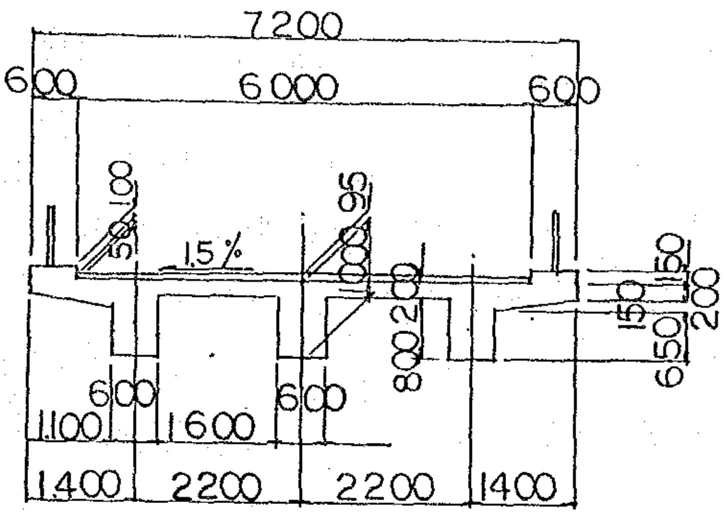
OVER BRIDGE(1) W=6m

No.① VEHICLE BRIDGE —Superstructure

1. Shape and size



2. Factor of section

Shape	b×h = A (m²)	y (m)	Ay (m³)	$I_0 = Ay^2 + \frac{bh^3}{12}$ (m⁴)
▭	7.20×0.20=1.440	0.100	0.144	0.0192
▭	0.60×0.80×3 =1.440	0.600	0.864	0.5952
Σ	2.880		1.008	0.6144

$$\bar{y} = \frac{\Sigma A y}{\Sigma A} = \frac{1.008}{2.880} = 0.350 \text{ m}$$

$$I = I_0 - \Sigma A \cdot \bar{y}^2 = 0.6144 - 2.880 \times 0.350^2 = 0.2616 \text{ m}^4$$

$$E_c = 27 \text{ KN/mm}^2 = 2.7 \times 10^7 \text{ KN/m}^2$$

3. Load

1) Dead load

pave : $22.6 \times \frac{0.05+0.095}{2} \times 6.0$ = 9.831 KN/m

con : $23.6 \times 7.2 \times 0.20$ = 33.984 KN/m

: $23.6 \times (1.10 \times 0.15 + 0.60 \times 0.15 \times 2)$ = 3.894 KN/m

: $23.6 \times 0.60 \times 0.80 \times 3$ = 33.984 KN/m

guard rall: 0.980×2 = 1.960 KN/m

ωd : = 83.653 KN/m

2) Live load (H A − load)

a) loaded strength

U.D.L — loaded length

(1) first span : ℓ =15.0^{m} < 30.0^{m} ∴K=1.0

∴Pu=30.0 KN/m, lane

(2) middle support : ℓ =30.0^{m} < 30.0^{m} ∴K=1.0

∴Pu=30.0 KN/m, lane

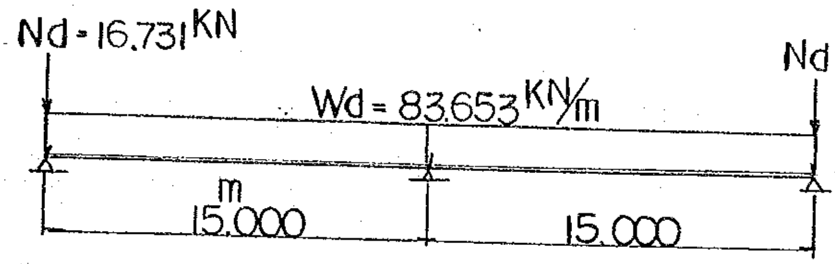
b) Loaded of all width

For U.D.L $P_u = 30.0 \times 2^{\text{lane}} \times 2/3$ = 40 KN/m

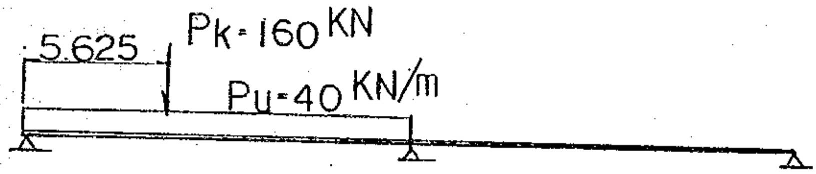
For K.E.L $P_K = 120 \times 2^{\text{lane}} \times 2/3$ = 160 KN/m

