社会開発協力部報告書

No. 3

AFRICAN DEVELOPMENT BANK

GOVERNMENT OF MAURITIUS

BEAU BASSIN - PORT LOUIS LINK ROAD

CALCULATION NOTE

FOR

SUPERSTRUCTURES

OF

PEDESTRIAN BRIDGES

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SEPTEMBER 1980

Japan International Cooperation Agency

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1. Pedestrian Bridge (1 Span)

C O N T E N T S

§§ 1. DESIGN CONDITION

§ 1. DESIGN CONDITION

TYPE ; RC SIMPLE BOX BRIDGE

BRIDGE LENGTH ; 19 040

GIRDER LENGTH ; 19 000

SPAN ; 18 400

WIDTH ; 2 400

LIVE LOAD ; BS 153

FOOTWAY LOADING

5 kN/m^2

§ 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

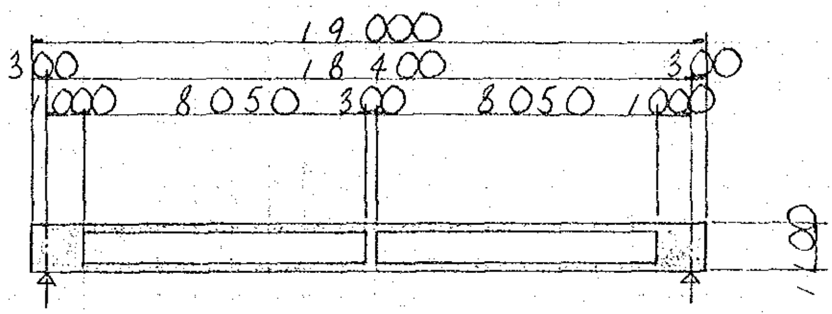
SPECIFIED CHARACTERISTIC STRENGTH

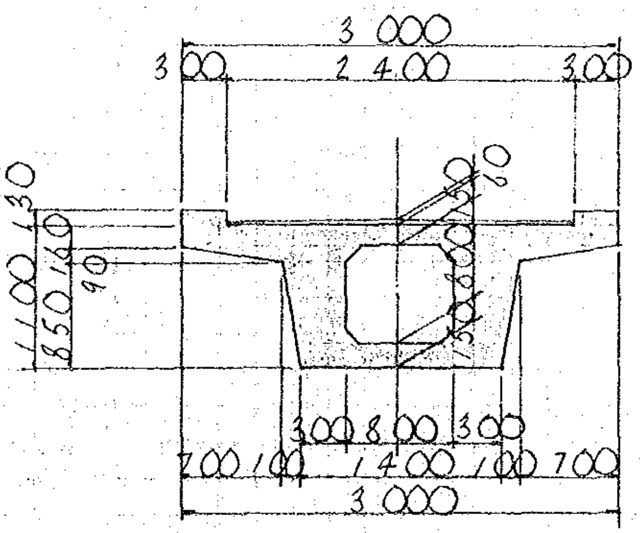
$f_{su} = 410\ N/m^2$ ($4180\ kg/cm^2$)

PERMISSIBLE TENSILE STRESS

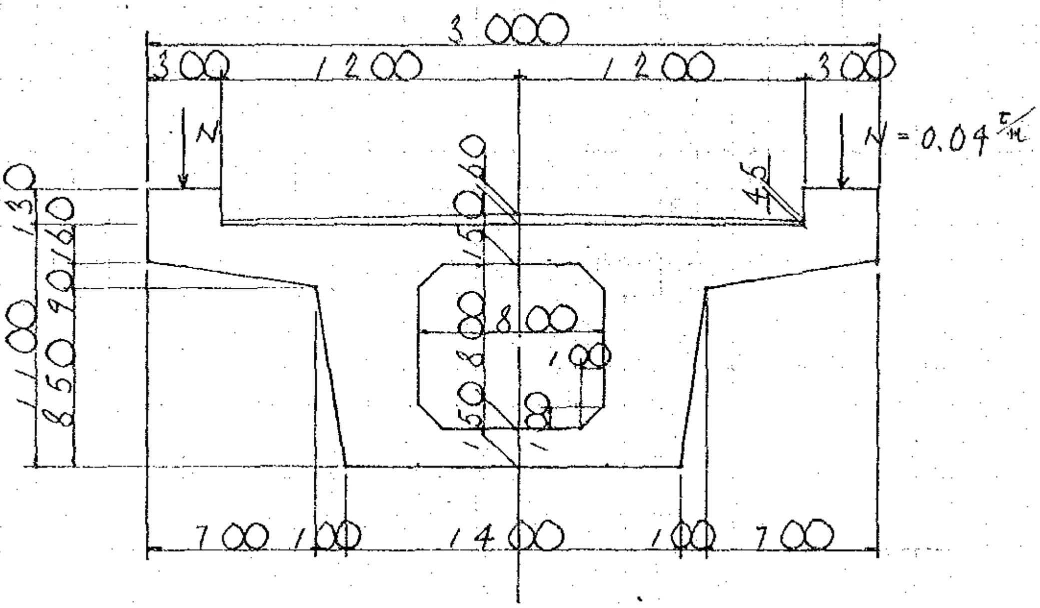
$f_{sa} = 230\ N/mm^2$ ($2340\ kg/cm^2$)

§§2 DESIGN OF MAIN SLAB





§1 CALCULATION OF LOAD



1) DEAD LOAD

			w (t/m)
MAIN SLAB	w_1	1/2 (1.60 + 1.40) × 0.85 × 2.41	3.07
〃	w_2	0.25 × 1.60 × 2.41	0.96
CANTILEVER SLAB	w_3	1/2 (0.16 + 0.25) × 0.70 × 2.41 × 2	0.69
KERB & RAILLING	w_4	(0.30 × 0.13 × 2.41 + 0.04) × 2	0.27
PAVEMENT	w_5	1/2 (0.045 + 0.06) × 1.20 × 2.30 × 2	0.29
VOIDED PARTS	w_6	(0.80 × 0.80 − 1/2 × 0.10 × 0.10 × 4) × 2.41	−1.49
Σ		——	3.79

UNIT WEIGHT AND LENGTH AT SUPPORT SECTION

$$\omega_{d1} = \omega_{1\sim5} = 5.28\ ^{t/m}$$

$$L_1 = 1.00 \times 2 + 0.30 \times 3 = 2.90\ ^{m}$$

UNIT WEIGHT AND LENGTH AT MIDSPAN SECTION

$$\omega_{d2} = 3.79\ ^{t/m}$$

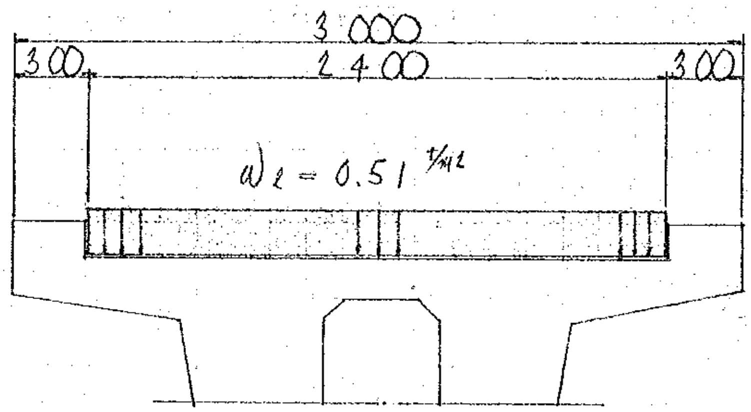
$$L_2 = 19.00 - 2.90 = 16.10\ ^{m}$$

TOTAL WEIGHT AND UNIT WEIGHT

$$\Sigma W = \omega_{d1} \times L_1 + \omega_{d2} \times L_2$$
$$= 5.28 \times 2.90 + 3.79 \times 16.10$$
$$= 76.33\ ^{t}$$

