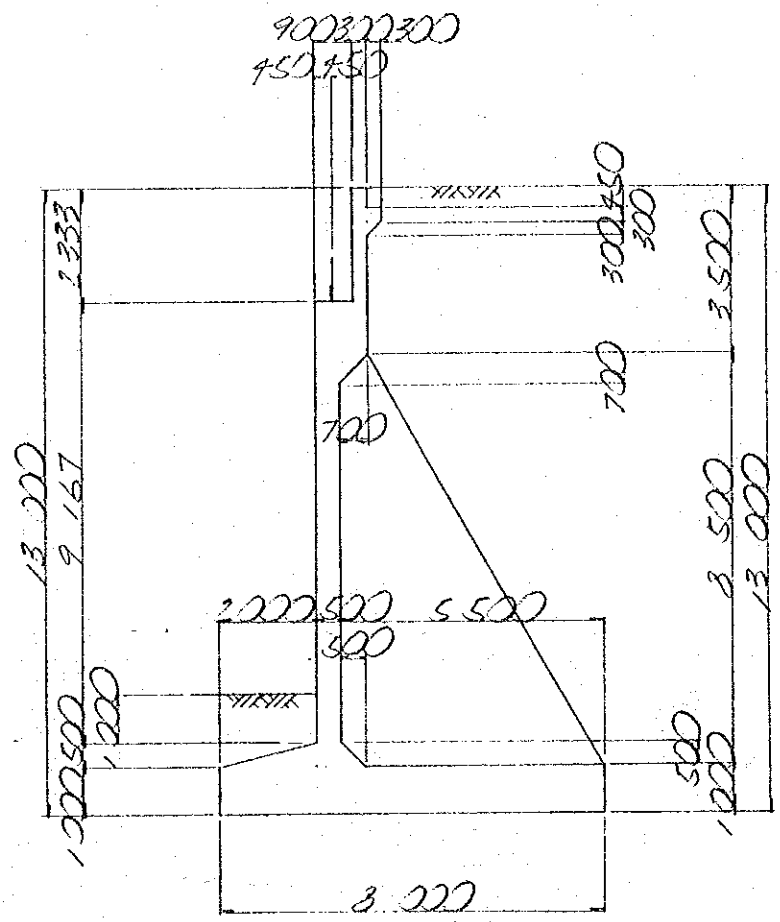
§§ 3 H = 13.00 m

E RAMP	A 2
A-L-1	A 2 (H = 12.50)
A-L-2	A 2
B-L-1	A 2 (H = 12.50)

§ 1 STRUCTURAL FIGURE

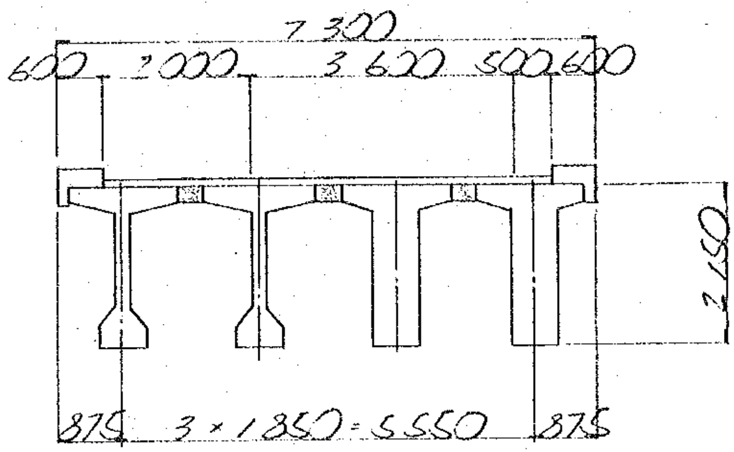


buttress span $l = 3.350^{m}$

(E − RAMP , A 2)
(A − LINE 1 , A 2)
(A − LINE 2 , A 2)
(B − LINE 1 , A 2)

§ 2 REACTION OF SUPERSTRUCTURE

2 - 1 structual figure

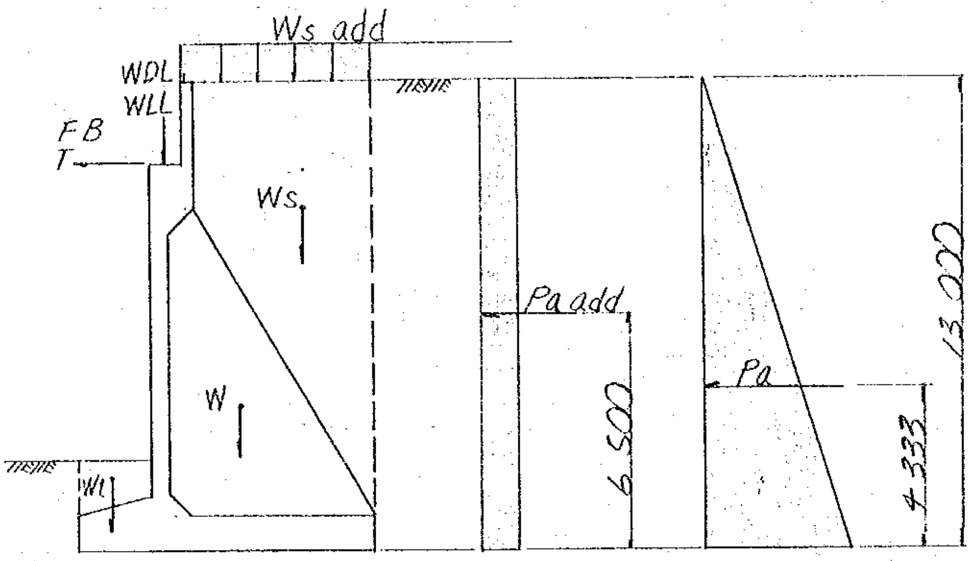


2 - 2 whole reaction of superstructure

		HA loading		HB loading	
		N (t)	H (t)	N (t)	H (t)
dead load of deck	I	175.5	———	175.5	———
	II	29.1	———	29.1	———
live load		112.0	———	127.6	———
crowd load		———	———	———	———
longitudinal forse		———	25.8	———	38.2
TOTAL		316.6	25.8	332.2	38.2

§ 3 CALCULATION OF LOAD

3-1 loading diagram



WDL : dead load of deck

WLL : max LL reaction under HA & HB

F B : HA & HB braking

W : self weight

Ws : weight of soil

Wt : fill on toe

Ws add : weight of surcharge

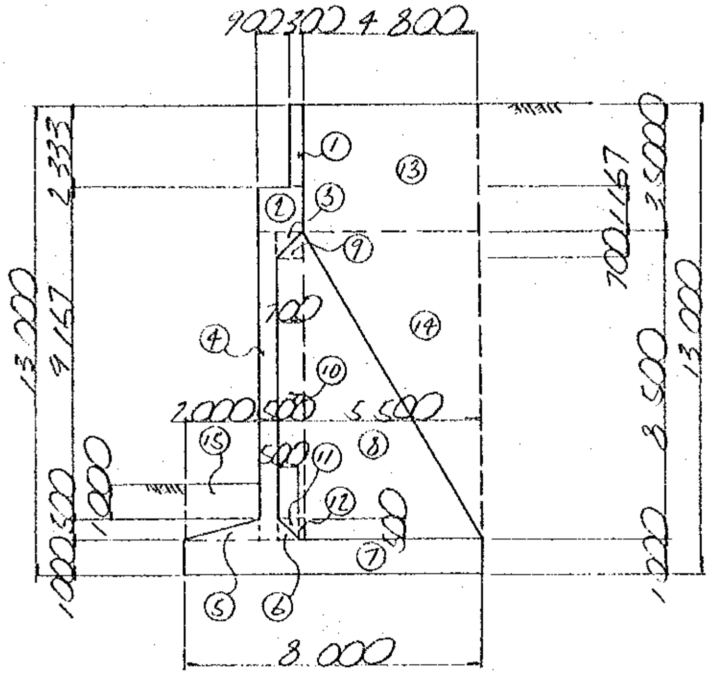
P_A : active pressure

P_P : passive pressure

P_A add : surcharge

T : temperature load

3-2 self weight and weight of soil



$$\bar{\gamma} = \frac{2.41 \times 0.60 \times 3 + 1.9 \times 5.50}{7.30} = 2.03 \ \text{t/m}^3$$

		N (t)	x (m)	N x (t m)
①	0.30×2.333×7.30×2.41	12.31	3.050	37.54
②	1.20×1.167×7.30×2.41	25.65	2.600	66.69
③	1/2×0.70×0.70×7.30×2.41	4.31	2.733	11.78
④	0.50×8.50×7.30×2.41	74.77	2.250	168.23
⑤	1/2×2.00×0.50×7.30×2.41	8.77	1.333	11.69
⑥	1/2×0.50×0.50×7.30×2.41	2.20	2.667	5.87
⑦	8.00×1.00×7.30×2.41	140.74	4.000	562.96
⑧	1/2×4.80×8.50×7.30×2.03	302.31	4.800	1451.09
⑨	1/2×0.70×0.70×7.30×2.03	3.63	2.967	10.77
⑩	0.70×7.30×7.30×2.03	75.73	2.850	215.83
⑪	1/2×0.50×0.50×7.30×2.03	1.85	2.833	5.24
⑫	0.20×0.50×7.30×2.03	1.48	3.100	4.59
⑬	4.80×3.50×7.30×1.9	271.32	5.600	1519.39
⑭	1/2×4.80×8.50×7.30×1.9	282.95	6.400	1810.88
⑮	1/2×(1.00+1.50)×2.00×7.30×1.9	34.68	0.933	32.36
Σ		1242.70		5914.91

3- 3 weight of surcharge

under H.A = 1.02 × 5.10 × 7.30 = 37.97^{t}

under H.B = 1.66 × 5.10 × 7.30 = 61.80^{t}

3 - 4 earth pressure

unit weight of soil $\gamma_s = 1.9\ {}^{t}/{m^3}$

angle of internal friction $\phi = 35°$

(1) active pressure

$$Pa = \frac{1}{2} \cdot K \cdot \gamma_s \cdot H^2 \cdot L$$

$$= 1/2 \times \frac{1 - \sin 35°}{1 + \sin 35°} \times 1.9 \times 13.00^2 \times 7.30 = 317.60^{t}$$

(2) active pressure due to surcharge

under H.A surcharge

$q = 1.02\ {}^{t}/{m^2}$

$Pa\ add = K \cdot q \cdot H \cdot L$

$= 0.27 \times 1.02 \times 13.00 \times 7.30 = 26.14^{t}$

under H B surcharge

$q = 1.66\ {}^{t}/{m^2}$

$Pa\ add = K \cdot q \cdot H \cdot L$

$= 0.27 \times 1.66 \times 13.00 \times 7.30 = 42.53^{t}$

3-5 temperature load

$$P_H = \frac{G_0 \cdot A \cdot \delta}{\Sigma \cdot te}$$

$$\delta = \alpha \cdot l \qquad \alpha = \begin{cases} P.C \longrightarrow 0.7 \\ R.C \longrightarrow 0.5 \end{cases}$$

$$\begin{bmatrix} \delta = 0.7 \times 29.20 = 20.44^{mm} \\ R(d+l) = 316.6 \times 1/4 \times 1.4 = 110.81^{t} \end{bmatrix}$$

RING SHOE

- 120 TON
- $D\phi$: 56 cm
- $d\phi$: 32 cm
- A : 2463 cm^2
- t ; 7.3 cm
- G_0 : 13.5 kg/cm^2 (modulus of rigidity)

$$P_H = \frac{13.5 \times 2463 \times 2.04}{7.3} = 9292^{kg} = 9.29^{t}$$

$$\Sigma P_H = n \cdot P_H \cdot 1/2$$

$$= 4 \times 9.29 \times 1/2 = 18.58^{t}$$

§ 4 CALCULATION OF STABILITY

case 1 HA loading

	N (t)	x (m)	N·x (tm)	H (t)	y (m)	H·y (tm)
WDL, WLL	316.60	2.450	775.67	—	—	—
F B	—	—	—	25.80	10.667	275.21
T	—	—	—	18.58	10.667	198.19
W. Ws. WT	1,242.70	—	5,914.91	—	—	—
Ws add	37.97	5.450	206.94	—	—	—
P a	—	—	—	317.60	4.333	1,376.16
Pa add	—	—	—	26.14	6.500	169.91
TOTAL	1,597.27	—	6,897.52	388.12	—	2,019.47

1) check for eccentric

$$x = \frac{\Sigma Nx - \Sigma HY}{\Sigma N} = \frac{6{,}897.52 - 2{,}019.47}{1{,}597.27} = 3.05^{m}$$

$$e = \frac{B}{2} - x = \frac{8.00}{2} - 3.05 = 0.95^{m} < \frac{B}{6} = 1.33^{m}$$

2) soil reaction

$$q = \frac{\Sigma N}{B \cdot L}\left(1 \pm \frac{6 \cdot e}{B}\right) = \frac{1{,}597.27}{8.00 \times 7.30} \times \left(1 \pm \frac{6 \times 0.95}{8.00}\right)$$

$$= \begin{cases} 46.84 \ t/m^2 \\ 7.86 \end{cases} < 60 \ t/m^2$$

3) check for sliding

$$H_u = C \cdot A' + N \cdot \tan\phi' \qquad c = 0 \qquad \tan\phi' = 0.6$$

$$F = \frac{H_u}{\Sigma H} = \frac{1{,}597.27 \times 0.6}{388.12} = 2.47 > F_a = 1.5$$

case 2 HB loading

	N (t)	x (m)	N·x (tm)	H (t)	y (m)	H·y (tm)
WDL. WLL	332.20	2.450	813.89	—	—	—
F B	—	—	—	38.20	10.667	407.48
T	—	—	—	18.58	10.667	198.19
W, Ws, WT	1242.70	—	5914.91	—	—	—
Ws add	61.80	5.450	336.81	—	—	—
P a	—	—	—	317.60	4.333	1376.16
Pa add	—	—	—	42.53	6.500	276.45
TOTAL	1 636.70	—	7065.61	416.91	—	2 258.28

1) check for eccentric

$$x = \frac{\Sigma N{\cdot}x + \Sigma H{\cdot}y}{\Sigma N} = \frac{7065.61 - 2258.28}{1\,636.70} = 2.94^{m}$$

$$e = \frac{B}{2} - x = \frac{8.00}{2} - 2.94 = 1.06^{m} < \frac{B}{3} = 1.33^{m}$$

2) soil reaction

$$q = \frac{1636.70}{8.00 \times 7.30} \times \left(1 \pm \frac{6 \times 1.06}{8.00}\right) = \begin{cases} 50.31\ ^{t}/_{m^2} \\ 5.74 \end{cases} < 75\ ^{t}/_{m^2}$$

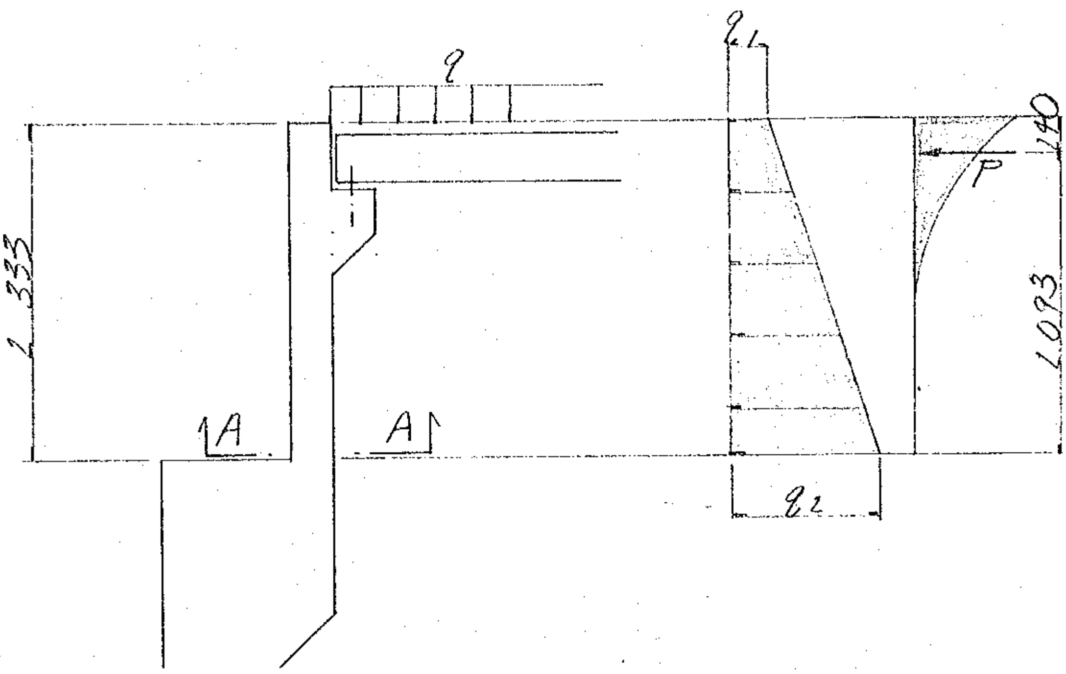
3) check for sliding

$$Hu = c{\cdot}A' + N \cdot \tan\phi' \qquad c = 0 \qquad \tan\phi' = 0.6$$

$$F = \frac{Hu}{\Sigma H} = \frac{0.6 \times 1636.70}{416.91} = 2.36 > Fa = 1.2$$

§ 5 CALCULATION OF PARAPET SECTION

5-1 dimenston and loading



	q_1	q_2
HA loading	0.28	1.48
HB loading	0.45	1.65

$$q_1 = q \cdot K = 0.27 \cdot q \quad t/m^2$$

$$q_2 = K \cdot \gamma_s \cdot H + q_1 = 0.513 \cdot H + 0.27 \cdot q \quad ''$$

5 - 2 sectional force of parapet

CASE 1 (HA)

$$S = 1/2 \times (0.28 + 1.48) \times 2.333 = 2.05 \ t$$

$$M = 2.05 \times 1/3 \times 2.333 \times \frac{2 \times 0.28 + 1.48}{0.28 + 1.48} = 1.85 \ tm$$

CASE 2 (HB)

$$S = 1/2 \times (0.45 + 1.65) \times 2.333 = 2.45 \ t$$

$$M = 2.45 \times 1/3 \times 2.333 \times \frac{2 \times 0.45 + 1.65}{0.45 + 1.65} = 2.31 \ tm$$