3) Loaded figure

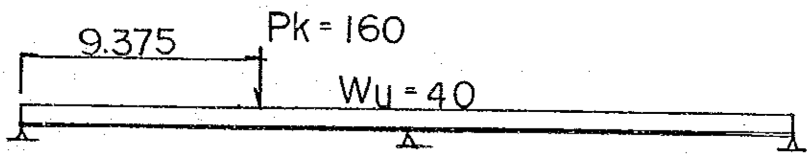
case－1



case－2



case－3



NOTE: THE DIMENSION(t) BE EXCHANG TO DIMENSION(KN) INTO THIS CALCULATION

No	X (m)	Y (m)
1	0.0000	0.0000
2	15.0000	0.0000
3	30.0000	0.0000

No	I	J	A (m2)	I (m4)	I - J	L (m)	E (t/m2)	EPS
1	1 -	2	2.88000	0.261600	Pin - Fix	15.000	2.70E+07	1.20E-05
2	2 -	3	2.88000	0.261600	Fix - Pin	15.000	2.70E+07	1.20E-05

	X (t/m)	Y (t/m)	M(tm/Rad)
1	Free	Fix	Free
2	Fix	Fix	Free
3	Free	Fix	Free

No		L-No 1 / 11	L-No 2 / 12	L-No 3 / 13	L-No 4 / 14	L-No 5 / 15	L-No 6 / 16	L-No 7 / 17	L-No 8 / 18	L-No 9 / 19	L-No 10 / 20
1	7	1.875	3.750	5.625	7.500	9.375	11.250	13.125			
2	7	1.875	3.750	5.625	7.500	9.375	11.250	13.125			

: Dead load
No. : 1

No	i -j	Li (m)	Lo (m)	Pi (t/m)	Pj (t/m)
1	1- 2	0.001		-16.731	
2	2- 3	14.999		-16.731	
1	1- 2	0.000	15.000	-83.653	-83.653
2	2- 3	0.000	15.000	-83.653	-83.653

Σ V = -2543.052 (t)
Σ H = 0.000 (t)

: HA Load
No. : 2

No	i -j	Li (m)	Lo (m)	Pi (t/m)	Pj (t/m)
1	1- 2	5.625		-160.000	
1	1- 2	0.000	15.000	-40.000	-40.000

Σ V = -760.000 (t)
Σ H = 0.000 (t)

: HA LOAD
No. : 3

No	i -j	Li (m)	Lo (m)	Pi (t/m)	Pj (t/m)
1	1- 2	9.375		-160.000	
1	1- 2	0.000	15.000	-40.000	-40.000
2	2- 3	0.000	15.000	-40.000	-40.000

Σ V = -1360.000 (t)
Σ H = 0.000 (t)

NO 1 VEHICLE BRIDGE

No No	C-No 1 No 4	C-No 2 No 5
No 1	1.3800	1.3800
No 2	1.6500	0.0000
No 3	0.0000	1.6500

No 1 : 4 5

	Case. 1			Case. 2			Case. 3		
No.	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)
1.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.0000
2.	0.00000	0.00000	0.00000	0.00000	0.00000	0.68795	0.00000	0.00000	0.2080
3.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.0000

	Case. 4			Case. 5		
No.	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)
1.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.	0.00000	0.00000	1.13511	0.00000	0.00000	0.34317
3.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

	Case. 1			Case. 2			Case. 3		
No.	RX (t)	RY (t)	RM (tm)	RX (t)	RY (t)	RM (tm)	RX (t)	RY (t)	RM (tm)
1.	0.000	487.277	0.000	0.000	349.609	0.000	0.000	269.766	0.000
2.	0.000	1568.500	0.000	0.000	460.781	0.000	0.000	880.469	0.000
3.	0.000	487.277	0.000	0.000	-50.391	0.000	0.000	209.766	0.000

	Case. 4			Case. 5		
No.	RX (t)	RY (t)	RM (tm)	RX (t)	RY (t)	RM (tm)
1.	0.000	1249.300	0.000	0.000	1117.560	0.000
2.	0.000	2924.810	0.000	0.000	3617.300	0.000
3.	0.000	589.298	0.000	0.000	1018.560	0.000