$$\omega_d = \frac{76.33}{19.00} = 4.02\ ^{t/m}$$

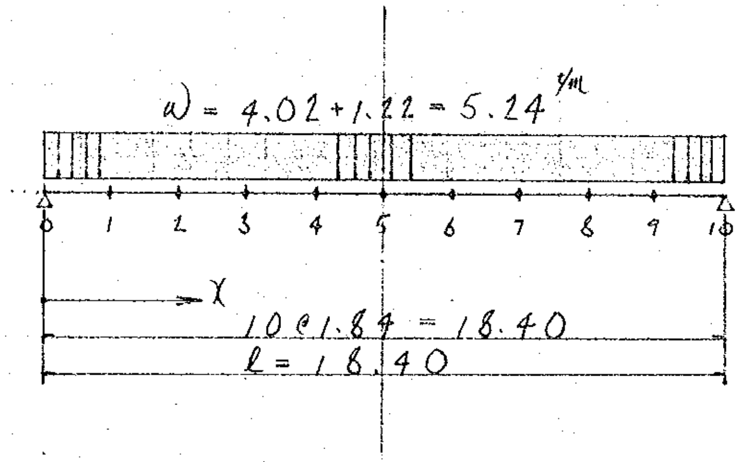
2.1 CROWD LOAD



UNIFORM LOAD

$P = 0.51 \times 2.40 = 1.22^t$

§2 CALCULATION OF SECTION FORCE



1) BENDING MOMENT

$$M = \frac{\omega \cdot x}{2}(\ell - x)$$

$$M_5 = \frac{5.24 \times 9.20}{2} \times (18.40 - 9.20)$$
$$= 221.76^{t.m}$$

$$M_4 = \frac{5.24 \times 7.36}{2} \times (18.40 - 7.36)$$
$$= 212.89^{t.m}$$

$$M_3 = \frac{5.24 \times 5.52}{2} \times (18.40 - 5.52)$$
$$= 186.28^{t.m}$$

$$M_2 = \frac{5.24 \times 3.68}{2} \times (18.40 - 3.68)$$
$$= 141.92^{t.m}$$

$$M_1 = \frac{5.24 \times 1.84}{2} \times (18.40 - 1.84)$$

$$= 79.83^{t.m}$$

$$M_0 = 0^{t.m}$$

2) SHEARING FORCE

$$S = \frac{w \cdot l}{2} (1 - 2 \cdot \frac{x}{l})$$

$$S_5 = 0^t$$

$$S_4 = \frac{5.24 \times 18.40}{2} \times (1 - \frac{2 \times 7.36}{18.40})$$

$$= 9.64^t$$

$$S_3 = 48.21 \times (1 - \frac{2 \times 5.52}{18.40})$$

$$= 19.28^t$$

$$S_2 = 48.21 \times (1 - \frac{2 \times 3.68}{18.40})$$

$$= 28.93^t$$

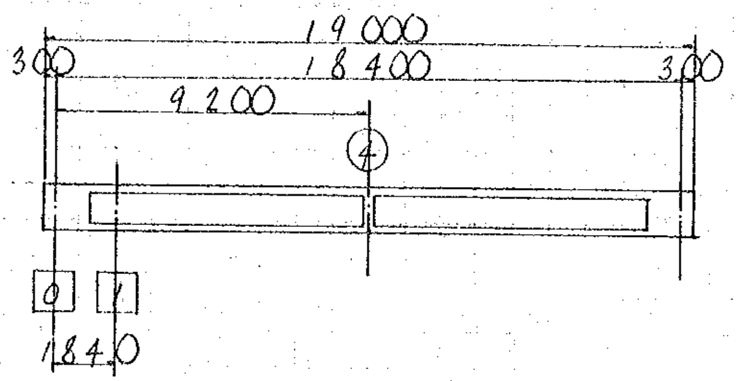
$$S_1 = 48.21 \times (1 - \frac{2 \times 1.84}{18.40})$$

$$= 38.57^t$$

$$S_0 = 48.21^t$$

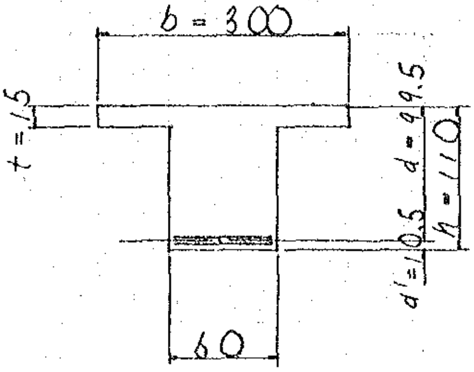
§3 CALCULATION OF STRESS

1) CALCULATION OF BENDING STRESS



□ : FOR CALCULATION OF SHEARING STRESS

point ④



$M = 221.76^{t.m}$

$A_s = 14 - \phi 32 = 113.00^{cm^2}$

$p = \frac{A_s}{b \cdot d} = \frac{113.00}{300 \times 99.5} = 0.00378$

$\frac{t}{d} = \frac{15}{99.5} = 0.150$

$K = \frac{np + \frac{1}{2}\left(\frac{t}{d}\right)^2}{np + \left(\frac{t}{d}\right)}$

$j = \frac{6 - 6\left(\frac{t}{d}\right) + 2\left(\frac{t}{d}\right)^2 + \left(\frac{t}{d}\right)^3 / 2np}{6 - 3\left(\frac{t}{d}\right)}$

$K = 0.330 \quad , \quad j = 0.933$

$\sigma_s = \frac{M}{A_s \cdot j \cdot d} = \frac{221.76 \times 10^5}{113.00 \times 0.933 \times 99.5}$

$= 2113^{kg/cm^2} < 2340^{kg/cm^2}$

$\sigma_c = \frac{K}{n(1-K)} \cdot \sigma_s = \frac{0.330 \times 2113}{15(1 - 0.330)}$

$= 69.4^{kg/cm^2} < 101^{kg/cm^2}$

2) CALCULATION OF SHERING STRESS

point ⓪

$$\tau = \frac{S_0}{b \cdot j \cdot d} = \frac{48.21 \times 10^3}{140 \times 0.875 \times 99.5}$$

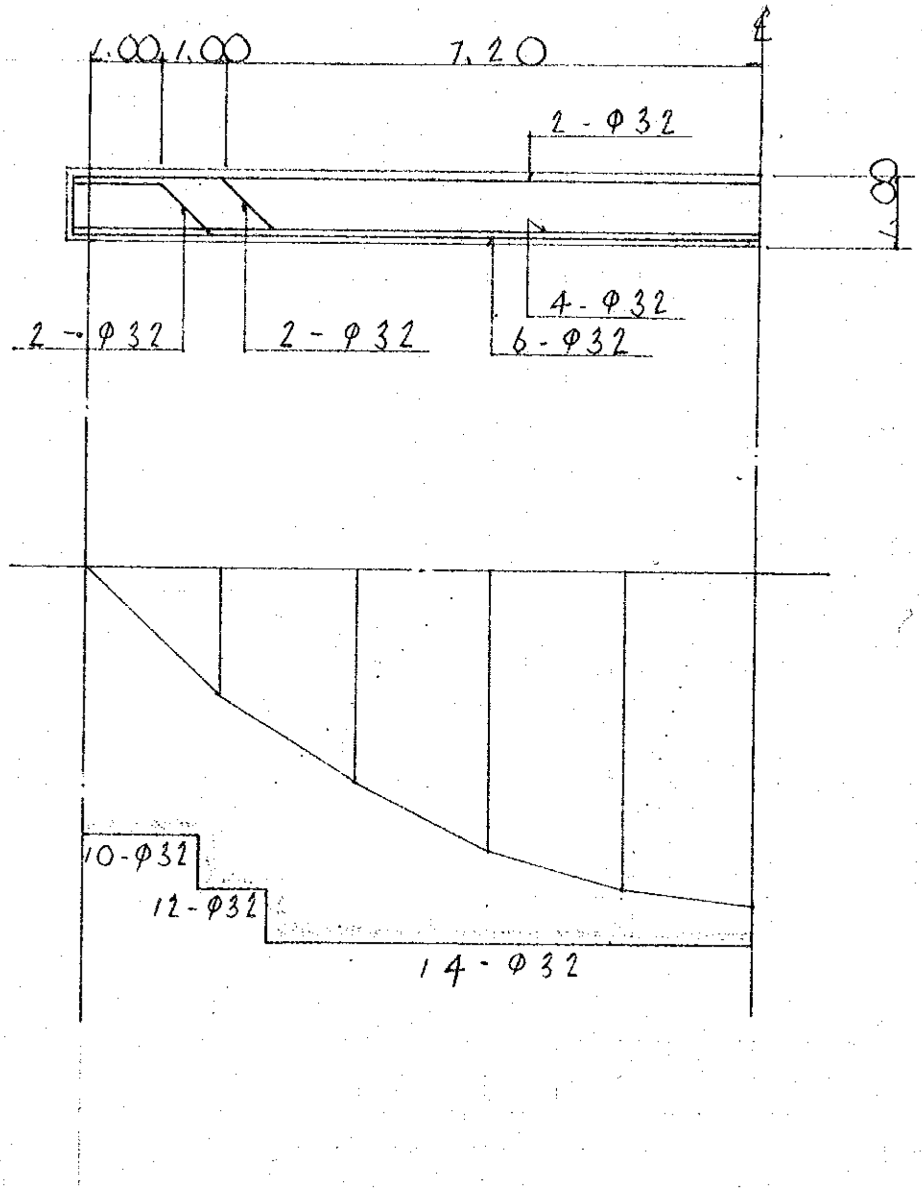
$$= 3.96 \ \mathrm{kg/cm^2} < 8.90 \ \mathrm{kg/cm^2}$$

point ①

$$\tau = \frac{38.57 \times 10^3}{60 \times 0.875 \times 99.5} = 7.38 \ \mathrm{kg/cm^2} < 8.90 \ \mathrm{kg/cm^2}$$

