社会開発協力部

ザイール共和国

マタディ橋梁建設計画調査報告書

取付道路設計計算書

昭和53年5月

国際協力事業団

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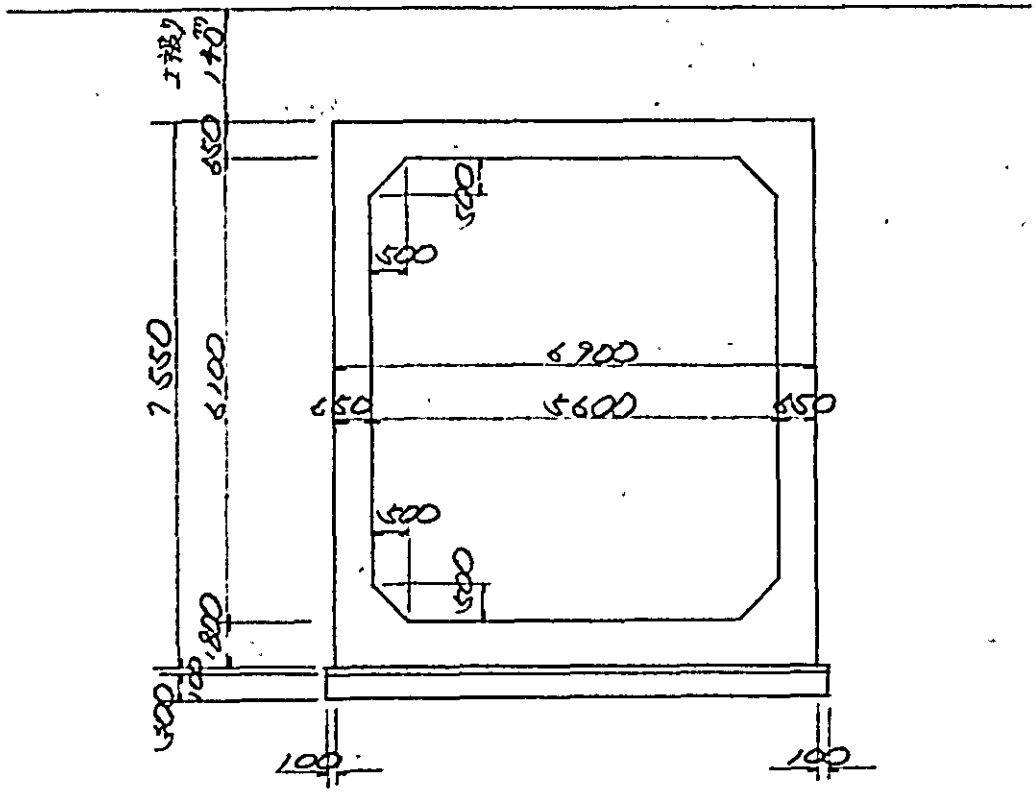
§.1 主要構造物応力計算書

(1) 設計条件

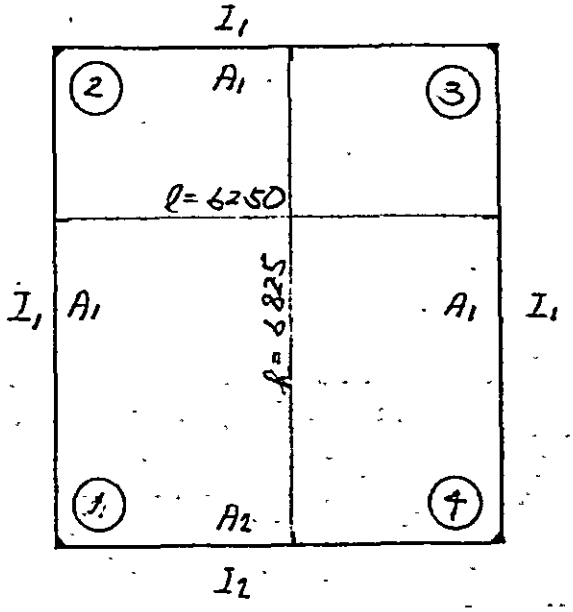
単位重量	鉄筋コンクリート	$W_c = 2.5$ t/m³
	土（粘性土）	$\gamma = 1.8$ 〃
許容応力度	コンクリートの圧縮応力度	$\sigma_{ca} = 80$ kg/cm²
	〃 のせん断 〃	$\tau_a = 8$ 〃
	鉄筋の引張応力度	$\sigma_{sa} = 1600$ 〃
土圧公式	静止土圧による。	
	静止土圧係数（粘性土）	$K_H = 0.60$
自動車荷重	サイール国道路面設規程 62/X/02 の Annex の荷重に関する規程を適用する。	
その他	鉄筋コンクリート標準示方書。	
	建設省制定土木構造物標準設計第1巻手引き。	
	道路橋下部構造設計指針2巻篇。等に依る。	

(2) 鉄道ボックスカルバート (1-Cell 5.60×6.10)

1) 形状寸法図



2) 軸線, 断面積及び断面2次モーメント



断面2次モーメント

$$I_1 = \frac{100 \times 65^3}{12} = 2,288,542 \ cm^4$$

$$I_2 = \frac{100 \times 80^3}{12} = 4,266,667 \ "$$

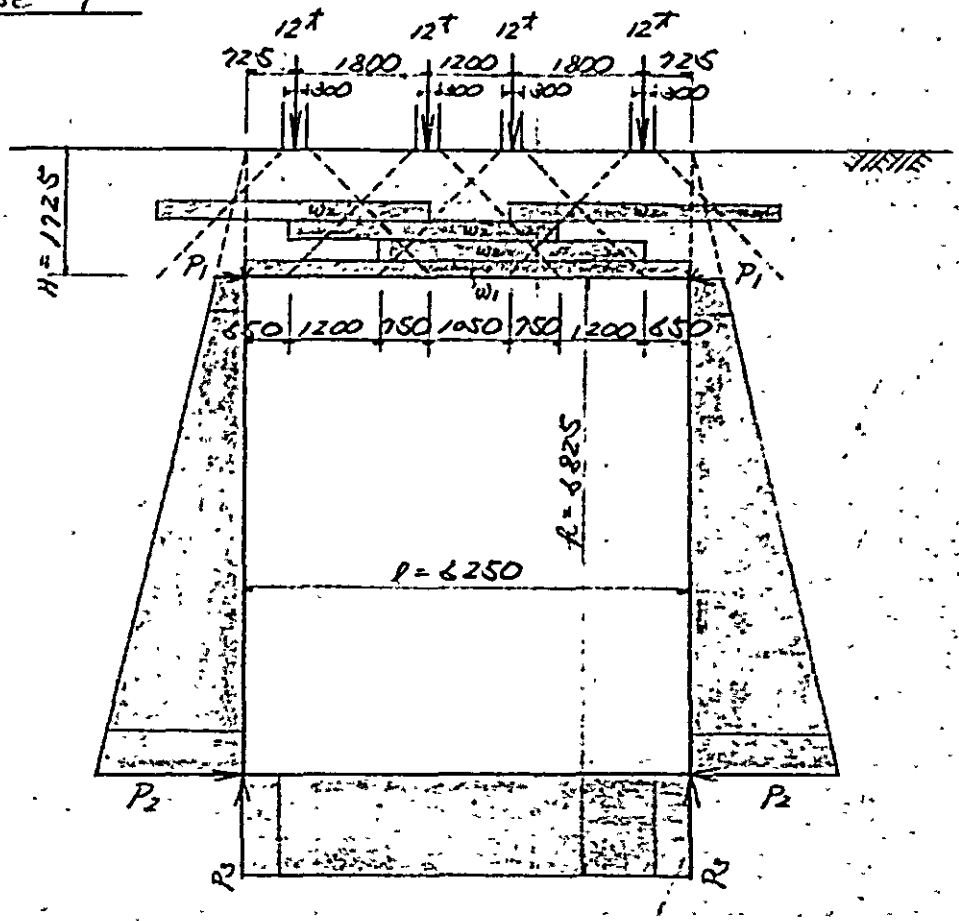
断面積

$$A_1 = 65 \times 100 = 6,500 \ cm^2$$

$$A_2 = 80 \times 100 = 8,000 \ "$$

3) 荷重計算

Case - 1



$W_1 = \gamma \cdot H + 0.25 \cdot W_c = 1.8 \times 1.725 + 0.65 \times 2.5 = 4.73$ t/m²

$W_2 = \frac{P_2(1+i)}{A} = \frac{12 \times (1+0.2)}{3.75} = 3.84$ "

$P_1 = \gamma \cdot K_H \cdot H = 1.8 \times 0.6 \times 1.725 = 1.86$ "

$P_2 = \gamma \cdot K_H (H+h) = 1.8 \times 0.6 \times (1.725 + 6.825) = 9.23$ "

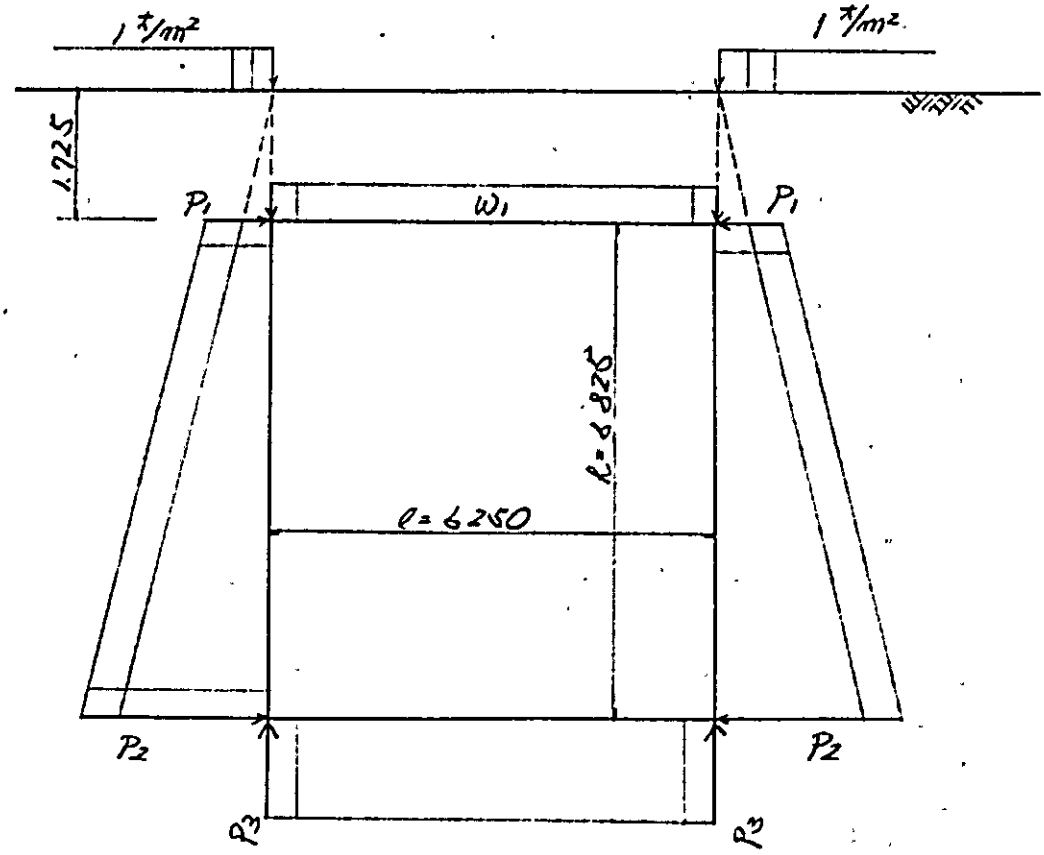
$P_3 = \gamma H + \{2W_2(0.65 + 2 \times 1.20 + 3 \times 0.75 + 2 \times 0.525) + D_1 + D_2\} / 9$

D_1(頂版重量) $= 2.5 \times 0.65 \times 6.25 = 10.16$ t

D_2(壁重量) $= 2.5 \times 0.65 \times 6.825 \times 2 = 22.18$ "

$\therefore P_3 = 1.8 \times 1.725 + \frac{2 \times 3.84 \times 6.35 + 10.16 + 22.18}{6.25} = 16.08$ t/m²

Case - 2



$W_1 = \gamma \cdot H + 0.65 \cdot W_C$ (頂版重量) $= 1.8 \times 1.725 + 0.65 \times 2.5 = 4.73$ t/m²

$P_1 = 0.6(\gamma \cdot H + 1) = 0.6 \times (1.8 \times 1.725 + 1) = 2.76$ "

$P_2 = 0.6\{\gamma \cdot (H + l) + 1\} = 0.6 \times \{1.8 \times (1.725 + 6.825) + 1\} = 9.83$ "

