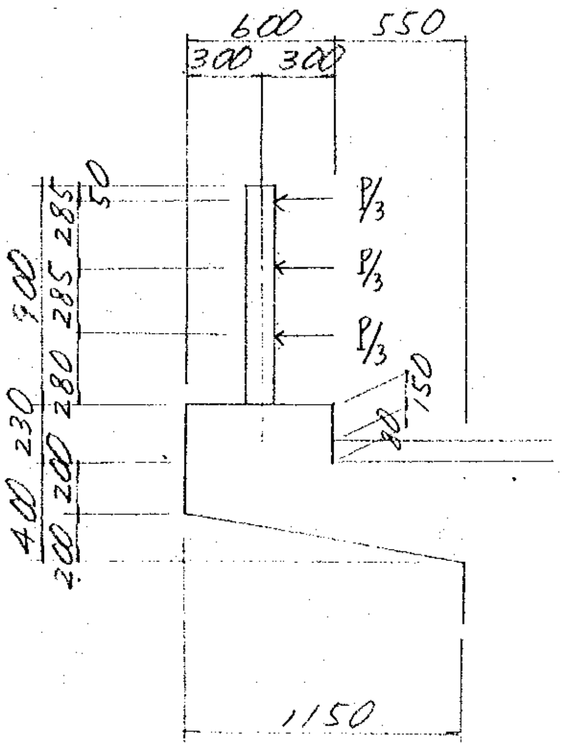
$K = 0.157$ $j = 0.967$

$\sigma_c = 208$ N/cm² < 1000 N/cm²

$\sigma_s = 16730$ " < 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	$\frac{1}{2} \times 1.808 \times 0.55^2$	$= 0.273$	"
Slab	$\frac{1}{6} \times 1.15^2 \times (2 \times 4.72 + 9.44)$	$= 4.161$	"

$Md = 8.137$ KN·m/m

Bending moment due to collision load

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

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

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

Interval of post 2.0 m

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

Bending moment due to live load

$$M_l = \frac{P}{\pi} \times \frac{1}{1 + (\frac{y}{U})^2}$$

$$P = 112.5 \ KN/m$$

$$y = 0 \ m$$

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

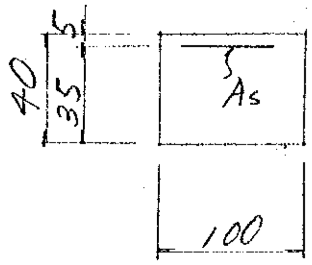
Total

$$M = Md + Mc + Ml$$

$$= 8.14 + 32.34 + 35.81$$

$$= 76.29 \ KNm/m$$

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

$= 9.05\ cm^2$

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

$K = 0.229$ $j = 0.923$

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

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

8. R.C. Voided Slab Bridge (C, F-Ramp BR)

CONTENTS

§§ 1 DESIGN CONDITION

§ I. DESIGN CONDITION

TYPE	2 SPANS CONTINUANCE RC VOIDED SLAB BRIDE
BRIDGE LENGTH	32 050
GIRDER LENGTH	32 000
SPAN	2 × 15 700
WIDTH	9 500
LIVE LOAD	BS I53 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	I.5 D + 2.5 L
	2 (D + L)
HB LOADING	I.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. REIN FORCEMENT

HOT ROLLED YIELD BARS

SPECIFIED CHARACTERISTIC STRENGTH

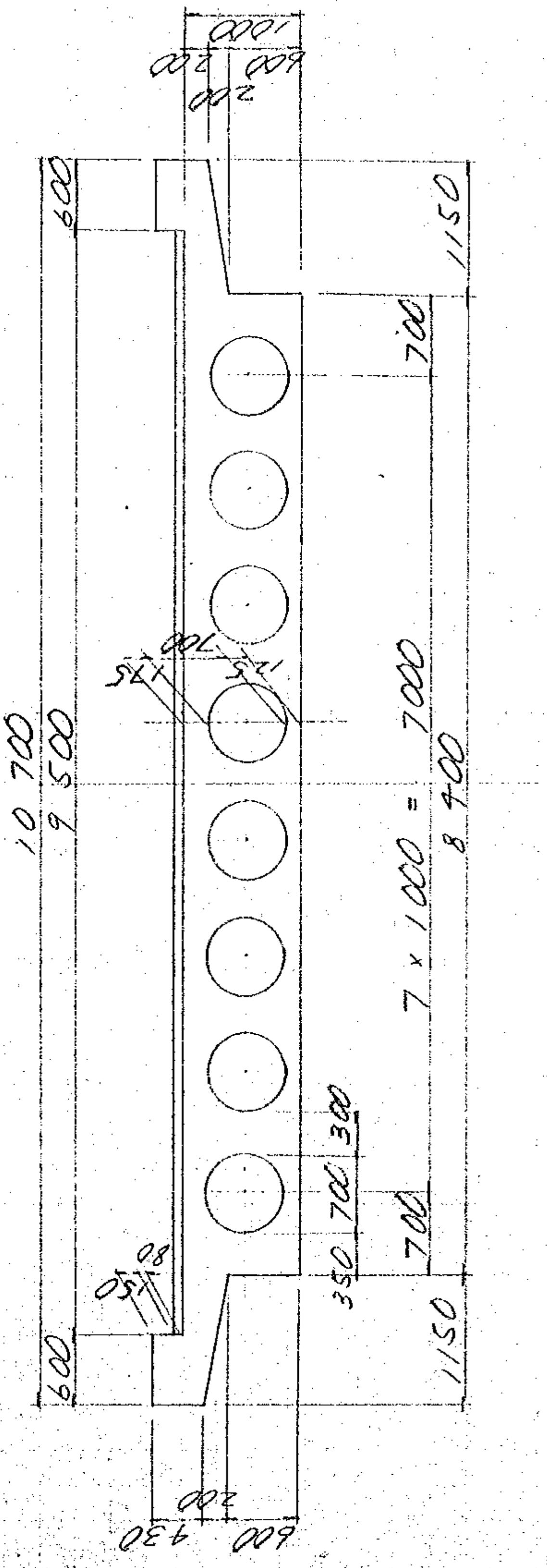
f_{su} = 410 N/m^2 (4180 kg/cm^2)