CASE 3

$$S = 10.97 \times 0.27 = 2.96 \ t$$

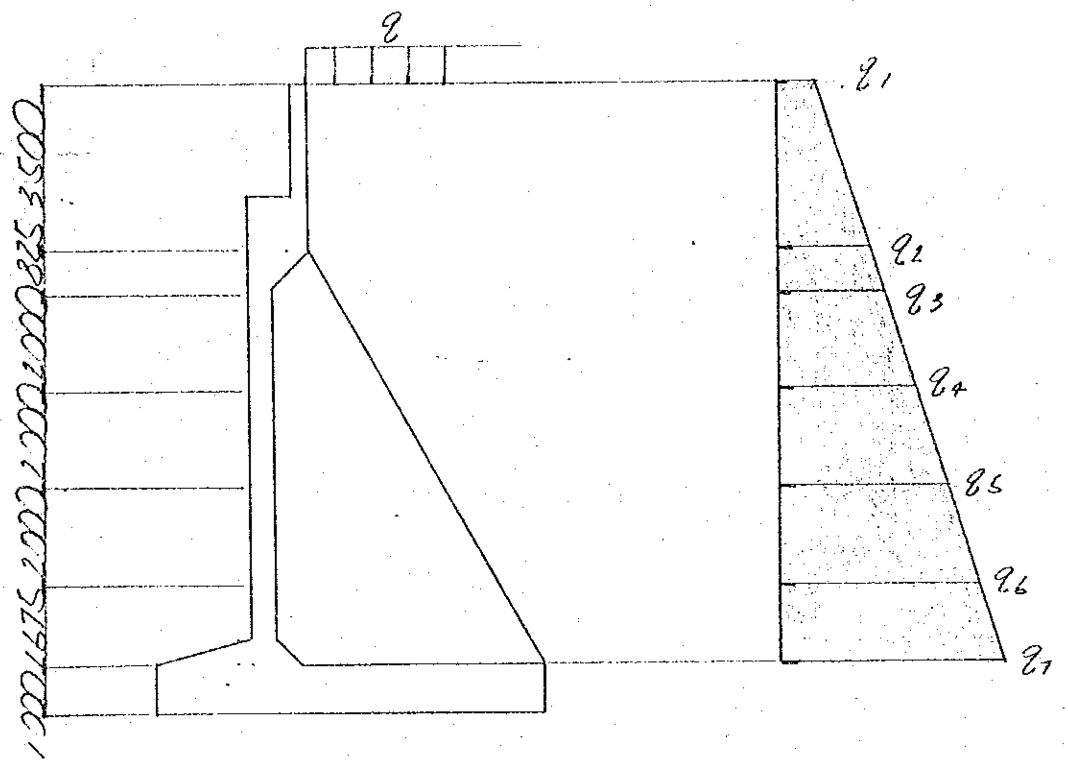
$$M = 2.96 \times 2.093 = 6.20 \ tm$$

5 − 3 list of stresses $\sigma c . \sigma s . \tau$: working stress.
$\sigma ca, \sigma sa, \tau a$: Permissible stress.

	case 1	case 2				
M	1.85	2.31				
N	———	———				
S	2.05	2.45				
b	100	100				
h	23	23				
d′	7	7				
As	D16@125 16.08	→				
As′	———	———				
f/d	0	0				
M'/bd^2	3.50	4.44				
S/bd	0.89	1.08				
n·P	0.1049	→				
C	6.24	→				
S	10.86	→				
Z	1.14	→				
σc	22	28				
σs	570	724				
τ	1.01	1.23				
σca	83	103				
σsa	2346	2933				
τa	2.35	2.94				

§ 6 CALCULATION OF WALL SECTION

6 – 1 dimension and loading

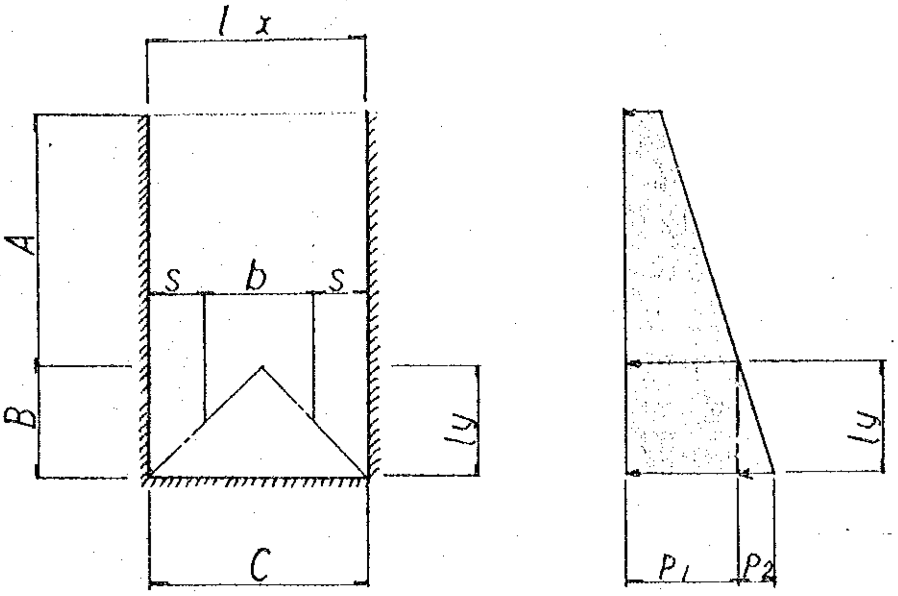


	q_1	q_2	q_3	q_4	q_5	q_6	q_7
HA loading	0.28	2.08	2.50	3.52	4.55	5.58	6.44
HB loading	0.45	2.25	2.66	3.69	4.72	5.75	6.61

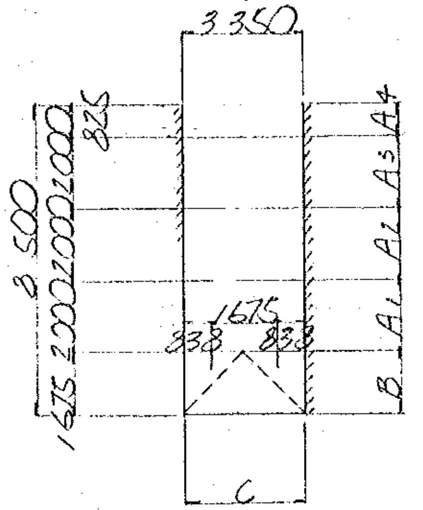
$q_1 = q \cdot K \quad = 0.27 \cdot q$ t/m²

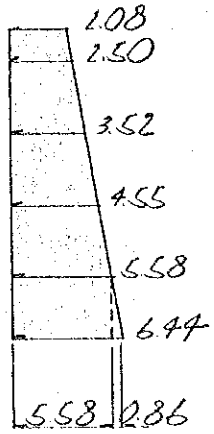
$q_x = K \cdot \gamma_s \cdot H_x + q_1 \quad = 0.513 \cdot H_x + 0.27 \cdot q$ "

6-2 sectional force of wall



	A	B	C
M (tm)	$\frac{p \cdot lx^2}{10}$	$\frac{p \cdot s^2}{6 \cdot lx}(2 \cdot lx + b)$	$\frac{1}{2}(\frac{P_1}{2} + \frac{P_2}{6}) ly^2$
S (t)	$\frac{p \cdot lx}{2}$	$p \cdot s$	$(P_1 + \frac{P_2}{2}) ly$





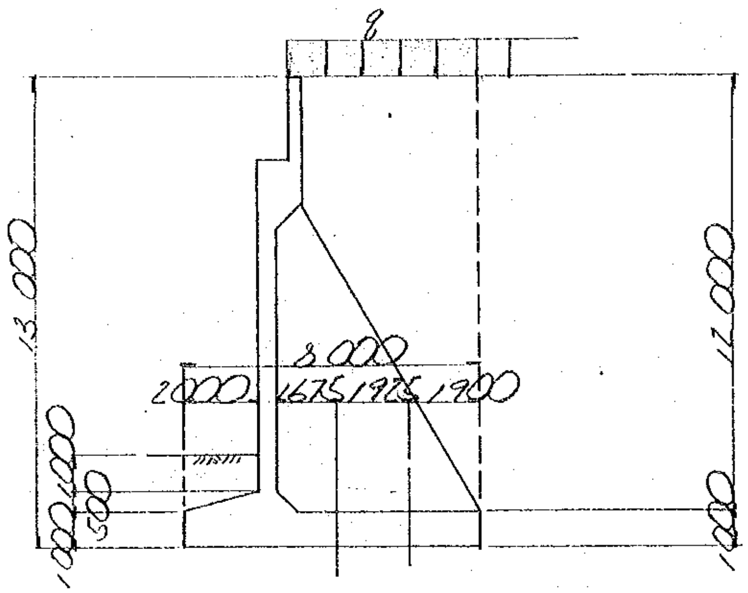
	M	(tm)	S	(t)
C−C	$\frac{1}{2}\times\left(\frac{5.58}{2}+\frac{0.86}{6}\right)\times1.675^2$	4.11	$\left(5.58+\frac{0.86}{2}\right)\times1.675$	10.07
B−B	$\frac{6.01\times0.838^2}{6\times3.35}\times(2\times3.35+1.675)$	1.76	6.01×0.838	5.04
A1−1	$\frac{5.58\times3.35^2}{10}$	6.26	$\frac{5.58\times3.35}{2}$	9.35
A2−2	$\frac{4.55\times3.35^2}{10}$	5.11	$\frac{4.55\times3.35}{2}$	7.62
A3−3	$\frac{3.52\times3.35^2}{10}$	3.95	$\frac{3.52\times3.35}{2}$	5.90
A4−4	$\frac{2.50\times3.35^2}{10}$	2.81	$\frac{2.50\times3.35}{2}$	4.19

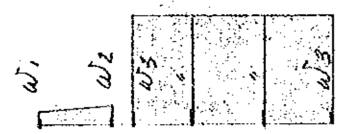
6 − 3 list of stresses   σc, σs, τ : working stress.
σca, σsa, τa : Permissible stress.

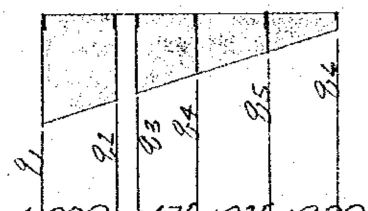
	C − C	B − B	A1 − 1	A2 − 2	A3 − 3	A4 − 4
	A_s min = 100 × 43 × 0.0015 = 6.45 cm^2					
M	4.11	1.76	6.26	5.11	3.95	2.81
N	—	—	—	—	—	—
S	10.07	5.04	9.35	7.62	5.90	4.19
b	100	→				
h	43	→				
d'	7	→				
As	※D16@250 8.04	→				
As'	—	—	—	—	—	—
f/d	↓	↓	0	↓	↓	↓
M'/bd²			3.89			
S/bd			2.17			
n·P			0.0280			
C			10.22			
S			38.36			
Z			1.08			
σc			35			
σs			1949			
τ	↓	↓	2.4	↓	↓	↓
σca	83	→				
σsa	2346	→				
τa	2.35	→				

§ 7 CALCULATION OF FOOTING SECTION

7-1 dimenston and loading







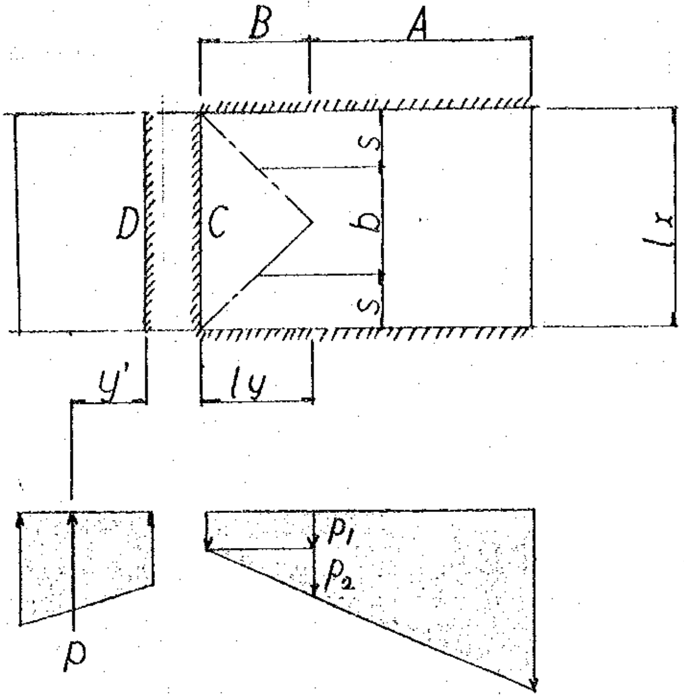
$w_1 = 1.00 \times 2.41 + 1.50 \times 1.9 = 5.26$ t/m²

$w_2 = 1.50 \times$ 〃 $+ 1.00 \times$ 〃 $= 5.52$ 〃

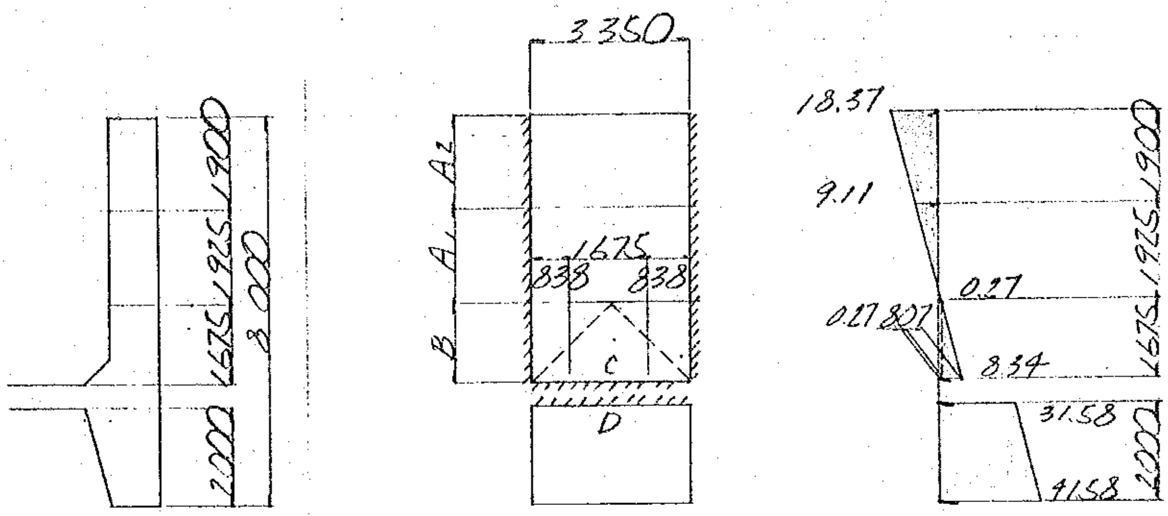
$w_3 = 1.00 \times$ 〃 $+ 12.00 \times$ 〃 $+ q = 25.21 + 8$ 〃

	q 1	q 2	q 3	q 4	q 5	q 6
HA loading	46.84	37.10	34.66	26.50	17.12	7.86
HB loading	50.31	39.17	36.38	27.05	16.33	5.74

7-2 sectional force of footing



	A	B	C	D
(tm) M	$\frac{p \cdot lx^2}{10}$	$\frac{p \cdot s}{6 \cdot lx}(2 \cdot lx + b)$	$\frac{1}{2}(\frac{p_1}{2} + \frac{p_2}{6}) ly^2$	$p \cdot y'$
(t) S	$\frac{p \cdot lx}{2}$	$p \cdot s$	$(p_1 + \frac{p_2}{2}) \cdot ly$	p



	M (tm)		S (t)	
D − D	$73.16 \times \frac{2.00}{3} \times \left(\frac{2\times41.58+31.58}{41.58+31.58}\right)$	76.39	$\frac{1}{2} \times (31.58+41.58) \times 2.00$	73.16
C − C	$\frac{1}{2} \times \left(\frac{0.27}{2}+\frac{8.07}{6}\right) \times 1.675^2$	2.08	$\left(0.27+\frac{8.07}{2}\right) \times 1.675$	7.21
B − B	$\frac{4.31 \times 0.838^2}{6 \times 3.35} \times (2\times3.35+1.675)$	1.26	4.31×0.838	3.61
A1 − 1	$\frac{9.11 \times 3.35^2}{10}$	10.22	$\frac{9.11 \times 3.35}{2}$	15.26
A2 − 2	$\frac{18.37 \times 3.35^2}{10}$	20.62	$\frac{18.37 \times 3.35}{2}$	30.77
A3 − 3	———	——	———	——

7 -3 list of stresses $\sigma c.\sigma s.\tau$: working stress.
$\sigma ca, \sigma sa, \tau a$: Permissible stress.