$P_3 = \gamma \cdot H + \dfrac{D_1 + D_2}{l}$

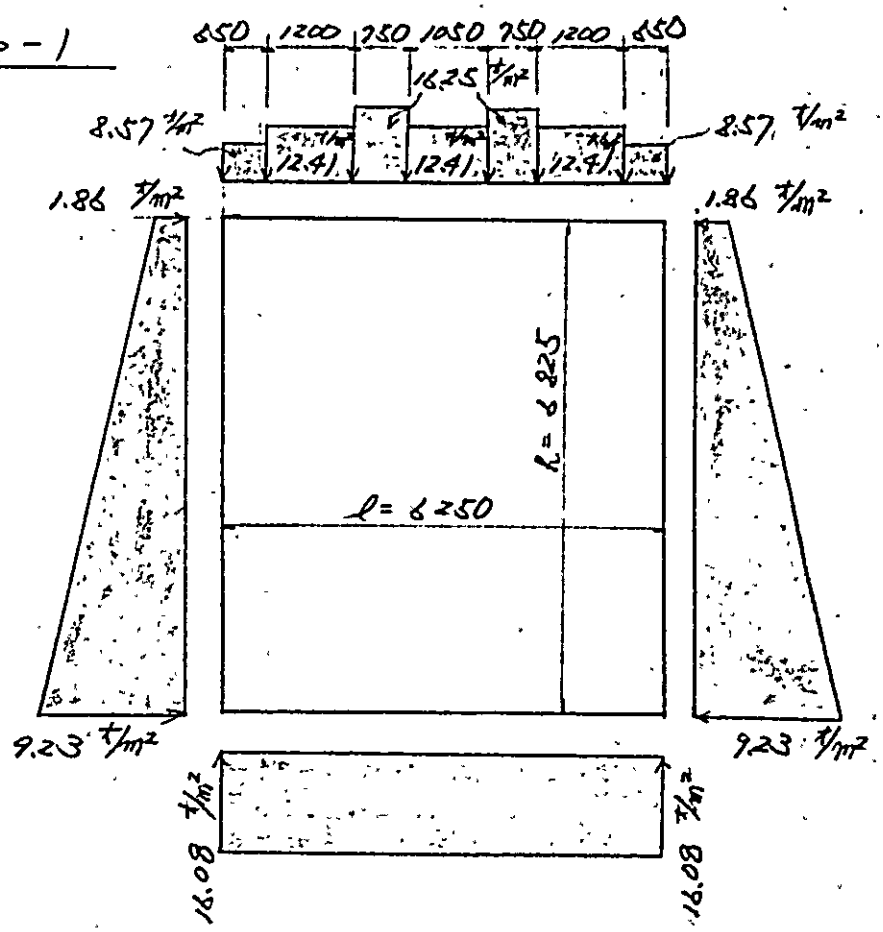
D_1 (頂版重量) $= 2.5 \times 0.65 \times 6.25 = 10.16$ t

D_2 (壁重量) $= 2.5 \times 0.65 \times 6.825 \times 2 = 22.18$ "

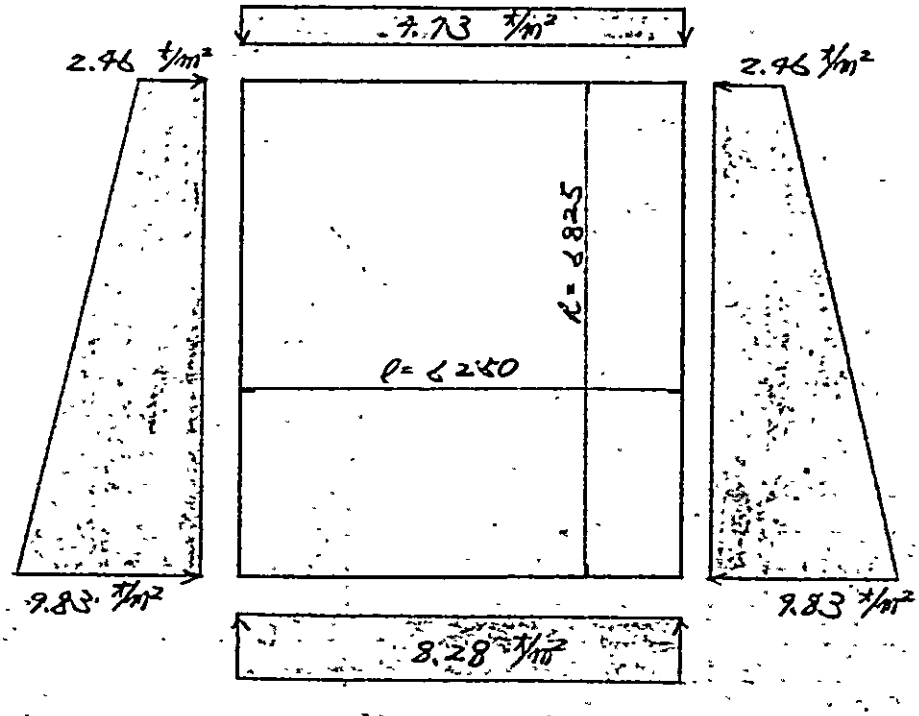
$\therefore P_3 = 1.8 \times 1.725 + \dfrac{10.16 + 22.18}{6.25} = 8.23$ t/m²

荷重図

Case-1

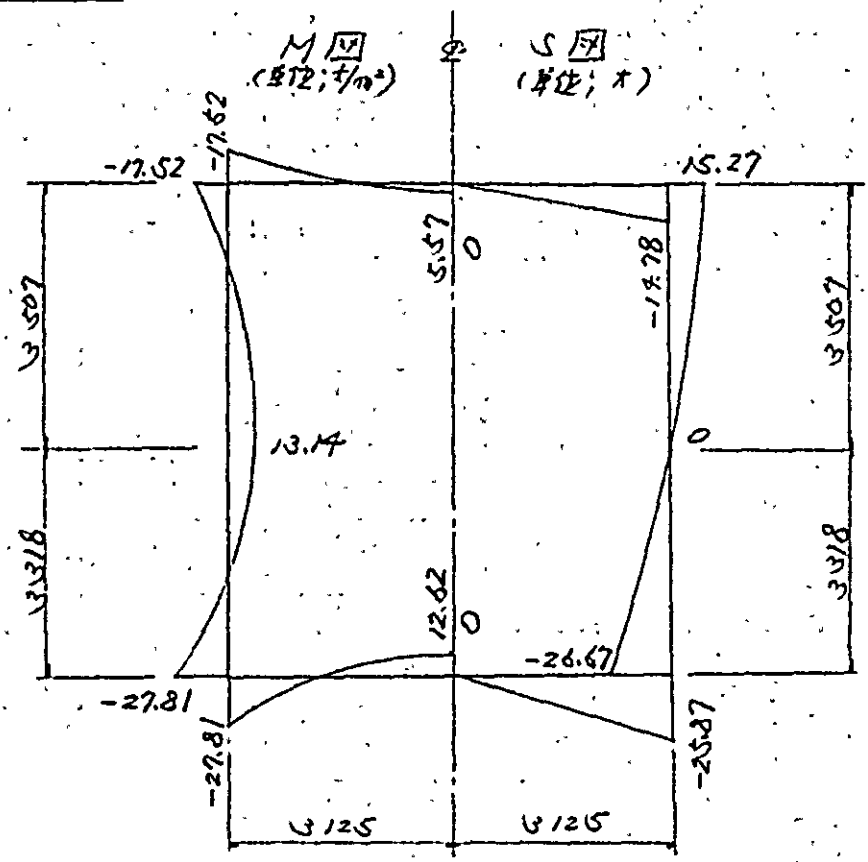


Case-2

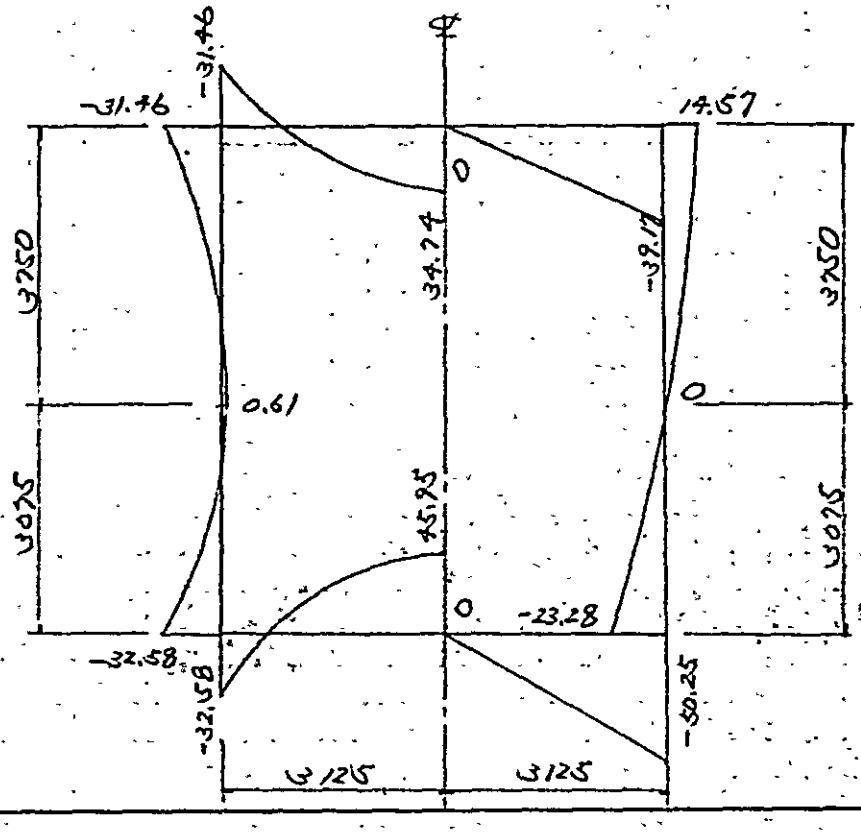


6) 曲げモーメント図，剪断力図

Case - 2



Case. -.1



d) 応力度計算

部材	頂版		底版		側壁			
箇所	支点	径間	支点	径間	下端	中間	上端	
ケース	1	1	1	1	1	2	1	
M t·m	-31.46	34.74	-32.58	45.95	-32.58	13.14	-31.46	
N t	14.57	14.57	23.28	23.28	37.17	14.78	37.17	
S t	-39.17	0	-50.25	0	-23.28	0	14.57	
b cm	100	100	100	100	100	100	100	
h "	65	65	80	80	65	65	65	
d "	58	58	70	70	58	58	58	
d' "	7	7	10	10	7	7	7	
$e'=M/N$ cm	216	238	140	197	83	89	80	
$e=e'+\frac{h}{2}-d'$	242	264	170	227	109	115	106	
d/e	0.240	0.220	0.412	0.308	0.532	0.504	0.547	
A_s cm²	4-D22 4-D25	8-D25	8-D22	8-D25	8-D22	8-D16	4-D22 4-D25	
	35.75	40.54	30.97	40.54	30.97	15.89	35.75	
$p=A_s/bd$	0.00616	0.00699	0.00442	0.00579	0.00534	0.00274	0.00616	
c	0.617	0.182	0.160	0.167	0.180	0.145	0.188	
β	24.5	20.5	26.5	24.5	21.0	32.0	19.0	
Ne/bd^2 kg/cm²	10.5	11.4	8.08	10.8	12.7	5.05	12.3	
σ_c "	62.9	62.6	50.5	64.7	70.0	34.8	65.4	
σ_s "	1541	1284	1338	1584	1482	1114	1243	
τ "	7.7	0	8.0	0	4.6	0	2.9	
σ_{ca} "	70	70	70	70	70	70	70	
σ_{sa} "	1600	1600	1600	1600	1600	1600	1600	
τ "	8.0	8.0	8.0	8.0	8.0	8.0	8.0	
ソモ NO.	MN-3	MN-3	MN-3	MN-3	MN-3	MN-3	MN-3	MN-3

注) τの計算に於て、jは0.875とする。

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* CASE 1 *
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* CASE 2 *
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********** DISPLACEMENT **********

DISP(X),DISP(Y) --- DISPLACEMENT (M)
DISP(R) --- ROTATION ANGLE (RADIAN)

JOINT	DISP(X)	DISP(Y)	DISP(R)	DISP(X)	DISP(Y)	DISP(R)
1	0.	0.	-0.5366E-03	0.	0.	0.2336E-04
2	0.4115E-20	0.	0.6216E-03	-0.3763E-21	0.	-0.1075E-03
3	0.4115E-20	0.	-0.6216E-03	-0.3763E-21	0.	0.1075E-03
4	0.	0.	0.5366E-03	0.	0.	-0.2336E-04

********** STRESS **********

L --- DISTANCE (M)
M --- BENDING MOMENT (T*M)
S --- SHEARING FORCE (T)
N --- AXIAL FORCE (T)

MEMBER

②- ③

L	M	S	N	M	S	N
0.	-31.457	39.165	14.569	-17.523	14.781	15.270
6.250	-31.457	-39.165	14.569	-17.523	-14.781	15.270

	L	M	S	N	L	M	S	N
M.MAX	3.125	34.736	-0.000	14.569	3.125	5.573	0.000	15.270
M.MIN	0.	-31.457	39.165	14.569	0.	-17.523	14.781	15.270
S.MAX	0.	-31.457	39.165	14.569	0.	-17.523	14.781	15.270
S.MIN	6.250	-31.457	-39.165	14.569	6.250	-17.523	-14.781	15.270
N.MAX	0.	-31.457	39.165	14.569	0.	-17.523	14.781	15.270
N.MIN	0.	-31.457	39.165	14.569	0.	-17.523	14.781	15.270

MEMBER

① - ④

L	M	S	N	M	S	N
0.	32.563	-50.250	23.276	27.814	-25.875	26.669
6.250	32.563	50.250	23.276	27.814	25.875	26.669

	L	M	S	N	L	M	S	N.
M.MAX	6.250	32.563	50.250	23.276	6.250	27.814	25.875	26.669
M.MIN	3.125	-45.953	-0.000	23.276	3.125	-12.615	-0.000	26.669
S.MAX	6.250	32.563	50.250	23.276	6.250	27.814	25.875	26.669
S.MIN	0.	32.563	-50.250	23.276	0.	27.814	-25.875	26.669
N.MAX	0.	32.563	-50.250	23.276	0.	27.814	-25.875	26.669
N.MIN	0.	32.563	-50.250	23.276	0.	27.814	-25.875	26.669