NO 1 VEHICLE BRIDGE

		Case 1 Dead load			Case 2 HA Load			Case 3 HA LOAD		
No	L(m)	M (tm)	S (t)	N (t)	M (tm)	S (t)	N (t)	M (tm)	S (t)	N (t)
1- 2	0.000	0.000	487.277	0.000	0.000	349.609	0.000	0.000	269.766	0.000
* 1	1.875	735.245	313.697	0.000	585.205	274.609	0.000	435.498	194.766	0.000
* 2	3.750	1176.381	156.848	0.000	1029.785	199.609	0.000	730.371	119.766	0.000
* 3	5.625	1323.424	-0.002	0.000	1333.740	124.609	0.000	884.619	44.766	0.000
* 4	7.500	1176.374	-156.851	0.000	1197.070	-110.391	0.000	898.242	-30.234	0.000
* 5	9.375	735.232	-313.700	0.000	919.775	-185.391	0.000	771.240	-105.234	0.000
* 6	11.250	-0.002	-470.550	0.000	501.855	-260.391	0.000	203.613	-340.234	0.000
* 7	13.125	-1029.329	-627.399	0.000	-56.689	-335.391	0.000	-504.639	-415.234	0.000
2- 1	15.000	-2352.749	-784.249	0.000	-755.859	-410.391	0.000	-1353.516	-490.234	0.000
2- 3	0.000	-2352.749	784.249	0.000	-755.859	50.391	0.000	-1353.516	390.234	0.000
* 1	1.875	-1029.329	627.399	0.000	-661.377	50.391	0.000	-692.139	315.234	0.000
* 2	3.750	-0.002	470.550	0.000	-566.895	50.391	0.000	-171.387	240.234	0.000
* 3	5.625	735.232	313.700	0.000	-472.412	50.391	0.000	208.740	165.234	0.000
* 4	7.500	1176.374	156.851	0.000	-377.930	50.391	0.000	448.242	90.234	0.000
* 5	9.375	1323.424	0.002	0.000	-283.447	50.391	0.000	547.119	15.234	0.000
* 6	11.250	1176.381	-156.848	0.000	-188.965	50.391	0.000	505.371	-59.766	0.000
* 7	13.125	735.245	-313.697	0.000	-94.482	50.391	0.000	322.998	-134.766	0.000
3- 2	15.000	0.000	-487.277	0.000	0.000	50.391	0.000	0.000	-209.766	0.000

NO 1 VEHICLE BRIDGE

			Case 4			Case 5		
No		L(m)	M (tm)	S (t)	N (t)	M (tm)	S (t)	N (t)
1-	2	0.000	0.000	1249.298	0.000	0.000	1117.556	0.000
*	1	1.875	1980.227	886.007	0.000	1733.210	754.265	0.000
*	2	3.750	3322.551	545.805	0.000	2828.518	414.063	0.000
*	3	5.625	4026.996	205.603	0.000	3285.947	73.861	0.000
*	4	7.500	3598.563	-398.599	0.000	3105.496	-266.341	0.000
*	5	9.375	2532.250	-738.801	0.000	2287.167	-606.543	0.000
*	6	11.250	828.059	-1079.003	0.000	335.959	-1210.745	0.000
*	7	13.125	-1514.012	-1419.205	0.000	-2253.128	-1550.948	0.000
2-	1	15.000	-4493.962	-1759.408	0.000	-5480.094	-1891.150	0.000
2-	3	0.000	-4493.962	1165.408	0.000	-5480.094	1726.150	0.000
*	1	1.875	-2511.746	948.955	0.000	-2562.503	1385.948	0.000
*	2	3.750	-935.379	732.503	0.000	-282.791	1045.745	0.000
*	3	5.625	235.141	516.051	0.000	1359.042	705.543	0.000
*	4	7.500	999.813	299.599	0.000	2362.996	365.341	0.000
*	5	9.375	1358.637	83.147	0.000	2729.072	25.139	0.000
*	6	11.250	1311.613	-133.305	0.000	2457.268	-315.063	0.000
*	7	13.125	858.742	-349.757	0.000	1547.585	-655.265	0.000
3-	2	15.000	0.000	-589.298	0.000	0.000	-1018.556	0.000