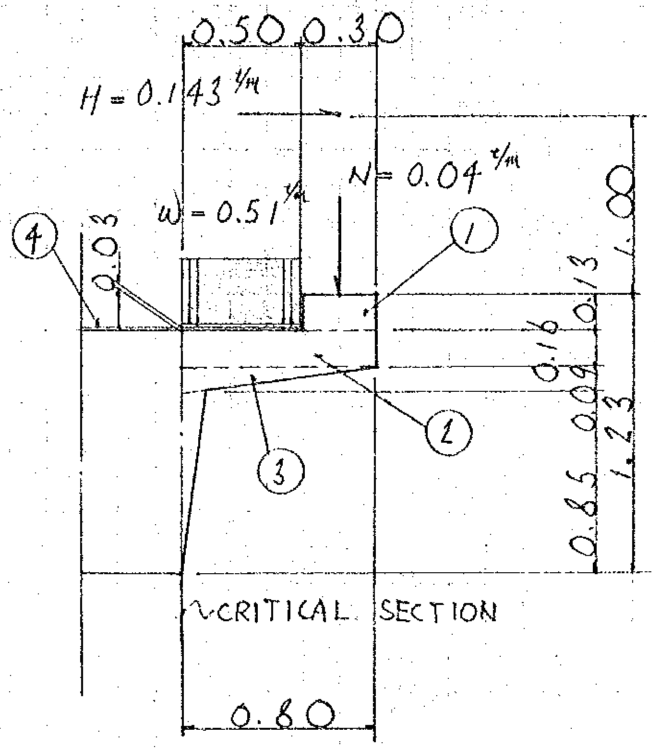
USED $\phi 12 - 2$ FOR SAFTY

4.) RESISTANCE MOMENT



§§3 DESIGN OF SLAB

§1 DESIGN OF CANTILEVER SLAB



1. CALCULATION OF STRESS

1) BENDING MOMENT & SHEARING FORCE DUE TO DEAD LOAD

		W (t)	χ (m)	W.χ (t.m)
①	0.13 × 0.30 × 2.41	0.09	0.65	0.06
②	0.16 × 0.80 × 2.41	0.31	0.40	0.12
③	½ × 0.09 × 0.80 × 2.41	0.09	0.267	0.02
④	0.03 × 0.50 × 2.30	0.03	0.25	0.01
Σ	—	0.52	—	0.21

2) BENDING MOMENT & SHEARING FORCE DUE TO RAILING LOAD

$$M_2 = 0.04 \times 0.65 + 0.143 \times 1.255$$
$$= 0.21^{t.m}$$

$$S_2 = 0.04^{t}$$

3) BENDING MOMENT & SHEARING FORCE DUE TO CROWD LOAD

$$M_3 = 0.51^{t/m} \times 0.50 \times 0.25$$
$$= 0.06^{t.m}$$

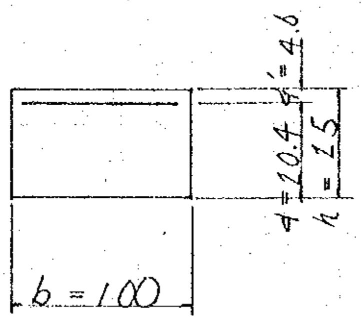
$$S_3 = 0.51 \times 0.50$$
$$= 0.26^{t}$$

4) COMPOSITION OF FORCE

$$M_0 = M_1 + M_2 + M_3$$
$$= 0.21 + 0.21 + 0.06$$
$$= 0.48^{t.m}$$

$$S_0 = S_1 + S_2 + S_3$$
$$= 0.52 + 0.04 + 0.26$$
$$= 0.82^{t}$$

2、CALCULATION OF STRESS



$M = 0.48^{t.m}$

$S = 0.82^{t}$

$As = \underset{ctc\,25.0}{4} - \phi 12 = 4.52^{cm^2}$

$$P = \frac{As}{b \cdot d} = \frac{4.52}{100 \times 20.4} = 0.00222$$

$$\frac{M}{bd^2} = \frac{0.48 \times 10^5}{100 \times 20.4} = 1.15$$

ノモグラム M-1 より

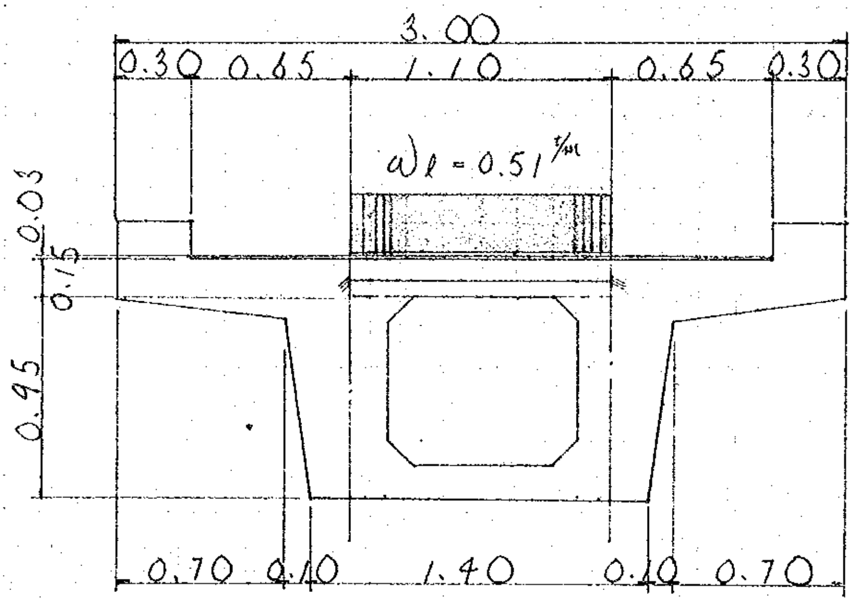
$$\frac{1}{Lc} = 10.3 \quad , \quad \frac{1}{Ls} = 580$$

$\sigma c = 1.15 \times 10.3 = 11.8^{kg/cm^2} < 101^{kg/cm^2}$

$\sigma s = 1.15 \times 580 = 667'' < 2346''$

$$\tau = \frac{0.82 \times 10^3}{100 \times 0.875 \times 20.4} = 0.45'' < 8.9''$$

§2 CALCULATION OF INTERMEDIATE SLAB



1. CALCULATION OF FORCE

SLAB	0.15 × 2.41	=	0.36 t/m
SCREEDING CONCRETE	0.03 × 2.30	=	0.07 "
CROWD LOAD		=	0.51 "
Σ		=	0.94 t/m

1) AT SUPPORT

$$M = -\frac{\omega \cdot l^2}{12}$$

$$= -\frac{1}{12} \times 0.94 \times 1.10^2$$

$$= -0.09^{t.m}$$

$$S = \frac{\omega \cdot l}{2}$$

$$= \frac{0.94 \times 1.10}{2}$$

$$= 0.52^{t}$$

2) AT MIDSPAN

$$M = \frac{\omega \cdot l^2}{8}$$

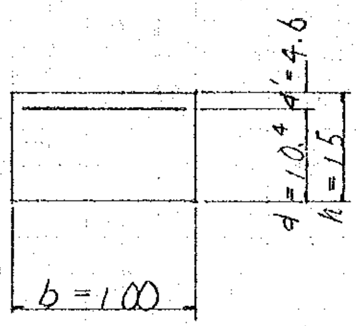
$$= \frac{0.94 \times 1.10^2}{8}$$

$$= 0.14^{t.m}$$

$$S = 0.52^{t}$$

2. CALCULATION OF STRESS

1). AT SUPPORT



$M = 0.09^{t.m}$

$S = 0.52^{t}$

$A_s = \underset{ctc\,25.0}{4} - \phi 12 = 4.52^{cm^2}$

$$P = \frac{A_s}{b \cdot d} = \frac{4.52}{100 \times 10.4} = 0.00435$$

$$\frac{M}{bd^2} = \frac{0.09 \times 10^5}{100 \times 10.4^2} = 0.83$$

$$\frac{1}{Lc} = 7.90 \qquad \frac{1}{Ls} = 310$$

$\sigma_c = 0.83 \times 7.90 = 6.6^{kg/cm^2} < 101^{kg/cm^2}$

$\sigma_s = 0.83 \times 310 = 257'' < 2346''$

$$\tau = \frac{0.52 \times 10^3}{100 \times 0.875 \times 10.4} = 0.57'' < 8.9''$$