MEMBER

② - ①

L	M	S	N	M	S	N
0.	31.457	-14.569	39.165	17.523	-15.270	14.781
6.825	32.563	23.276	39.165	27.814	26.669	14.781

	L	M	S	N	L	M	S	N
M.MAX	6.825	32.563	23.276	39.165	6.825	27.814	26.669	14.781
M.MIN	3.750	-0.606	-0.000	39.165	3.507	-13.139	0.000	14.781
S.MAX	6.825	32.563	23.276	39.165	6.825	27.814	26.669	14.781
S.MIN	0.	31.457	-14.569	39.165	0.	17.523	-15.270	14.781
N.MAX	0.	31.457	-14.569	39.165	0.	17.523	-15.270	14.781
N.MIN	0.	31.457	-14.569	39.165	0.	17.523	-15.270	14.781

MEMBER

③ - ④

L	M	S	N	M	S	N
0.	-31.457	14.569	39.165	-17.523	15.270	14.781
6.825	-32.563	-23.276	39.165	-27.814	-26.669	14.781

	L	M	S	N	L	M	S	N
M.MAX	3.750	0.606	0.000	39.165	3.507	13.139	-0.000	14.781
M.MIN	6.825	-32.563	-23.276	39.165	6.825	-27.814	-26.669	14.781
S.MAX	0.	-31.457	14.569	39.165	0.	-17.523	15.270	14.781
S.MIN	6.825	-32.563	-23.276	39.165	6.825	-27.814	-26.669	14.781

MEMBER
③ - ④

	L	M	S	N	L	M	S	N
N.MAX	0.	-31.457	14.569	39.165	0.	-17.523	15.270	14.781
N.MIN	0.	-31.457	14.569	39.165	0.	-17.523	15.270	14.781

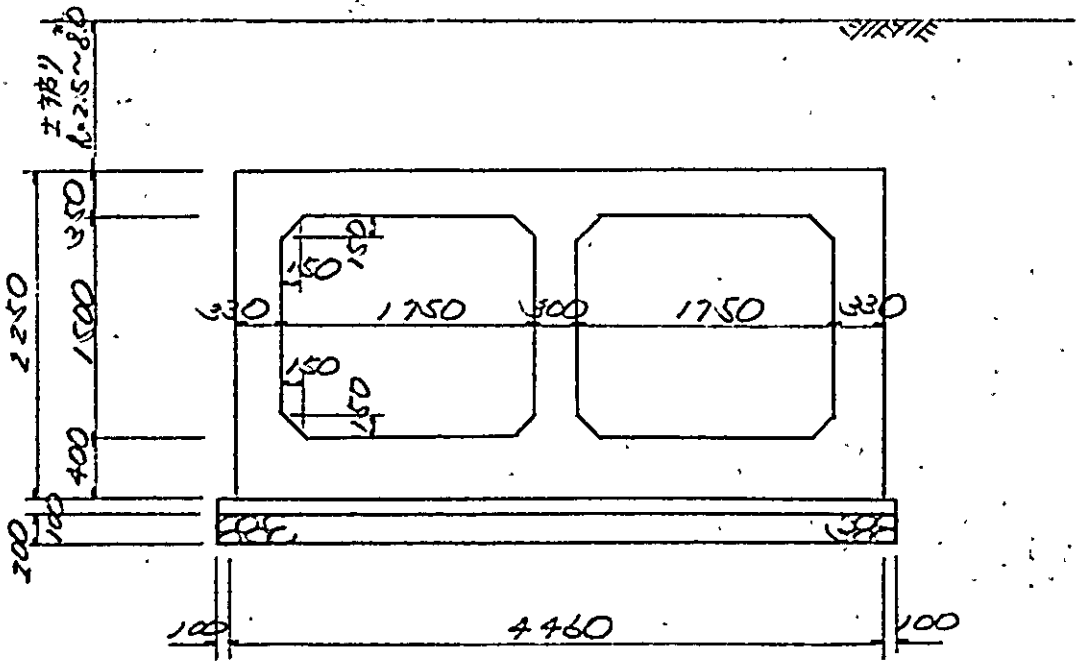
********** REACTION **********

REAC(X),REAC(Y) --- REACTION (T)
REAC(R) --- REACTION (T*M)

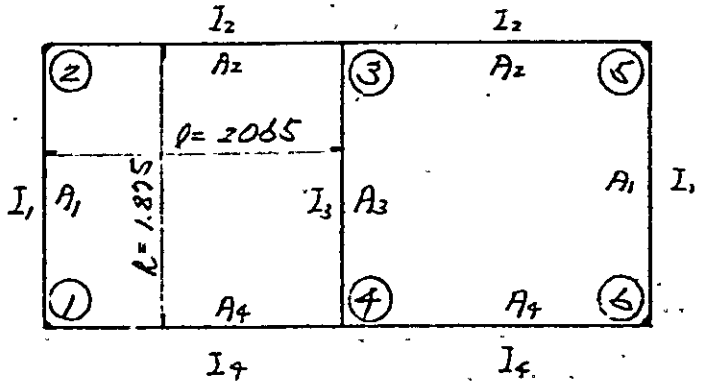
JOINT	REAC(X)	REAC(Y)	REAC(R)	REAC(X)	REAC(Y)	REAC(R)
①	-0.000	0.005	0.000	0.000	-0.004	0.000
④	0.	0.005	0.000	0.	-0.004	0.000

(2) 水路ボックス・カルバート (2-Col) 1.75×1.50)

1) 形状寸法図



2) 軸線, 断面積 & 断面2次モーメント



断面2次モーメント

$I_1 = \frac{100 \times 33^3}{12} = 299,475\ cm^4$

$I_2 = \frac{100 \times 35^3}{12} = 357,292\ "$

$I_3 = \frac{100 \times 30^3}{12} = 225,000\ "$

$I_4 = \frac{100 \times 40^3}{12} = 533,333\ "$

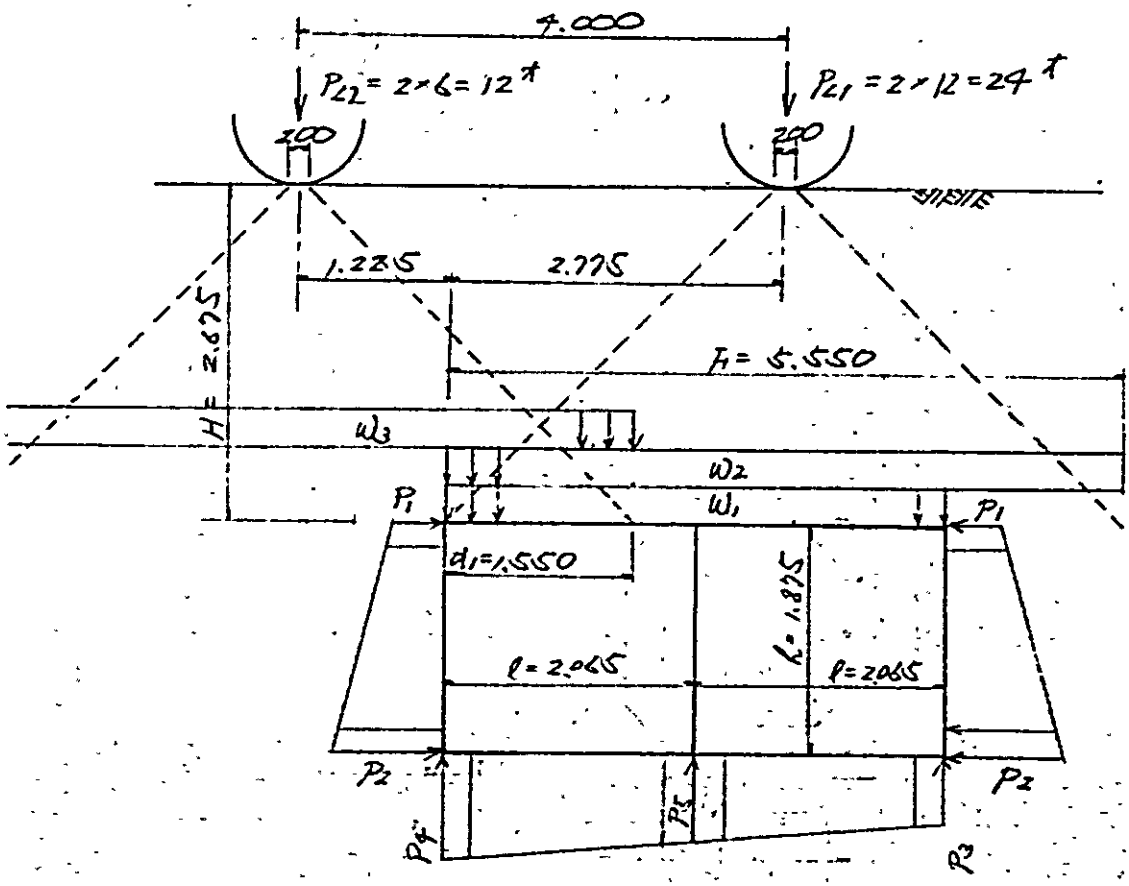
断面積

$A_1 = 33 \times 100 = 3300\ cm^2$, $A_3 = 30 \times 100 = 3000\ cm^2$

$A_2 = 35 \times 100 = 3500\ "$, $A_4 = 40 \times 100 = 4000\ "$

3) 荷重計算

Case-1



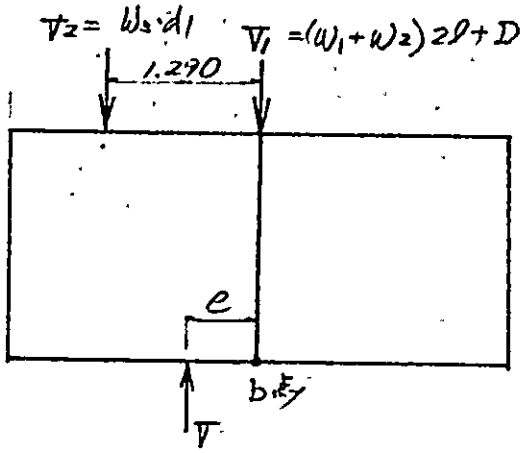
$w_1 = \gamma \cdot H + 0.35\,W_c$（頂物量）$= 1.8 \times 2.50 + 0.35 \times 2.5 = 5.38\ t/m^2$

$w_2 = \dfrac{P_{L1}(1+i)}{A} = \dfrac{24 \times (1+0.1)}{5.550} = 4.76\ ''$

$w_3 = \dfrac{P_{L2}(1+i)}{A} = \dfrac{12 \times (1+0.1)}{5.550} = 2.38\ ''$

$P_1 = \gamma \cdot K_H \cdot H = 1.8 \times 0.6 \times 2.675 = 2.89\ ''$

$P_2 = \gamma \cdot K_H \cdot (H + h) = 1.8 \times 0.6 \times (2.675 + 1.875) = 4.91\ ''$



D（壁重量）$= 2.5 \times (2 \times 0.33 + 0.30) \times 1.875 = 4.50\ t/m$

V（底版に作用する全重量）

$= V_1 + V_2 = w_3 \cdot d_1 + (w_1 + w_2) 2l \cdot + D$

$= 2.38 \times 1.55 + (5.38 + 4.76) \times 2 \times 2.065 + 4.50$

$= 50.07\ t/m$

b点においてモーメントをとると

$Ve = -1.29 \times V_2$

$\therefore e = \dfrac{-1.29 \times 2.38 \times 1.55}{50.07}$

$= -0.10\ m$

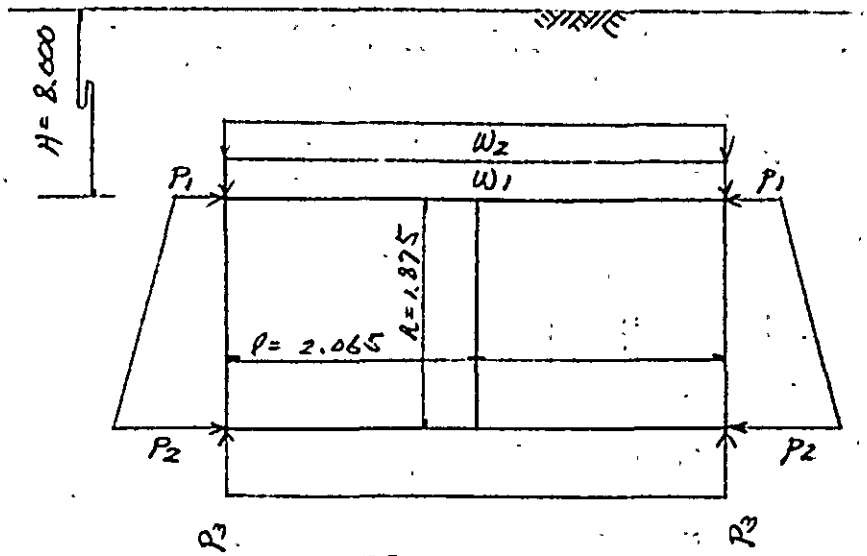
故に P_4, P_3 は

$$P_4, P_3 = \frac{V}{2l}\left(1 \pm \frac{6e}{2l}\right)$$

$$= \frac{50.07}{2\times 2.065}\left(1 \pm \frac{6\times 0.10}{2\times 2.065}\right)$$

$$= 13.88\ t/m^2,\ 10.37\ t/m^2$$

Case-2



頂版厚
$W_1 = \gamma \cdot H + 0.35 \times W_c = 1.8 \times 8.00 + 0.35 \times 2.5 = 15.28$ t/m²