PERMISSIBLE TENSILE STRESS

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

§§2 DESIGN OF MAIN SRAB

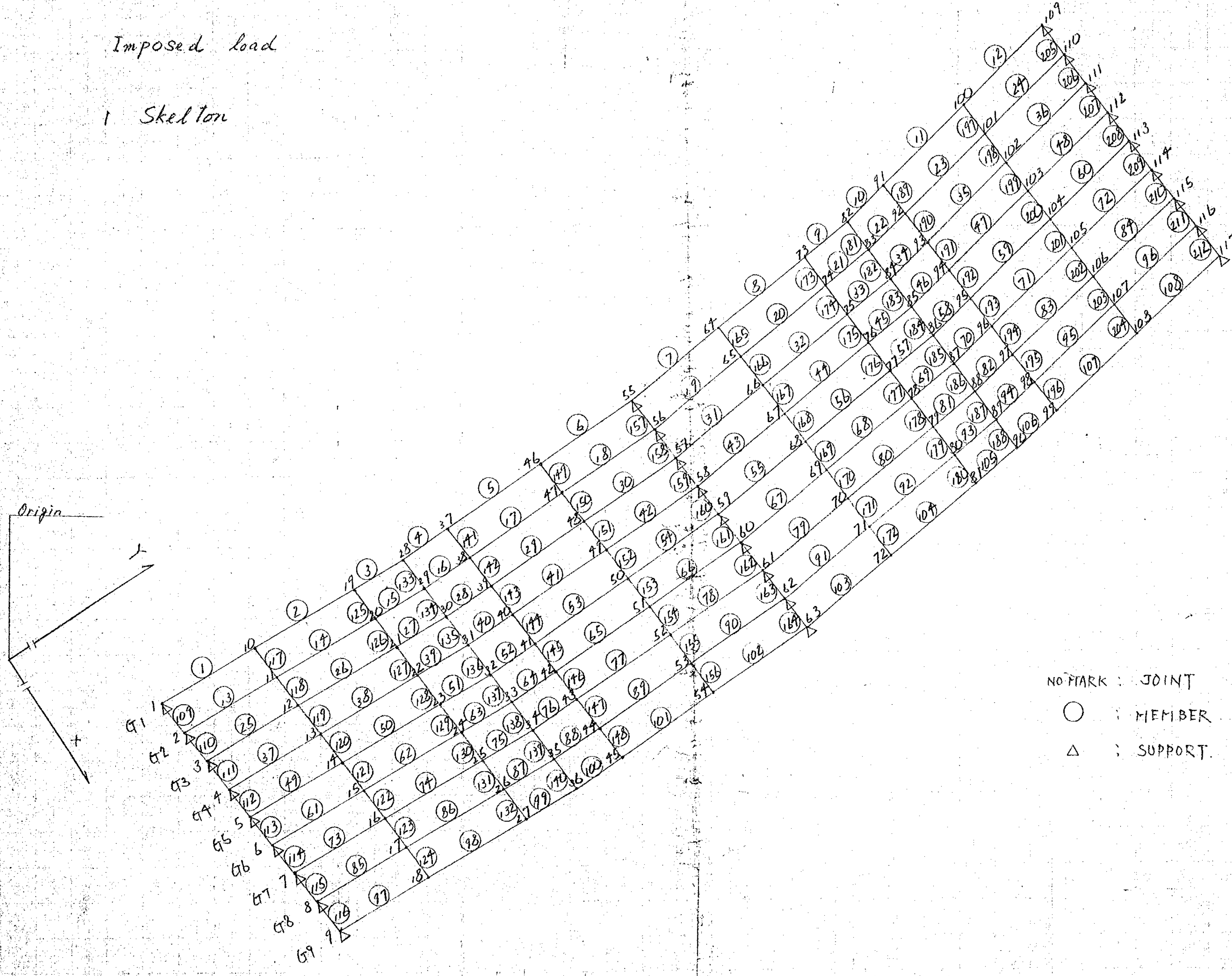
§1 PREPARATION



Typical cross section

Imposed load

1 Skelton



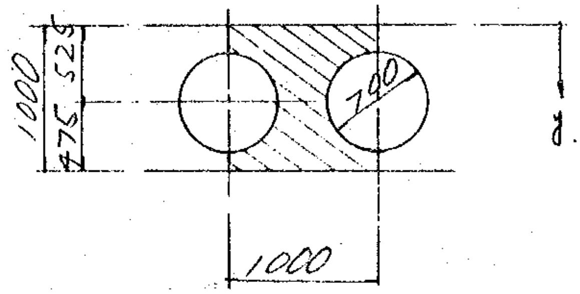
2 Co-ordinate

	X	Y		X	Y
1	482.503	615.362	31	491.141	613.801
2	483.140	616.185	32	491.755	614.595
3	483.761	616.987	33	492.370	615.389
4	484.381	617.789	34	492.985	616.182
5	485.002	618.591	35	493.599	616.976
6	485.623	619.392	36	494.229	617.789
7	486.243	620.194	37	490.605	610.554
8	486.863	620.995	38	491.234	611.366
9	487.499	621.816	39	491.848	612.159
10	485.256	613.847	40	492.462	612.952
11	485.890	614.666	41	493.075	613.745
12	486.508	615.464	42	493.689	614.538
13	487.125	616.262	43	494.303	615.330
14	487.743	617.060	44	494.916	616.123
15	488.361	617.858	45	495.545	616.935
16	488.978	618.656	46	493.195	608.778
17	489.596	619.453	47	493.823	609.590
18	490.228	620.270	48	494.436	610.381
19	487.958	612.244	49	495.048	611.172
20	488.589	613.059	50	495.661	611.964
21	489.204	613.854	51	496.274	612.755
22	489.820	614.649	52	496.886	613.546
23	490.435	615.444	53	497.499	614.338
24	491.051	616.239	54	498.127	615.149
25	491.666	617.034	55	495.726	606.920
26	492.281	617.829	56	496.353	607.730
27	492.912	618.643	57	496.966	608.521
28	489.282	611.399	58	497.578	609.312
29	489.912	612.213	59	498.190	610.102
30	490.526	613.007	60	498.802	610.893

	X	Y		X	Y
61	499.414	611.684	91	502.937	600.863
62	500.026	612.475	92	503.566	601.676
63	500.654	613.285	93	504.181	602.470
64	498.195	604.980	94	504.795	603.264
65	498.822	605.790	95	505.410	604.057
66	499.435	606.581	96	506.024	604.851
67	500.047	607.372	97	506.638	605.645
68	500.659	608.163	98	507.253	606.438
69	501.272	608.954	99	507.882	607.251
70	501.884	609.745	100	505.203	598.687
71	502.496	610.536	101	505.835	599.504
72	503.124	611.347	102	506.452	600.301
73	500.599	602.960	103	507.068	601.097
74	501.227	603.772	104	507.685	601.893
75	501.841	604.564	105	508.301	602.690
76	502.454	605.356	106	508.917	603.486
77	503.067	606.147	107	509.534	604.282
78	503.680	606.939	108	510.165	605.098
79	504.293	607.731	109	507.388	596.429
80	504.906	608.523	110	508.024	597.251
81	505.534	609.335	111	508.644	598.051
82	501.768	601.912	112	509.264	598.852
83	502.397	602.724	113	509.884	599.652
84	503.011	603.517	114	510.503	600.453
85	503.625	604.310	115	511.123	601.252
86	504.239	605.102	116	511.741	602.052
87	504.852	605.895	117	512.376	602.872
88	505.466	606.688			
89	506.080	607.481			
90	506.708	608.293			

3 Flexural rigidity of main girder

Interior girder



$$A = 1.00 \times 1.00 - \tfrac{1}{4}\pi \times 0.70^2$$

$$= 1.0000 - 0.3847 = 0.6153\ m^2$$

$$Ay = 1.000 \times 0.50 - 0.3847 \times 0.525 = 0.2980 m^3$$

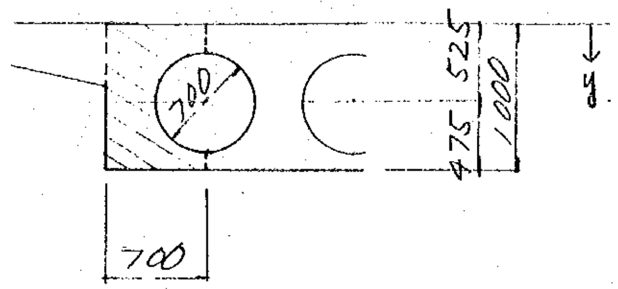
$$Ay^2 = 1.000 \times 0.50^2 - 0.3847 \times 0.525^2 = 0.1440\ m^4$$

$$I_0 = \tfrac{1}{12} \times 1.00 \times 1.00^3 - \tfrac{1}{64}\pi \times 0.70^4 = 0.0715\ m^4$$