	※As min = 100 × 90 × 0.0015 = 13.50 cm²					
	D — D	C — C	B — B	A1 — 1	A2 — 2	
M	76.39	2.08	1.26	10.22	20.62	
N	——	——	——	——	——	
S	73.16	7.21	3.61	15.26	30.77	
b	100	——→				
h	140	90	——→			
d'	10	——→				
As	D20@125 25.12	*D16@125 16.08	——→			
As'	——	——	——	——	——	
f/d	0				0	
M'/bd²	3.90				2.55	
S/bd	5.23				3.42	
n·P	0.0269				0.0268	
C	10.40				10.42	
S	39.93				40.10	
Z	1.07				1.07	
σc	41				27	
σs	2334				1531	
τ	5.2				3.4	
σca	83	——→				
σsa	2346	——→				
τa	3.5	——→				

Check for stirrups

Sect D - D

$$\tau = \frac{S}{b \cdot d} Z = \frac{73.16 \times 10^3}{100 \times 140} \times 1.07 = 5.59 \ kg/cm^2 > \tau_a = 2.35 \ kg/cm^2$$

$$S' = S - S_c$$

$$S_c = \tau_a \cdot b \cdot d \cdot 1/Z = 2.35 \times 100 \times 140 \times 1/1.07 = 30.75 \times 10^2 \ kg$$

$$S' = (73.16 - 30.75) \times 10^3 = 42.41 \times 10^3 \ kg$$

$$\text{Req } A_v = \frac{S' \times a}{\sigma_{sa} \cdot d} \times Z = \frac{42.41 \times 10^3 \times 25}{1780 \times 140} \times 1.07 = 4.55 \ cm^2$$

Φ 20 - ctc 250 $n = 2$

$$A_v = 3.14 \times 2 = 6.28 > \text{Req } A_v = 4.55 \ cm^2$$

Sect A_2 - 2

$$\tau = \frac{S}{b \cdot d} Z = \frac{30.77 \times 10^3}{100 \times 90} \times 1.07 = 3.66 \ kg/cm^2 > \tau_a = 2.35 \ kg/cm^2$$

$$S' = S - S_c$$

$$S_c = \tau_a \cdot b \cdot d \cdot 1/Z = 2.35 \times 100 \times 90 \times 1/1.07 = 19.77 \times 10^3 \ kg$$

$$S' = (30.77 - 19.77) \times 10^3 = 11.00 \times 10^3 \ kg$$

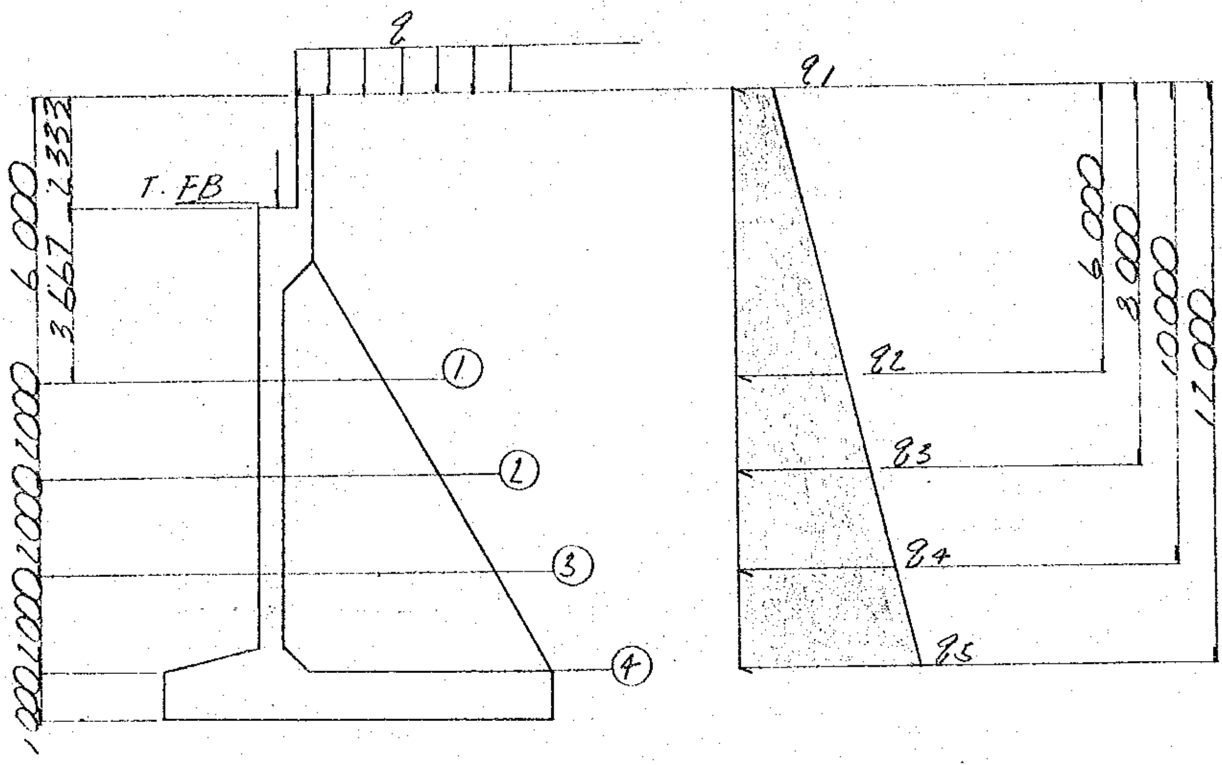
$$\text{Req } A_v = \frac{S' \times a}{\sigma_{sa} \times d} Z = \frac{11 \times 10^3 \times 25}{1780 \times 90} \times 1.07 = 1.84 \ cm^2$$

Φ 16 - ctc 250 $n = 2$

$$A_v = 2.01 \times 2 = 4.02 \ cm^2 > \text{Req } A_v = 1.84 \ cm^2$$

§ 8 CALCULATION OF BUTTRESS SECTION

8 - 1 dimenston and loading



$$q_x = (K \cdot \gamma_s \cdot H + q \cdot K) \cdot l$$

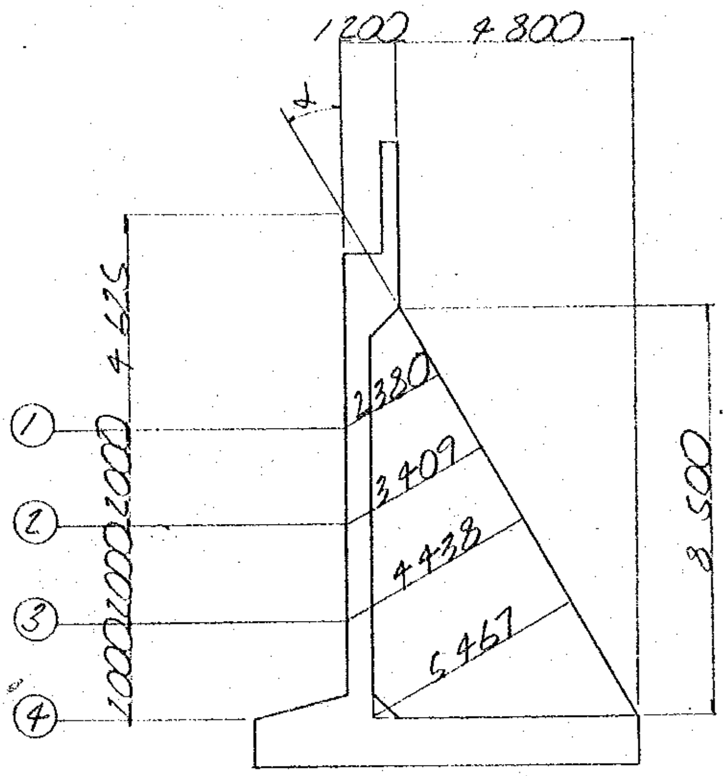
	(t) F B	(t) T	(t) FB + T	(t) $\frac{(FB+T)\,l}{B}$
HA loading	25.80	18.58	44.38	20.37
HA loading	38.20	18.58	56.78	26.05

	q 1	q 2	q 3	q 4	q 5	q 6
HA loading	0.92	11.23	14.67	18.11	21.54	—
HB loading	1.50	11.81	15.25	18.69	22.12	—

8 − 2 sectional force of buttress

		HA loading			HB loading		
		H (t)	y (m)	H·y (tm)	H (t)	y (m)	H·y (tm)
1 - 1	FB · T	20.37	3.667	74.70	26.05	3.667	95.53
	Pa	36.45	2.151	78.40	39.93	2.225	88.84
	Σ	56.82		153.10	65.98		184.37
2 - 2	FB · T	20.37	5.667	115.44	26.05	5.667	147.63
	Pa	62.36	2.824	176.10	67.00	2.905	194.64
	Σ	82.73		291.54	93.05		342.27
3 - 3	FB · T	20.37	7.667	156.18	26.05	7.667	199.73
	Pa	95.15	3.494	332.45	100.95	3.581	361.50
	Σ	115.52		488.63	127.00		561.23
4 - 4	FB · T	20.37	9.667	196.92	26.05	9.667	251.83
	Pa	134.76	4.164	561.14	141.72	4.254	602.88
	Σ	155.13		758.06	167.77		854.71
5 - 5	FB · T						
	Pa						
	Σ						

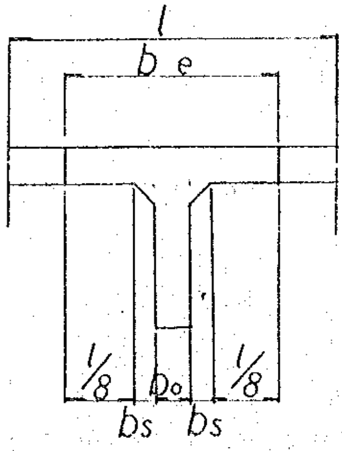
8 – 3 calculation of members



$$\tan\alpha = \frac{4.80}{8.50} = 0.565$$

$$\alpha = 29°27'$$

$$H = h \cdot \sin\alpha$$
$$= 0.4917 \cdot h$$



$$b_e = b_0 + 2\left(b_s + \frac{l}{8}\right) = 60 + 2 \times (30 + 42)$$
$$= 204^{\,cm}$$

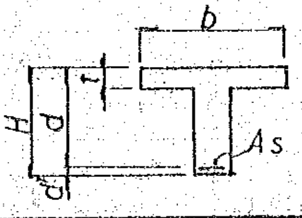
8 - 4 list of stresses

σ_c, σ_s, τ : working stress.

σ_{ca}, σ_{sa}, τ_a : Permissible stress.

※ A_s min = 50 · d × 0.0015 = 0.075 · d cm^2

		1 − 1	2 − 2	3 − 3	4 − 4	
M	tm	153.10	291.54	488.63	758.06	
S	t	56.82	82.73	115.52	155.13	
b	cm	204	204	204	204	
t	〃	50	50	50	50	
d	〃	228	331	434	537	
A_s	cm^2	5 − D32 40.20 ※(17.10)	5/1 > D32 48.24 ※(24.83)	5/3 > D32 64.32 ※(32.55)	5/5 > D32 80.40 ※(40.28)	
P		0.0009	0.0007	0.0007	0.0007	
t/d		0.219	0.151	0.151	0.093	
K		0.162	0.136	0.136	0.144	
j		0.968	0.956	0.956	0.961	
σ_s	kg/cm^2	1726	1910	1831	1827	
σ_c	〃	23	20	19	21	
τ	〃	4.98	4.99	5.32	5.18	
σ_{sa}	〃	83	→	→	→	
σ_{ca}	〃	2346	→	→	→	
τ_a	〃	8.2	→	→	→	



8 - 5 check for tie bers

1) wall and buttress

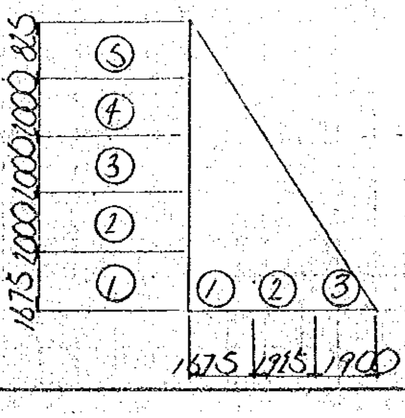
$$As = \frac{S}{\sigma sa} \quad (cm^2)$$

		S (t)	As (cm²)	As'	(cm²)
section	1 — 1	5.04	2.15	D16 ctc 250	8.04
	2 — 2	9.35	3.99	↓	↓
	3 — 3	7.62	3.25		
	4 — 4	5.90	2.51		
	5 — 5	4.19	1.79	↓	↓

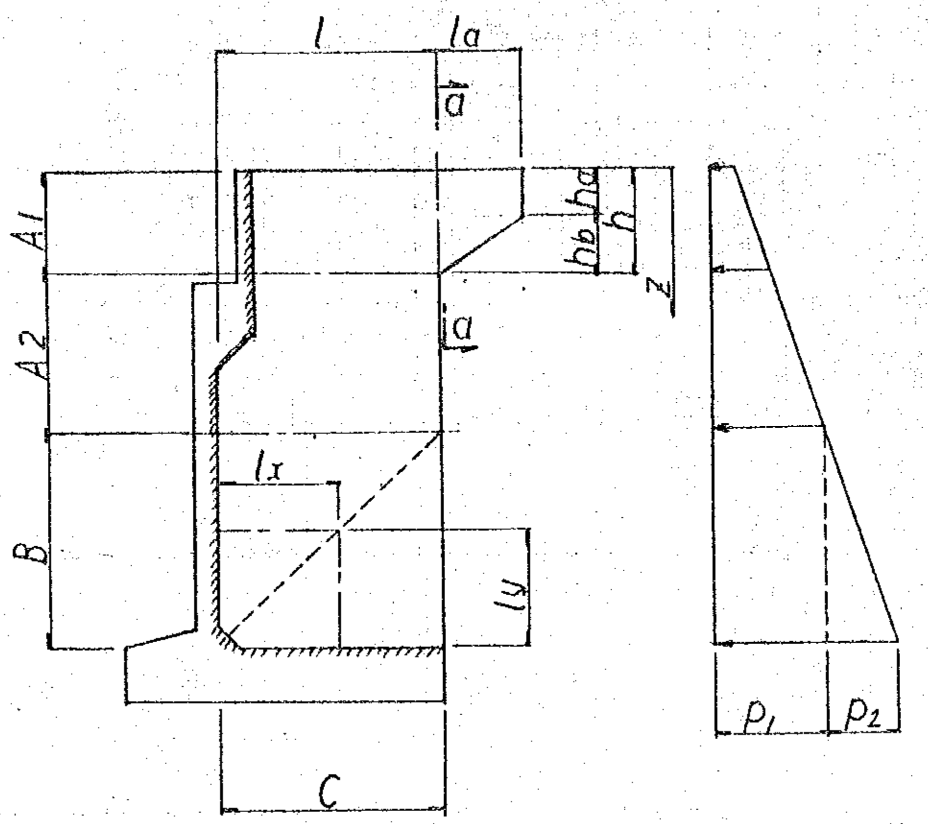
2) footing and buttress

$$As = \frac{S}{\sigma sa} \quad (cm^2)$$

		S (t)	As (cm²)	As'	(cm²)
section	1 1	3.61	1.54	D16 ctc 250	8.04
	2 2	15.26	6.50	↓	↓
	3 3	30.77	13.12	D16 ctc 125	16.08



§ 9 CALCULATION OF WING SECTION



		S (t)	M (tm)
a–a	$0 < z < h_a$	$(q + \gamma \cdot z) \cdot K \cdot l_a$	$(q + \gamma \cdot z) \cdot K \cdot \frac{l_a^2}{2}$
	$h_a < z < h$	$(q + \gamma \cdot z) \cdot K \cdot l_a \cdot \frac{h - z}{h_b}$	$(q + \gamma \cdot z) \cdot K \cdot \frac{l_a^2}{2} \cdot \left(\frac{h - z}{h_b}\right)^2$

$$M_{max} \quad (h_a < z < h) \longrightarrow z = \frac{\gamma \cdot h - 2 \cdot q}{3 \gamma} \quad (m)$$

$$q = 1.02 \quad t/m^2$$

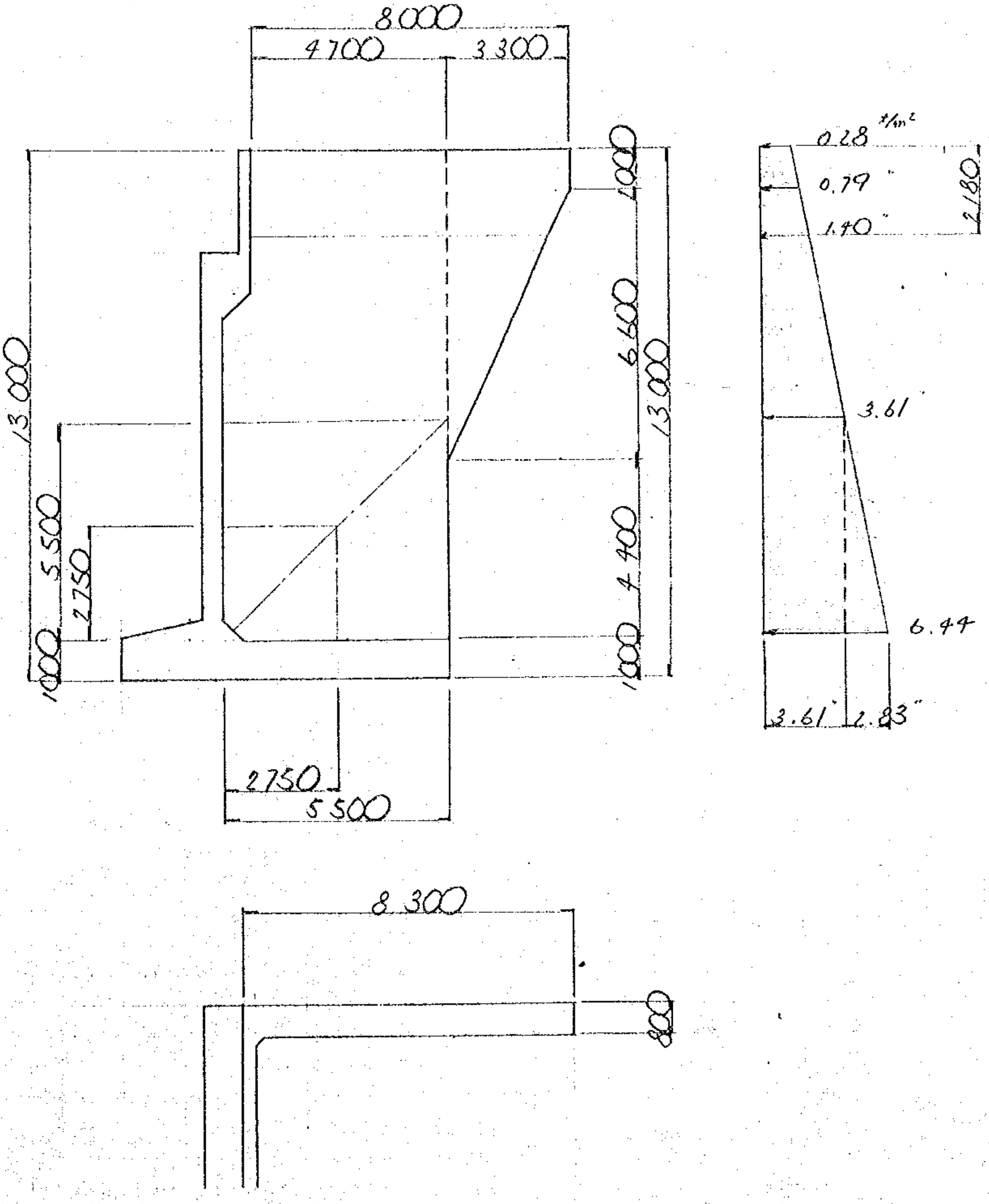
$$K = 0.27$$

$$\gamma = 1.9 \quad t/m^3$$

	M (t)	S (tm)
A1 − 1	$\frac{1}{2} p \cdot l^2 + Ma + Sa \cdot l$	$p \cdot l + Sa$
A2 − 2	$\frac{1}{2} \cdot p \cdot l^2$	$p \cdot l$
B − B	$\frac{1}{2} \cdot p \cdot lx^2$	$p \cdot lx$
C − C	$(\frac{p_1}{2} + \frac{p_2}{6})\, ly^2$	$(p_1 + \frac{p_2}{2}) \cdot ly$