$W_2 = 1.00$ t/m²

$P_1 = K_H(\gamma \cdot H + 1) = 0.6 \times (1.8 + 8.0 + 1) = 9.29$ "

$P_2 = K_H\{\gamma(H+h)+1\}$

$= 0.6 \times \{1.8 \times (8 + 1.875) + 1\} = 11.27$ "

$P_2 = \gamma \cdot H + W_2 + \dfrac{D_1 + D_2}{2\ell}$

(D_1 (頂版重量) $= 2.5 \times 0.35 \times 2 \times 2.065 = 3.61$ t

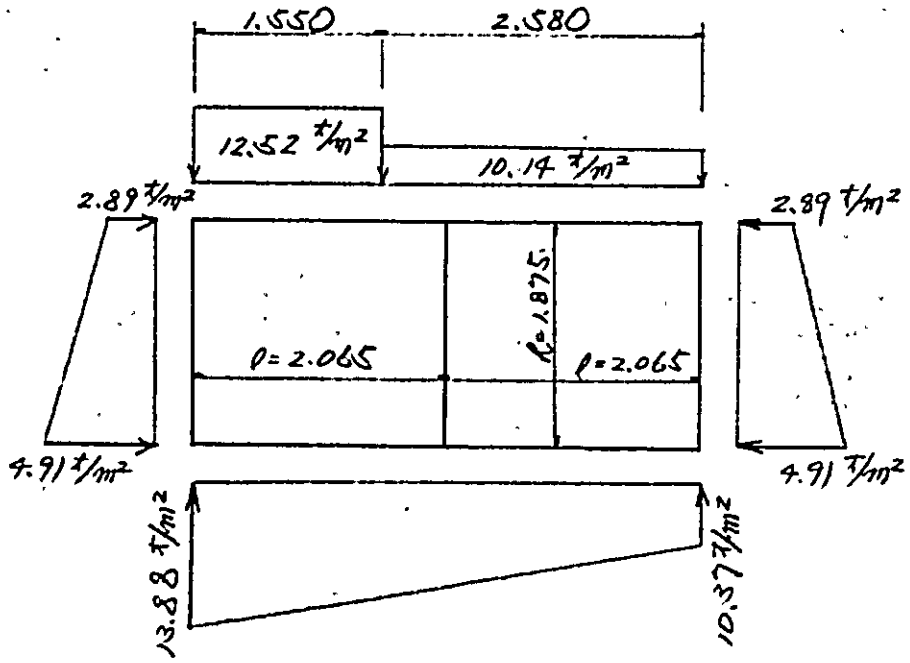
D_2 (壁重量) $= 2.5 \times (0.33 \times 2 + 0.30) \times 1.875$

$= 4.50$ t

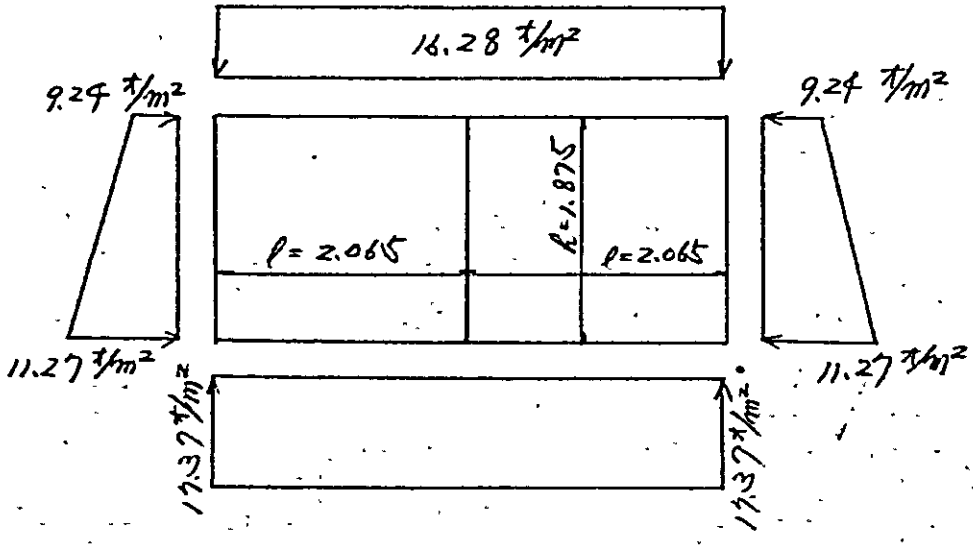
$\therefore P_3 = 1.8 \times 8.0 + 1.0 + \dfrac{3.61 + 4.50}{2 \times 2.065} = 17.97$ t/m²

4) 荷重図

Case-1

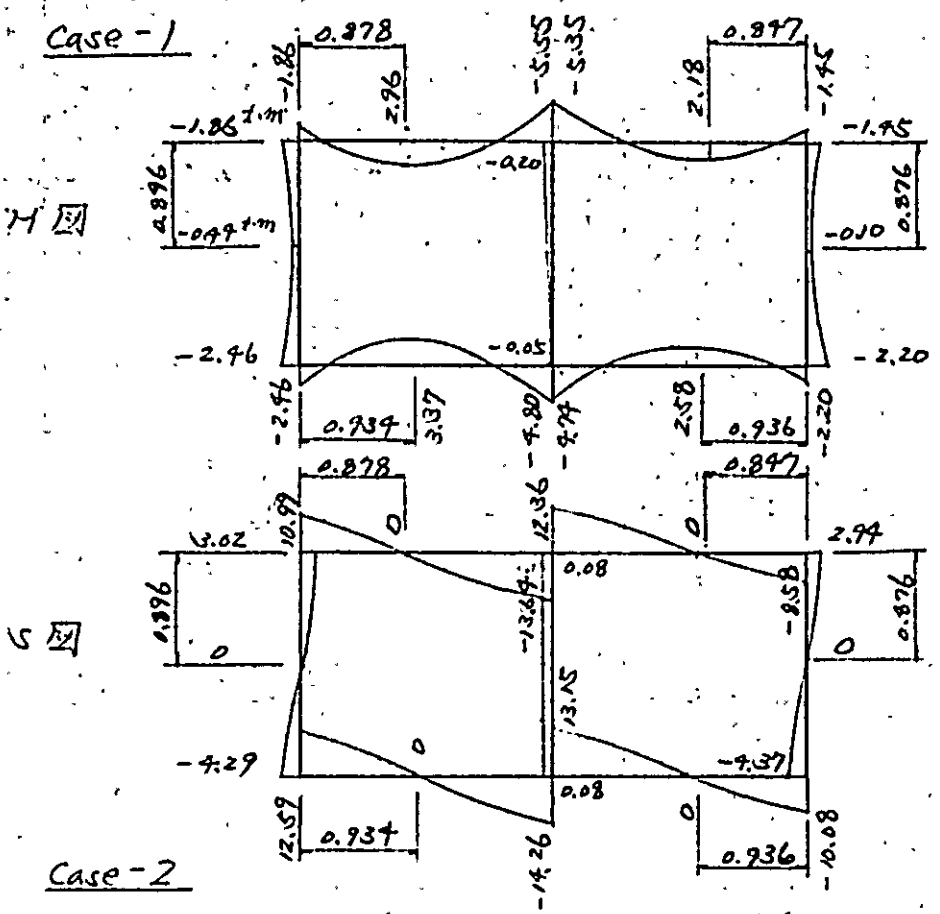


Case-2

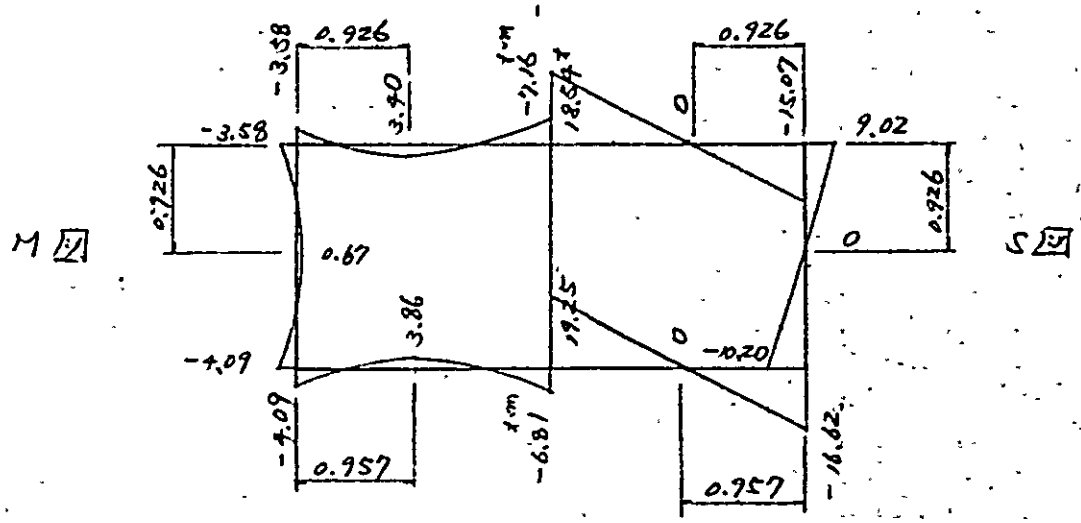


5) 曲げモーメント図，剪断力図

Case-1



Case-2



d) 応力度計算

部材	頂版			底版			側壁			中壁
箇所	側支点	径間	中支点	側支点	径間	中支点	下端	中間	上端	上端
ケース	2	2	2	2	2	2	2	2	2	2
M t·m	-3.58	3.90	-7.16	-9.09	3.86	-6.81	-9.09	0.67	-3.58	0
N t	9.02	9.02	9.02	10.20	10.20	10.20	15.07	15.07	15.07	37.09
S t	-16.07	0	18.54	-16.62	0	19.25	-10.20	0	9.02	0
b cm	100	100	100	100	100	100	100	100	100	100
h "	35	35	35	40	40	40	33	33	33	30
d "	28	28	28	30	30	30	23	23	23	20
d' "	7	7	7	10	10	10	7	7	7	10
e'=M/N cm	40	38	79	40	38	69	27	4	24	0
e=e'+h/2-d'	51	49	90	50	48	77	37	14	34	5
d/e	0.549	0.571	0.311	0.600	0.625	0.390	0.622	1.64	0.676	4.00
As cm²	8-D19	8-D19	8-D19	8-D16	8-D16	8-D16	8-D16	4-D13	8-D19	4-D13
	22.92	22.92	22.92	15.89	15.89	15.89	15.89	5.068	22.92	5.068
p=As/bd	0.00819	0.00819	0.00819	0.00530	0.00530	0.00530	0.00691	0.00220	0.00997	0.00253
C	0.203	0.205	0.186	0.185	0.187	0.168	0.200	以	0.224	以
B	16.0	15.6	19.6	20.0	19.6	24.0	16.7	下	12.4	下
Nc/bd² kg/cm²	5.87	5.67	10.4	5.67	5.49	8.73	10.5	省	9.69	省
σc "	28.9	27.5	55.9	30.6	29.1	52.0	52.5	略	43.3	略
σs "	462	429	1096	613	570	1247	877		536	
τ "	6.2	0	7.6	6.3	0	7.3	5.1		4.5	
σca "	70	70	70	70	70	70	70	70	70	70
σsa "	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600
τa "	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
断面 NO.	M-1	M-1	M-1	M-1	M-1	M-1	M-1	M-1	M-1	M-1

注) τの計算に於て、jは0.875とする。

CASE 1 CASE 2

********** DISPLACEMENT **********

DISP(X),DISP(Y) --- DISPLACEMENT (M)
DISP(R) --- ROTATION ANGLE (RADIAN)

JOINT	DISP(X)	DISP(Y)	DISP(R)	DISP(X)	DISP(Y)	DISP(R)
1	0.	0.2157E-22	-0.1261E-03	0.	0.1952E-22	-0.1039E-03
2	-0.1734E-05	0.2157E-22	0.1094E-03	0.5137E-21	0.1952E-22	0.8875E-04
3	-0.1734E-05	-0.5232E-04	-0.2225E-04	0.5137E-21	-0.4032E-04	-0.5988E-21
4	0.	-0.5232E-04	0.1652E-04	0.	-0.4032E-04	-0.3726E-22
5	-0.1734E-05	0.	-0.6600E-04	0.5137E-21	0.	-0.8875E-04
6	0.	0.	0.9205E-04	0.	0.	0.1039E-03

********** STRESS **********

L --- DISTANCE (M)
M --- BENDING MOMENT (T*M)
S --- SHEARING FORCE (T)
N --- AXIAL FORCE (T)

MEMBER
② - ③

	L	M	S	N	L	M	S	N
	0.	-1.859	10.989	3.022		-3.580	15.074	9.024
	2.065	-5.545	-13.639	3.022		-7.162	-18.544	9.024
	L	M	S	N	L	M	S	N
M.MAX	0.878	2.963	0.000	3.022	0.926	3.600	0.000	9.024
M.MIN	2.065	-5.545	-13.639	3.022	2.065	-7.162	-18.544	9.024
S.MAX	0.	-1.859	10.989	3.022	0.	-3.580	15.074	9.024
S.MIN	2.065	-5.545	-13.639	3.022	2.065	-7.162	-18.544	9.024
N.MAX	0.	-1.859	10.989	3.022	0.	-3.580	15.074	9.024
N.MIN	0.	-1.859	10.989	3.022	0.	-3.580	15.074	9.024