$$y = \frac{Ay}{A} = \frac{0.2980}{0.6153} = 0.484\ m$$

$$I = 0.1440 + 0.0715 - 0.6153 \times 0.484^2 = 0.0714 m^4$$

Edge girder



$$A = 0.70 \times 1.00 - \tfrac{1}{4}\pi \times 0.70^2 \times \tfrac{1}{2}$$

$$= 0.7000 - 0.1923 = 0.5077\ m^2$$

$$Ay = 0.7000 \times 0.50 - 0.1923 \times 0.525 = 0.2490\ m^3$$

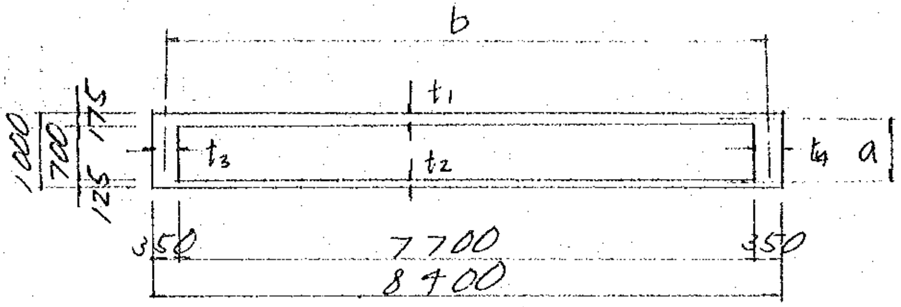
$$Ay^2 = 0.7000 \times 0.50^2 - 0.1923 \times 0.525^2 = 0.1220\ m^4$$

$$I_0 = \tfrac{1}{12} \times 0.70 \times 1.00^3 - \tfrac{1}{64}\pi \times 0.70^4 \times \tfrac{1}{2} = 0.0524\ m^4$$

$$y = \frac{Ay}{A} = \frac{0.2490}{0.5077} = 0.490^m$$

$$I = 0.1220 + 0.0524 - 0.5077 \times 0.490^2 = 0.0525\ m^4$$

Torsional rigidity of main girder



$a = 0.850\ m \qquad b = 8.050\ m$

$t_1 = 0.175\ m \qquad t_2 = 0.125\ m \qquad t_3 = t_4 = 0.350\ m$

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

$$= 0.329 \times 8.050 \times 0.175^3 + 0.330 \times 8.050 \times 0.125^3$$

$$+ 2 \times 0.247 \times 0.850 \times 0.350^3$$

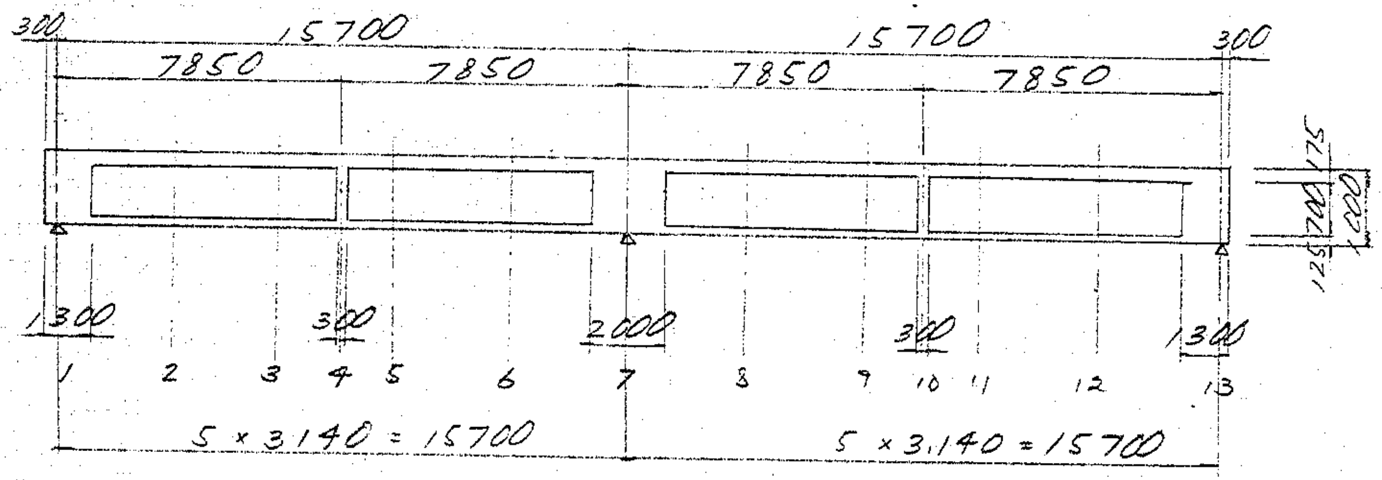
$$+ \frac{4 \times 0.850^2 \times 8.050^2}{\frac{8.050}{0.175} + \frac{8.050}{0.125} + 2 \times \frac{0.850}{0.350}}$$

$$= 0.0142 + 0.0052 + 0.0180 + 1.6249$$

$$= 1.6623\ m^4$$

$$J = \frac{1.6623}{9} = 0.1847\ m^4$$

Flexural rigidity of cross beam



List of flexural & torsional rigidity

Point	I (m^4)	J (m^4)
1	0.1385	0.3974
2	0.1677	0.6673
3	0.1255	0.5004
4	0.0935	0.3336
5	0.1255	0.5004
6	0.1677	0.6673
7	0.2299	0.6673
8	0.1677	0.6673
9	0.1255	0.5004
10	0.0935	0.3336
11	0.1255	0.5004
12	0.1677	0.6673
13	0.1385	0.3974

Cross beam - 1.

	A	y	Ay	Ay^2	I_o
1.870 × 0.175	0.327	0.088	0.0288	0.0025	0.0008
1.300 × 0.700	0.910	0.525	0.4778	0.2508	0.0372
1.870 × 0.125	0.234	0.938	0.2195	0.2059	0.0003
	1.471		0.7261	0.4592	0.0383

$y = 0.494$ m

$I = 0.4592 + 0.0383 - 1.471 \times 0.494^2 = 0.1385\ m^4$

Cross beam - 2.6

	A	y	Ay	Ay^2	I_o
3.140 × 0.175	0.550	0.088	0.0484	0.0043	0.0014
3.140 × 0.125	0.393	0.938	0.3686	0.3457	0.0005
	0.943		0.4170	0.3500	0.0019

$y = 0.442$ m

$I = 0.3500 + 0.0019 - 0.943 \times 0.442^2 = 0.1677\ m^4$

Cross beam - 3.5

	A	y	Ay	Ay^2	I_o
2.355 × 0.175	0.412	0.088	0.0363	0.0032	0.0011
2.355 × 0.125	0.294	0.938	0.2758	0.2587	0.0004
	0.706		0.3121	0.2619	0.0015

$y = 0.442$ m

$I = 0.2619 + 0.0015 - 0.706 \times 0.442^2 = 0.1255\ m^4$

Cross beam - 4

	A	y	Ay	Ay^2	I_0
1.570 × 0.175	0.275	0.088	0.0242	0.0021	0.0007
0.300 × 0.700	0.210	0.525	0.1103	0.0579	0.0086
1.570 × 0.125	0.196	0.938	0.1838	0.1724	0.0003
	0.681		0.3183	0.2324	0.0096

$y = 0.467$ m

$I = 0.2324 + 0.0096 - 0.681 \times 0.467^2 = 0.0935$ m^4

Cross beam - 7

	A	y	Ay	Ay^2	I_0
3.190 × 0.175	0.558	0.088	0.0491	0.0043	0.0014
2.000 × 0.700	1.400	0.525	0.7350	0.3859	0.0572
3.190 × 0.125	0.399	0.938	0.3743	0.3511	0.0005
	2.357		1.1584	0.7413	0.0591

