§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	441
3	〃	〃	〃	〃	12.5	3	24.10	456
4	〃	〃	〃	〃	12.5	7	56.30	621
5	〃	〃	〃	〃	12.5	8	64.30	627
6	〃	〃	〃	〃	—	8	64.30	988
7	〃	〃	〃	〃	12.5	8	—	627
8	〃	〃	〃	〃	12.5	7	—	621
9	〃	〃	〃	〃	12.5	3	—	456
10	〃	〃	〃	〃	—	3	—	441
11	〃	〃	〃	〃	—	4	—	581
12	〃	〃	〃	〃	—	3	—	441
13	〃	〃	〃	〃	17.5	3	—	447
14	〃	〃	〃	〃	17.5	4	24.10	595
15	〃	〃	〃	〃	17.5	3	32.20	447
16	〃	〃	〃	〃	—	3	—	441
17	〃	〃	〃	〃	17.5	3	—	447
18	〃	〃	〃	〃	17.5	4	—	594
19	〃	〃	〃	〃	17.5	3	—	447
20	〃	〃	〃	〃	—	3	—	441

$G_2 \sim G_8$

	b (cm)	h (cm)	d' (cm)	d (cm)	t (cm)	Φ 32	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	5	40.20	760
5	〃	〃	〃	〃	12.5	9	80.40	888
6	〃	〃	〃	〃	—	9	80.40	1354
7	〃	〃	〃	〃	12.5	9	—	888
8	〃	〃	〃	〃	12.5	5	—	760
9	〃	〃	〃	〃	12.5	3	—	457
10	〃	〃	〃	〃	—	3	—	447
11	〃	〃	〃	〃	—	5	—	730
12	〃	〃	〃	〃	—	3	—	447
13	〃	〃	〃	〃	17.5	3	24.10	450
14	〃	〃	〃	〃	17.5	6	48.30	893
15	〃	〃	〃	〃	17.5	3	—	450
16	〃	〃	〃	〃	—	3	—	447
17	〃	〃	〃	〃	17.5	3	—	450
18	〃	〃	〃	〃	17.5	6	—	893
19	〃	〃	〃	〃	17.5	3	—	450
20	〃	〃	〃	〃	—	3	—	447

Resisting shear.

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

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

	V_c ($\times 10^3$N)		As(cm²)	Su (cm)	V_R ($\times 10^3$N)
1	338	Φ16 - 2	4.02	12.5	1347
2	283	〃	〃	〃	1292
3	194	〃	〃	〃	1203
4	219	〃	〃	25	723
5	265	〃	〃	12.5	1274
6	277	〃	〃	〃	1286
7	431	〃	〃	〃	1440
8	277	〃	〃	〃	1286
9	265	〃	〃	〃	1274
10	219	〃	〃	25	723
11	194	〃	〃	12.5	1203
12	283	〃	〃	〃	1292
13	338	〃	〃	〃	1347

$G_2 \sim G_8$

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

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

	V_c ($\times 10^3$N)		As (cm²)	Su (cm)	V_R ($\times 10^3$N)
1	448	Φ16 - 2	4.02	25	952
2	316	〃	〃	〃	820
3	176	〃	〃	〃	680
4	227	〃	〃	〃	731
5	211	〃	〃	12.5	1220
6	250	〃	〃	25	754
7	590	〃	〃	〃	1094
8	590	〃	〃	〃	1094
9	211	〃	〃	12.5	1220
10	227	〃	〃	25	731
11	176	〃	〃	〃	680
12	316	〃	〃	〃	820
13	448	〃	〃	〃	952

G, . 9.9

	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	219
5	〃	〃	56.30	1.83	86	265
6	〃	〃	64.30	2.09	90	277
7	70	〃	64.30	1.04	70	431
8	35	〃	64.30	—	—	277
9	〃	〃	56.30	—	—	265
10	〃	〃	32.20	—	—	219
11	〃	〃	24.10	—	—	194
12	70	〃	24.10	—	—	283
13	〃	〃	32.20	—	—	338

$G_2 \sim G_8$

$V_c = v\,bd$

	b (cm)	d (cm)	As (cm^2)	P (%)	v (N/cm^2)	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	〃	〃	48.30	1.83	86	227
5	〃	〃	40.20	1.52	80	211
6	〃	〃	80.40	3.05	95	250
7	100	〃	80.40	0.91	67	590
8	〃	〃	80.40	—	—	590
9	30	〃	40.20	—	—	211
10	〃	〃	48.30	—	—	227
11	〃	〃	24.10	—	—	176
12	100	〃	24.10	—	—	316
13	〃	〃	40.20	—	—	448