12

MEMBER

③- ⑤

L	M	S	N	M	S	N
0.	-5.346	12.355	2.943	-7.162	18.544	9.024
2.065	-1.452	-8.564	2.943	-3.580	-15.074	9.024

	L	M	S	N	L	M	S	N
M.MAX	1.218	2.141	0.000	2.943	1.139	3.400	0.000	9.024
M.MIN	0.	-5.346	12.355	2.943	0.	-7.162	18.544	9.024
S.MAX	0.	-5.346	12.355	2.943	0.	-7.162	18.544	9.024
S.MIN	2.065	-1.452	-8.564	2.943	2.065	-3.580	-15.074	9.024
N.MAX	0.	-5.346	12.355	2.943	0.	-7.162	18.544	9.024
N.MIN	0.	-5.346	12.355	2.943	0.	-7.162	18.544	9.024

MEMBER

①- ④

L	M	S	N	M	S	N
0.	2.457	-12.594	4.290	4.091	-16.620	10.204
2.065	4.796	14.256	4.290	6.805	19.249	10.204

	L	M	S	N	L	M	S	N
M.MAX	2.065	4.796	14.256	4.290	2.065	6.805	19.249	10.204
M.MIN	0.934	-3.368	0.000	4.290	0.957	-3.861	0.	10.204
S.MAX	2.065	4.796	14.256	4.290	2.065	6.805	19.249	10.204
S.MIN	0.	2.457	-12.594	4.290	0.	4.091	-16.620	10.204
N.MAX	0.	2.457	-12.594	4.290	0.	4.091	-16.620	10.204
N.MIN	0.	2.457	-12.594	4.290	0.	4.091	-16.620	10.204

MEMBER

④- ⑥

L	M	S	N	M	S	N
0.	4.744	-13.149	4.369	6.805	-19.249	10.204
2.065	2.197	10.078	4.369	4.091	16.620	10.204

	L	M	S	N	L	M	S	N
M.MAX	0.	4.744	-13.149	4.369	0.	6.805	-19.249	10.204
M.MIN	1.129	-2.577	-0.000	4.369	1.108	-3.861	-0.000	10.204
S.MAX	2.065	2.197	10.078	4.369	2.065	4.091	16.620	10.204
S.MIN	0.	4.744	-13.149	4.369	0.	6.805	-19.249	10.204

MEMBER
④- ⑥

	L	M	S	N	L	M	S	N
N.MAX	0.	4.744	-13.149	4.369	0.	6.805	-19.249	10.204
N.MIN	0.	4.744	-13.149	4.369	0.	6.805	-19.249	10.204

MEMBER
②- ①

L	M	S	N	M	S	N
0.	1.859	-3.022	10.989	3.580	-9.024	15.074
1.875	2.457	4.290	10.989	4.091	10.204	15.074

	L	M	S	N	L	M	S	N
M.MAX	1.875	2.457	4.290	10.989	1.875	4.091	10.204	15.074
M.MIN	0.896	0.441	-0.000	10.989	0.926	-0.672	-0.000	15.074
S.MAX	1.875	2.457	4.290	10.989	1.875	4.091	10.204	15.074
S.MIN	0.	1.859	-3.022	10.989	0.	3.580	-9.024	15.074
N.MAX	0.	1.859	-3.022	10.989	0.	3.580	-9.024	15.074
N.MIN	0.	1.859	-3.022	10.989	0.	3.580	-9.024	15.074

MEMBER
③- ④

L	M	S	N	M	S	N
0.	-0.199	0.079	25.994	-0.000	0.000	37.087
1.875	-0.052	0.079	25.994	-0.000	0.000	37.087

	L	M	S	N	L	M	S	N
M.MAX	1.875	-0.052	0.079	25.994	1.875	-0.000	0.000	37.087
M.MIN	0.	-0.199	0.079	25.994	0.	-0.000	0.000	37.087
S.MAX	0.	-0.199	0.079	25.994	0.	-0.000	0.000	37.087
S.MIN	0.	-0.199	0.079	25.994	0.	-0.000	0.000	37.087
N.MAX	0.	-0.199	0.079	25.994	0.	-0.000	0.000	37.087
N.MIN	0.	-0.199	0.079	25.994	0.	-0.000	0.000	37.087

MEMBER
⑤- ⑥

	L	M	S	N	L	M	S	N
	0.	-1.452	2.943	8.584		-3.580	9.024	15.074
	1.875	-2.197	-4.369	8.584		-4.091	-10.204	15.074

	L	M	S	N	L	M	S	N
M.MAX	0.870	-0.103	0.000	8.584	0.920	0.672	0.000	15.074
M.MIN	1.875	-2.197	-4.369	8.584	1.875	-4.091	-10.204	15.074
S.MAX	0.	-1.452	2.943	8.584	0.	-3.580	9.024	15.074
S.MIN	1.875	-2.197	-4.369	8.584	1.875	-4.091	-10.204	15.074
N.MAX	0.	-1.452	2.943	8.584	0.	-3.580	9.024	15.074
N.MIN	0.	-1.452	2.943	8.584	0.	-3.580	9.024	15.074

********** REACTION **********

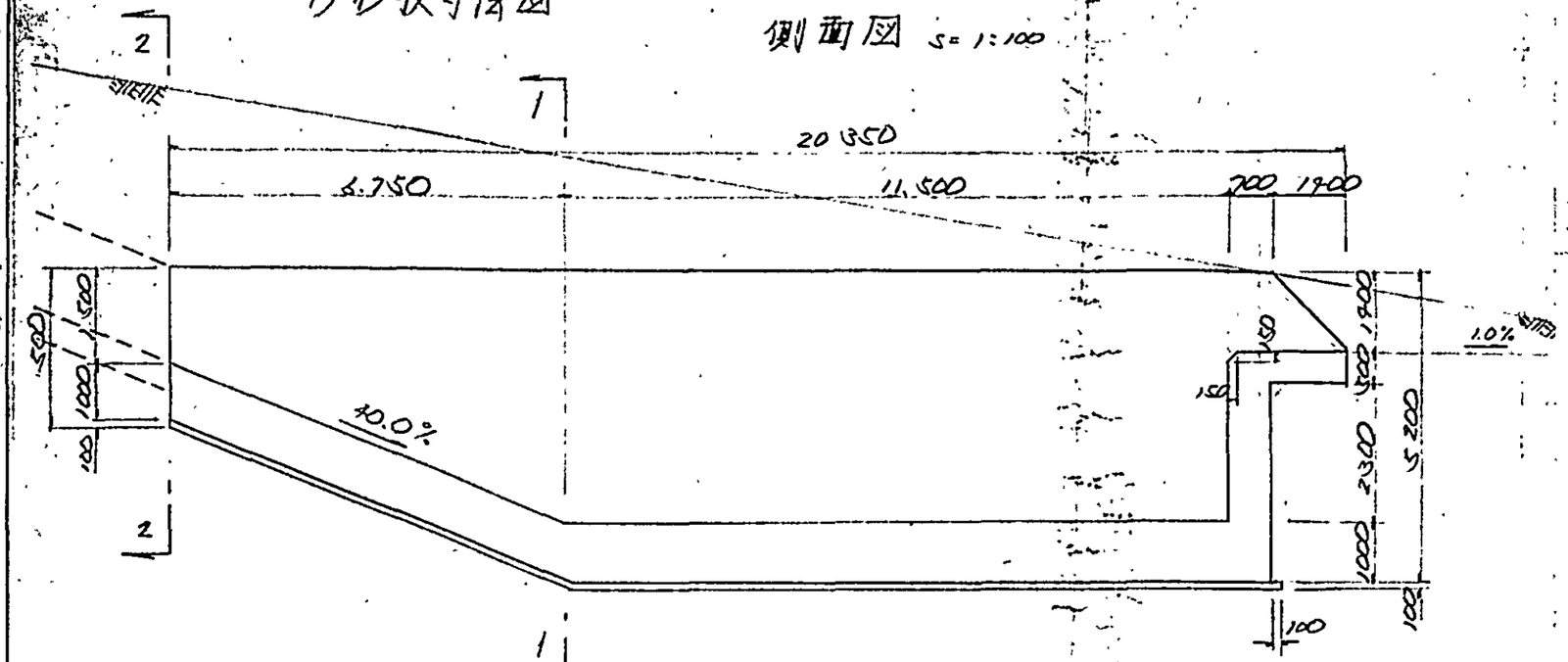
REAC(X) REAC(Y) --- REACTION (T)
REAC(R) --- REACTION (T-M)

JOINT	REAC(X)	REAC(Y)	REAC(R)	REAC(X)	REAC(Y)	REAC(R)
1	-0.000	-0.055	0.000	-0.000	0.004	0.000
6	0.	0.056	0.000	0.	0.004	0.000