$y = 0.492$ m

$I = 0.7413 + 0.0591 - 2.357 \times 0.492^2 = 0.2299$ m^4

Cross beam -

	A	y	Ay	Ay^2	I_0

$y =$ m

$I = \quad + \quad - \quad \times \quad ^2 = \quad$ m^4

Torsional rigiding of cross beam

$a = 0.850\,m \qquad b = 14.850\,m$

$t_1 = 0.175\,m \qquad t_2 = 0.125\,m \qquad t_3 = 1.300\,m \qquad t_4 = 1.000\,m$

$$J = 0.331 \times 14.850 \times 0.175^3 + 0.332 \times 14.850 \times 0.125^3$$
$$+ 0.198 \times 1.300 \times 0.850^3 + 0.163 \times 1.000 \times 0.850^3$$
$$+ \frac{4 \times 0.850^2 \times 14.850^2}{\frac{14.850}{0.175} + \frac{14.850}{0.125} + \frac{0.850}{1.300} + \frac{0.850}{1.000}}$$
$$= 0.0263 + 0.0096 + 0.1581 + 0.1001 + 3.1064$$
$$= 3.4005\ m^4$$

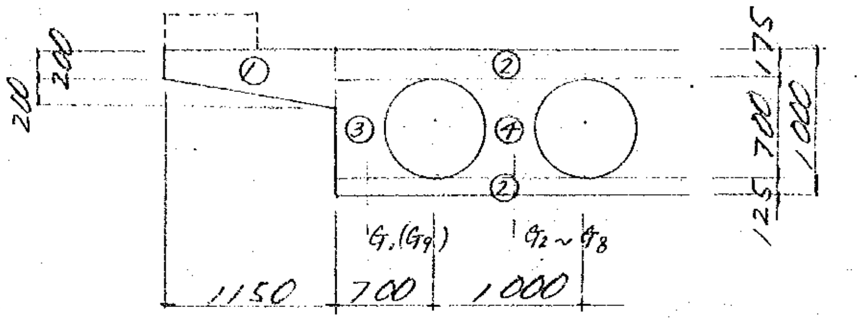
$$J = 3.4005 \times 1/16.00 = 0.2125\ m^4/m$$

Cross beam – 1	$J = 0.2125 \times 1.870$	$= 0.3974\ m^4$
〃 – 2, 6	$J =$ 〃 $\times 3.140$	$= 0.6673$ 〃
〃 – 3, 5	$J =$ 〃 $\times 2.355$	$= 0.5004$ 〃
〃 – 4	$J =$ 〃 $\times 1.570$	$= 0.3336$ 〃
〃 – 7	$J =$ 〃 $\times 3.140$	$= 0.6673$ 〃

LOADING.

1. Dead load

1) Slab



① $Wd_1 = \frac{1}{2} \times (0.20 + 0.40) \times 23.6 = 7.080 \ KN/m^2$

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

③ $Wd_3 = (0.70 \times 0.70 - \frac{1}{4} \times 0.70^2 \times \pi \times \frac{1}{2}) \times 23.6 = 7.025 \ KN/m$

④ $Wd_4 = (0.70 \times 1.00 - \frac{1}{4} \times 0.70^2 \times \pi) \times 23.6 = 7.442 \ KN/m$

2) Cross beam

G_1, G_9

$A = 1/4 \times 0.70^2 \times \pi \times 1/2 \doteq 0.192\ m^2$

Edge support

$Wd_5 = 0.192 \times 1.00 \times 23.6 = 4.531\ KN$

Center support

$Wd_5 = 0.192 \times 2.00 \times 23.6 = 9.062\ KN$

Center beam

$Wd_5 = 0.192 \times 0.30 \times 23.6 = 1.359\ KN$

$G_2 \sim G_8$

$A = 1/4 \times 0.70^2 \times \pi = 0.385\ m^2$

Edge support

$Wd_5 = 0.385 \times 1.00 \times 23.6 = 9.086\ KN$

Center support

$Wd_5 = 0.385 \times 2.00 \times 23.6 = 18.172\ KN$

Center beam

$Wd_5 = 0.385 \times 0.30 \times 23.6 = 2.726\ KN$

3) Kerb

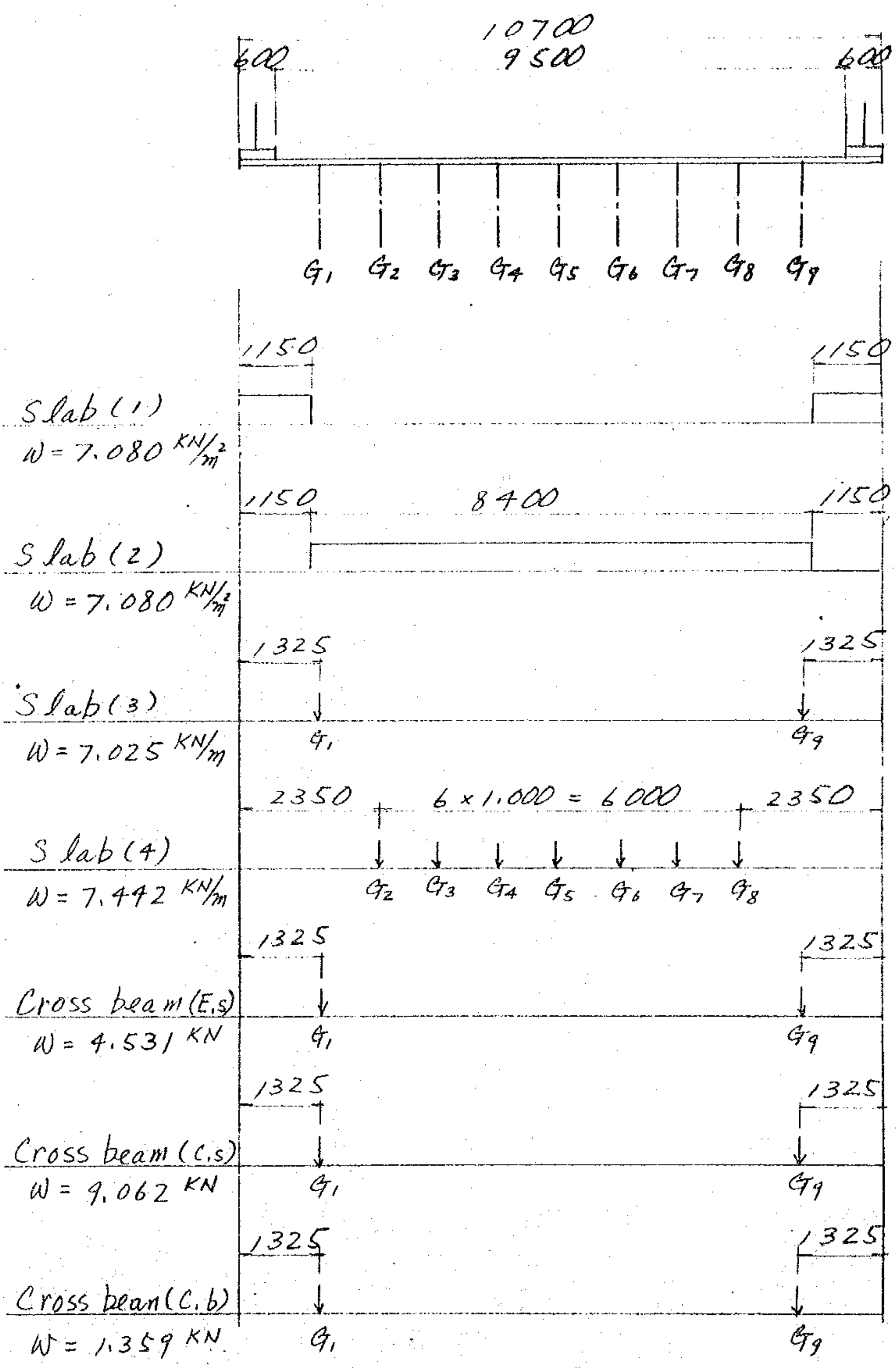
$W_{d6} = 0.60 \times 0.23 \times 23.6 = 3.257\ KN/m$