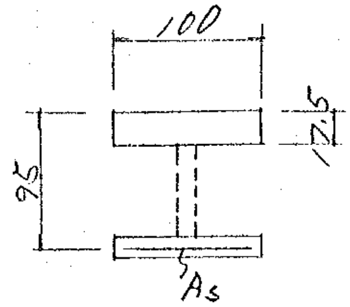
§§3 DESIGN OF CROSS BEAM

Moment list

HA × 1/b

HB × 1/b × 1/1.25

	HA (KN·m)	HB (KN·m)	b (m)	HA (KN m/m)	HB (KN m/m)
1	108.3 -175.2	152.1 -243.2	1.870	57.9 -93.7	65.1 -104.0
2	110.9 -181.5	147.8 -187.1	3.140	35.3 -57.8	37.7 -47.7
3	69.2 -185.1	91.0 -195.8	2.355	29.4 -78.6	30.9 -66.5
4	46.0 -142.3	58.6 -142.1	1.570	29.3 -90.6	29.9 -72.4
5	79.3 -192.5	101.3 -199.8	2.355	33.7 -81.7	34.4 -67.9
6	88.4 -179.0	104.8 -186.8	3.140	28.2 -57.0	26.7 -47.6
7	81.9 -172.4	102.3 -204.5	3.190	25.7 -54.0	25.7 -52.3
8	82.4 -173.0	95.2 -184.3	3.140	26.2 -55.1	24.3 -47.0
9	75.9 -191.1	97.8 -199.2	2.355	32.2 -81.1	33.2 -67.7
10	44.2 -142.3	56.0 -142.3	1.570	28.2 -90.6	28.5 -72.5
11	66.6 -186.0	88.9 -196.9	2.355	28.3 -79.0	30.2 -66.9
12	105.8 -181.6	140.8 -189.5	3.140	33.7 -57.8	35.9 -48.3
13	92.6 -169.3	128.2 -235.4	1.870	49.5 -90.5	54.8 -100.7



$M = 65.1$ KNm.

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

$A_s = \Phi 12$ ctc 12.5 cm

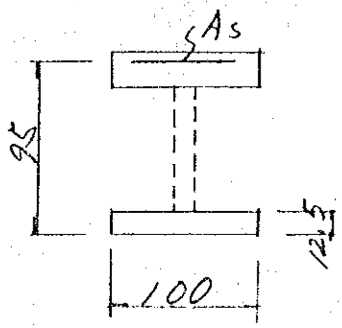
$= 9.05$ cm²

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

$K = 0.155$ $j = 0.948$

$\sigma_c = 98$ N/cm² $<$ 1000 N/cm²

$\sigma_s = 7987$ " $<$ 23000 "



$M \doteq 104.0$ KNm

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

$A_s = \Phi 12$ ctc 12.5 cm

$= 9.05$ cm²

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

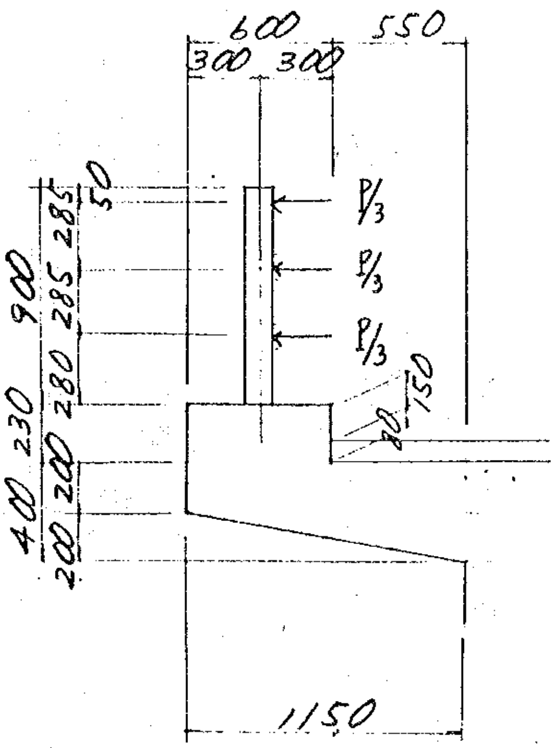
$K = 0.157$ $j = 0.967$

$\sigma_c = 155$ N/cm² $<$ 1000 N/cm²

$\sigma_s = 12509$ " $<$ 23000 "

§§4 Design of cantilever slab

1. Calculation of bending moment



Bending moment due to dead load

Rail	1.10×0.85	=	0.935	KNm/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	"

$Md = 8.137$ KNm/m

Bending moment due to collision load

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

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

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

Interval of post 2.0 m

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

Bending moment due to live load

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

$$P = 112.5 \ KN/m$$

$$y = 0 \ m$$

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

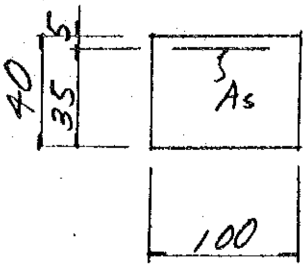
Total

$$M = M_d + M_c + M_l$$

$$= 8.14 + 32.34 + 35.81$$

$$= 76.29 \ KNm/m$$

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

$= 9.05\ cm^2$

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

$K = 0.229$ $j = 0.923$

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

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