(E - RAMP , A2 , L)

9 - 1 dimension and loading



		x (m)	M (tm)		S (t)	
a–a	1 − 1	1.00	$(1.02+1.9\times1.00)\times0.27\times\frac{1}{2}\times3.30^2$	4.29	$(1.02+1.9\times1.00)\times0.27\times3.30$	2.60
	2 − 2	1.00 ~ 7.60	$(1.02+1.9\times2.18)\times0.27\times\frac{3.30^2}{2}\times\left(\frac{7.60-2.18}{6.60}\right)^2$	5.12	$(1.02+1.9\times2.18)\times0.27\times3.30\times\frac{7.60-2.18}{6.60}$	3.78
A 1		0 ~ 7.60	$\frac{1}{2}\times1.40\times5.50^2+5.12+3.78\times5.50$	47.09	$1.40\times5.50+3.78$	11.48
A 2	1 − 1		$\frac{1}{2}\times3.61\times5.50^2$	54.60	3.61×5.50	19.86
	2 − 2	—	—	—	—	—
B − B		7.60 ~ 12.00	$\frac{1}{2}\times\frac{3.61\times6.44}{2}\times2.75^2$	19.00	$\frac{3.61+6.44}{2}\times2.75$	13.82
C − C		12.00	$\left(\frac{3.61}{2}+\frac{2.83}{6}\right)\times2.75^2$	16.90	$\left(3.61+\frac{2.83}{2}\right)\times2.75$	13.82

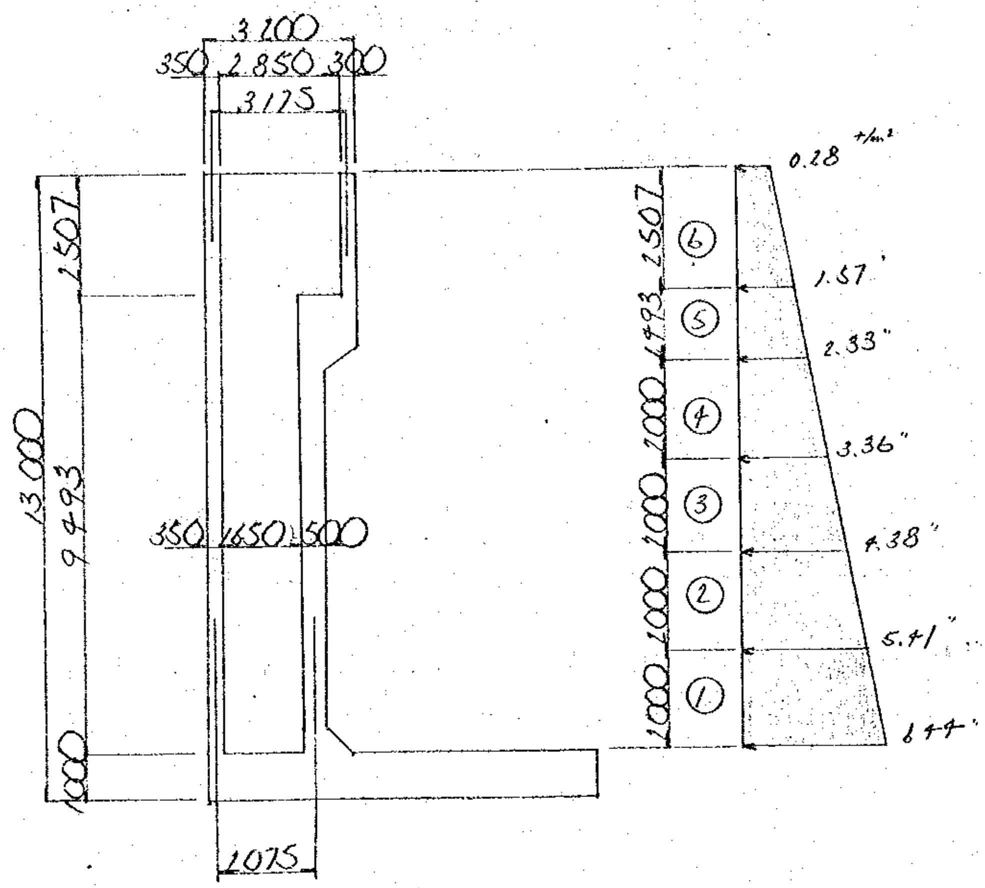
$$x = \frac{1.9\times7.60-2\times1.02}{3\times1.9} = 2.18^{m}$$

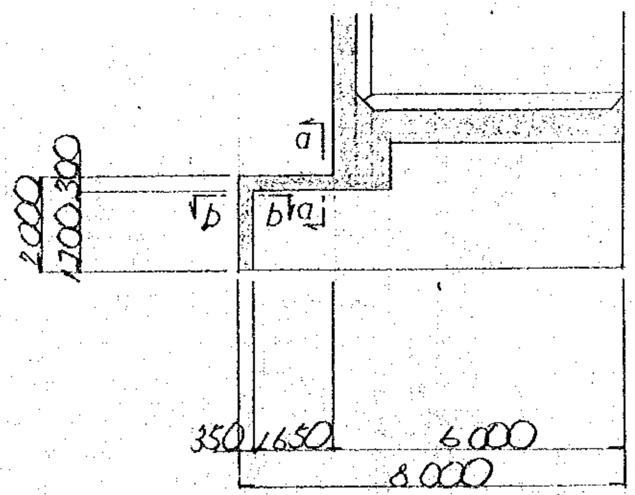
9-2 list of stresses σ_c, σ_s, τ : working stress.
σ_{ca}, σ_{sa}, τ_a : permissible stress.

	※ $A_{s\,min} = 100 \times 73 \times 0.0015 = 10.95\ cm^2$					
	a-a	A_1	A_2	B	C	
M	5.12	47.09	54.60	19.00	16.90	
N	—	—	—	—	—	
S	3.78	11.48	19.86	13.82	13.82	
b	100	→				
h	73	→				
d'	7	→				
As	D20@250 ※12.56	D25@125 39.28	→	D25@250 19.64	D16@125 16.08	
As'	—	—	—	—	—	
f/d		0	0	0	0	
M'/bd^2		10.64	10.25	3.57	3.17	
S/bd		2.02	2.72	1.89	1.89	
n·P		0.0807	0.0807	0.0404	0.0330	
C		6.83	6.83	8.84	9.57	
S		13.93	13.93	27.02	32.77	
Z		1.12	1.12	1.09	1.08	
σ_c		73	70	32	31	
σ_s		2222	2240	1945	1559	
τ		2.3	3.1	2.1	2.0	
σ_{ca}	83	→				
σ_{sa}	2346	→				
τ_a	2.35	3.47	→		2.35	

(E - RAMP, A2, R)

9 — 3 dimension and loading





$$M_a = \frac{w \cdot l^2}{10} \qquad M_b = \frac{w \cdot l^2}{2}$$

$$S_a = \frac{w\,l}{2} \qquad S_b = w \cdot l$$

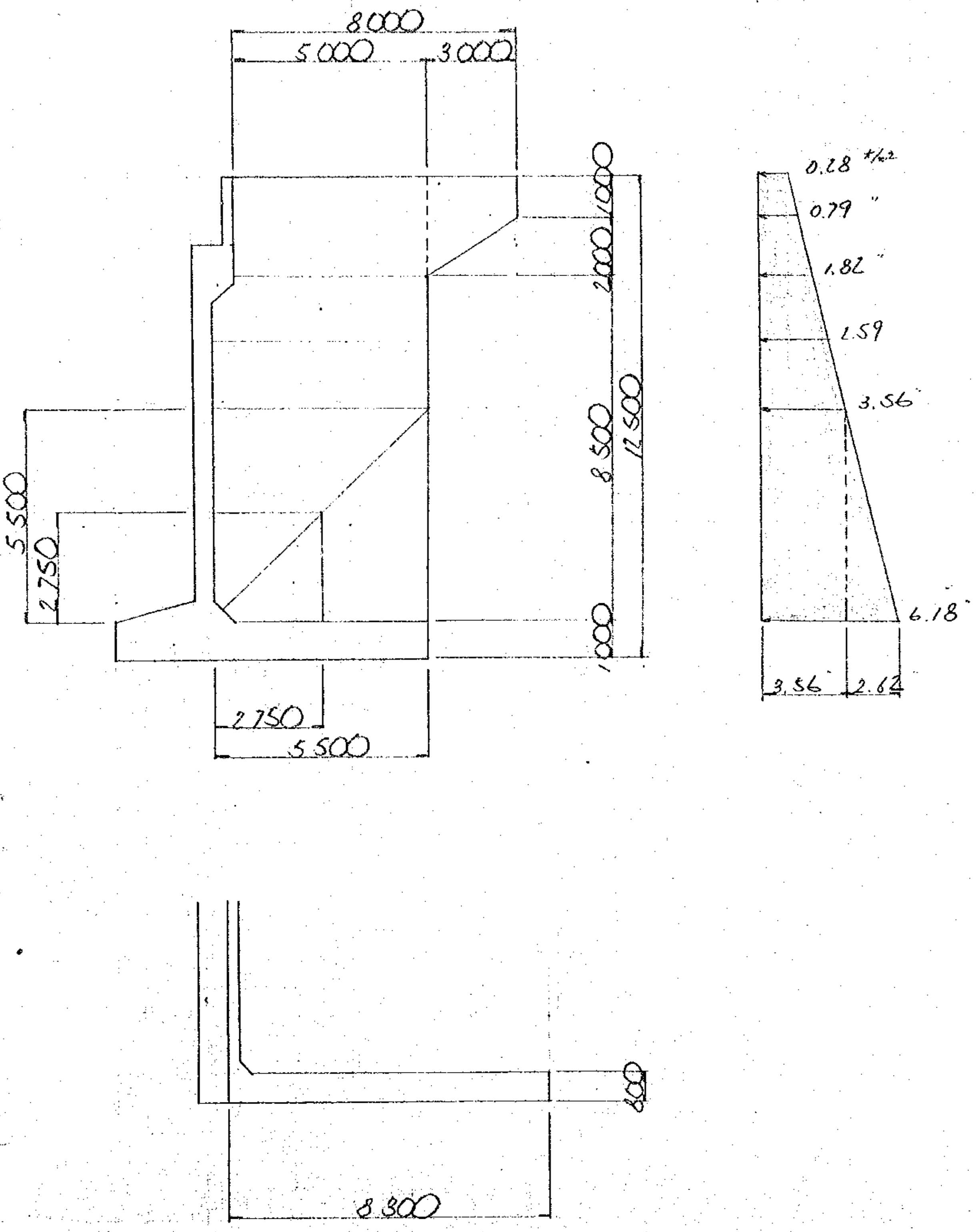
	section a-a		section b-b	
	M (tm)	S (t)	M (tm)	S (t)
①	2.84	6.76	9.31	10.95
②	2.39	5.68	7.82	9.20
③	1.93	4.60	6.33	7.45
④	1.48	3.53	4.86	5.71
⑤	1.03	2.45	3.37	3.96
⑥	1.92	2.75	2.27	2.67

9 - 4 list of stresses σ_c, σ_s, τ : working stress.
σ_{ca}, σ_{sa}, τ_a : Permissible stress.

	※ $As_{min} = 100 \times 23 \times 0.0015 = 3.45$ cm^2					
	a-a	b 1-1	b 3-3	b 5-5		
M	2.84	9.31	6.33	3.37		
N	—	—	—	—		
S	6.76	10.95	7.45	3.96		
b	100	→	→	→		
h	23	18	→	→		
d'	7	→	→	→		
As	D16 @ 250 8.04	D16 D20 > @ 125 20.60	D20 @ 250 12.56	D16 @ 250 8.04		
As'	—	—	—	—		
f/d	0	0	0	0		
M'/bd²	5.37	11.88	8.07	4.30		
S/bd	2.94	3.91	2.66	1.41		
n·P	0.0524	0.1104	0.0673	0.0431		
C	7.99	6.13	7.29	8.62		
S	21.00	10.35	16.56	25.38		
Z	1.10	1.14	1.11	1.09		
σ_c	43	73	59	37		
σ_s	1691	1843	2005	1637		
τ	3.2	3.4	2.9	1.5		
σ_{ca}	83	→	→	→		
σ_{sa}	2346	→	→	→		
τ_a	3.47	→	2.35	→		

(B-LINE-1, A2, R)

9 − 5 dimension and loading



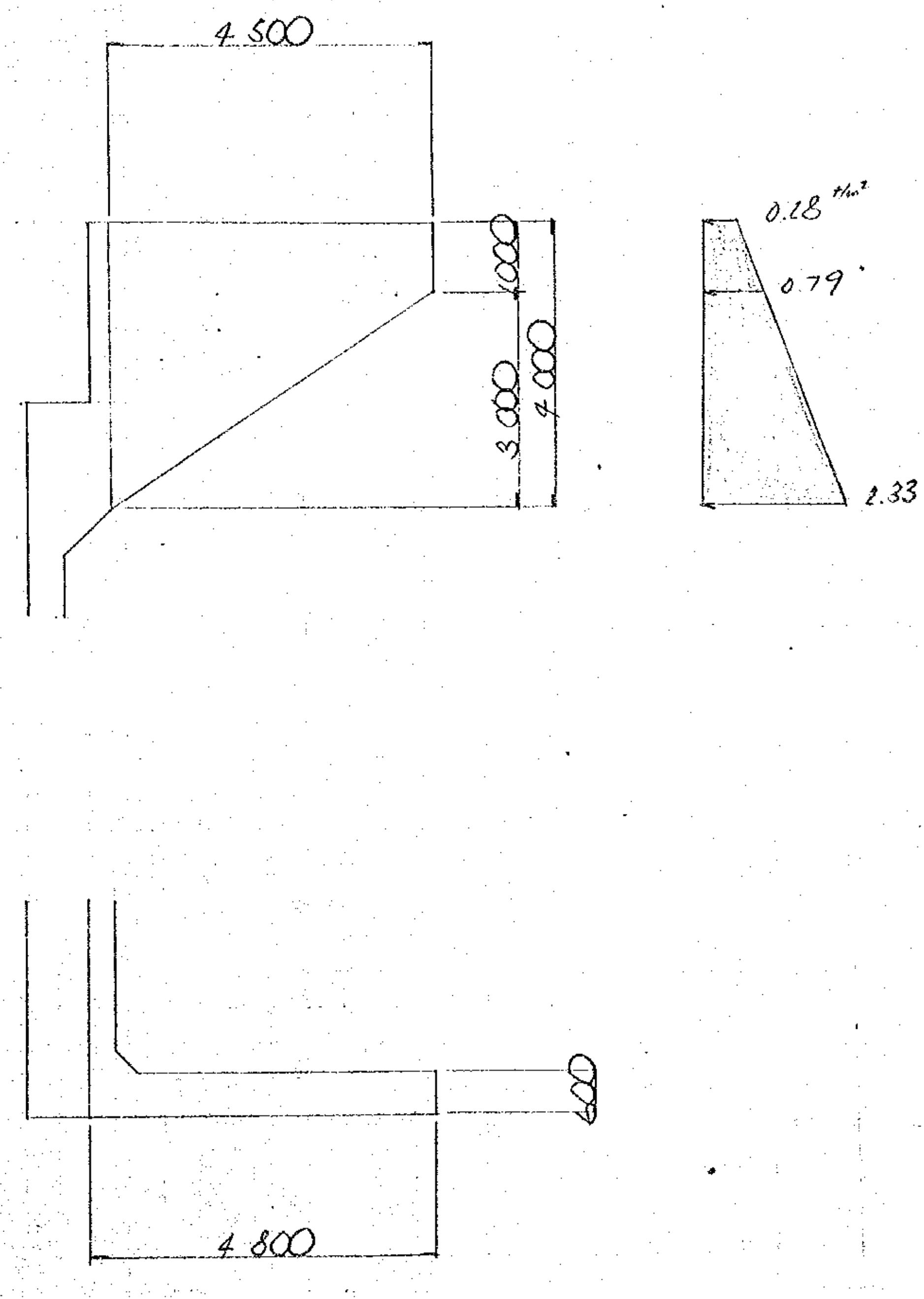
		z (m)	M	(tm)	S	(t)
a – a	1 – 1	1.00	$\frac{1}{2} \times 0.79 \times 3.00^2$	3.56	0.79×3.00	2.37
	2 – 2	—	—	—	—	—
A 1		1.00 ~ 3.00	$\frac{1}{2} \times 1.82 \times 5.00^2$	22.75	1.82×5.00	9.10
A 2	1 – 1	4.500	$\frac{1}{2} \times 2.59 \times 5.50^2$	39.17	2.59×5.60	14.24
	2 – 2	6.00	$\frac{1}{2} \times 3.56 \times 5.50^2$	53.85	3.56×5.50	19.58
B – B		6.00 ~ 11.50	$\frac{1}{2} \times \frac{3.56+6.18}{2} \times 2.75^2$	18.42	$\frac{3.56+6.18}{2} \times 2.75$	13.39
C – C		11.50	$\left(\frac{3.56}{2} + \frac{2.62}{6}\right) \times 2.75^2$	16.76	$\left(3.56 + \frac{2.62}{2}\right) \times 2.75$	13.39

$$z = \frac{1.9 \times 3.00 - 2 \times 1.02}{3 \times 1.9} = 0.64 < 1.00^{m}$$

9-6 list of stresses σ_c, σ_s, τ : working stress.
$\sigma_{ca}, \sigma_{sa}, \tau_a$: permissible stress.