4) Wearing surface

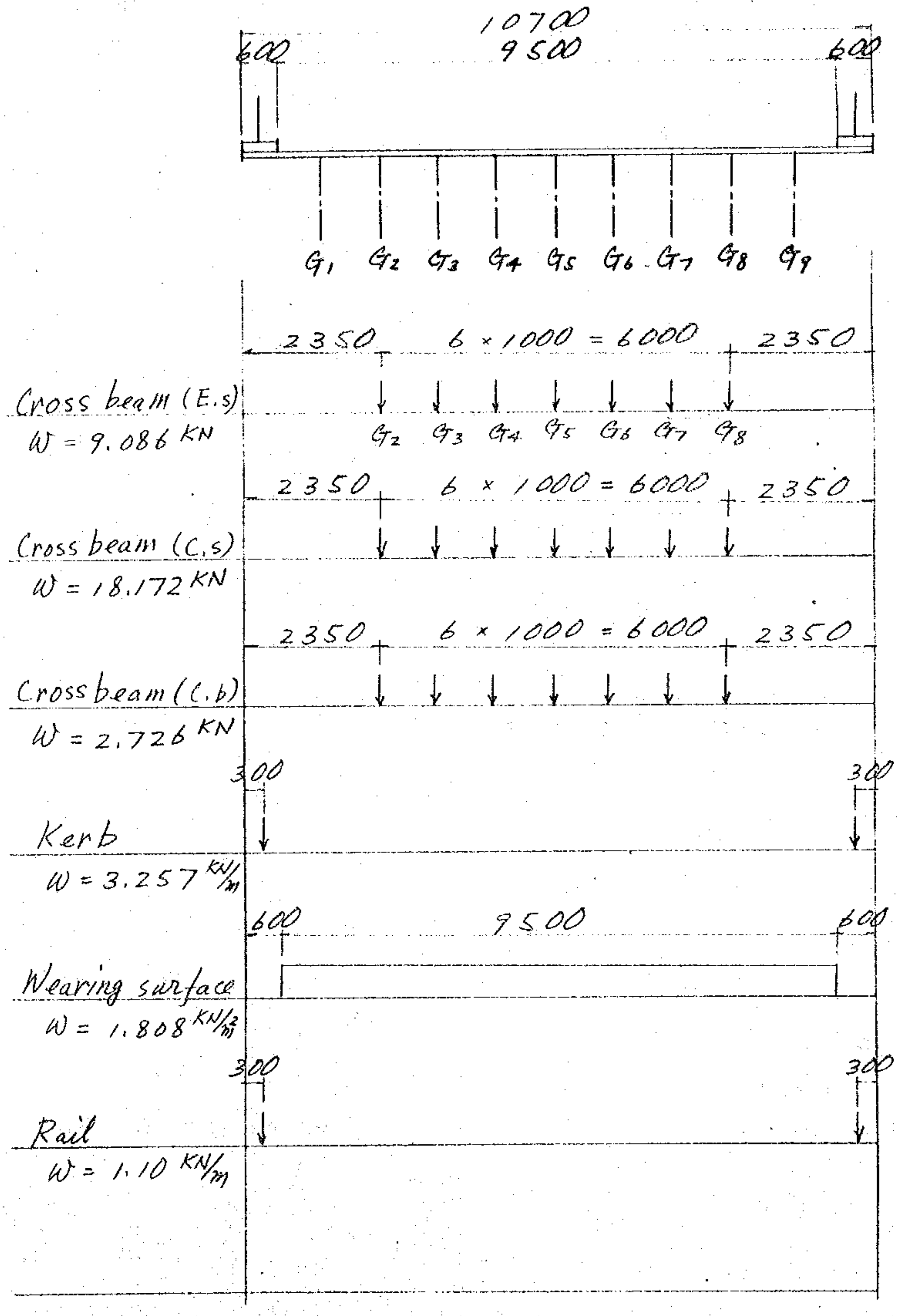
$W_{d7} = 1.808\ KN/m^2$

5) Rail

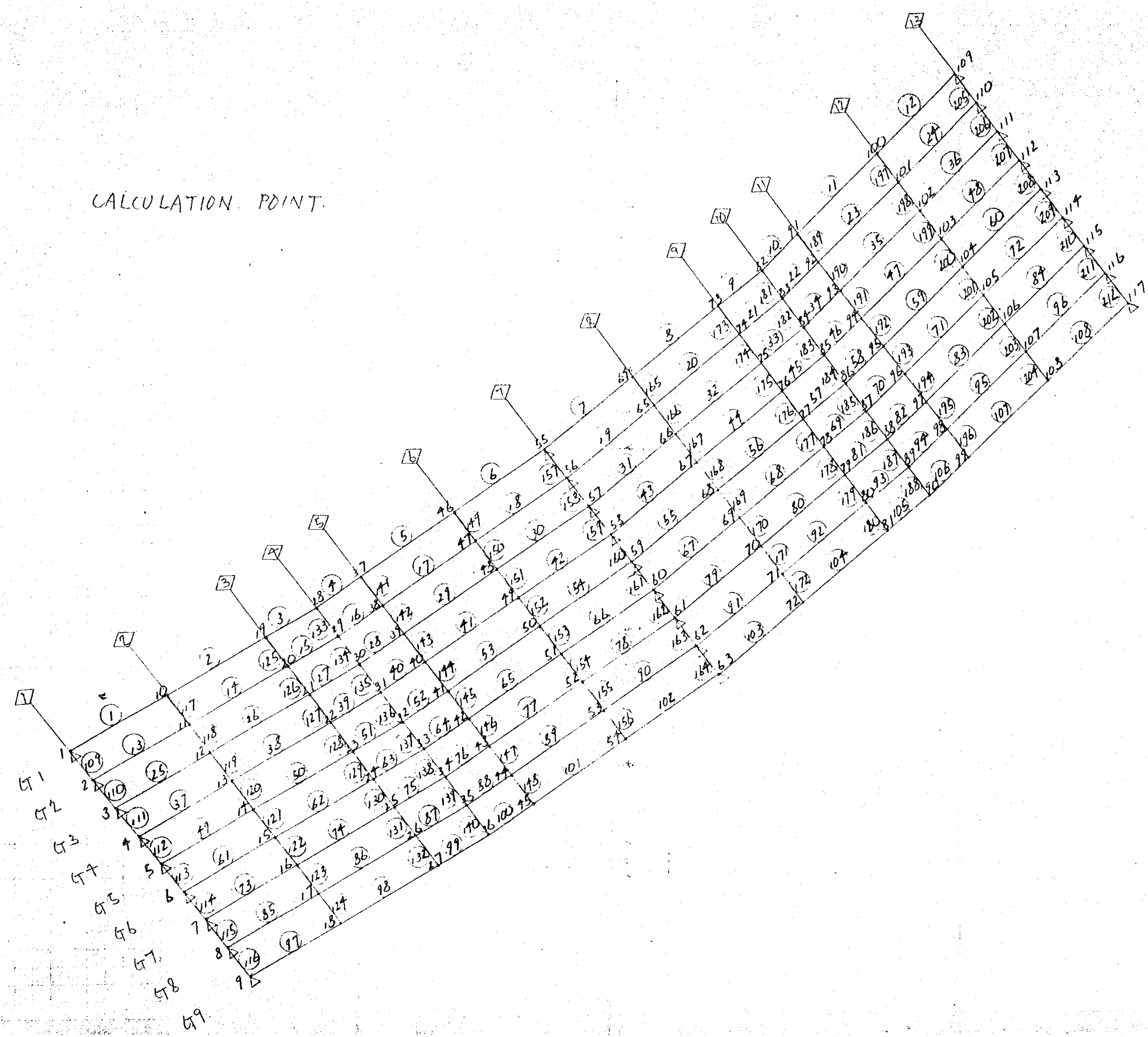
$W_{d8} = 1.10\ KN/m$



10700
9500
600
600
G1 G2 G3 G4 G5 G6 G7 G8 G9
1150
1150
Slab (1)
W = 7.080 KN/m2
1150
8400
1150
Slab (2)
W = 7.080 KN/m2
1325
1325
Slab (3)
W = 7.025 KN/m
G1
G9
2350
6 × 1.000 = 6000
2350
Slab (4)
W = 7.442 KN/m
G2 G3 G4 G5 G6 G7 G8
1325
1325
Cross beam (E.s)
W = 4.531 KN
G1
G9
1325
1325
Cross beam (C.s)
W = 9.062 KN
G1
G9
1325
1325
Cross bean (C.b)
W = 1.359 KN
G1
G9