2) AT MIDSPAN

EQUIVALENT TO SUPPORT SECTION

2. Pedestrian Bridge (2 Spans)

C O N T E N T S

§§ 1. D E S I G N   C O N D I T I O N

§ 1. DESIGN CONDITION

TYPE ; 2 SPANS CONTINUANCE RC BOXED BRIDGE

BRIDGE LENGTH ; 38 060

GIRDER LENGTH ; 38 000

SPAN ; 2 x 18700

WIDTH ; 2.4

LIVE LOAD ; BS 153
FOOTWAY LOADING
5 kN/m^2

§ 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

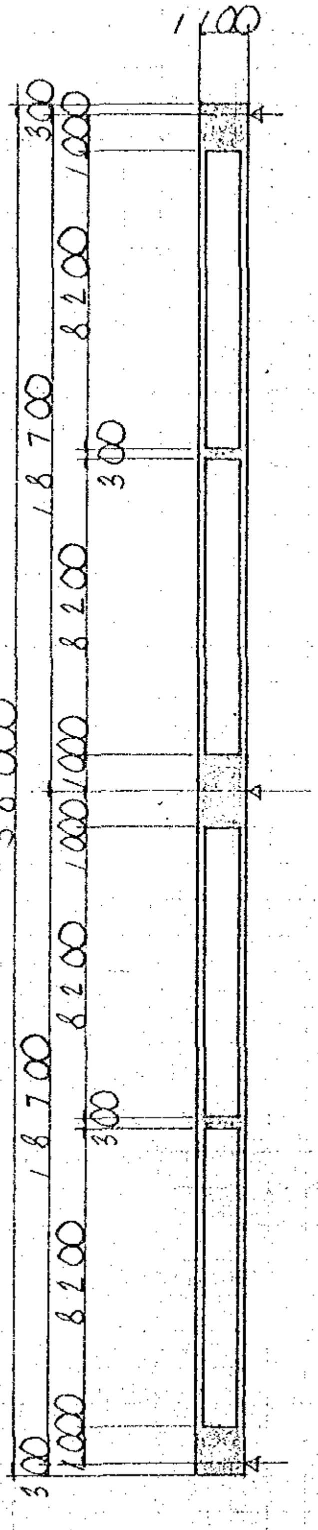
SPECIFIED CHARACTERISTIC STRENGTH

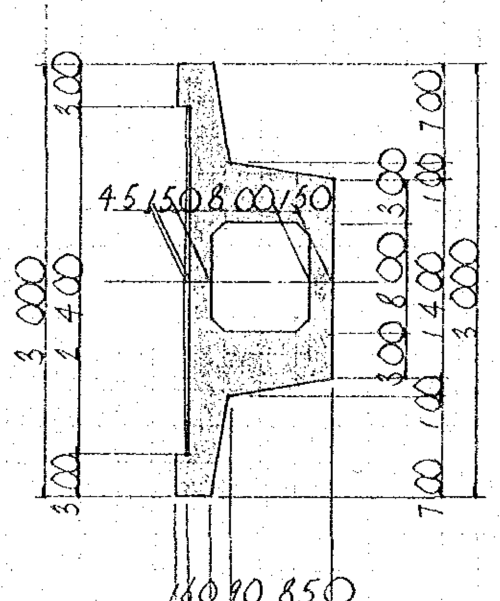
f_{su} = 410 N/m^2 (4180 kg/cm^2)

PERMISSIBLE TENSILE STRESS

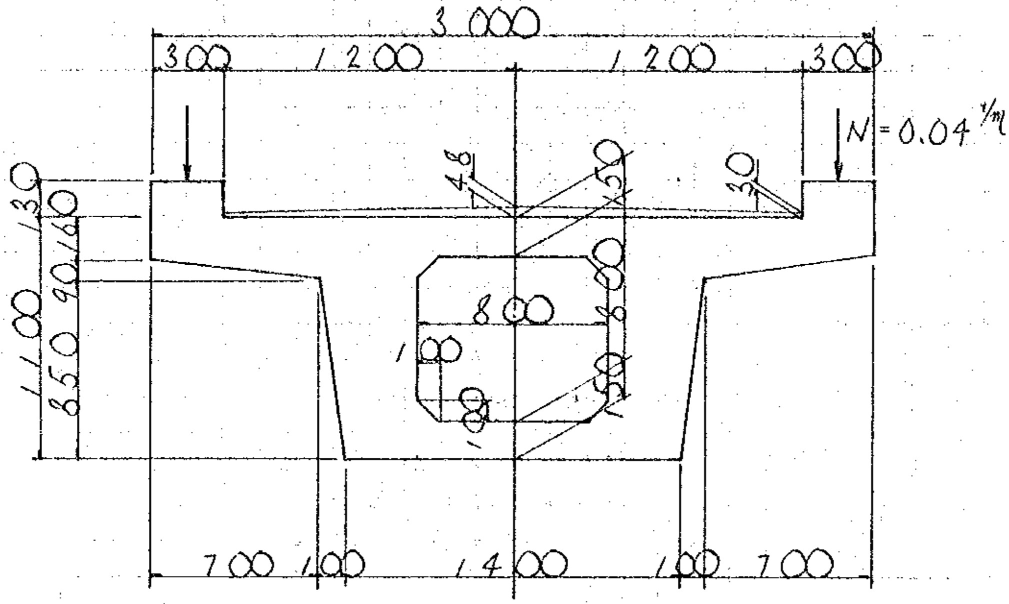
f_{sa} = 230 N/mm^2 (2340 kg/cm^2)

§§2 DESIGN OF MAIN SLAB





§1 CALCULATION OF LOAD



1). DEAD LOAD

			w (t/m)
MAIN SLAB	w_1	$\frac{1}{2}(1.60+1.40)\times 0.85\times 2.41$	3.07
〃	w_2	$0.25\times 1.60\times 2.41$	0.96
CANTILEVER SLAB	w_3	$\frac{1}{2}(0.16+0.25)\times 0.70\times 2.41\times 2$	0.69
KERB & RAILING	w_4	$(0.30\times 0.13\times 2.41+0.04)\times 2$	0.27
PAVEMENT	w_5	$\frac{1}{2}(0.03+0.048)\times 1.20\times 2.30\times 2$	0.22
VOIDED PARTS	w_6	$(0.80\times 0.80-\frac{1}{2}\times 0.10\times 0.10\times 4)\times 2.41$	−1.49
Σ		———	3.72

UNIT WEIGHT AND LENGTH AT SUPPORT SECTION.