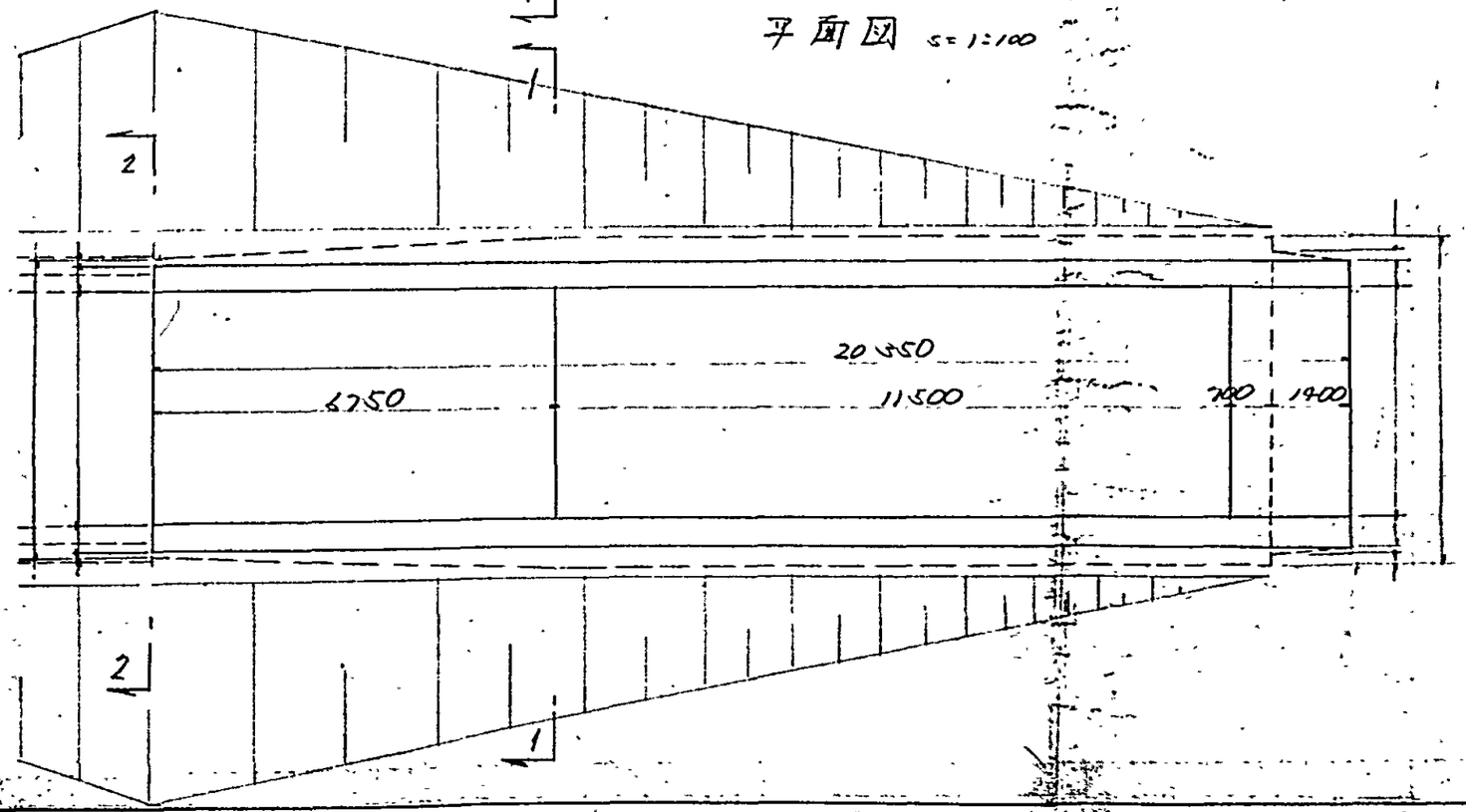
(3) 静水池

1) 形状寸法図

側面図 S=1:100

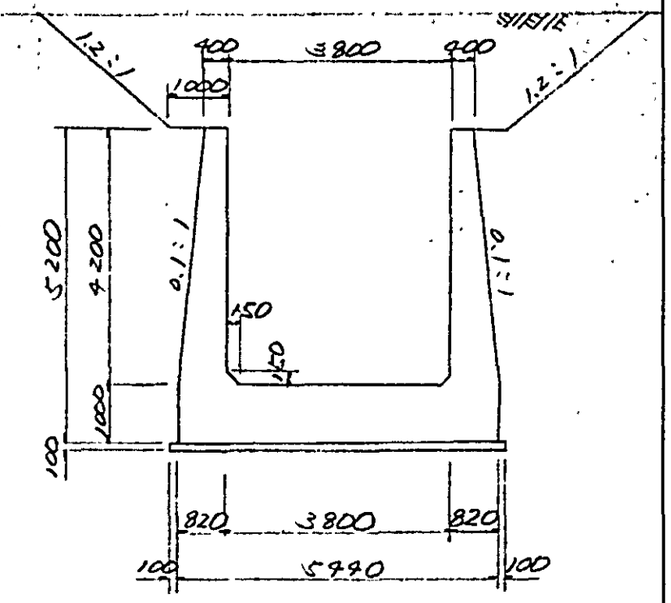


平面図 S=1:100

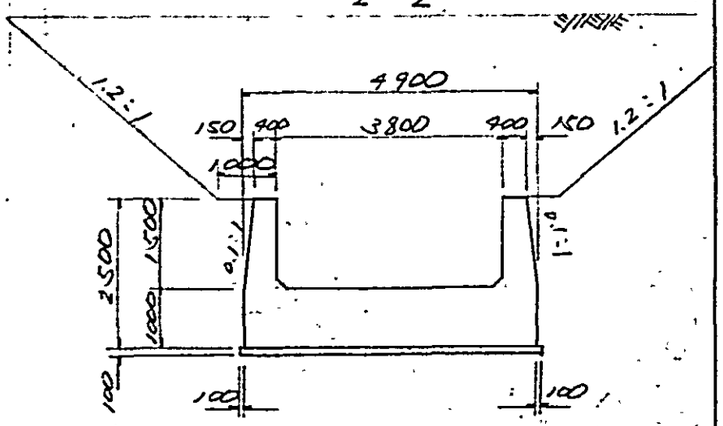


横断面図 S=1:100

1 - 1

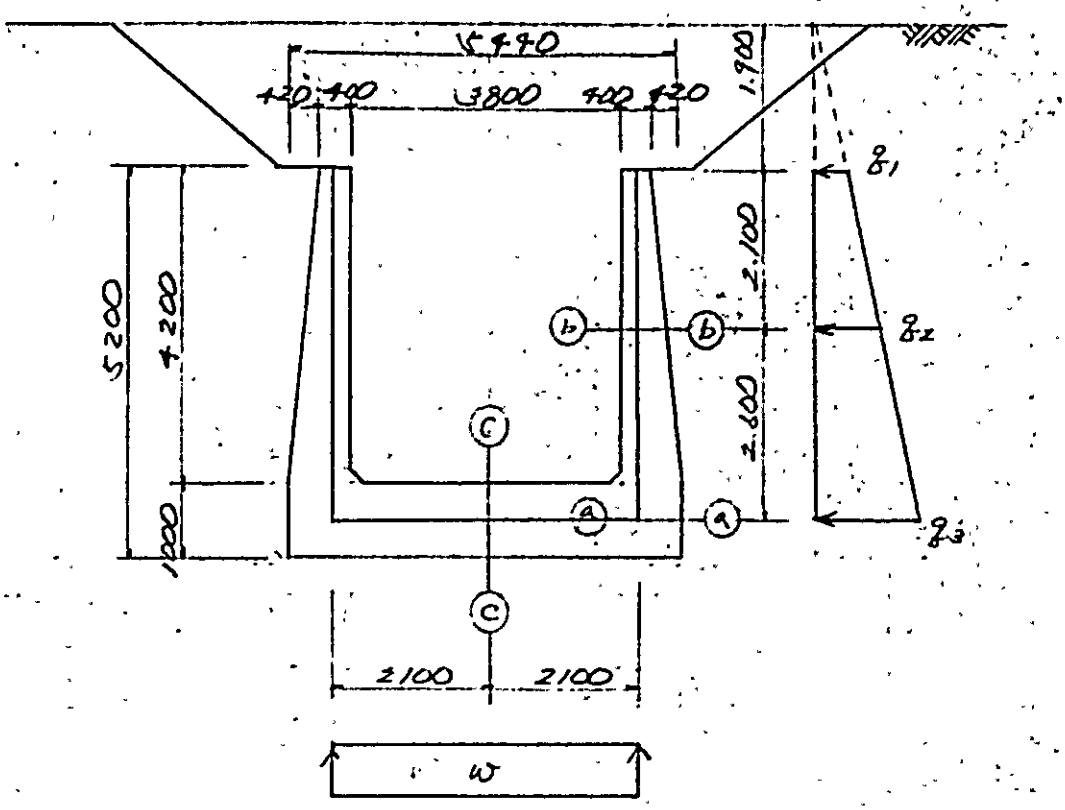


2 - 2



2) 荷重計算

①-① 断面



a) 側壁に働く荷重

$g_1 = \gamma \cdot K_H \cdot H = 1.8 \times 0.6 \times 1.90 = 2.05$ t/m²

$g_2 = \gamma \cdot K_H \cdot H = 1.8 \times 0.6 \times 4.00 = 4.32$ "

$g_3 = \gamma \cdot K_H \cdot H = 1.8 \times 0.6 \times 6.60 = 7.13$ "

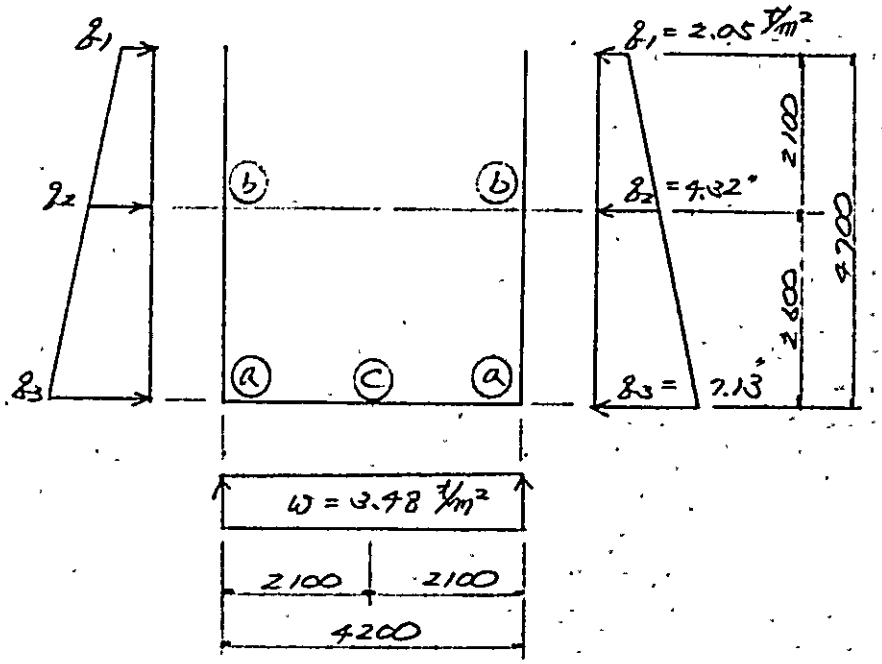
b) 底版荷力

側壁	$\frac{1}{2} \times (0.40 + 0.82) \times 4.20 \times 2 \times 2.5$	=	12.81 t/m
ハンチ	$\frac{1}{2} \times 0.150^2 \times 2 \times 2.5$	=	0.06 "
土	$\frac{1}{2} \times 0.42 \times 4.20 \times 2$	=	1.76 "
		P =	14.63 "

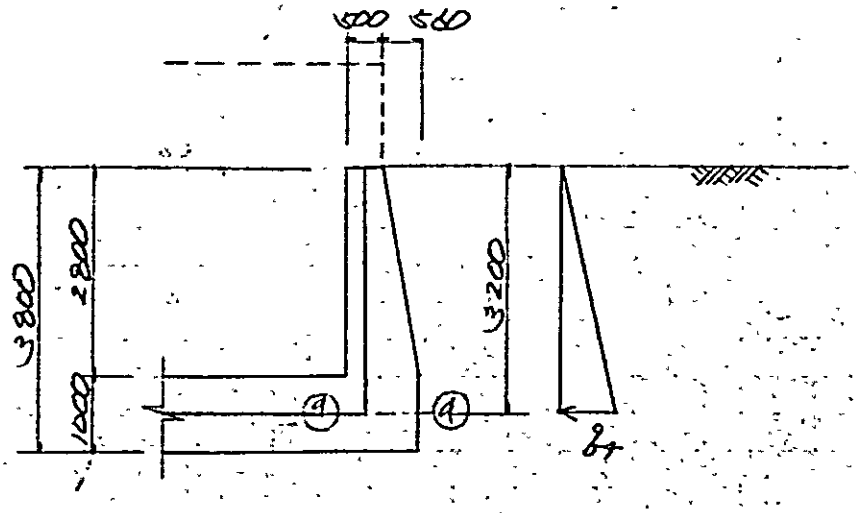
1m当り反力

$$w = \frac{P}{l} = \frac{14.63}{4.20} = 3.48 \ t/m^2$$

c) 荷重図



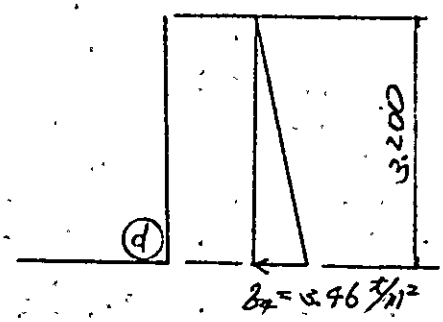
②-② 断面



a) 壁に働く荷重

$q_4 = \gamma \cdot K_H \cdot H = 1.8 \times 0.6 \times 3.20 = 3.46\ t/m^2$

b) 荷重図



3) 曲げモーメントおよび剪断力

①-① 断面

a) ⓑ点

$S_b = 1/2 \times (2.05 + 4.32) \times 2.10 = 6.69\ t$

$M_b = 6.69 \times 0.93 = 6.22\ t \cdot m$

b) ⓐ点

$S_a = 6.69 + 1/2 \times (4.32 + 7.13) \times 2.60 = 21.58\ t$

$M_a = 21.58 \times 1.92 = 41.43\ t \cdot m$

c) ⓒ点

$M_a = 41.43\ t \cdot m$

$M_c = M_a - \frac{wl^2}{8} = 41.43 - \frac{3.78 \times 7.20^2}{8} = 33.76\ t \cdot m$

$$S_c = \frac{wl}{2} = \frac{3.48 \times 4.20}{2} = 7.31\ t$$

②-② 断面

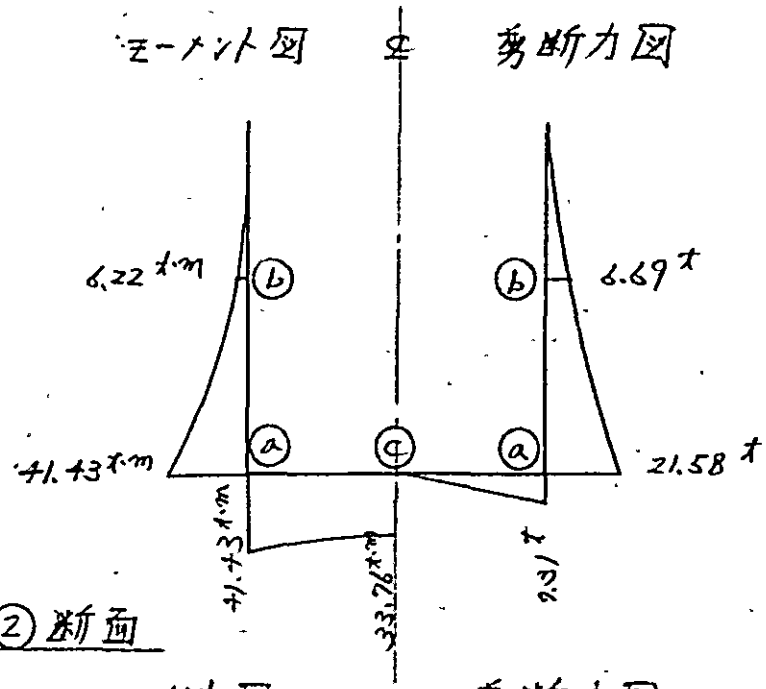
a) ⓓ 点

$$S_d = \frac{1}{2} \times 3.20 \times 3.46 = 5.54\ t$$

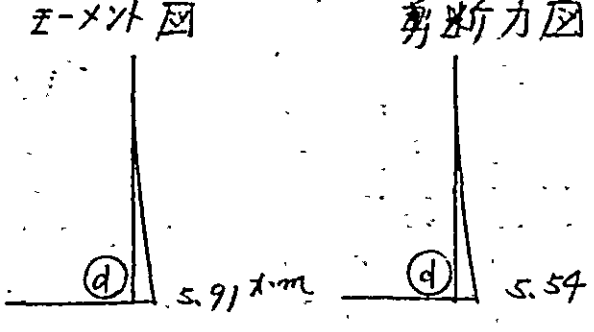
$$M_d = 5.54 \times \frac{3.20}{3} = 5.91\ t\cdot m$$