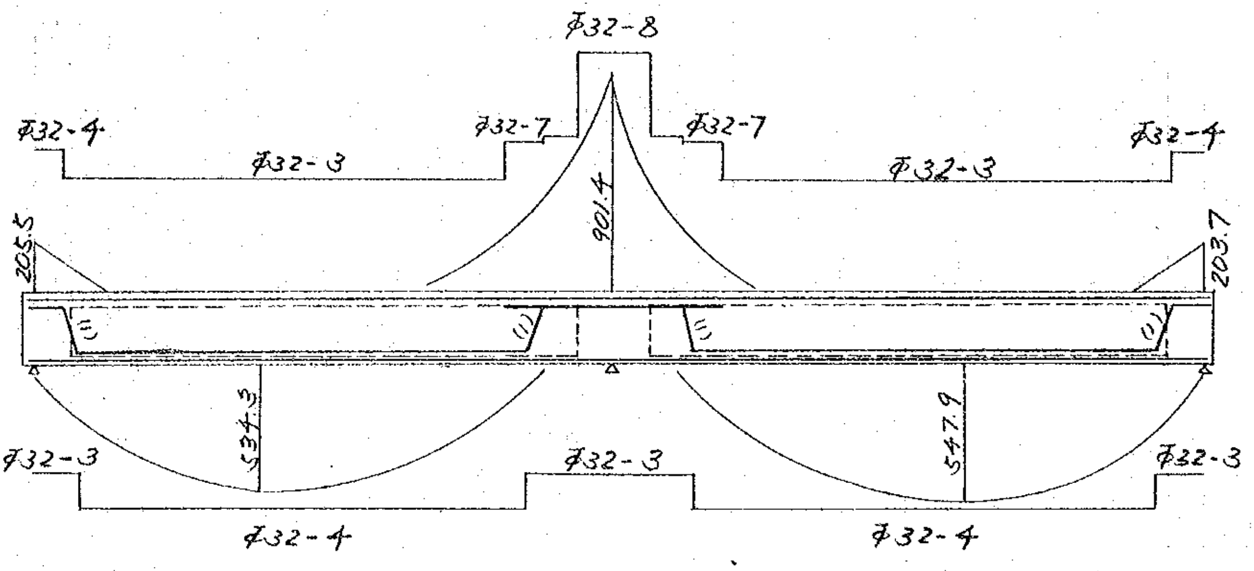

10700
9500
600
600
G1 G2 G3 G4 G5 G6 G7 G8 G9
2350 6 × 1000 = 6000 2350
Cross beam (E.s)
W = 9.086 KN
G2 G3 G4 G5 G6 G7 G8
2350 6 × 1000 = 6000 2350
Cross beam (C.s)
W = 18.172 KN
2350 6 × 1000 = 6000 2350
Cross beam (C.b)
W = 2.726 KN
300
300
Kerb
W = 3.257 KN/m
600 9500 600
Wearing surface
W = 1.808 KN/m2
300
300
Rail
W = 1.10 KN/m