	※ $A_{s\,min} = 100 \times 73 \times 0.0015 = 10.95$ cm^2					
	a−a	A_1	A_2 1−1	A_2 2−2	B	C
M	3.56	22.75	39.17	53.85	18.42	16.76
N	—	—	—	—	—	—
S	2.37	9.10	14.24	19.38	13.39	13.39
b	100	→				
h	73	→				
d'	7	→				
As	D20 @ 250 ※ 12.56	D25 @ 250 19.64	D25 D16 > @ 125 27.68	D25 @ 125 39.28	D25 @ 250 19.64	D16 @ 125 16.08
As'	—	—	—	—	—	—
f/d		0	0	0	0	0
M'/bd^2		5.20	7.35	10.11	3.46	3.15
S/bd		1.08	1.95	2.68	1.83	1.83
n·P		0.0404	0.0569	0.0807	0.0404	0.0330
C		8.84	7.75	6.83	8.84	9.57
S		27.02	19.44	13.93	27.02	32.78
Z		1.09	1.11	1.12	1.09	1.08
σ_c		46	57	69	31	30
σ_s		2108	2143	2110	1401	1547
τ		1.18	2.16	3.01	2.00	1.98
σ_{ca}	83	→				
σ_{sa}	2346	→				
τ_a	3.5	→	3.47	→	2.35	→

9 − 7 dimension and loading



		z (m)	M (tm)		S (t)	
a–a	1−1	1.00	$\frac{1}{2}\times 0.79\times 4.50^2$	8.00	0.79×4.50	3.56
	2−2	1.00 ~1.00	—	—	—	—
A 1		—	—	—	—	—
A 2	1−1	—	—	—	—	—
	2−2	—	—	—	—	—
B − B		—	—	—	—	—
C − C		—	—	—	—	—

$$z = \frac{1.9\times 4.00 - 2\times 1.02}{3\times 1.90} = 0.98 < 1.00^{m}$$

9 − 8 list of stresses $\sigma_c . \sigma_s . \tau$: working stress.
$\sigma_{ca}, \sigma_{sa}, \tau_a$: Permissible stress.

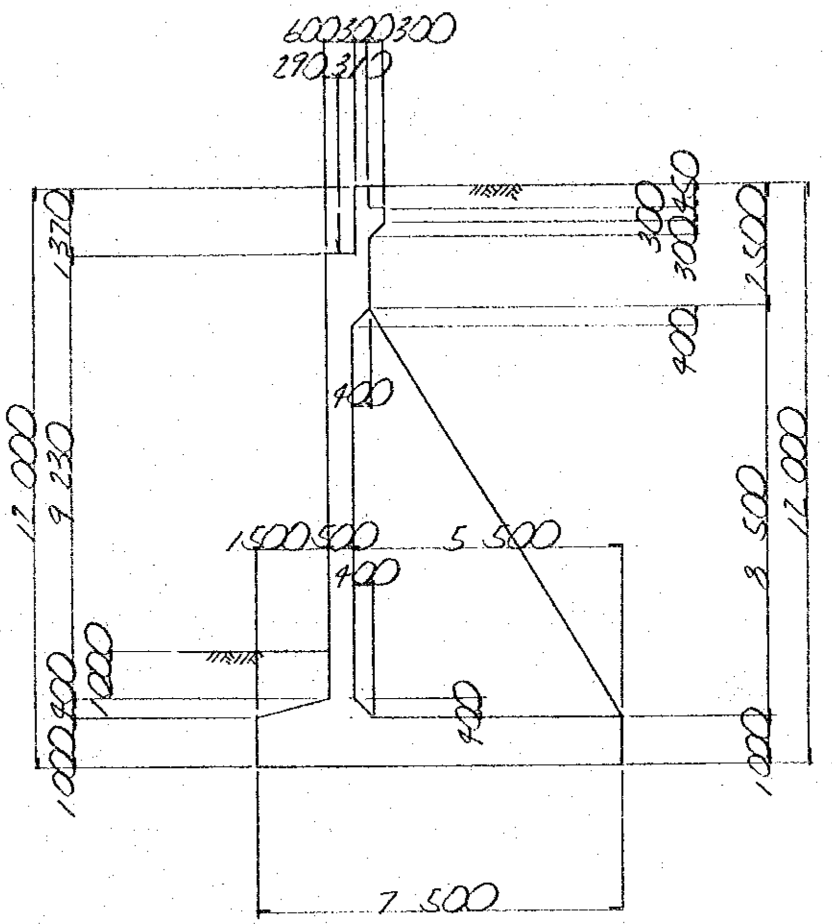
※ $A_{s\,min} = 100 \times 53 \times 0.0015 = 7.95$ cm²

	a − a					
M	8.00					
N	—					
S	3.56					
b	100					
h	53					
d'	7					
As	D16 @ 250 8.04					
As'	—					
f/d	0					
M'/bd²	2.85					
S/bd	0.67					
n·P	0.0228					
C	11.15					
S	46.99					
Z	1.07					
σ_c	32					
σ_s	2008					
τ	0.72					
σ_{ca}	83					
σ_{sa}	2346					
τ_a	2.35					

§§ 4 $H = 12.00$ m

B-L-1	A_1
B-L-3	A_1
A-L-3	A_1

§ 1 STRUCTURAL FIGURE

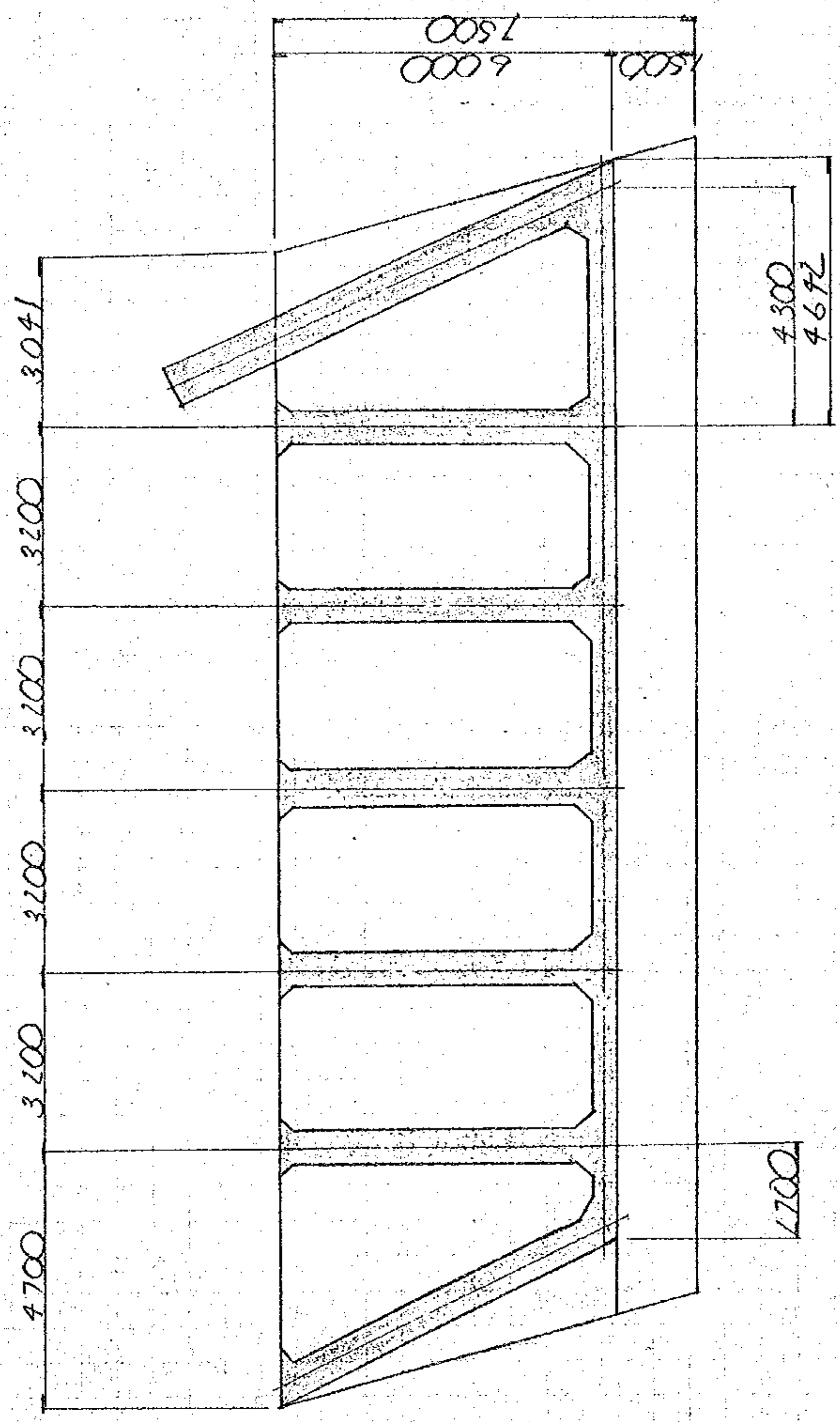


buttress span $l = 3.600^{m}$

(B – LINE 3 , A 1)

(A – LINE 3 , A 1)

(A - LINE 3 ; A1)



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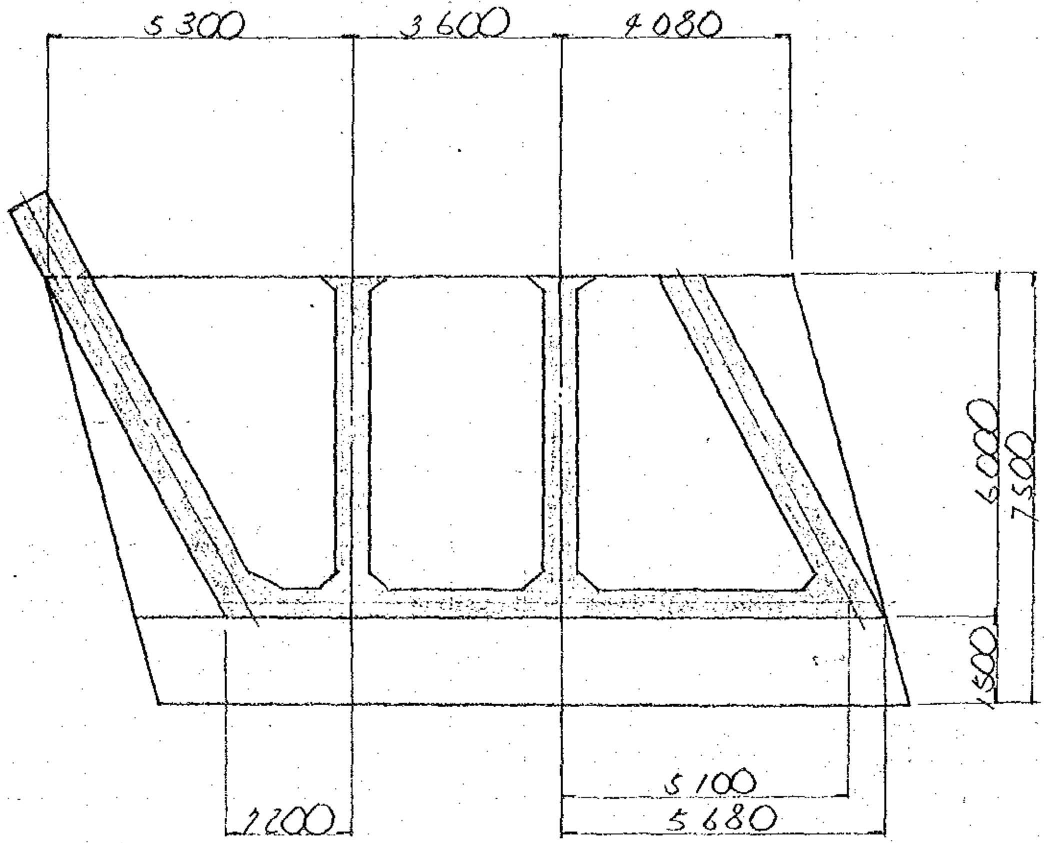
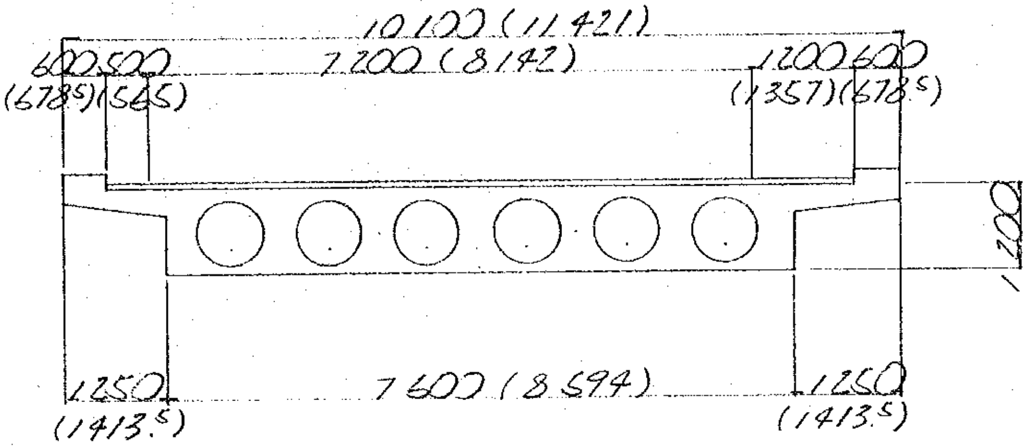
(B - LINE 3 , A1)



§ 2 REACTION OF SUPERSTRUCTURE

2 - 1 structural figure



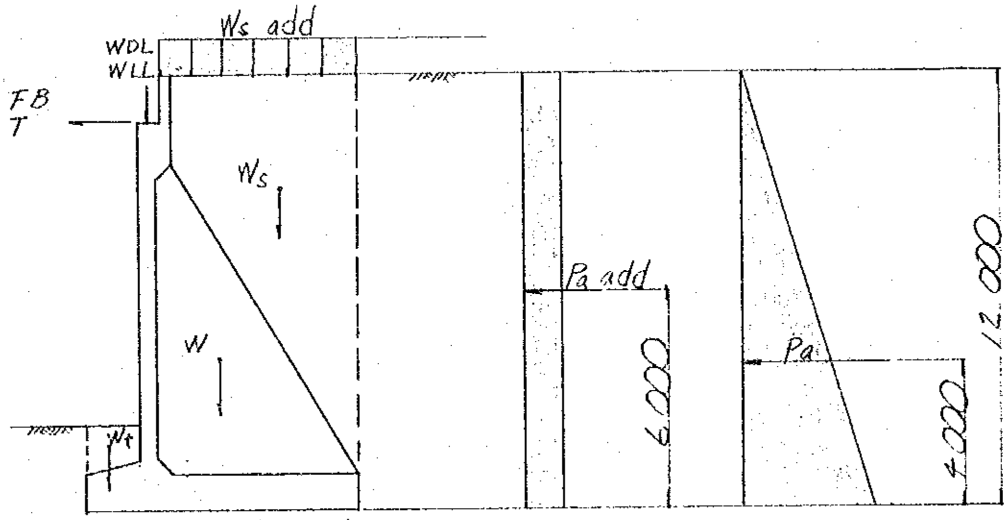
θ = 62°10'19.17"

2 - 2 whole reaction of superstructure

		HA loading		HB loading	
		N (t)	H (t)	N (t)	H (t)
dead load of deck	I	214.1	——	214.1	——
	II	32.2	——	32.2	——
live load		115.7	——	146.3	——
crowd load		——	——	——	——
longitudinal forse		——	25.8	——	38.2
TOTAL		362.0	25.8	392.6	38.2

§ 3 CALCULATION OF LOAD

3-1 loading diagram



WDL : dead load of deck

WLL : max LL reaction under HA & HB

F B : HA & HB braking

W : self weight

Ws : weight of soil

Wt : fill on toe

Ws add : weight of surcharge

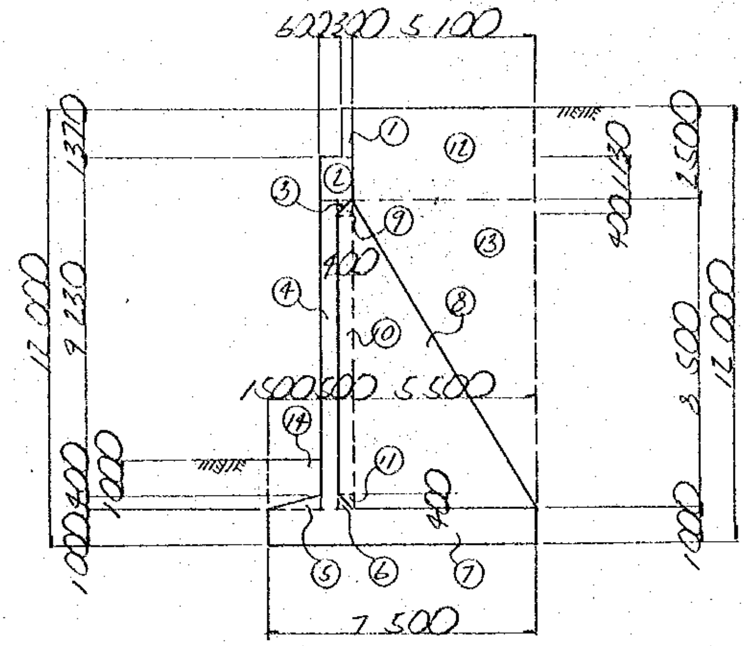
PA : active pressure

PP : passive pressure

PA add : surcharge

T : temperature load

3-2 self weight and weight of soil



$$\bar{\gamma} = \frac{2.41 \times 0.60 \times 4 + 1.9 \times 9.021}{11.421} = 2.01 \ t/m^3$$

		N (t)	x (m)	N x (t m)
①	0.30×1.37×11.421×2.41	11.31	2.250	25.45
②	0.90×1.13×11.421×2.41	27.99	1.950	54.58
③	½×0.40×0.40×11.421×2.41	2.20	2.133	4.69
④	0.50×8.50×11.421×2.41	116.98	1.750	204.72
⑤	½×1.50×0.40×11.421×2.41	8.26	1.000	8.26
⑥	½×0.40×0.40×11.421×2.41	2.20	2.133	4.69
⑦	7.50×1.00×11.421×2.41	206.43	3.750	774.13
⑧	½×5.10×8.50×11.421×2.01	497.58	4.100	2 040.08
⑨	½×0.40×0.40×11.421×2.01	1.84	2.267	4.17
⑩	0.40×7.70×11.421×2.01	70.71	2.200	155.56
⑪	½×0.40×0.40×11.421×2.01	1.84	2.267	4.17
⑫	5.10×2.50×11.421×1.9	276.67	4.950	1 369.52
⑬	½×5.10×8.50×11.421×1.9	470.35	5.800	2 728.03
⑭	½×(1.00+1.40)×1.50×11.421×1.9	39.06	0.708	27.65
Σ		1 733.42		7 405.70