$$\omega_{d1} = \omega_{1\sim5} = 5.21\ ^{t}/_{m}$$

$$L_1 = 1.00 \times 4 + 0.30 \times 4 = 5.20^{m}$$

UNIT WEIGHT AND LENGTH AT MIDSPAN SECTION

$$\omega_{d2} = 3.72\ ^{t}/_{m}$$

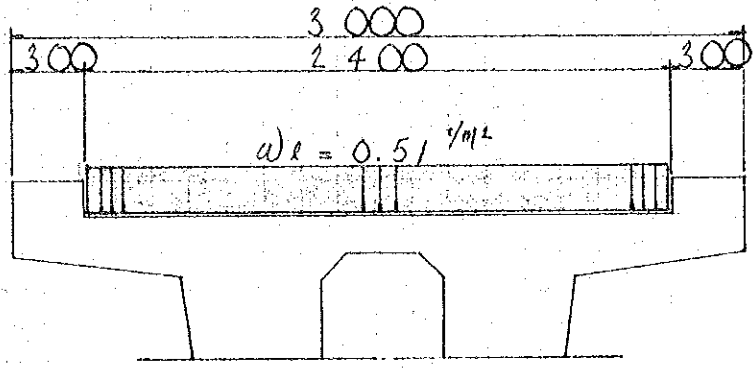
$$L_2 = 38.00 - 5.20 = 32.80^{m}$$

TOTAL WEIGHT AND UNIT WEIGHT

$$\Sigma W = \omega_{d1} \times L_1 + \omega_{d2} \times L_2$$
$$= 5.21 \times 5.20 + 3.72 \times 32.80$$
$$= 149.11^{t}$$

$$\omega_d = \frac{149.11}{38.00} = 3.92\ ^{t}/_{m}$$

2) CROWD LOAD

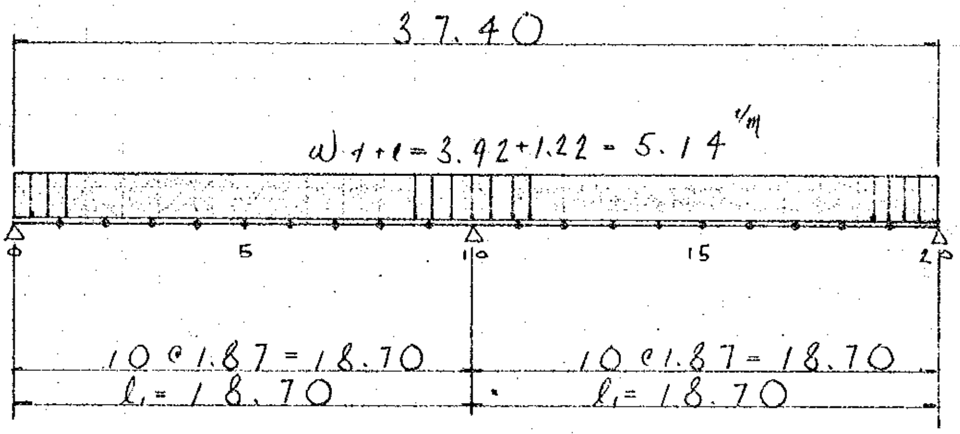


UNIFORM LOAD

$$P = 0.51 \times 2.40 = 1.22^t$$

§2 CALCULATION OF SECTION FORCE

1) CASE - I. DEAD LOAD + CROWD LOAD



a) BENDING MOMENT

REFER TO ANGER'S FOMULA 1 : 1

$$M_d = \Sigma A \cdot \omega_{d+l} \cdot l_1^2$$

WHERE

ΣA : INFLUENCE AREA

ω_{d+l} : $5.14^{t/m}$

l_1 : 18.70^m

$$M_0 = 0^{tm}$$

$$M_1 = 0.0325 \times 5.14 \times 18.70^2 = 58.42^{tm}$$

$$M_2 = 0.0550 \times \text{〃} \times \text{〃} = 98.86 \text{〃}$$

$M_3 = 0.0675 \times 5.14 \times 18.70^2 = 121.32^{t.m}$

$M_4 = 0.0700 \times$ " $\times$ " $= 125.82$ "

$M_5 = 0.0625 \times$ " $\times$ " $= 112.34$ "

$M_6 = 0.0450 \times$ " $\times$ " $= 80.88$ "

$M_7 = 0.0175 \times$ " $\times$ " $= 31.45$ "

$M_8 = -0.0200 \times$ " $\times$ " $= -35.95$ "

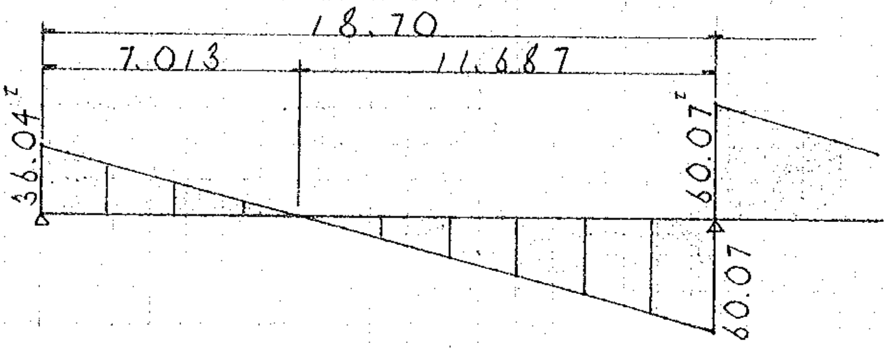
$M_9 = -0.0675 \times$ " $\times$ " $= -121.32$ "

$M_{10} = -0.1250 \times$ " $\times$ " $= -224.67$ "

b) SHEAR FORCE

$$S_0 = \frac{3}{8} \cdot \omega l$$
$$= \frac{3}{8} \times 5.14 \times 18.70 = 36.04^t$$

$$S_{10} = \frac{5}{8} \cdot \omega l$$
$$= \frac{5}{8} \times 5.14 \times 18.70 = 60.07''$$



$$S_1 = \frac{5.143}{7.013} \times 36.04 = 26.43^t$$

$$S_2 = \frac{3.273}{7.013} \times 〃 = 16.82 〃$$

$$S_3 = \frac{1.403}{7.013} \times 〃 = 7.21 〃$$

$$S_4 = \frac{0.467}{11.687} \times 60.07 = 2.40 〃$$

$$S_5 = \frac{2.337}{11.687} \times 〃 = 12.01 〃$$

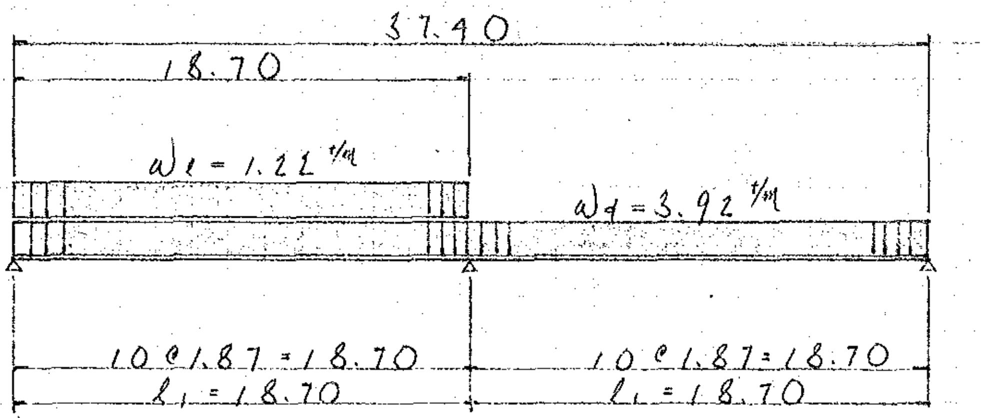
$$S_6 = \frac{4.207}{11.687} \times 〃 = 21.62 〃$$

$$S_7 = \frac{6.077}{11.687} \times 〃 = 31.24 〃$$

$$S_8 = \frac{7.947}{11.687} \times 〃 = 40.85 〃$$

$$S_9 = \frac{9.817}{11.687} \times 〃 = 50.46 〃$$

2) CASE 2 DEAD LOAD + CROWD LOAD



A). BENDING MOMENT

REFER TO ANGER'S FOMULA 1:1

$$M_d = \Sigma A_1 \cdot w_d \cdot l_1^2 + \Sigma A_2 \cdot w_l \cdot l_1^2$$

ここに ΣA_1 : INFLUENCE AREA FOR 2-SPANS

ΣA_2 : " " 1-SPAN

w_d : 3.92 t/m

w_l : 1.22 "

l_1 : 18.70 m

$$M_0 = 0 \ \text{tm}$$

$$M_1 = 0.0325 \times 3.92 \times 18.70^2 + 0.0388 \times 1.22 \times 18.70^2$$

$$= 61.10 \ \text{tm}$$

$M_2 = 0.0550 \times 3.92 \times 18.70^2 + 0.0675 \times 1.22 \times 18.70^2$

1475.69 426.62

$= 104.19^{t.m}$

$M_3 = 0.0675 \times 1370.78 + 0.0863 \times 426.62 = 129.34^{t.m}$

$M_4 = 0.0700 \times \quad " \quad + 0.0950 \times \quad " \quad = 136.48''$

$M_5 = 0.0625 \times \quad " \quad + 0.0938 \times \quad " \quad = 125.69''$

$M_6 = 0.0450 \times \quad " \quad + 0.0825 \times \quad " \quad = 96.88''$

$M_7 = 0.0175 \times \quad " \quad + 0.0613 \times \quad " \quad = 50.14''$

$M_8 = -0.0200 \times \quad " \quad + 0.0300 \times \quad " \quad = -14.62''$

$M_9 = -0.0675 \times \quad " \quad - 0.0113 \times \quad " \quad = -97.35''$

$M_{10} = -0.1250 \times \quad " \quad - 0.0625 \times \quad " \quad = -198.01''$