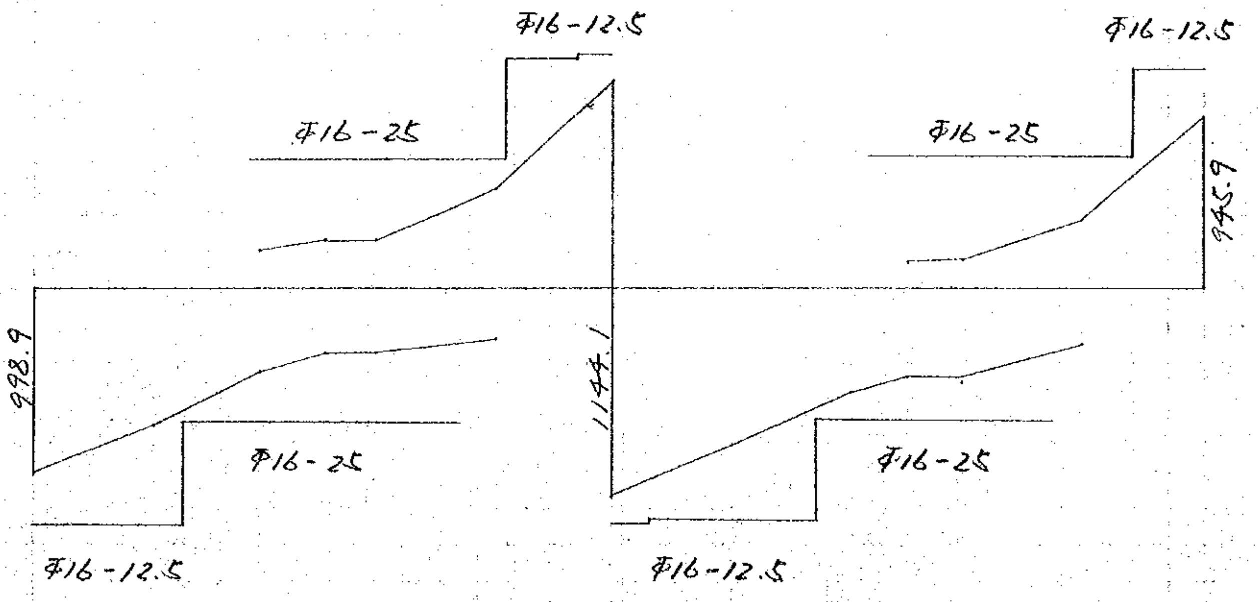
CALCULATION POINT



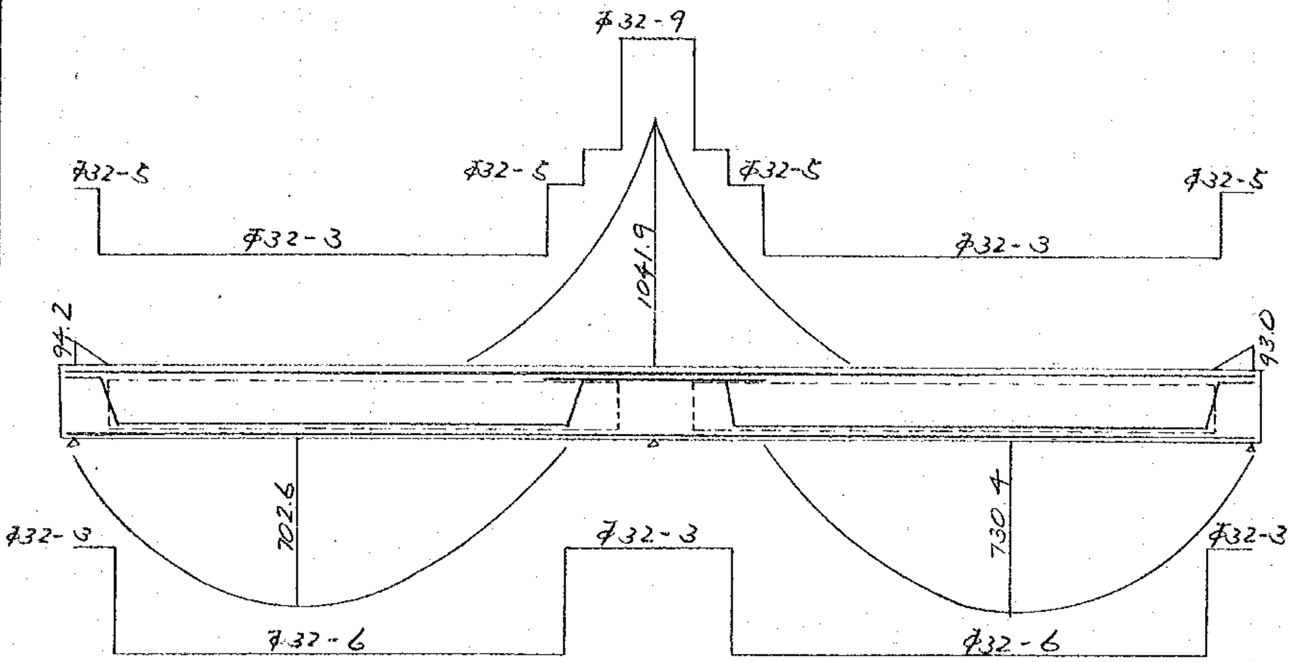
§2 DRAWING OF SECTIONAL FORCE DIAGRAM

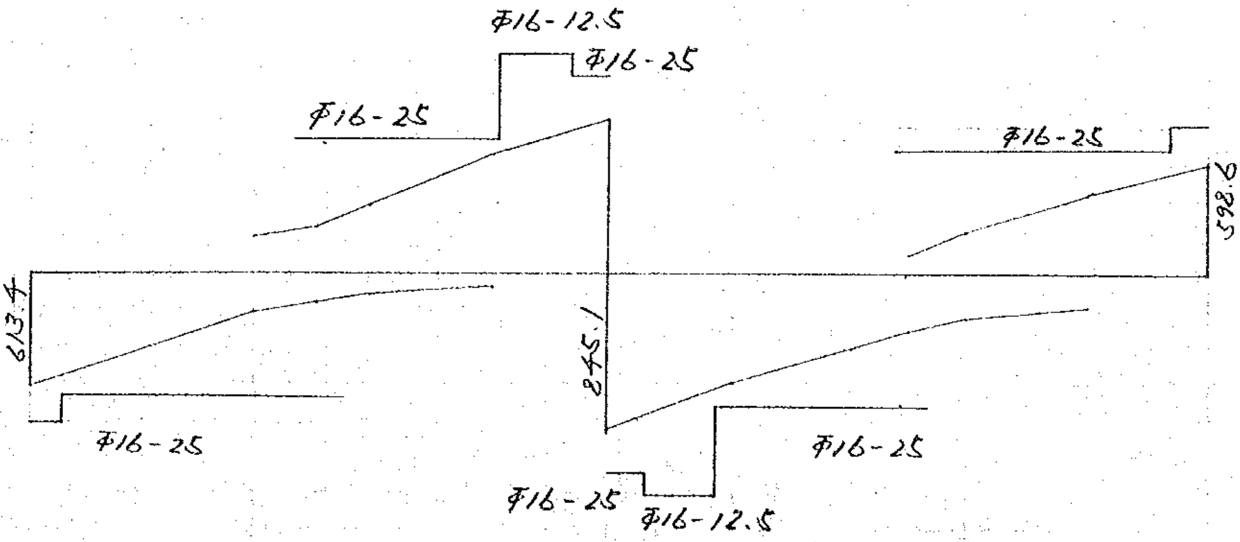
G1, G9





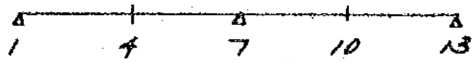
G2 ~ G8


Φ32-9
Φ32-5
Φ32-5
Φ32-5
Φ32-5
Φ32-3
Φ32-3
1041.9
94.2
93.0
702.6
730.4
Φ32-3
Φ32-3
Φ32-3
Φ32-6
Φ32-6


Φ16-12.5
Φ16-25
Φ16-25
Φ16-25
598.6
613.4
845.1
Φ16-25
Φ16-25
Φ16-25
Φ16-12.5

Moment list

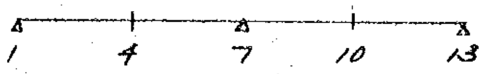
Mmax	
Mmin	



HA-LOADING or 1/1.25 HB-LOADING

	G1	G2	G3	G4	G5	G6	G7	G8	G9
1	41.4	45.4	39.4	45.0	46.1	49.7	51.8	60.6	46.5
	-158.4	-53.6	-35.8	-30.5	-31.3	-39.5	-46.6	-94.2	-205.5
2	347.7	506.3	509.7	508.9	503.4	513.5	521.3	545.5	405.2
	95.8	176.9	178.7	181.6	182.6	183.6	185.2	194.0	121.7
3	505.7	695.7	688.7	675.9	661.8	672.6	685.7	702.6	534.3
4	468.6	663.3	652.9	637.6	623.1	633.1	645.3	656.6	509.7
5	427.3	571.0	536.3	515.9	501.6	511.7	528.6	563.2	418.1
	60.5	90.7	78.4	74.2	72.1	71.4	71.8	80.6	46.6
6	186.9	149.0	68.4	50.7	48.4	46.5	63.0	131.7	156.1
	-164.3	-220.3	-246.7	-258.2	-262.5	-262.9	-256.7	-240.4	-194.3
7	-402.2	-497.0	-481.9	-469.7	-465.2	-465.9	-473.0	-481.3	-382.6
	-901.4	-1041.9	-979.7	-952.4	-929.0	-947.1	-963.1	-1014.3	-870.2
8	55.9	74.1	52.6	51.7	43.0	50.2	48.0	66.9	45.0
	-239.0	-243.9	-240.4	-241.0	-242.2	-243.4	-244.1	-247.1	-243.4
9	416.8	548.4	531.1	516.2	504.6	514.5	525.6	531.4	386.5
	56.7	85.0	80.6	78.4	76.5	74.7	73.3	73.0	42.9
10	516.5	666.2	651.6	637.1	625.4	635.1	647.1	654.2	489.1
11	547.9	730.4	691.3	672.1	661.8	670.5	686.0	713.3	521.7
12	450.9	574.0	525.2	507.2	496.6	503.8	522.0	580.9	474.6
	132.6	189.8	175.8	171.6	170.2	172.1	176.8	193.5	137.8
13	43.2	47.5	41.1	34.2	46.5	49.4	51.8	58.7	45.2
	-158.2	-53.3	-34.3	-30.0	-29.8	-38.2	-44.8	-93.0	-203.7

Ha - loading



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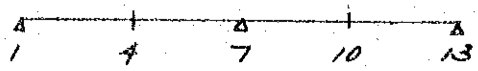
DEAD LOAD + HA LIVE LOAD