NO 1 VEHICLE BRIDGE

PICK-UP No. 1 *

		M. MAXIMUM				M. MINIMUM			
No.	L (m)	Case	M (tm)	S (t)	N (t)	Case	M (tm)	S (t)	N (t)
1 - 2	0.000	C- 4	0.000	1249.298	0.000	C- 4	0.000	1249.298	0.000
* 1	1.875	C- 4	1980.227	886.007	0.000	C- 5	1733.210	754.265	0.000
* 2	3.750	C- 4	3322.551	545.805	0.000	C- 5	2828.518	414.063	0.000
* 3	5.625	C- 4	4026.996	205.603	0.000	C- 5	3285.947	73.861	0.000
* 4	7.500	C- 4	3598.563	-398.599	0.000	C- 5	3105.496	-266.341	0.000
* 5	9.375	C- 4	2532.250	-738.801	0.000	C- 5	2287.167	-606.543	0.000
* 6	11.250	C- 4	828.059	-1079.003	0.000	C- 5	335.959	-1210.745	0.000
* 7	13.125	C- 4	-1514.012	-1419.205	0.000	C- 5	-2253.128	-1550.948	0.000
2 - 1	15.000	C- 4	-4493.962	-1759.408	0.000	C- 5	-5480.094	-1891.150	0.000
2 - 3	0.000	C- 4	-4493.962	1165.408	0.000	C- 5	-5480.094	1726.150	0.000
* 1	1.875	C- 4	-2511.746	948.955	0.000	C- 5	-2562.503	1385.948	0.000
* 2	3.750	C- 5	-282.791	1045.745	0.000	C- 4	-935.379	732.503	0.000
* 3	5.625	C- 5	1359.042	705.543	0.000	C- 4	235.141	516.051	0.000
* 4	7.500	C- 5	2362.996	365.341	0.000	C- 4	999.813	299.599	0.000
* 5	9.375	C- 5	2729.072	25.139	0.000	C- 4	1358.637	83.147	0.000
* 6	11.250	C- 5	2457.268	-315.063	0.000	C- 4	1311.613	-133.305	0.000
* 7	13.125	C- 5	1547.585	-655.265	0.000	C- 4	858.742	-349.757	0.000
3 - 2	15.000	C- 4	0.000	-589.298	0.000	C- 4	0.000	-589.298	0.000

NO 1 VEHICLE BRIDGE

PICK-UP No. 1 *

No.	L (m)	S. MAXIMUM Case	M (tm)	S (t)	N (t)	S. MINIMUM Case	M (tm)	S (t)	N (t)
1 - 2	0.000	C- 4	0.000	1249.298	0.000	C- 5	0.000	1117.556	0.000
* 1	1.875	C- 4	1980.227	886.007	0.000	C- 5	1733.210	754.265	0.000
* 2	3.750	C- 4	3322.551	545.805	0.000	C- 5	2828.518	414.063	0.000
* 3	5.625	C- 4	4026.996	205.603	0.000	C- 5	3285.947	73.861	0.000
* 4	7.500	C- 5	3105.496	-266.341	0.000	C- 4	3598.563	-398.599	0.000
* 5	9.375	C- 5	2287.167	-606.543	0.000	C- 4	2532.250	-738.801	0.000
* 6	11.250	C- 4	828.059	-1079.003	0.000	C- 5	335.959	-1210.745	0.000
* 7	13.125	C- 4	-1514.012	-1419.205	0.000	C- 5	-2253.128	-1550.948	0.000
2 - 1	15.000	C- 4	-4493.962	-1759.408	0.000	C- 5	-5480.094	-1891.150	0.000
2 - 3	0.000	C- 5	-5480.094	1726.150	0.000	C- 4	-4493.962	1165.408	0.000
* 1	1.875	C- 5	-2562.503	1385.948	0.000	C- 4	-2511.746	948.955	0.000
* 2	3.750	C- 5	-282.791	1045.745	0.000	C- 4	-935.379	732.503	0.000
* 3	5.625	C- 5	1359.042	705.543	0.000	C- 4	235.141	516.051	0.000
* 4	7.500	C- 5	2362.996	365.341	0.000	C- 4	999.813	299.599	0.000
* 5	9.375	C- 4	1358.637	83.147	0.000	C- 5	2729.072	25.139	0.000
* 6	11.250	C- 4	1311.618	-133.305	0.000	C- 5	2457.268	-315.063	0.000
* 7	13.125	C- 4	858.742	-349.757	0.000	C- 5	1547.585	-655.265	0.000
3 - 2	15.000	C- 4	0.000	-589.298	0.000	C- 5	0.000	-1018.556	0.000