b) SHEAR FORCE

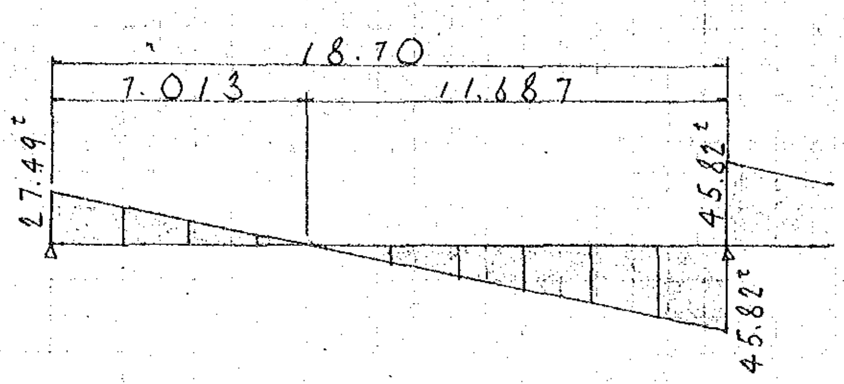
i) DEAD LOAD

$$S_0 = \frac{3}{8} \cdot w \cdot l$$

$$= \frac{3}{8} \times 3.92 \times 18.70 = 27.49^t$$

$$S_{10} = \frac{5}{8} \cdot w \cdot l$$

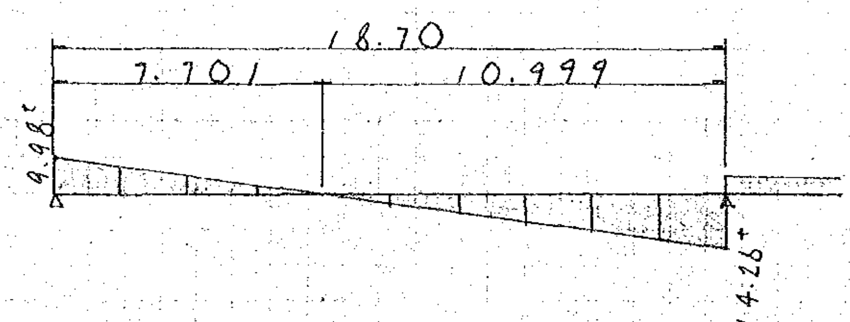
$$= \frac{5}{8} \times 3.92 \times 18.70 = 45.82''$$



ii) CROWD LOAD

$$S_0 = 0.4375 \cdot w \cdot l$$
$$= 0.4375 \times 1.22 \times 18.70$$
$$= 9.98^t$$

$$S_{10} = 0.6250 \cdot w \cdot l$$
$$= 0.6250 \times 1.22 \times 18.70$$
$$= 14.26^t$$



iii) SHEAR FORCE AT EACH SECTION.

(DEAD LOAD + CROWD LOAD)

$$S_0 = 27.49 + 9.98 = 37.47^t$$

$$S_1 = \frac{5.143}{7.013} \times 27.49 + \frac{5.831}{7.701} \times 9.98$$
$$= 27.72^t$$

$$S_2 = \frac{3.273}{7.013} \times \text{〃} + \frac{3.961}{7.701} \times \text{〃}$$
$$= 17.96^t$$

$$S_3 = \frac{1.403}{7.013} \times \text{〃} + \frac{2.091}{7.701} \times \text{〃}$$
$$= 8.21^t$$

$$S_4 = \frac{0.467}{11.687} \times 45.82 + \frac{0.221}{7.701} \times \text{〃}$$
$$= 2.12^t$$

$$S_5 = \frac{2.337}{11.687} \times \text{〃} + \frac{1.649}{10.999} \times 14.26$$
$$= 11.30^t$$

$$S_6 = \frac{4.207}{11.687} \times \text{〃} + \frac{3.519}{10.999} \times \text{〃}$$
$$= 21.06^t$$

$$S_7 = \frac{6.077}{11.687} \times 45.82 + \frac{5.389}{10.999} \times 14.26$$
$$= 30.82^t$$

$$S_8 = \frac{7.947}{11.687} \times \text{〃} + \frac{7.259}{10.999} \times \text{〃}$$
$$= 40.57^t$$

$$S_9 = \frac{9.817}{11.687} \times \text{〃} + \frac{9.129}{10.999} \times \text{〃}$$
$$= 50.33^t$$

$$S_{10} = 45.82 \times 2 + 14.26$$
$$= 105.90^t$$

3) LIST OF SECTION FORCE

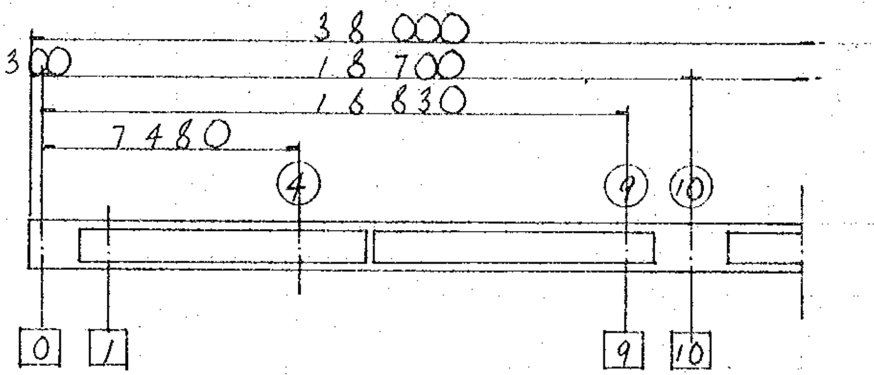
AIMED POINT	CASE 1 DEAD + CROWD (2-SPANS)		CASE 2 DEAD + CROWD (1-SPAN)	
	M t.m	S t	M t.m	S t
0	—	36.04	—	37.47
1	58.42	26.43	61.10	27.72
2	98.86	16.82	104.19	17.96
3	121.32	7.21	129.34	8.21
4	125.82	2.40	136.48	2.12
5	112.34	12.01	125.69	11.30
6	80.88	21.62	96.88	21.06
7	31.45	31.24	50.14	30.82
8	-35.95	40.85	-14.62	40.57
9	-121.32	50.46	-97.35	50.33
10	-224.67	120.14	-198.01	105.90

M : BENDING MOMENT

S : SHEAR FORCE

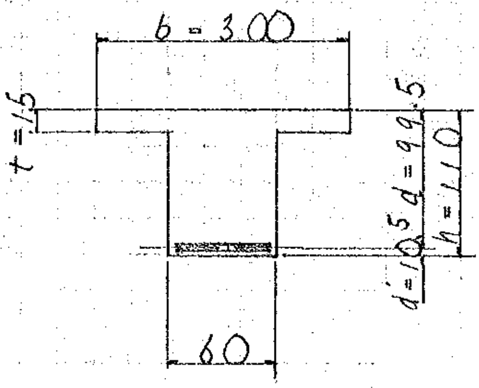
§3 CALCULATION OF STRESS

1). CALCULATION OF BENDING STRESS



□ ; FOR CALCULATION OF SHEAR STRESS

point ④



$M = 136.48^{t.m}$

$As = 10 - \phi 32 = 80.42^{cm^2}$

$$p = \frac{As}{b \cdot d} = \frac{80.42}{300 \times 99.5} = 0.00269$$

$$\frac{t}{d} = \frac{15}{99.5} = 0.151$$

$$K = \frac{np + \frac{1}{2}(\frac{t}{d})^2}{np + (\frac{t}{d})}$$

$$j = \frac{6 - 6(\frac{t}{d}) + 2(\frac{t}{d})^2 + (\frac{t}{d})^3 / 2np}{6 - 3(\frac{t}{d})}$$