	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9
1	29.3	40.1	39.4	45.0	45.8	48.4	45.6	51.0	29.3
	-140.1	-46.4	-35.8	-30.5	-31.3	-39.5	-46.6	-71.3	-177.7
2	347.7	506.3	509.7	508.9	503.4	513.5	521.3	545.5	405.2
	115.6	228.9	230.3	233.7	235.2	236.8	239.3	251.1	155.3
3	505.7	695.7	688.7	675.9	661.8	672.6	685.7	702.6	534.3
	191.0	278.1	276.0	274.6	273.0	272.6	273.0	277.6	199.4
4	468.6	663.3	652.9	637.6	623.1	633.1	645.3	656.6	509.7
	162.8	228.7	225.2	222.3	219.8	218.4	218.1	220.1	159.2
5	427.3	571.0	536.3	515.9	501.6	511.7	528.6	563.2	418.1
	90.5	134.5	119.5	114.3	111.2	110.1	111.2	121.9	74.1
6	128.5	116.5	57.2	37.7	22.1	34.5	48.2	97.1	96.2
	-164.3	-220.3	-246.7	-258.2	-262.5	-262.9	-256.7	-240.4	-194.3
7	-494.0	-618.0	-600.5	-586.0	-581.5	-581.5	-589.6	-598.5	-474.1
	-901.4	-1041.9	-979.7	-952.4	-929.0	-947.1	-963.1	-1014.3	-870.2
8	55.9	68.1	52.6	50.2	43.0	48.8	48.0	58.9	45.0
	-239.0	-243.9	-240.4	-241.0	-242.2	-243.4	-244.1	-247.1	-243.4
9	416.8	548.4	531.1	516.2	504.6	514.5	525.6	531.4	386.5
	88.0	127.4	121.3	118.3	116.2	114.4	113.1	113.4	71.1
10	516.5	666.2	651.6	637.1	625.4	635.1	647.1	654.2	489.1
	168.5	230.2	225.3	222.4	220.8	219.5	218.9	219.0	152.3
11	547.9	730.4	691.3	672.1	661.8	670.5	686.0	713.3	521.7
	203.3	289.1	274.9	270.8	269.7	269.5	270.2	278.4	184.7
12	440.6	574.0	525.2	507.2	496.6	503.8	522.0	580.9	467.2
	172.6	245.0	227.0	221.6	219.8	222.1	228.1	250.4	180.9
13	31.3	42.2	41.1	45.7	46.8	48.3	46.0	49.0	27.8
	-139.3	-45.3	-34.3	-30.0	-29.8	-38.2	-44.8	-71.0	-176.3

HB - loading



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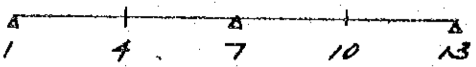
DEAD LOAD + HB LIVE LOAD

	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9
1	51.7	56.8	43.3	41.1	57.6	62.1	64.7	75.7	58.1
	-198.0	-67.0	-22.0	-34.9	-36.9	-37.0	-54.7	-117.8	-256.9
2	357.5	571.2	547.8	556.4	543.8	551.9	557.0	609.9	410.6
	119.7	221.1	223.4	227.0	228.2	229.5	231.5	242.5	152.1
3	565.7	762.3	726.3	707.7	705.2	702.3	727.3	769.3	594.7
	179.9	264.4	262.3	260.9	259.4	258.7	258.9	263.2	187.6
4	548.8	701.6	671.4	646.5	643.0	639.4	664.5	698.2	560.2
	149.9	211.5	207.9	204.9	202.6	201.1	200.6	202.5	145.6
5	427.8	646.8	567.5	545.5	531.6	544.2	562.7	640.9	489.1
	75.6	113.4	98.0	92.7	90.1	89.2	89.8	100.8	58.2
6	233.6	186.2	85.5	63.4	60.5	58.1	78.7	164.6	195.1
	-185.3	-251.4	-277.4	-285.3	-287.4	-291.2	-289.0	-273.8	-218.9
7	-502.8	-621.3	-602.4	-587.1	-581.5	-582.4	-591.3	-601.6	-478.3
	-920.2	-1061.4	-957.5	-899.0	-894.8	-893.6	-947.4	-1041.4	-892.8
8	42.5	92.6	59.4	64.6	52.5	62.8	56.5	83.6	32.6
	-230.3	-268.6	-270.3	-265.8	-263.4	-269.5	-275.0	-272.8	-230.8
9	472.6	614.2	572.9	545.3	547.2	546.2	561.2	595.2	441.7
	70.9	106.3	100.7	98.0	95.6	93.4	91.6	91.2	53.6
10	366.5	709.5	672.4	645.4	647.2	646.5	663.0	694.5	539.9
	154.4	213.1	208.5	205.5	203.7	202.1	201.3	200.9	137.6
11	611.7	808.7	727.5	707.5	690.7	686.2	712.8	784.5	582.6
	191.0	274.4	261.0	257.2	256.1	255.7	255.8	263.0	171.6
12	563.6	675.6	595.7	548.1	554.1	557.5	565.2	671.0	593.2
	165.7	237.2	219.7	214.5	212.7	215.1	221.0	241.9	172.2
13	54.0	59.9	45.9	42.7	58.1	61.8	64.8	73.4	56.5
	-197.7	-66.6	-21.0	-34.0	-35.1	-35.8	-51.6	-116.3	-254.6

Shear list

Smax
Smin



1.5(DEAD)+2.5(HA.LIVE) or 2.0(DEAD+HA LIVE) or {1.5(DEAD)+2.0(HB.LIVE)}/1.15

	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9
1	952.2	588.0	613.4	597.2	598.5	603.9	612.1	534.4	998.9
	164.5	131.2	146.4	141.4	140.0	141.2	145.6	127.1	179.6
2	746.4	387.5	401.6	401.5	390.6	397.3	388.0	242.6	688.6
	50.5	-27.7	-12.6	-10.9	8.1	1.9	-5.5	-49.3	23.1
3	460.7	204.8	211.4	196.5	190.6	195.2	186.3	97.9	374.2
	-133.9	-181.9	-153.9	-149.1	-146.8	-134.9	-129.8	-205.4	-203.5
4	352.1	130.6	136.8	148.9	112.6	118.1	109.0	32.7	281.5
	-225.2	-248.3	-231.4	-226.0	-216.5	-205.2	-202.5	-268.5	-281.7
5	355.6	63.8	82.3	110.5	70.3	77.4	53.4	-96.8	341.9
	-268.0	-372.4	-316.8	-302.8	-279.7	-281.8	-294.1	-377.8	-268.7
6	273.1	-18.7	20.4	71.9	-66.0	-54.8	-104.8	-218.4	165.2
	-545.9	-650.3	-520.1	-480.9	-452.4	-450.0	-488.3	-622.4	-496.7
7	1144.1	845.1	816.4	806.2	772.0	776.7	796.9	727.3	1123.3
	298.5	291.0	297.7	289.3	287.0	286.3	288.3	271.2	287.7
8	856.2	572.9	579.3	587.7	562.3	569.4	573.5	442.7	860.5
	150.4	119.7	143.8	144.8	163.1	160.2	158.0	128.0	173.0
9	520.6	374.1	391.7	400.2	351.1	355.1	353.4	280.4	573.1
	-56.3	-30.4	12.5	16.7	14.5	25.1	40.4	-20.3	-12.9
10	408.6	290.6	309.5	319.8	269.4	274.8	272.4	217.1	479.6
	-153.3	-103.1	-56.3	-50.9	-58.4	-48.0	-34.2	-86.2	-99.0
11	457.2	218.0	244.2	---	230.1	238.3	228.1	84.2	509.1
	-157.6	-215.2	-132.4		-118.0	-114.5	-119.7	-193.1	-120.9
12	429.3	154.7	175.3	---	90.9	94.5	74.8	-68.4	305.4
	-330.8	-411.1	-305.0		-283.5	-285.3	-300.1	-436.7	-381.8
13	-156.3	-116.7	-132.2	---	-126.3	-127.7	-132.2	-114.9	-174.9
	-945.9	-574.7	-598.6		-584.2	-590.0	-597.5	-521.8	-991.0