4) 応力図

①-① 断面



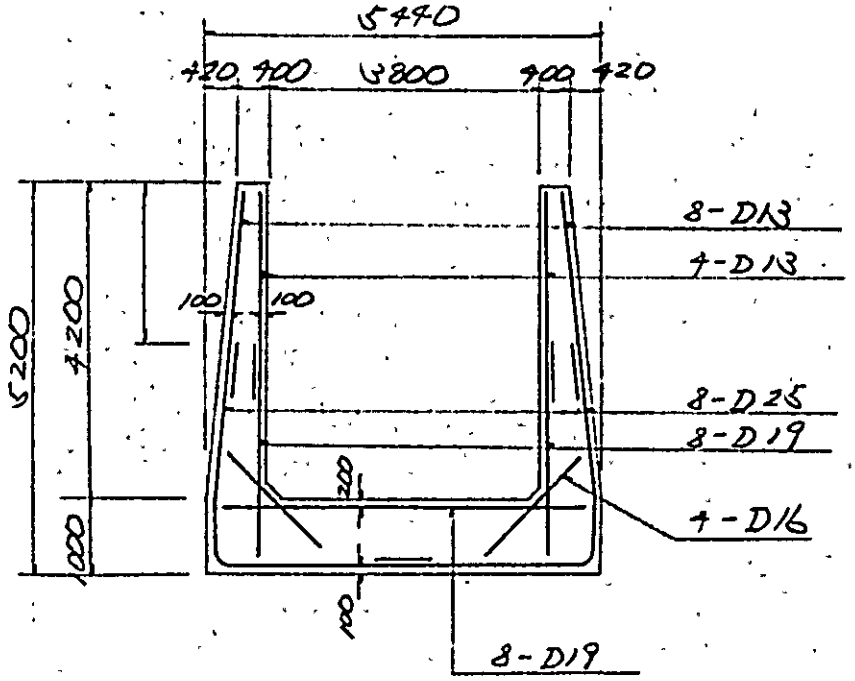
②-② 断面

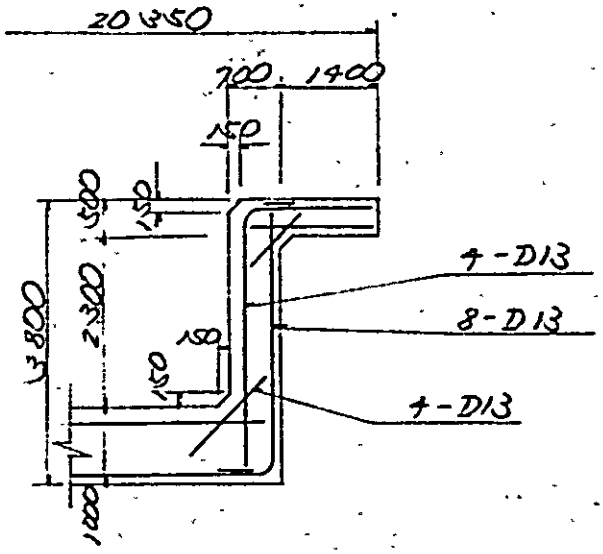


5) 応力度計算

断面	①-①				②-②
部材	底版		側壁		側壁
位置	ⓐ	ⓒ	ⓐ	ⓑ	ⓓ
M t·m	−41.43	−33.76	−41.43	−6.22	−5.91
S t	7.31	0	21.58	6.69	5.54
b cm	100	100	100	100	100
h 〃	100	100	82	61	70
d 〃	80	80	72	51	60
d′ 〃	10	10	10	10	10
A_s cm²	D25−8	D25−8	D25−8	D13−8	D13−8
	40.54	40.54	40.54	10.14	10.14
$p=\frac{A_s}{bd}$	0.00507	0.00507	0.00563	0.00199	0.00169
$\frac{M}{bd^2}$ kg/cm²	6.47	5.28	7.99	2.39	1.64
$\frac{l}{L_c}$	6.98	6.98	6.72	10.0	10.7
$\frac{l}{L_s}$	219	219	198	590	630
j	0.892	0.892	0.887	0.928	0.935
σ_c	45	37	54	24	18
σ_s	1420	1160	1582	1290	1033
τ	1.0	0	3.9	1.4	1.0
σ_{ca}	80	80	80	80	80
σ_{sa}	1600	1600	1600	1600	1600
τ_a	8	8	8	8	8
主筋 NO.	M-1	M-1	M-1	M-1	M-1

6) 配筋方法


5440
420 400 3800 400 420
8-D13
4-D13
8-D25
8-D19
4-D16
8-D19
5200
4200
1000
100
100
200
100


20350
700 1400
450
300
150
4-D13
8-D13
4-D13
3800
2300
150
150
1000

§.2 付替水路水理計算書

(1) 水路勾配急変化点での緩和曲線

急流水路の縦断勾配急変化点では、水脈のはく離を防止するために、次に示すような緩和曲線をそう入する。

$$y = x\tan\theta + \frac{Kx^2}{4h_v\cos^2\theta}$$

$$S = \tan\theta + \frac{Kx}{2h_v\cos^2\theta}$$

ここに、 y ; 縦距

x ; 横距

S ; xにおける放射流路の勾配

h_v ; 放射流路起点の速度水頭

θ ; 放射流路起点における水路の傾斜角

K ; 重力による加速度が放射運動に作用する比率、ふつう0.5またはそれ以下とする。

<STA. 4 付近>

$$h_v = \frac{v^2}{2g} = \frac{17.4^2}{2\times 9.8} = 15.45$$

$$S = 0.234 + \frac{0.5x}{2\times 15.45\times 0.974^2}$$

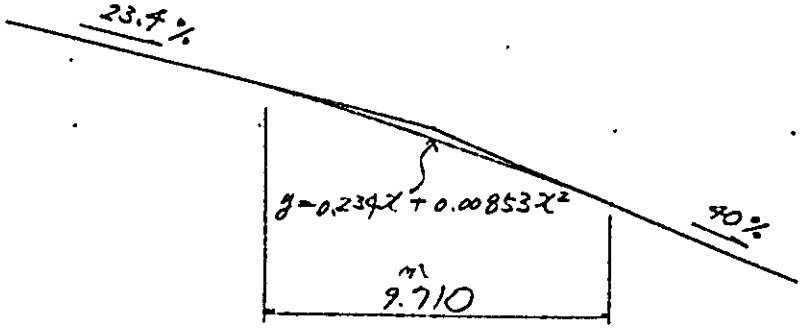
$$= 0.234 + 0.0171x$$

$S = 0.40$ とすると $x = 9.71$

$$y = 0.234x + \frac{0.5x^2}{4\times 15.45\times 0.974^2}$$

$$= 0.234x + 0.00853x^2$$

故に、以下のような計算になる。

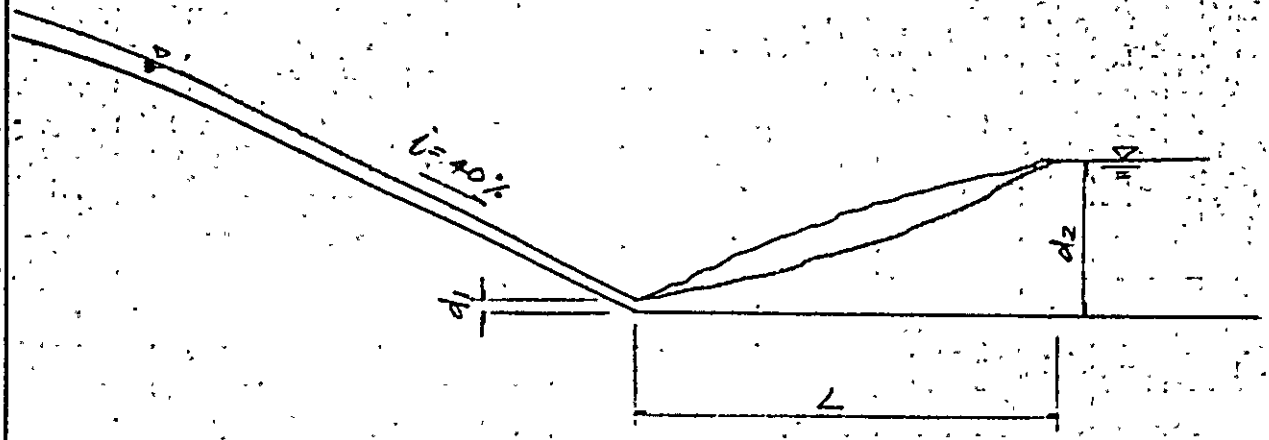


x	y
0	0
1.000	0.243
2.000	0.502
3.000	0.779
4.000	1.072
4.855	1.337
5.000	1.382
6.000	1.711
7.000	2.056
8.000	2.418
9.000	2.797
9.710	3.076

尚、他の勾配変化点については、上記計算結果より想定した。

(2) 急流工, 静水池 水理設計

(水路幅 $b=3.8^m$, 流量 $Q=20\ m^3/sec.$, $n=0.015$)



跳水を伴うときの水深(d_1)と等流水深に等しいと仮定すると、

$$Q = A \times \frac{1}{n} \times R^{2/3} \times I^{1/2}$$

$$= b \times d_1 \times \frac{1}{n} \times \left(\frac{b d_1}{b+2d_1}\right)^{2/3} \times i^{1/2}$$

$$= 3.8 \times d_1 \times \frac{1}{0.015} \times \left(\frac{3.8 d_1}{3.8+2d_1}\right)^{2/3} \times 0.4^{1/2}$$

$$= 160.2\, d_2 \left(\frac{3.8 d_1}{3.8+2d_1}\right)^{2/3} \quad \text{--------(式-1)}$$

$d_1 = 0.31^m$ とすると (式-1) より

$Q = 20.6\ m^3/sec. \fallingdotseq 20\ m^3/sec.$ OK

水深 d_1 での流速は

$v = 17.5\ m/sec.$ となる。

フルード数

$$F_{r1} = \frac{17.5}{\sqrt{9.8 \times 0.31}} = 10.0$$

$$\frac{d_2}{d_1} = \frac{1}{2}\left(\sqrt{1+8Fr_1^2} - 1\right)$$

$$= \frac{1}{2}\left(\sqrt{1+8\times 10.0^2} - 1\right)$$

$$= 12.7$$

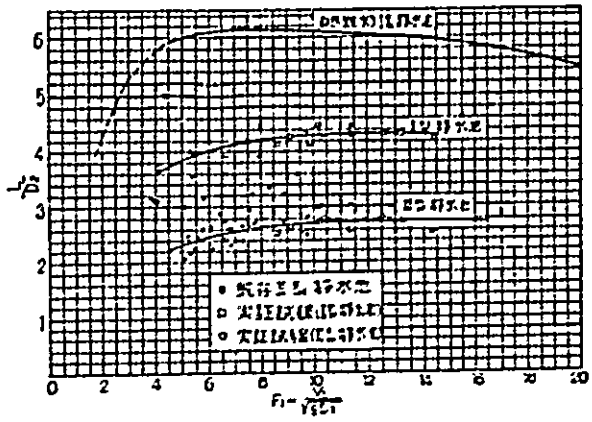
$$\therefore d_2 = 12.7 \times 0.33 = 4.2\ m$$

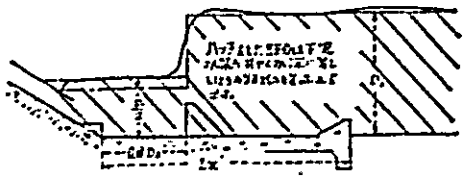
III型静水池を使用すると、本図より

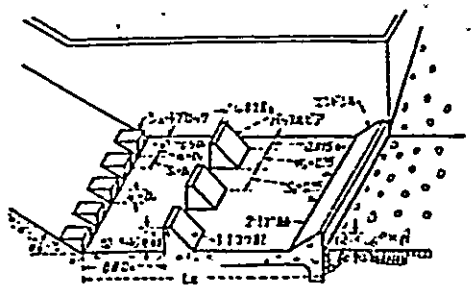
$$\frac{L}{d_2} = 2.7$$

$$\therefore L = 2.7 \times 4.2 = 11.3\ m$$

水平静水池上の跳水の長さ（I, II, III型静水池）







また、静水池流出口における水深は限界水深(h_c)となる。

$$h_c = \sqrt[3]{\frac{\alpha Q^2}{g b^2}}$$

$$= \sqrt[3]{\frac{1.0 \times 20^2}{9.8 \times 3.8^2}} = 1.71\ m$$

以上の計算より静水池の型式はⅢ型を変形したものとする。(型状寸法は本体設計図参照)

8.3 流出量計算書

11) 設計条件

1) 流出量の算出

ラショナル式（合理式）を用いて計算する。

$$Q_0 = \frac{1}{3.6 \times 10^6} \cdot C \cdot \gamma \cdot a$$

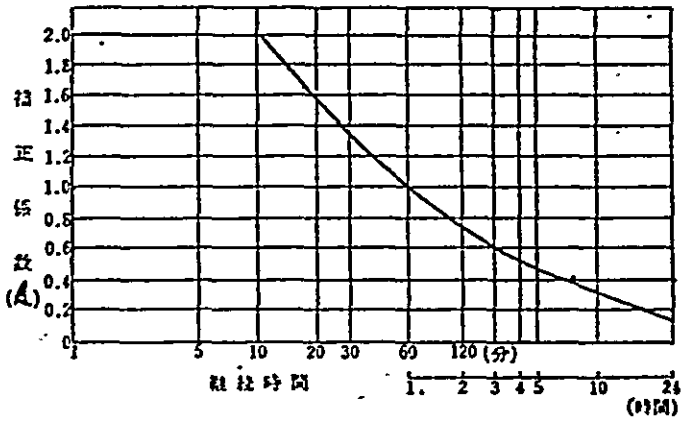
但し、

$$\gamma = k \cdot \gamma_k$$

ここに、

- γ；設計降雨強度（mm/h）
- γ_k；確率降雨強度（〃）で20mm/hと仮定した。
- k；降雨の継続時間による補正係数（下図参照）
- Q_0；流出量（m³/sec.）
- C；流出係数（急峻な山地 0.8、緩い山地 0.7）
- a；集水面積（m²）

降水の継続時間による補正係数



2) 計画通水量の算出

マニング式を用いて計算する。

$$Q_a = A \cdot v \times 0.8$$

$$= A \cdot \frac{1}{n} \cdot R^{2/3} \cdot I^{1/2} \times 0.8$$

ここに、

- Q_a；計画通水量 ($m^3/sec.$)
- A；通水断面積 (m^2)
- v；平均流速 ($m/sec.$)
- R；径深 (m)
- I；勾配
- n；粗度係数 (コルゲート管；0.018)