$K = 0.275$, $j = 0.934$

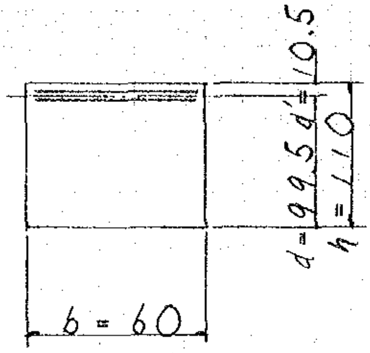
$$\sigma_s = \frac{M}{As \cdot j \cdot d} = \frac{136.48 \times 10^5}{80.42 \times 0.934 \times 99.5}$$

$$= 1826^{kg/cm^2} < 2340^{kg/cm^2}$$

$$\sigma_c = \frac{K}{n(1-K)} \cdot \sigma_s$$

$$= \frac{0.275}{15(1-0.275)} \times 1826 = 46.2^{kg/cm^2} < 101^{kg/cm^2}$$

Point ⑨



$M = -121.32^{t.m}$

$A_s = 12 - \phi 32 = 96.50^{cm^2}$

$P = \frac{A_s}{b.d} = \frac{96.50}{60 \times 99.5} \doteq 0.01616$

$\frac{M}{bd^2} = \frac{121.32 \times 10^5}{60 \times 99.5} = 20.42$

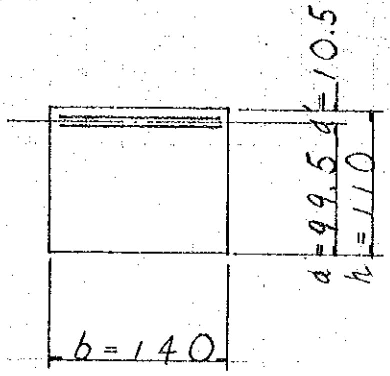
$K = \sqrt{2np + (np)^2} - np \qquad j = 1 - \frac{K}{3}$

$\frac{1}{Lc} = \frac{2}{Kj} = 4.48 \quad \frac{1}{Ls} = \frac{1}{Pj} = 76.3$

$\sigma_c = 20.42 \times 4.48 = 91.5^{kg/cm^2} < 101^{kg/cm^2}$

$\sigma_s = 20.42 \times 76.3 = 1558'' < 2340''$

point ⑩



$M = -224.67^{t.m}$

$A_s = 14 - \phi 32 = 113.00^{cm^2}$

$p = \frac{A_s}{b.d} = \frac{113.00}{140 \times 99.5} = 0.00811$

$\frac{M}{bd^2} = \frac{224.67 \times 10^5}{140 \times 99.5^2} = 16.20$

$K = \sqrt{2np + (np)^2} - np \qquad j = 1 - \frac{K}{3}$

$\frac{1}{L_c} = \frac{2}{Kj} = 5.40 \qquad \frac{1}{L_s} = \frac{1}{pj} = 138$

$\sigma_c = 16.20 \times 5.40 = 87.5^{kg/cm^2} < 101^{kg/cm^2}$

$\sigma_s = 16.20 \times 138 = 2235'' < 2340''$

2). CALCULATION OF SHEAR STRESS

Point ⓪

$$\tau_0 = \frac{S_0}{b \cdot j \cdot d} = \frac{37.47 \times 10^3}{140 \times 0.875 \times 99.5} = 3.07^{kg/cm^2} < 8.9^{kg/cm^2}$$

Point ①

$$\tau_1 = \frac{27.72 \times 10^3}{60 \times 0.875 \times 99.5} = 5.31^{kg/cm^2} < 8.9^{kg/cm^2}$$

Point ⑨

$$\tau_9 = \frac{50.46 \times 10^3}{60 \times 0.875 \times 99.5} = 9.65'' > 8.9'' \quad \text{OUT.}$$

Point ⑩

$$\tau_{10} = \frac{120.14 \times 10^3}{140 \times 0.875 \times 99.5} = 9.85'' > 8.9'' \quad \text{OUT.}$$

3) CALCULATION OF PRINCIPAL TENSIL REINFORCEMENT.

CALCULATION OF STIRRUPS

Point ⑩

$$Aw = \frac{S \cdot a}{\sigma sa \cdot d}$$

ここに Aw : AREA OF STIRRUPS

S : SHEA FORCE

a : SPACING OF STIRRUPS

σsa : PERMISSIBLE STRESS OF REINFORCEMENT

d : EFECTIVE HEIGHT

$$Aw = \frac{120.14 \times 10^3 \times 12.5}{2340 \times 99.5}$$

$$= 6.43^{cm^2}$$

USED $\phi 12 - 3$

$$1.18 \times 6 = 7.08^{cm^2} > Aw = 6.43^{cm^2}$$

OK

point ⑨

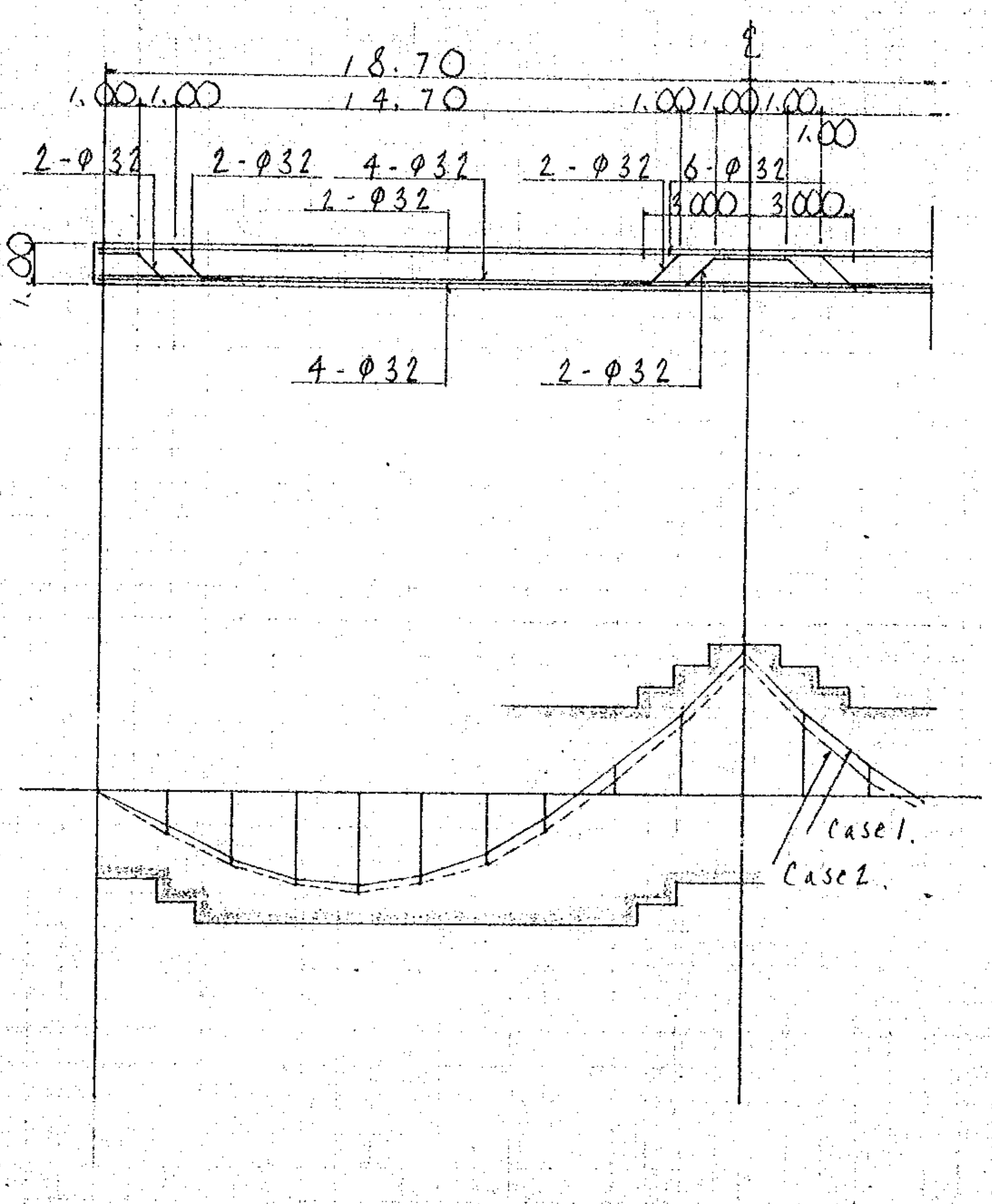
$$Aw = \frac{50.46 \times 10^3 \times 12.5}{2346 \times 99.5}$$