3-3 weight of surcharge

under H.A $= 1.02 \times 5.40 \times 11.421 = 62.91^{t}$

under H.B $= 1.66 \times 5.40 \times 11.421 = 102.38^{t}$

3-4 earth pressure

unit weight of soil $\gamma_s = 1.9\ {}^{t}/_{m^3}$

angle of internal friction $\phi = 35°$

(1) active pressure

$$Pa = \frac{1}{2} \cdot K \cdot \gamma_s \cdot H^2 \cdot L$$

$$= 1/2 \times \frac{1 - \sin 35°}{1 + \sin 35°} \times 1.9 \times 12.00^2 \times 11.421 = 423.39^{t}$$

(2) active pressure due to surcharge

under H.A surcharge

$q = 1.02\ {}^{t}/_{m^2}$

$$Pa\ add = K \cdot q \cdot H \cdot L$$

$$= 0.27 \times 1.02 \times 12.00 \times 11.421 = 37.74^{t}$$

under H B surcharge

$q = 1.66\ {}^{t}/_{m^2}$

$$Pa\ add = K \cdot q \cdot H \cdot L$$

$$= 0.27 \times 1.66 \times 12.00 \times 11.421 = 61.43^{t}$$

3-5 temperature load

$$P_H = \frac{G_0 \cdot A \cdot \delta}{\Sigma \cdot te}$$

$$\delta = \bar{\alpha} \cdot l \qquad \bar{\alpha} = \begin{cases} P.C \longrightarrow 0.7 \\ R.C \longrightarrow 0.5 \end{cases}$$

$$\left[\begin{array}{ll} \delta = 0.5 \times 16.40 & = 8.20^{mm} \\ A = 30 \times 859.40 & = 25782^{t} \end{array} \right]$$

RING SHOE

	TON	
$D\phi$	:	cm
$d\phi$	:	cm
A	: 25782	cm^2
t	: 5.0	cm
G_0	: 13.5	kg/cm^2 (modulus of rigidity)

$$P_H = \frac{13.5 \times 25782 \times 0.82}{5.0} = 57081^{kg} = 57.08^{t}$$

$$\Sigma P_H = P_H \cdot \frac{1}{2}$$

$$= 57.08 \times 1/2 = 28.54^{t}$$

§ 4 CALCULATION OF STABILITY

case 1 HA loading

	N (t)	x (m)	N·x (tm)	H (t)	y (m)	H·y (tm)
WDL, WLL	362.00	1.790	647.98	—	—	—
F B	—	—	—	25.80	10.630	274.25
T	—	—	—	28.54	10.630	303.38
W. Ws. WT	1 733.42	—	7 405.70	—	—	—
Ws add	62.91	4.950	311.40	—	—	—
P a	—	—	—	423.39	4.00	1 693.56
Pa add	—	—	—	37.74	6.00	226.44
TOTAL	2 158.33	—	8 365.08	515.47	—	2 497.63

1) check for eccentric

$$x = \frac{\Sigma Nx - \Sigma HY}{\Sigma N} = \frac{8365.08 - 2497.63}{2158.33} = 2.72 \ m$$

$$e = \frac{B}{2} - x = \frac{7.50}{2} - 2.72 = 1.03 \ m < \frac{B}{6} = \ m$$

2) soil reaction

$$q = \frac{\Sigma N}{B \cdot L}\left(1 \pm \frac{6 \cdot e}{B}\right) = \frac{2158.33}{7.50 \times 11.421} \times \left(1 \pm \frac{6 \times 1.03}{7.50}\right)$$

$$= \begin{cases} 45.96 \ t/m^2 \\ 4.43 \ " \end{cases} < 60 \ t/m^2$$

3) check for sliding

$$Hu = C \cdot A' + N \cdot \tan\phi' \qquad c = 0 \qquad \tan\phi' = 0.6$$

$$F = \frac{Hu}{\Sigma H} = \frac{2158.33 \times 0.6}{515.47} = 2.51 > Fa = 1.5$$

case 2 HB loading

	N (t)	x (m)	N·x (tm)	H (t)	y (m)	H·y (tm)
WDL. WLL	392.60	1.790	702.75	——	——	——
F B	——	——	——	38.20	10.630	406.07
T	——	——	——	28.54	10.630	303.38
W, WS, WT	1,733.42	——	7405.70	——	——	——
Ws add	102.38	4.950	506.78	——	——	——
P a	——	——	——	423.39	4.000	1,693.56
Pa add	——	——	——	61.43	6.000	368.58
TOTAL	2,228.40		8,615.23	551.56		2,771.59

1) check for eccentric

$$x = \frac{\Sigma N \cdot x + \Sigma H \cdot y}{\Sigma N} = \frac{8615.23 - 2771.59}{2228.40} = 2.62^{m}$$

$$e = \frac{B}{2} - x = \frac{7.50}{2} - 2.62 = 1.13^{m} < \frac{B}{3} = \quad ^{m}$$

2) soil reaction

$$q = \frac{2228.40}{7.50 \times 11.421} \times \left(1 \pm \frac{6 \times 1.13}{7.50}\right) = \begin{cases} 49.53 \ t/m^2 \\ 2.50 \end{cases} < 75 \ t/m^2$$

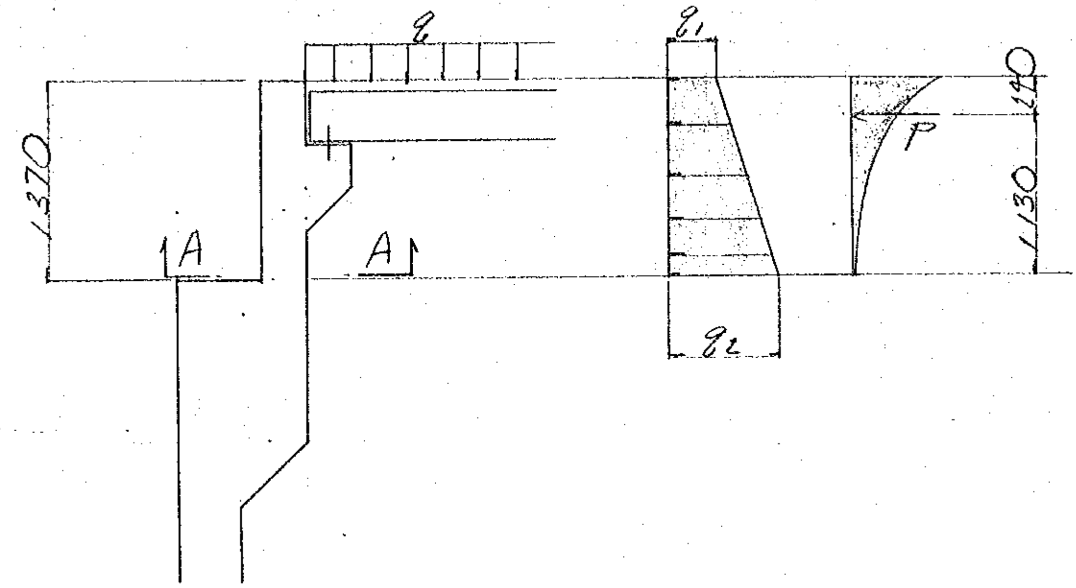
3) check for sliding

$$Hu = c \cdot A' + N \cdot \tan\phi' \qquad c = 0 \qquad \tan\phi = 0.6$$

$$F = \frac{Hu}{\Sigma H} = \frac{0.6 \times 2228.40}{551.56} = 2.42 > Fa = 1.2$$

§ 5. CALCULATION OF PARAPET SECTION

5-1 dimenston and loading



	q_1	q_2
HA loading	0.28	0.98
HB loading	0.45	1.15

$$q_1 = q \cdot K \qquad = 0.27 \cdot q \quad t/m^2$$

$$q_2 = K \cdot \gamma_s \cdot H + q_1 = 0.513 \cdot H + 0.27 \cdot q \quad "$$

5 - 2 sectional force of parapet

CASE 1 (HA)

$$S = 1/2 \times (0.28 + 0.98) \times 1.37 = 0.86^{t}$$

$$M = 0.86 \times 1/3 \times 1.370 \times \frac{2 \times 0.28 + 0.98}{0.28 + 0.98} = 0.48^{tm}$$

CASE 2 (HB)

$$S = 1/2 \times (0.45 + 1.15) \times 1.37 = 1.10^{t}$$

$$M = 1.10 \times 1/3 \times 1.370 \times \frac{2 \times 0.45 + 1.15}{0.45 + 1.15} = 0.64^{tm}$$

CASE 3.

$$S = 10.97 \times 0.27 = 2.96^{t/m^2}$$

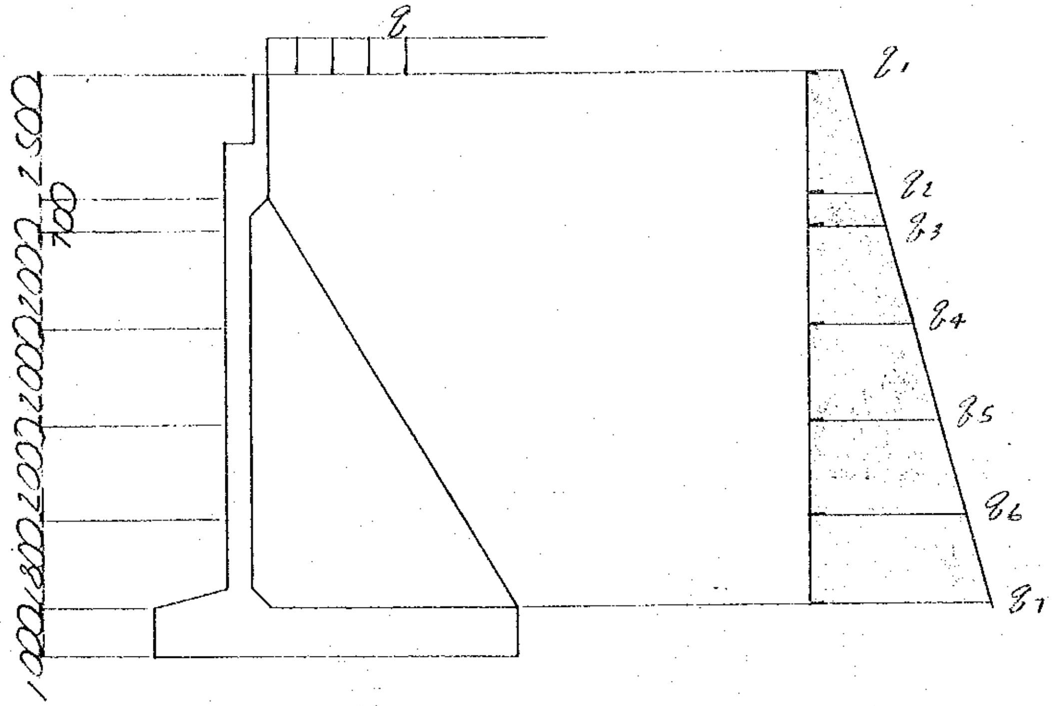
$$M = 2.96 \times 1.13 = 3.34^{tm}$$

5 - 3 list of stresses σ_c, σ_s, τ : working stress.
$\sigma_{ca}, \sigma_{sa}, \tau_a$: Permissible stress.

	case 1	case 2				
M	0.48	0.64				
N	———	———				
S	0.86	1.10				
b	100	100				
h	23	23				
d'	7	7				
As	D16 c250 8.04	→				
As'	———	———				
f/d	0	0				
M'/bd^2	0.91	1.21				
S/bd	0.37	0.48				
n·P	0.0524	→				
C	7.99	→				
S	21.00	→				
Z	1.10	→				
σ_c	7	10				
σ_s	186	381				
τ	0.4	0.5				
σ_{ca}	83	———				
σ_{sa}	2346	———				
τ_a	2.35	2.94				

§ 6 CALCULATION OF WALL SECTION

6 - 1 dimension and loading

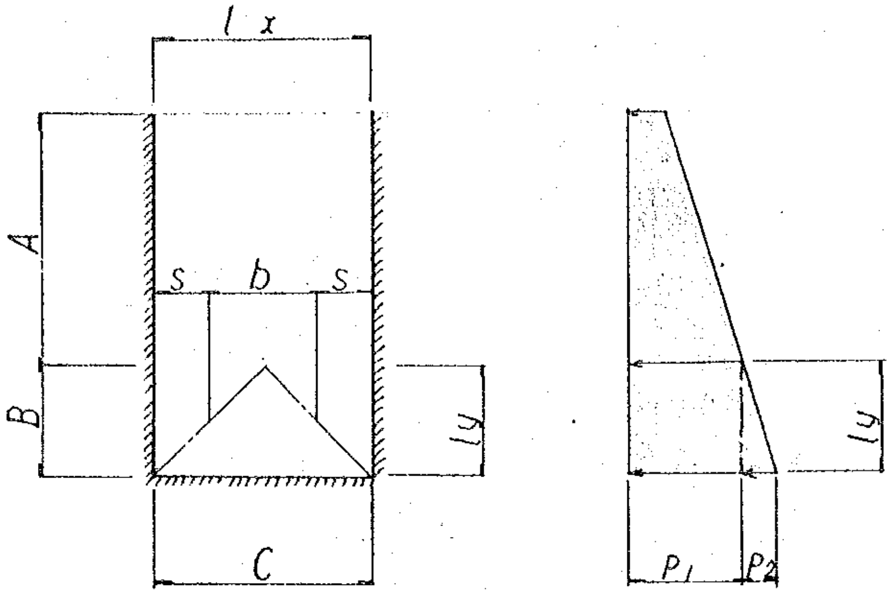


	q1	q2	q3	q4	q5	q6	q7
HA loading	0.28	1.56	1.92	3.05	3.97	5.00	5.92
HB loading	0.45	1.73	2.09	3.22	4.14	5.17	6.09

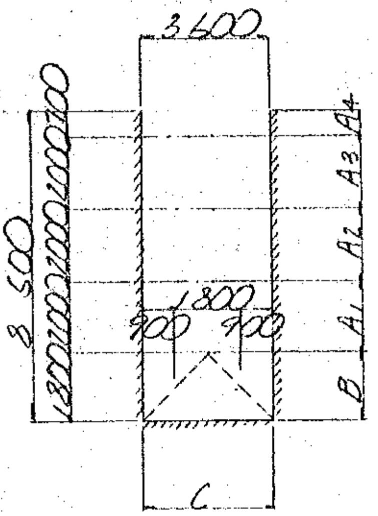
$$q_1 = q \cdot K \qquad = 0.27 \cdot q \quad t/m^2$$

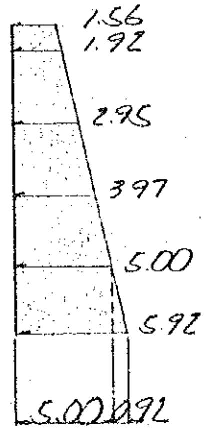
$$q_x = K \cdot \gamma_s \cdot H_x + q_1 = 0.513 \cdot H_x + 0.27 \cdot q \quad ''$$

6-2 sectional force of wall



	A	B	C
M (tm)	$\frac{p \cdot lx^2}{10}$	$\frac{p \cdot s^2}{6 \cdot lx}(2 \cdot lx + b)$	$\frac{1}{2}(\frac{p_1}{2} + \frac{p_2}{6}) ly^2$
S (t)	$\frac{p \cdot lx}{2}$	$p \cdot s$	$(p_1 + \frac{p_2}{2}) ly$



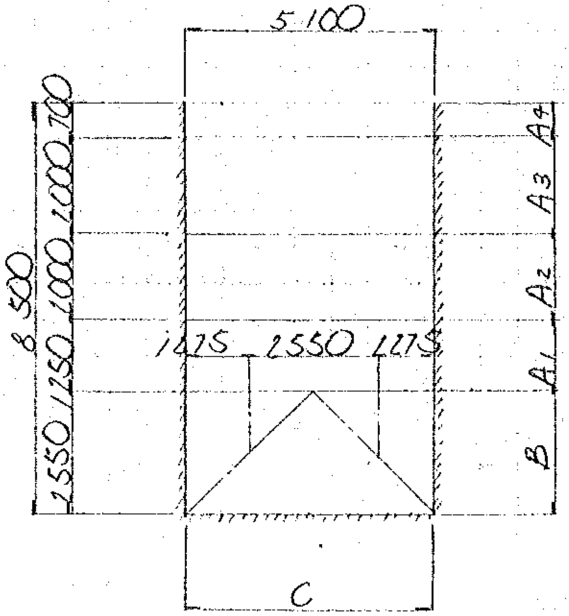


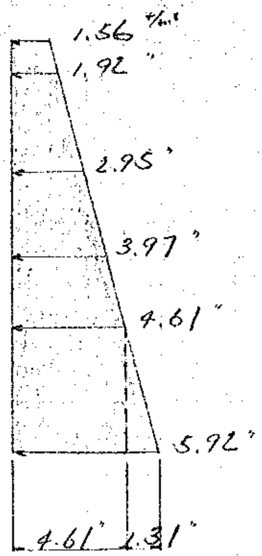
	M (tm)		S (t)	
C − C	$\frac{1}{2}\times\left(\frac{5.00}{2}+\frac{0.92}{6}\right)\times 1.80^2$	4.30	$\left(5.00+\frac{0.92}{2}\right)\times 1.800$	9.83
B − B	$\frac{5.46\times 0.90^2}{6\times 3.60}\times(2\times 3.60+1.80)$	1.84	5.46×0.900	4.91
A1 − 1	$\frac{5.00\times 3.60^2}{10}$	6.48	$\frac{5.00\times 3.60}{2}$	9.00
A2 − 2	$\frac{3.97\times 3.60^2}{10}$	5.15	$\frac{3.97\times 3.60}{2}$	7.15
A3 − 3	$\frac{2.95\times 3.60^2}{10}$	3.82	$\frac{2.95\times 3.60}{2}$	5.31
A4 − 4	$\frac{1.92\times 3.60^2}{10}$	2.49	$\frac{1.92\times 3.60}{2}$	3.46

6 − 3 list of stresses σc, σs, τ : working stress.
σca, σsa, τa : Permissible stress.