(3) 流出量計算及び断面決定

Route ⑧-2

右岸側 Calculation Sheet for Drain -1

No.	Station of Drain	Length of River Channel or Gutter L (km)	Gradient of River Channel or Gutter ΔH/L	Velocity of Flow V=72×(ΔH/L)^0.6 (km/h)	Time of Inlet To = L/V ×60 (min)	Time of Inlet Ti (min)	Total Time of Inlet T = To+Ti (min)	k	Probability Intensity of Rainfall Yk (mm/h)	Design Intensity of Rainfall r = k·Yk (mm/h)	Coeff't of Discharge C	Catchment Area a (m²)	Run-off Q1 = 1/3.6×10⁶ ×r×c×a (m³/sec)	Gradient I (%)	Type	Velocity of Flow v (m/sec)	Ref.
1	1+75	0.08	0.070	14.6	0.3	45	45	1.1	80	88	0.7	30,000	0.51	1.0	P(H)0.6	2.2	
2	2+50	0.165	〃	〃	0.7	50	50	1.0	〃	80	〃	32,500	0.51	1.0	〃	2.2	
3	4+30	0.19	〃	〃	0.8	20	20	1.6	〃	128	〃	12,500	0.31	0.5	〃	1.6	
4	6+30	0.42	〃	〃	1.7	40	40	1.2	〃	96	〃	87,500	1.63	0.7	P(H)1.0	2.5	
5	10+80	0.05	〃	〃	0.2	55	55	1.0	〃	80	〃	87,500	1.36	0.6	〃	2.3	
6	11+25	0.16	〃	〃	0.7	55	55	1.0	〃	80	〃	57500	0.89	3.0	P(H)0.6	3.8	
7	12+95	0.16	0.250	31.3	0.3	45	45	1.1	〃	88	〃	45,000	0.77	3.0	〃	3.8	
8	15+00	0.32	0.234	30.1	0.6	40	40	1.2	〃	96	〃	65000	1.21	0.4	P(H)1.0	1.8	
9	16+40	0.56	0.196	27.1	1.2	30	30	1.3	〃	104	〃	150000	3.03	2.8	P(H)1.0	5.0	
10	17+70	0.62	0.177	25.5	1.5	35	35	1.3	〃	104	〃	112500	2.28	1.5	P(H)1.0	3.8	
11	18+40	0.36	0.181	25.8	0.81	90	90	0.9	〃	72	〃	195000	19.78 (2.73)	1.0	2C-BOX 1.75×1.50	4.4	11+17+18 +19+20+59 Qo=21.6
12	19+80	0.16	0.281	33.6	0.35	8	8	2.0	〃	160	〃	37500	1.17	0.4	P(H)1.0	1.8	

Calculation Sheet for Drain-2

No.	Station of Drain	Length of River Channel or Gutter L (km)	Gradient of River Channel or Gutter $\Delta H/L$	Velocity of Flow $V=72\times(\frac{\Delta H}{L})^{0.6}$ (km/h)	Time of Inlet $T_0=\frac{L}{V}\times 60$ (min)	Time of Inlet T_1 (min)	Total Time of Inlet $T=T_0+T_1$ (min)	k	Probability Intensity of Rainfall r_k (mm/h)	Design Intensity of Rainfall $r=k\cdot r_k$ (mm/h)	Coeff't of Discharge C	Catchment Area a (m^2)	Run-off $Q=\frac{1}{3.6\times10^3}\times r\times C\times a$ (m^3/sec)	Gradient I (%)	Type	Velocity of Flow v (m/sec)	Ref.
13	22+20	0.10	0.250	31.3	0.2	12	12	2.0	80	160	0.7	20000	0.62	2.0	P(H)0.6	3.2	Route Ⓐ-2
14	25+00	0.12	0.020	6.9	1.0	30	30	1.3	"	104	"	30.000	2.28 (0.61)	1.5	P(H)1.0	3.7	16+14
15		0.19	0.070	14.6	0.8	35	35	1.3	"	104	"	25000	0.51				overflow
16	29+45	0.50	0.025	7.9	3.8	70	70	1.0	"	80	"	107500	1.67	0.8	P(H)1.0	2.7	"
17		0.67	0.070	14.6	2.8	80	80	0.9	"	72	"	157500	2.21				flow into No.59
18	41+70	0.22	0.070	14.6	0.9	80	80	0.9	"	72	"	65,000	0.91	3.0	P(H)0.6	3.8	"
19	44+00	0.15	0.070	14.6	0.6	100	100	0.9	"	72	"	42500	0.67	2.0	P(H)0.6	3.1	"
20	47+10	0.38	0.003	2.2	10.4	90	100	0.9	"	72	"	147500	2.07	1.5	P(H)1.0	3.7	"
21		0.26	0.030	8.8	1.8	90	90	0.8	"	64	0.8	130,000	1.85				Overflow Route Ⓑ
22	3+55	0.21	0.060	11.9	1.1	25	25	1.5	"	120	"	27,500	0.73	3.0	P(H)0.6	3.8	"
23	6+35	0.06	0.060	11.9	0.3	60	60	1.0	"	80	"	77,500	1.38	0.6	P(H)1.0	2.3	"
24	7+80	0.07	0.025	7.9	0.5	25	25	1.5	"	120	"	7500	0.20	0.2	P(H)0.6	1.0	"

Calculation Sheet for Drain -3

No.	Station of Drain	Length of River Channel or Gutter L (km)	Gradient of River Channel or Gutter $\frac{\Delta H}{L}$	Velocity of Flow $V=72\times(\frac{\Delta H}{L})^{0.6}$ (km/h)	Time of Inlet $T_0=\frac{L}{V}\times 60$ (min)	Time of Inlet T_1 (min)	Total Time of Inlet $T=T_0+T_1$ (min)	k	Probability Intensity of Rainfall r_k (mm/h)	Design Intensity of Rainfall $r=k\cdot r_k$ (mm/h)	Coeff't of Discharge C	Catchment Area a (m^2)	Run-off $Q=\frac{1}{3.6\times10^6}\times r\times C\times a$ (m^3/sec)	Gradient I (%)	Type	Velocity of Flow v (m/sec)	Ref.
																	Route ⑧
25	10+20	0.17	0.025	7.9	1.3	40	40	1.2	80	96	0.8	45000	0.96	0.3	P(H)1.0	1.7	
26	11+00	0.8	0.025	7.9	6.1	60	70	0.9	"	72	"	92500	1.56	0.8	P(H)1.0	2.7	
27	12+00	0.1	0.025	7.9	0.8	120	120	0.7	"	56	"	340000	4.23	1.0	C-BOX 1.5×1.5	3.5	Qa =4.41
28	13+00	0.095	0.025	7.9	0.7	55	55	1.0	"	80	"	100000	1.78	1.0	P(H)1.0	3.0	
29	14+00	0.095	0.025	7.9	0.8	25	25	1.5	"	120	"	7500	0.20				Flow into Bridge
30	—	—	—	—	—	35	35	1.3	"	104	"	25000	0.58				
31	15+55	0.21	0.04	10.4	1.2	55	55	1.0	"	80	"	90000	1.60	0.8	P(H)1.0	2.7	
32	17+90	0.96	0.213	28.5	2.0	45	45	1.1	"	88	"	432500	10.41	1.0	C-BOX 1.75×1.75	4.4	Qa =10.81
33	18+80	0.14	0.04	10.4	0.8	18	19	1.6	"	128	"	7500	0.21	0.2	P(H)0.6	1.0	
34	—	—	—	—	—	20	20	1.6	"	128	"	5000	0.14				Flow into Bridge
35	20+95	0.17	0.04	10.4	1.0	30	30	1.3	"	104	"	27500	0.64				
36	22+65	0.1	0.04	10.4	0.6	60	60	1.0	"	80	"	60000	1.07	0.4	P(H)1.0	1.8	

Calculation Sheet for Drain -4

Route ⑥

No.	Station of Drain	Length of River Channel or Gutter L (km)	Gradient of River Channel or Gutter ΔH/L	Velocity of Flow V=72 × (ΔH/L)^0.6 (km/h)	Time of Inlet $T_0 = L/V \times 60$ (min)	Time of Inlet T_1 (min)	Total Time of Inlet $T = T_0 + T_1$ (min)	k	Probability Intensity of Rainfall r_k (mm/h)	Design Intensity of Rainfall $r = k \cdot r_k$ (mm/h)	Coeff't of Discharge C	Catchment Area a (m^2)	Run-off $Q = \frac{1}{3.6\times10^6} \times r \times C \times a$ (m^3/sec)	Gradient I (%)	Type	Velocity of Flow v (m/sec)	Ref.
37	23+70	0.13	0.04	10.4	0.8	30	30	1.3	80	104	0.8	17,500	0.40	0.7	P(H)0.6	1.8	
38	25+00	0.095	0.04	10.4	0.5	50	50	1.0		80	"	62,500	1.11	0.4	P(H)1.0	1.8	
39	26+00	0.15	0.04	10.4	0.9	70	70	1.0	"	80	"	117,500	2.09	1.5	P(H)1.0	3.8	
40	27+60	0.185	0.04	10.4	1.1	45	45	1.1	"	88	"	57,500	1.12	0.4	P(H)1.0	1.8	
41	29+50	0.09	0.04	10.4	0.5	60	60	1.0	"	80	"	47,500	0.84	3.0	P(H)0.6	3.8	
42	30+45	0.09	0.018	6.5	0.8	50	50	1.0	"	80	"	35,000	0.62	2.0	P(H)0.6	3.1	

Calculation Sheet for Drain - 5

No.	Station of Drain	Length of River Channel or Gutter L (km)	Gradient of River Channel or Gutter $\Delta H/L$	Velocity of Flow $V=72\times(\frac{\Delta H}{L})^{0.6}$ (km/h)	Time of Inlet $T_0=L/V\times 60$ (min)	Time of Inlet T_1 (min)	Total Time of Inlet $T=T_0+T_1$ (min)	k	Probability Intensity of Rainfall r_k (mm/h)	Design Intensity of Rainfall $r=k\cdot r_k$ (mm/h)	Coeff't of Discharge C	Catchment Area a (m^2)	Run-off $Q_1=\frac{1}{3.6\times10^6}\times r\times c\times a$ (m^3/sec)	Gradient I (%)	Type	Velocity of FLow v (m/sec)	Ref.
43	32+70	0.13	0.070	14.6	0.5	40	40	1.2	80	96	0.8	37,500	0.80	3.0	P(H)0.6	3.8	Route Ⓑ
44	33+80	0.15	"	"	0.6	40	40	1.2	"	96	0.7	39,400	0.64	2.0	P(H)0.6	3.1	
45	35+90	0.15	"	"	0.6	40	40	1.2	"	96	"	28,300	0.53				"
46	37+50	0.16	"	"	0.7	45	45	1.1	"	88	"	41,000	0.70				"
47	37+90	0.04	"	"	0.2	90	90	0.9	"	72	"	418,300	7.09	1.0	C-BOX 1.5×1.5	4.0	"
48	—	—	—	—	—	45	45	1.1	"	88	"	711,800	12.18				Flow into Bridge
49	41+60	0.22	0.070	14.6	0.9	15	15	1.8	"	144	"	10800	0.30	0.4	P(H)0.6	1.4	"
50	—	—	—	—	—	55	55	1.0	"	80	"	93300	1.45				Flow into Bridge
51	35+0	—	—	—	—	120	120	0.7	"	56	"	1,027,500	17.05	1.0	2C-BOX 1.25×1.50	4.2	17+18+17 +20+57 =129 Route Ⓑ-2

左岸側 Calculation Sheet for Drain – 6

No.	Station of Drain	Length of River Channel or Gutter L (km)	Gradient of River Channel or Gutter $\Delta H/L$	Velocity of Flow $V=72\times(\frac{\Delta H}{L})^{0.6}$ (km/h)	Time of Inlet $T_0=L/V\times 60$ (min)	Time of Inlet T_1 (min)	Total Time of Inlet $T=T_0+T_1$ (min)	k	Probability Intensity of Rainfall r_k (mm/h)	Design Intensity of Rainfall $r=k\cdot r_k$ (mm/h)	Coeff't of Discharge C	Catchment Area a (m^2)	Run-off $Q=\frac{1}{3.6\times10^6}\times r\times C\times a$ (m^3/sec)	Gradient I (%)	Type	Velocity of Flow v (m/sec)	Ref.
101	—	0.18	0.095	11.2	1.0	45	45	1.1	80	88	0.7	13800	0.24				Flow into Bridge
102	-2-95	0.11	〃	〃	0.6	45	45	1.1	〃	88	〃	17800	0.30	0.4	P(H)0.6	1.4	
103	-4-30	0.19	〃	〃	1.0	35	35	1.3	〃	104	〃	22300	0.45	0.9	P(H)0.6	2.1	
104	-6-20	0.18	〃	〃	1.0	35	35	1.3	〃	109	〃	26000	0.53	1.5	P(H)0.6	2.6	
105	-8-05	0.28	〃	〃	1.5	30	30	1.3	〃	109	〃	47300	0.96	0.3	P(H)1.0	1.7	
106	-11-00	0.20	〃	〃	1.1	30	30	1.3	〃	109	〃	41500	0.84	3.0	P(H)0.6	3.8	
107	-12-75	0.19	〃	〃	1.0	45	45	1.1	〃	88	〃	46300	0.79	3.0	P(H)0.6	3.8	
108	-15-30	0.11	〃	〃	0.6	90	90	0.9	〃	72	〃	104500	1.46	0.6	P(H)1.0	2.3	
109	-21-75	0.47	〃	〃	2.5	60	60	1.0	〃	80	〃	71300	1.11	0.4	P(H)1.0	1.9	

Route Ⓐ-1