$$= 2.70^{cm^2}$$

USED φ12 - 2

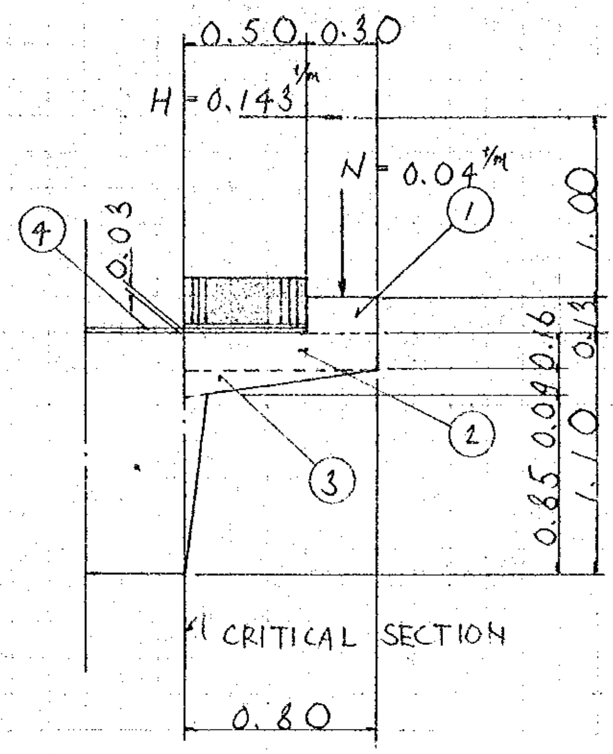
$$1.18 \times 4 = 4.72^{cm^2} > 2.70^{cm^2}$$ OK

4) RESISTANCE MOMENT



§§3 DESIGN OF SLAB

§1 DESIGN OF CANTILEVER SLAB



1. CALCULATION OF STRESS

1). BENDING MOMENT & SHEAR FORCE DUE TO DEAD LOAD

		W (t)	χ (m)	W.χ (t.m)
①	0.13 × 0.30 × 2.41	0.09	0.65	0.06
②	0.16 × 0.80 × 2.41	0.31	0.40	0.12
③	1/2 × 0.09 × 0.80 × 2.41	0.09	0.267	0.02
④	0.03 × 0.50 × 2.30	0.03	0.25	0.01
Σ	————	0.52	——	0.21

2) BENDING MOMENT & SHEAR FORCE DUE TO RAILING LOAD

$$M_2 = 0.04 \times 0.65 + 0.143 \times 1.255$$
$$= 0.21^{t.m}$$

$$S_2 = 0.04^{t}$$

3) BENDING MOMENT & SHEAR FORCE DUE TO CROWD LOAD

$$M_3 = 0.51^{t/m} \times 0.50 \times 0.25$$
$$= 0.06^{t.m}$$

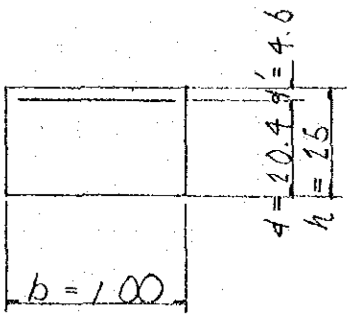
$$S_3 = 0.51 \times 0.50$$
$$= 0.26^{t}$$

4) COMPOSITION OF FORCE

$$M_0 = M_1 + M_2 + M_3$$
$$= 0.21 + 0.21 + 0.06$$
$$= 0.48^{t.m}$$

$$S_0 = S_1 + S_2 + S_3$$
$$= 0.52 + 0.04 + 0.26$$
$$= 0.82^{t}$$

2. CALCULATION OF STRESS



$M = 0.48^{tm}$

$S = 0.82^{t}$

$A_s = \underset{ctc\,25.0}{4} - \phi 12 = 4.52^{cm^2}$

$$P = \frac{A_s}{b \cdot d} = \frac{4.52}{100 \times 20.4} = 0.00222$$

$$\frac{M}{b \cdot d^2} = \frac{0.48 \times 10^5}{100 \times 20.4} = 1.15$$

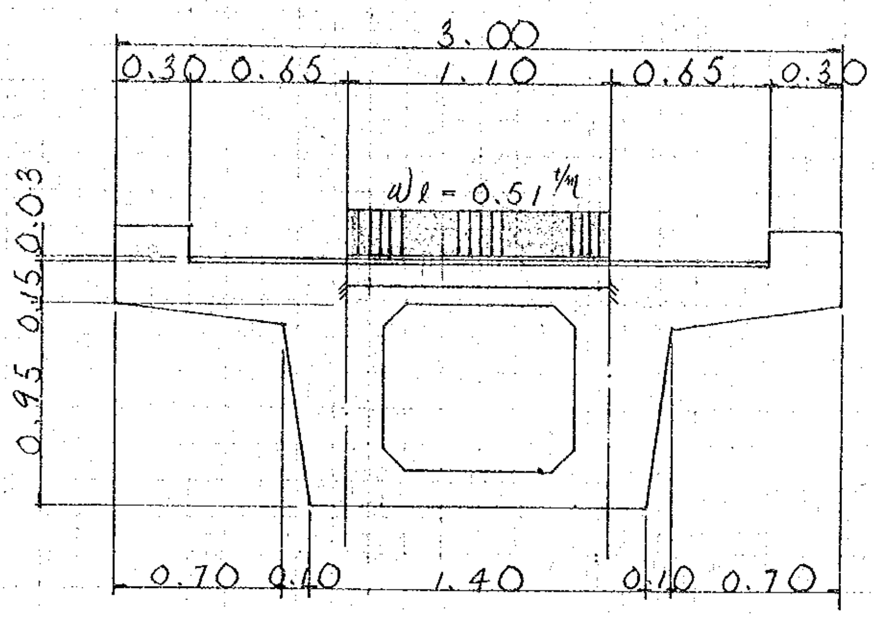
$$\frac{1}{L_c} = 10.3 \quad , \quad \frac{1}{L_s} = 580$$

$\sigma_c = 1.15 \times 10.3 = 11.8^{kg/cm^2} < 101^{kg/cm^2}$

$\sigma_s = 1.15 \times 580 = 667$ " < 2340 "

$$\tau = \frac{0.82 \times 10^3}{100 \times 0.875 \times 20.4} = 0.45 \text{ " } < 8.9 \text{ "}$$

§2 CALCULATION OF INTERMEDIATE SLAB



1. CALCULATION OF FORCE

SLAB	0.15 × 2.41	= 0.36 t/m
SCREEDING CONCRETE	0.03 × 2.30	= 0.07 "
CROWD LOAD		= 0.51 "
	Σ	= 0.94 t/m

1) AT SUPPORT

$$M = -\frac{w \cdot l^2}{12}$$

$$= -\frac{1}{12} \times 0.94 \times 1.10^2$$

$$= -0.09^{t.m}$$

$$S = \frac{w \cdot l}{2}$$

$$= \frac{0.94 \times 1.10}{2}$$

$$= 0.52^{t}$$

2) AT MIDSPAN

$$M = \frac{w \cdot l^2}{8}$$

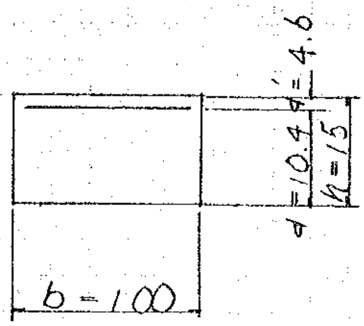
$$= \frac{0.94 \times 1.10^2}{8}$$

$$= 0.14^{t.m}$$

$$S = 0.52^{t}$$

2. CALCULATION OF STRESS

1) AT SUPPORT



$M = 0.09^{t.m}$

$S = 0.52^{t}$

$As = \underset{ctc\,25.0}{4} - \phi 12 = 4.52^{cm^2}$

$p = \frac{As}{b \cdot d} = \frac{4.52}{100 \times 10.4} = 0.00435$

$\frac{M}{b\,d^2} = \frac{0.09 \times 10^5}{100 \times 10.4^2} = 0.83$

$\frac{1}{Lc} = 7.90 \quad , \quad \frac{1}{Ls} = 310$

$\sigma c = 0.83 \times 7.90 = 6.6^{kg/cm^2} < 101^{kg/cm^2}$

$\sigma s = 0.83 \times 310 = 257\,'' < 2340\,''$

$\tau = \frac{0.52 \times 10^3}{100 \times 0.875 \times 10.4} = 0.57\,'' < 8.9\,''$

2) AT MIDSPAN

EQUIVALENT TO SUPPORT SECTION