※ $As_{min} = 100 \times 43 \times 0.0015 = 6.45\ cm^2$

	C − C	B − B	A1 − 1	A2 − 2	A3 − 3	A4 − 4
M	4.30	1.84	6.48	5.15	3.82	2.49
N	———	———	———	———	———	———
S	9.83	4.91	9.00	7.15	5.31	3.46
b	100	→				
h	43	→				
d'	7	→				
As	D16@250 ※ 8.04	※ →		※	※	※
As'	———	———	———	———	———	———
f/d	|	|	0	|	|	|
M'/bd²			3.50			
S/bd			2.09			
n·P			0.0280			
C			10.22			
S			38.36			
Z			1.08			
σc			36			
σs			2017			
τ			2.25			
σca	83	→				
σsa	2346	→				
τa	2.35	→				





	M	(tm)	S	(t)
C−C	$\frac{1}{2}\times\left(\frac{4.61}{2}+\frac{1.31}{6}\right)\times 2.55^2$	8.20	$\left(4.61+\frac{1.31}{2}\right)\times 2.55$	13.43
B−B	$\frac{5.27\times 1.275^2}{6\times 5.10}\times(2\times 5.10+2.55)$	3.57	5.27×1.275	6.72
A1−1	$\frac{4.61\times 5.10^2}{10}$	11.99	$\frac{4.61\times 5.10}{2}$	11.76
A2−2	$\frac{3.97\times 5.10^2}{10}$	10.33	$\frac{3.97\times 5.10}{2}$	10.12
A3−3	$\frac{2.95\times 5.10^2}{10}$	7.67	$\frac{2.95\times 5.10}{2}$	7.52
A4−4	$\frac{1.92\times 5.10^2}{10}$	4.99	$\frac{1.92\times 5.10}{2}$	4.90

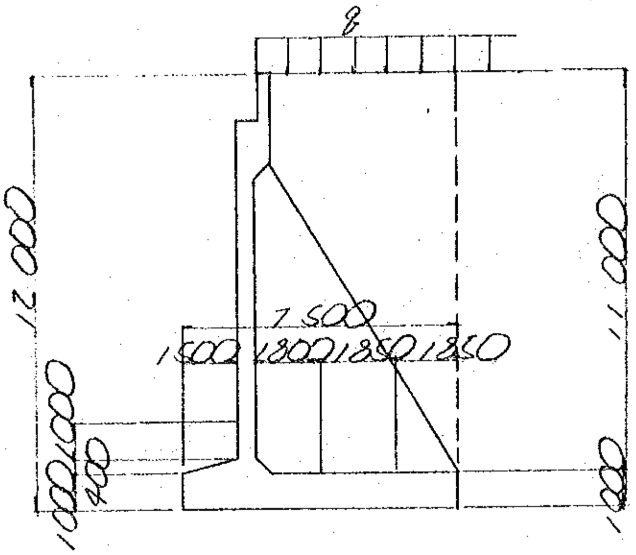
6 - 4 list of stresses σ_c, σ_s, τ : working stress.
σ_{ca}, σ_{sa}, τ_a : Permissible stress.

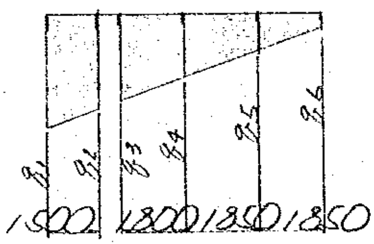
※ $As_{min} = 100 \times 43 \times 0.0015 = 6.45$ cm^2

	C - C	B - B	$A_1 - 1$	$A_2 - 2$	$A_3 - 3$	$A_4 - 4$
M	8.20	3.57	11.99	10.33	7.67	4.99
N	—	—	—	—	—	—
S	13.43	6.72	11.76	10.12	7.52	4.90
b	100	→				
h	43	→				
d'	7	→				
As	D16@125 16.08	D16@250 8.04	D16@125 16.08	D16@125 16.08	D16@250 8.04	D16@250 8.04
As'	—	—	—	—	—	—
f/d	0	0	0	0	0	0
M'/bd²	4.43	1.93	6.48	5.59	4.15	2.70
S/bd	3.12	1.56	2.73	2.35	1.75	1.14
n·P	0.0561	0.0280	0.0561	0.0561	0.0280	0.0280
C	7.79	10.22	7.79	7.79	10.22	10.22
S	19.69	38.36	19.69	19.69	38.36	38.36
Z	1.10	1.08	1.10	1.10	1.08	1.08
σ_c	35	19	51	44	42	28
σ_s	1310	1111	1916	1650	2337	1553
τ	3.4	1.7	3.0	2.6	1.9	1.3
σ_{ca}	83	→				
σ_{sa}	2346	→				
τ_a	2.35	→	3.47	→	2.35	→

§ 7 CALCULATION OF FOOTING SECTION

7-1 dimenston and loading





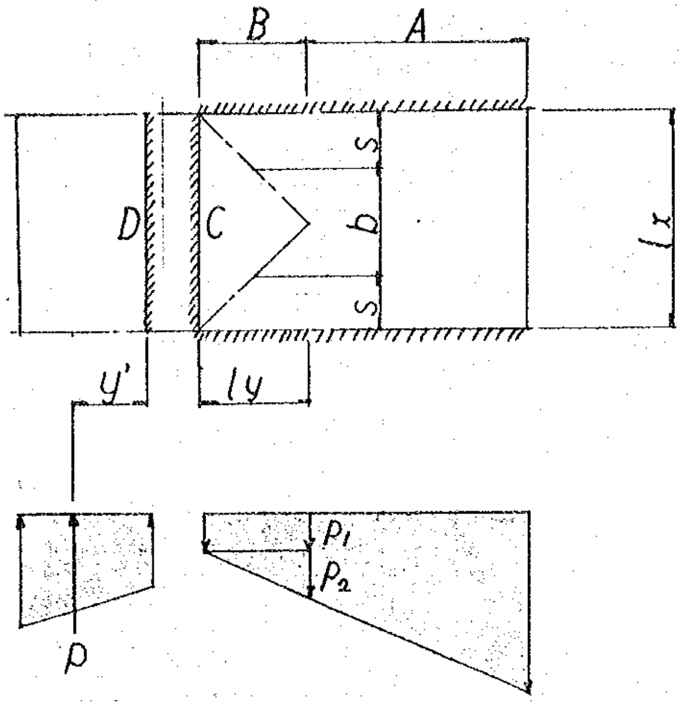
$w_1 = 1.00 \times 2.41 + 1.40 \times 1.9 = 5.07 \; t/m^2$

$w_2 = 1.40 \times$ 〃 $+ 1.00 \times$ 〃 $= 5.27$ 〃

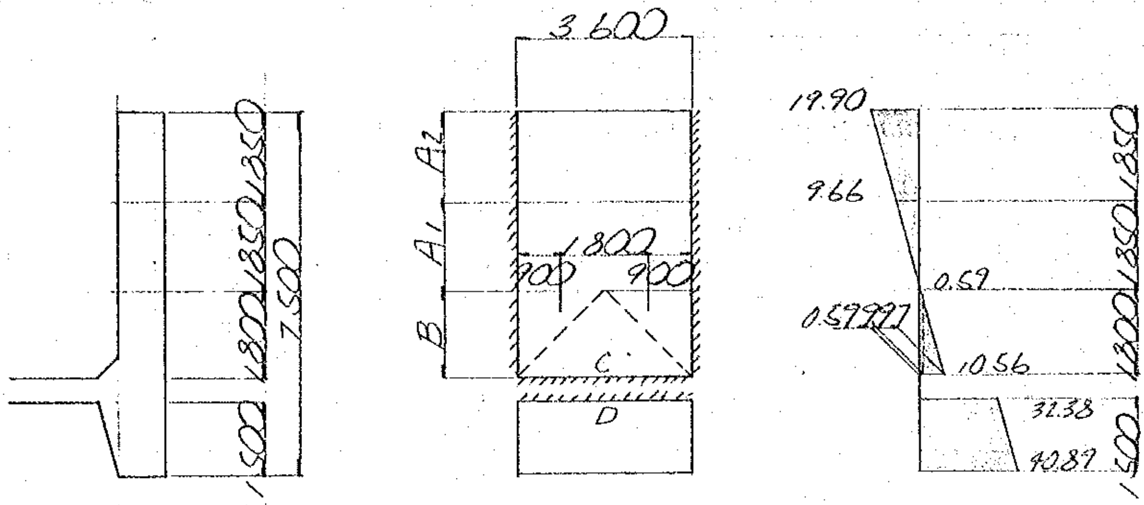
$w_3 = 1.00 \times$ 〃 $+ 11.00 \times$ 〃 $+ q = 23.31 + q$ 〃

	q 1	q 2	q 3	q 4	q 5	q 6
HA loading	45.96	37.65	34.89	24.92	14.67	4.43
HB loading	49.53	40.12	36.99	25.70	14.10	2.50

7-2 sectional force of footing



	A	B	C	D
(tm) M	$\frac{p \cdot lx^2}{10}$	$\frac{p \cdot s}{6 \cdot lx}(2 \cdot lx + b)$	$\frac{1}{2}(\frac{P_1}{2} + \frac{P_2}{6}) ly^2$	$p \cdot y'$
(t) S	$\frac{p \cdot lx}{2}$	$p \cdot s$	$(p_1 + \frac{P_2}{2}) \cdot ly$	p



	M (tm)		S (t)	
D − D	$54.95 \times \frac{1.50}{3} \times \left(\frac{2 \cdot 40.89 + 32.38}{40.89 + 32.38}\right)$	42.81	$\frac{1}{2} \times (32.38 + 40.89) \times 1.50$	54.95
C − C	$\frac{1}{2} \times \left(\frac{0.59}{2} + \frac{9.97}{6}\right) \times 1.80^2$	3.17	$\left(0.59 + \frac{9.97}{2}\right) \times 1.80$	10.04
B − B	$\frac{5.575 \times 0.90}{6 \times 3.60} \times (2 \times 3.60 + 1.80)$	1.88	5.575×0.90	5.02
A1 − 1	$\frac{9.66 \times 3.60^2}{10}$	12.52	$\frac{9.66 \times 3.60}{2}$	17.39
A2 − 2	$\frac{19.90 \times 3.60^2}{10}$	25.79	$\frac{19.90 \times 3.60}{2}$	35.82
A3 − 3	———	———	———	———

7-3 list of stresses σc, σs, τ : working stress.
σca, σsa, τa : Permissible stress.

	※ $A_{s\,min} = b \cdot d \cdot 0.0015 = 19.5\ cm^2\ (13.50\ cm^2)$					
	D—D	C—C	B—B	A1—1	A2—2	
M	42.81	3.17	1.88	12.52	25.79	
N	—	—	—	—	—	
S	54.95	10.04	5.02	17.39	35.82	
b	100	→				
h	130	90	→			
d'	10	→				
As	D20@125 ※ 25.12	D16@125 ※ 16.08	※ →	※		
As'	—	—	—	—	—	
f/d	0				0	
M'/bd²	2.53				3.18	
S/bd	4.22				25.79	
n·P	0.0290				0.0268	
C	10.09				10.42	
S	37.15				40.09	
Z	1.08				1.07	
σc	26				33	
σs	1411				1915	
τ	4.22				3.98	
σca	83	→				
σsa	2346	→				
τa	2.35	→				

Check for stirrups

Sect D-D

$$\tau = \frac{S}{b \cdot d} \cdot Z = \frac{54.95 \times 10^3}{100 \times 130} \times 1.08 = 4.57 \ kg/cm^2 > \tau_a = 2.35 \ kg/cm^2$$

$$S' = S - S_c$$

$$S_c = \tau_a \cdot b \cdot d \cdot 1/Z = 2.35 \times 100 \times 130 \times 1/1.08 = 28.29 \times 10^3 \ kg$$

$$S' = (54.95 - 28.29) \times 10^3 = 26.66 \times 10^3 \ kg$$

$$Req\ A_v = \frac{S' \times a}{\sigma_{sa} \times d} \times Z = \frac{26.66 \times 10^3 \times 25}{1780 \times 130} \times 1.08 = 3.11 \ cm^2$$

Φ16 - ctc 250 $n = 2$

$$A_v = 2.01 \times 2 = 4.02 \ cm^2 > Req\ A_v = 3.11 \ cm^2$$

Sect A2-2

$$\tau = \frac{S}{b \cdot d} Z = \frac{35.82 \times 10^3}{100 \times 90} \times 1.07 = 4.26 \ kg/cm^2 > \tau_a = 2.35 \ kg/cm^2$$

$$S' = S - S_c$$

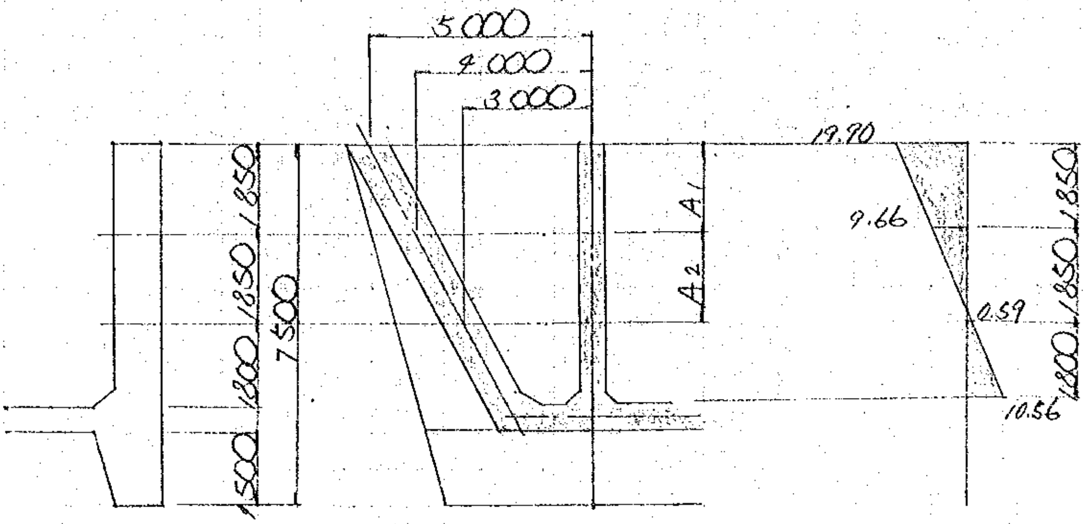
$$S_c = \tau_a \cdot b \cdot d \cdot 1/Z = 2.35 \times 100 \times 90 \times 1/1.07 = 19.77 \times 10^3 \ kg$$

$$S' = (35.82 - 19.77) \times 10^3 = 16.05 \times 10^3 \ kg$$

$$Req\ A_v = \frac{S' \times a}{\sigma_{sa} \cdot d} \times Z = \frac{16.05 \times 10^3 \times 25}{1780 \times 90} \times 1.07 = 2.68 \ cm^2$$

Φ16 - ctc 250 $n = 2$

$$A_v = 2.01 \times 2 = 4.02 \ cm^2 > Req\ A_v = 2.68 \ cm^2$$



	M	(tm)	S	(t)
A1-1	$\frac{19.90 \times 5.00^2}{10}$	49.75	$\frac{19.90 \times 5.00}{2}$	49.75
A2-2	$\frac{9.66 \times 4.00^2}{10}$	15.46	$\frac{9.66 \times 4.00}{2}$	19.32

7 − 6 list of stresses σ_c, σ_s, τ : working stress.
σ_{ca}, σ_{sa}, τ_a : permissible stress.

	※ As min = 13.50 cm²					
	A_1-1	A_2-2				
M	49.75	15.46				
N	———	———				
S	49.75	19.32				
b	100	——→				
h	90	——→				
d′	10	——→				
As	D20 @ 125 25.12	D16 @ 125 ※ 16.08				
As′	———	———				
f/d	26.93 0	0				
M'/bd^2	6.14					
S/bd	5.53					
n·P	0.0419					
C	8.71					
S	16.06					
Z	1.09					
σ_c	54					
σ_s	2331					
τ	5.53					
σ_{ca}	83	——→				
σ_{sa}	2346	——→				
τ_a	2.35	——→				

Check for stirrups

Sect A1-1

$$\tau = \frac{49.75 \times 10^3}{100 \times 90} \times 1.09 = 6.03 \ kg/cm^2 > \tau_a = 2.35 \ kg/cm^2$$

$$S' = S - S_c$$

$$S_c = \tau_a \cdot b \cdot d \cdot 1/z = 2.35 \times 100 \times 90 \times 1/1.09 = 19.40 \times 10^3 \ kg$$

$$S' = (49.75 - 19.40) \times 10^3 = 30.35 \times 10^3 \ kg$$

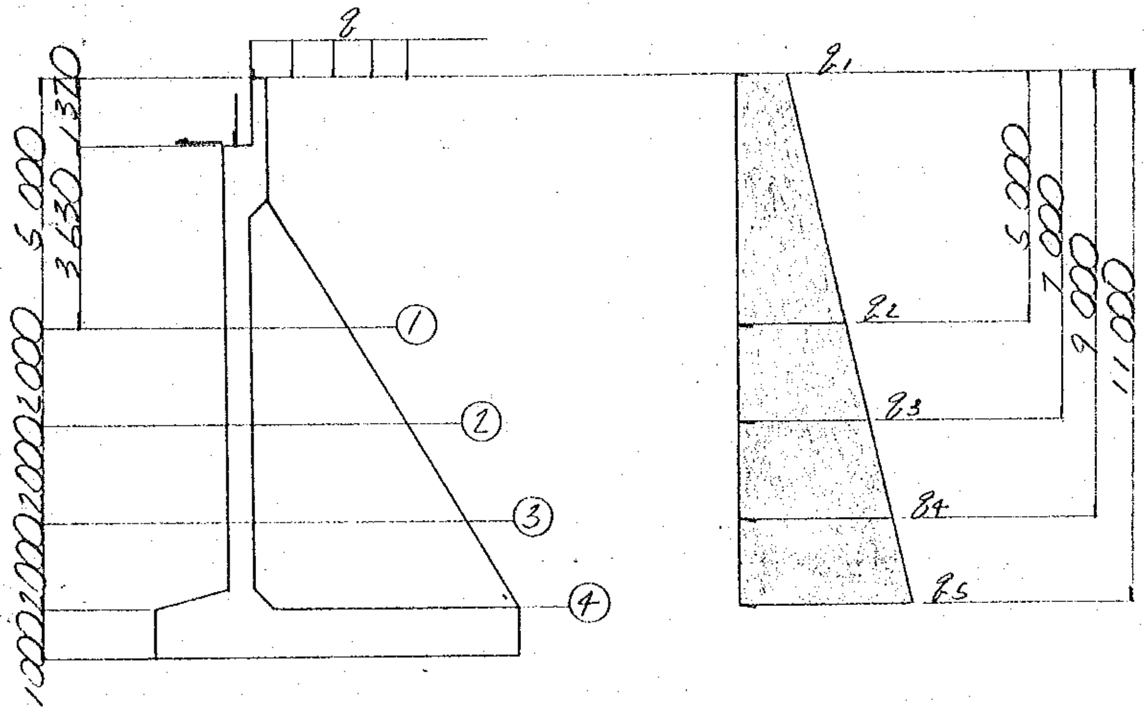
$$Req\ A_v = \frac{30.35 \times 10^3 \times 25}{1780 \times 90} \times 1.09 = 5.16 \ cm^2$$

$\phi 20$ - ctc 250 $n = 2$

$$A_v = 3.14 \times 2 = 6.28 \ cm^2 > Req\ A_v = 5.16 \ cm^2$$

§ 8 CALCULATION OF BUTTRESS SECTION

8 - 1 dimenston and loading



$$q_x = (K \cdot \gamma_s \cdot H + q \cdot K) \cdot l$$

	F B (t)	T (t)	FB + T (t)	$\frac{(FB+T)\,l}{B}$ (t)
HA loading	25.80	28.54	54.34	17.13
HA loading	38.20	28.54	66.74	21.04

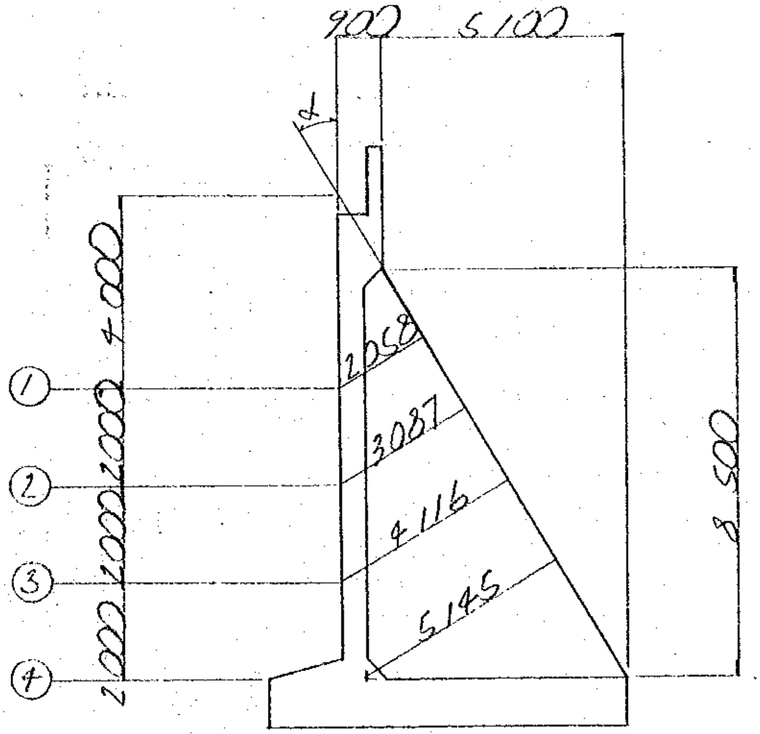
	q 1	q 2	q 3	q 4	q 5	q 6
HA loading	1.01	10.24	13.94	17.63	21.33	——
HB loading	1.62	10.85	14.55	18.24	21.93	——

٢

8 - 2 sectional force of buttress

		HA loading			HB loading		
		H (t)	y (m)	H·y (tm)	H (t)	y (m)	H·y (tm)
1-1	FB·T	17.13	3.63	62.18	21.04	3.63	76.38
	Pa	28.13	1.816	51.08	31.18	1.883	58.71
	Σ	45.26		113.26	52.22		135.09
2-2	FB·T	17.13	5.63	96.44	21.04	5.63	118.46
	Pa	52.33	2.491	130.35	56.60	2.567	145.29
	Σ	69.46		226.79	77.64		263.75
3-3	FB·T	17.13	7.63	130.70	21.04	7.63	160.54
	Pa	83.88	3.163	265.31	89.37	3.245	290.01
	Σ	101.01		396.01	110.41		450.55
4-4	FB·T	17.13	9.63	164.96	21.04	9.63	202.62
	Pa	122.87	3.832	470.84	129.53	3.919	507.63
	Σ	140.00		635.80	150.57		710.25
5-5	FB·T						
	Pa						
	Σ						

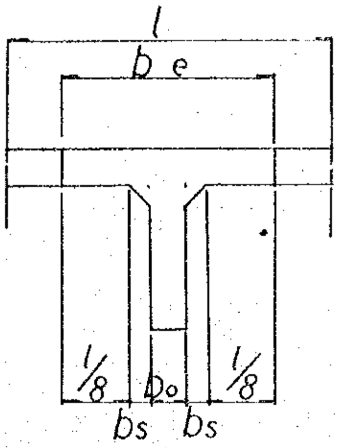
8 - 3 calculation of members



$$\tan\alpha = \frac{5.10}{8.50} = 0.60$$

$$\alpha = 30°58'$$

$$H = h \cdot \sin\alpha$$
$$= 0.5145 \cdot h$$



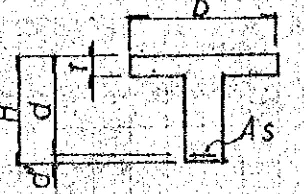
$$be = b_0 + 2\left(bs + \frac{l}{8}\right) = 60 + 2 \times (30 + 45)$$
$$= 210 \text{ cm}$$

8 - 4 list of stresses

σ_c, σ_s, τ : working stress.

σ_{ca}, σ_{sa}, τ_a : Permissible stress.

		(As min) = b · d · 0.0015				
		1 − 1	2 − 2	3 − 3	4 − 4	
M	tm	113.26	226.79	396.01	635.80	
S	t	45.26	69.46	101.01	140.00	
b	cm	210	210	210	210	
t	〃	50	50	50	50	
d	〃	196	299	402	505	
A s	cm²	5, 1 > D25 19.46 (14.70)	5, 3 > D25 39.28 (22.43)	5, 5 > D25 49.10 (30.15)	5, 5, 3 > D25 63.83 (37.88)	
P		0.0007	0.0006	0.0006	0.0006	
t/d		0.255	0.167	0.124	0.099	
K		0.162	0.131	0.126	0.129	
j		1.03	0.966	0.958	0.961	
σ_s	kg/cm²	1904	1998	2094	2053	
σ_c	〃	25	20	20	20	
τ	〃	2.3	2.7	3.2	3.4	
σ_{sa}	〃	83	→	→	→	
σ_{ca}	〃	2346	→	→	→	
τ_a	〃	8.2	→	→	→	



8 - 5 check for tie bers

1) wall and buttress

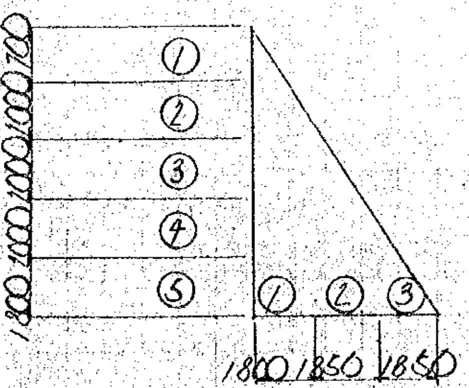
$$A_s = \frac{S}{\sigma_{sa}} \quad (cm^2)$$

		S (t)	As (cm²)	As'	(cm²)
section	1 — 1	3.46	1.47	D16 c 150	8.04
	2 — 2	5.31	2.26	↓	↓
	3 — 3	7.15	3.05		
	4 — 4	9.00	3.84		
	5 — 5	4.91	2.09		

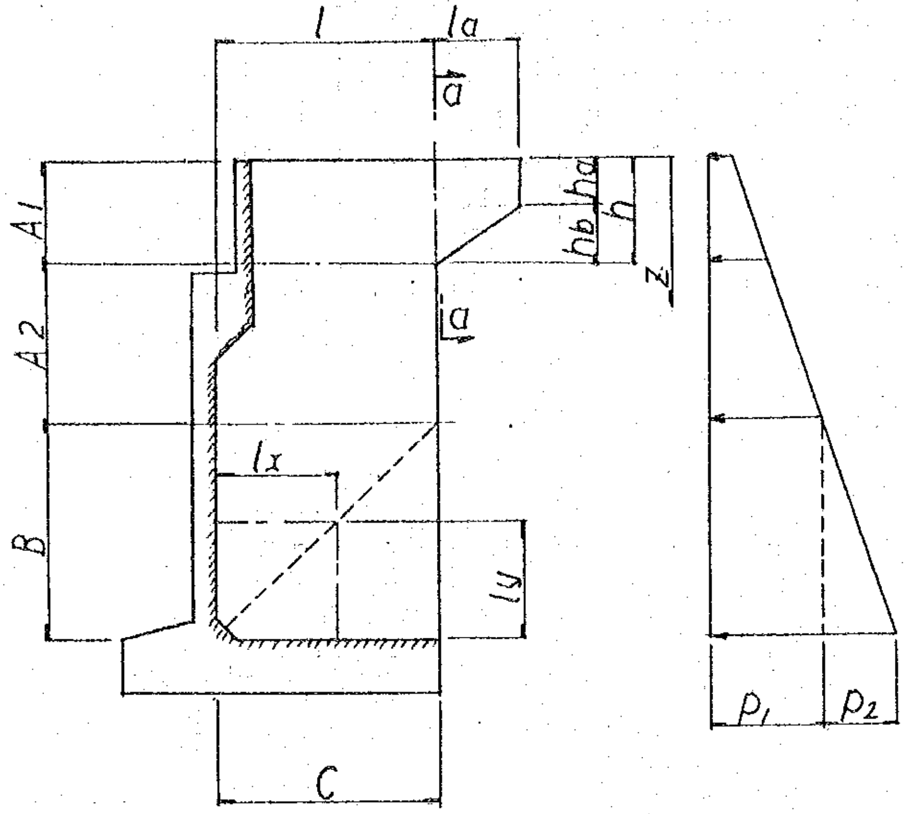
2) footing and buttress

$$A_s = \frac{S}{\sigma_{sa}} \quad (cm^2)$$

		S (t)	As (cm²)	As'	(cm²)
section	1 1	5.02	2.14	D16 c 250	8.04
	2 2	17.39	7.41	↓	↓
	3 3	35.82	15.27	D16 c 125	16.08



§ 9 CALCULATION OF WING SECTION



		S (t)	M (tm)
a – a	$0 < z < h_a$	$(q + \gamma \cdot z) \cdot K \cdot l_a$	$(q + \gamma \cdot z) \cdot K \cdot \frac{l_a^2}{2}$
	$h_a < z < h$	$(q + \gamma \cdot z) \cdot K \cdot l_a \cdot \frac{h - z}{h_b}$	$(q + \gamma \cdot z) \cdot K \cdot \frac{l_a^2}{2} \cdot \left(\frac{h - z}{h_b}\right)^2$

$$M_{max} \quad (h_a < z < h) \longrightarrow z = \frac{\gamma \cdot h - 2 \cdot q}{3\gamma} \quad (m)$$

$q = 1.02 \quad t/m^2$

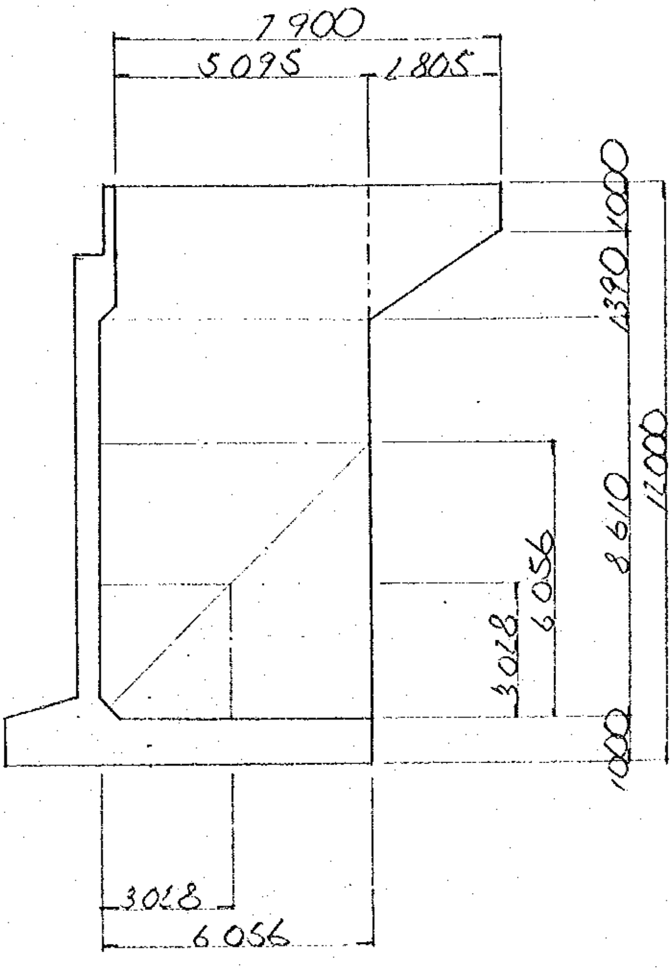
$K = 0.27$

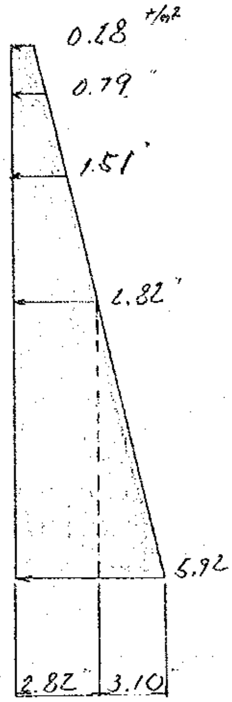
$\gamma = 1.9 \quad t/m^3$

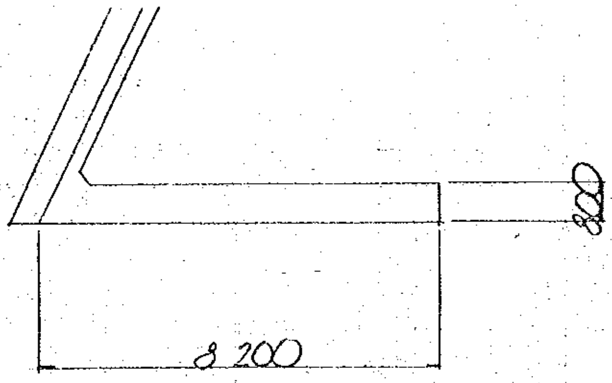
	M (t)	S (tm)
A1 − 1	$\frac{1}{2} p \cdot l^2 + Ma + Sa \cdot l$	$p \cdot l + Sa$
A2 − 2	$\frac{1}{2} \cdot p \cdot l^2$	$p \cdot l$
B − B	$\frac{1}{2} \cdot p \cdot lx^2$	$p \cdot lx$
C − C	$(\frac{p_1}{2} + \frac{p_2}{6}) \, ly^2$	$(p_1 + \frac{p_2}{2}) \cdot ly$

(A-LINE 3 , A1 , R)

9 - 1 dimension and loading







		z (m)	M	(tm)	S	(t)
a-a	1 − 1	1.00	$\frac{1}{2} \times 0.79 \times 2.805^2$	3.11	0.79×2.805	2.22
a-a	2 − 2	1.00 ~2.39	—	—	—	—
A 1		1.00 ~2.39	$\frac{1}{2} \times 1.51 \times 6.056^2$	27.69	1.51×6.056	9.14
A 2	1 − 1	4.944	$\frac{1}{2} \times 2.82 \times 6.056^2$	51.71	2.82×6.056	17.08
A 2	2 − 2	—	—	—	—	—
B − B		4.944 ~11.00	$\frac{1}{2} \times \frac{2.82 + 5.92}{2} \times 3.028^2$	20.03	$\frac{2.82 + 5.92}{2} \times 3.028$	13.23
C − C		11.000	$(\frac{2.82}{2} + \frac{3.10}{6}) \times 3.028^2$	17.65	$(2.82 + \frac{3.10}{2}) \times 3.028$	13.23

$$z = \frac{1.9 \times 2.39 - 2 \times 1.02}{3 \times 1.9} = 0.44 < 1.00^{m}$$

9 – 2 list of stresses σ_c, σ_s, τ : working stress.
$\sigma_{ca}, \sigma_{sa}, \tau_a$: Permissible stress.

※ $A_{s\,min} = 100 \times 73 \times 0.0015 = 10.95\ cm^2$

	a – a	A_1	A_2	B	C	
M	3.11	27.69	51.71	20.03	17.65	
N	—	—	—	—	—	—
S	2.22	9.14	17.08	13.23	13.23	
b	100	→	→	→	→	
h	73	→	→	→	→	
d′	7	→	→	→	→	
As	D20 @ 250 ※ 12.56	D25 @ 250 19.64	D25 @ 125 39.28	D25 @ 250 19.64	D16 @ 125 16.08	
As′	—	—	—	—	—	
f/d		0	0	0	0	
M'/bd^2		4.06	9.70	3.76	3.31	
S/bd		0.91	2.34	1.81	1.81	
n·P		0.0404	0.0807	0.0404	0.0330	
C		8.84	6.83	8.84	9.57	
S		27.02	13.93	27.02	32.78	
Z		1.09	1.12	1.09	1.08	
σ_c		36	66	33	32	
σ_s		1647	2027	1523	1629	
τ		1.0	2.6	1.9	1.9	
σ_{ca}	83	→	→	→	→	
σ_{sa}	2346	→	→	→	→	
τ_a	2.35	3.47	→	→	2.35	