NO 1 VEHICLE BRIDGE

PICK-UP No. 1 *

			N. MAXIMUM				N. MINIMUM		
No.	L (m)	Case	M (tm)	S (t)	N (t)	Case	M (tm)	S (t)	N (t)
1 - 2	0.000	C- 4	0.000	1249.298	0.000	C- 4	0.000	1249.298	0.000
* 1	1.875	C- 4	1980.227	886.007	0.000	C- 4	1980.227	886.007	0.000
* 2	3.750	C- 4	3322.551	545.805	0.000	C- 4	3322.551	545.805	0.000
* 3	5.625	C- 4	4026.996	205.603	0.000	C- 4	4026.996	205.603	0.000
* 4	7.500	C- 4	3598.563	-398.599	0.000	C- 4	3598.563	-398.599	0.000
* 5	9.375	C- 4	2532.250	-738.801	0.000	C- 4	2532.250	-738.801	0.000
* 6	11.250	C- 4	828.059	-1079.003	0.000	C- 4	828.059	-1079.003	0.000
* 7	13.125	C- 4	-1514.012	-1419.205	0.000	C- 4	-1514.012	-1419.205	0.000
2 - 1	15.000	C- 4	-4493.962	-1759.408	0.000	C- 4	-4493.962	-1759.408	0.000
2 - 3	0.000	C- 4	-4493.962	1165.408	0.000	C- 4	-4493.962	1165.408	0.000
* 1	1.875	C- 4	-2511.746	948.955	0.000	C- 4	-2511.746	948.955	0.000
* 2	3.750	C- 4	-935.379	732.503	0.000	C- 4	-935.379	732.503	0.000
* 3	5.625	C- 4	235.141	516.051	0.000	C- 4	235.141	516.051	0.000
* 4	7.500	C- 4	999.813	299.599	0.000	C- 4	999.813	299.599	0.000
* 5	9.375	C- 4	1358.637	83.147	0.000	C- 4	1358.637	83.147	0.000
* 6	11.250	C- 4	1311.613	-133.305	0.000	C- 4	1311.613	-133.305	0.000
* 7	13.125	C- 4	858.742	-349.757	0.000	C- 4	858.742	-349.757	0.000
3 - 2	15.000	C- 4	0.000	-589.298	0.000	C- 4	0.000	-589.298	0.000

Calculation for bending moment

1) middle span

$b = 250^{cm} (b_o = 60)$ $h = 100$ $d = 87.5$ $d' = 12.5$

$Mu.max = 4027.0/3 \times 1.05 \doteqdot 1410.0$ KNm/Girder

$$As = \left(\begin{array}{l} Y_{32} - 4^{NO} = 8.042 \times 4 \\ Y_{25} - 4^{NO} = 4.909 \times 4 \end{array} \right) = 51.804 \ cm^2$$

$$\chi = \frac{0.87 \times 41000 \times 51.804}{0.40 \times 3000 \times 250} = 8.6^{cm}$$

$$Z = 87.5 - \frac{8.6}{2} = 83.2^{cm} \leqq 0.95 \times 87.5 = 83.2^{cm} \quad OK$$

$M_{RS} = 0.87 \times 41000 \times 51.804 \times 83.2 \times 10^{-5} = 1537.4^{KNm} > Mu = 1410.0^{NNm}$

$M_{RC} = 0.40 \times 3000 \times 250 \times 8.6 \times 83.2 \times 10^{-5} = 2146.5^{KNm} > Mu = 1410.0^{Nm}$

OK

middle fulcrum

$b = 60^{cm}$ $h = 100$ $d = 88.5$ $d' = 11.5$

$Mu.min = -5480.1/3 \times 1.05 = 1918.1$ $^{KN/m}$

$$As = \left(\begin{array}{l} Y_{12} - 4^{NO} = 1.131 \times 4 \\ Y_{32} - 4^{NO} \times 2 = 8.042 \times 8 \end{array} \right) = 68.860 \ cm^2$$

$As' = Y_{32} - 4^{NO} = 8.042 \times 4^{NO} = 32.168 \ cm^2$

$$\chi = \frac{(0.87 \times 68.860 - 0.72 \times 32.168) \times 41000}{0.40 \times 3000 \times 60} = 20.8^{cm}$$

$$Z = 88.5 - \frac{20.8}{2} = 78.1^{cm} \leqq 0.95 \times 88.5 = 84.1^{cm} \quad OK$$

$M_{RS} = 0.87 \times 41000 \times 68.860 \times 78.1 \times 10^{-5} = 1918.3^{KNm} > Mu = 1918.1^{NNm}$

$M_{RC} = (0.72 \times 41000 \times 32.168 \times 81.0 + 0.40 \times 3000 \times 60 \times 20.8 \times 78.1)$

$\times 10^{-5} = 1938.8^{KNm} > Mu = 1918.1^{NNm}$

OK

Calculation for shearing force

Edge support $Su.max \doteqdot 886.0/3 \times 1.10 = 324.9$ KN/Girder

middle Support $Su.min \doteqdot -1551.0/3 \times 1.10 = 568.7$ KN/Girder

the shearing bar is arrange same at No2 vehicle bridge.

Calculation of deck slab for No.① Vehicle bridge (U.L.S)

1. Span and bending moment

a) Span $\ell = (2.200 - 0.60) = 1.600^{m}$

b) moment of middle span :

$$M \fallingdotseq \left\{ 0.8(0.12\ \ell + 0.07)\ P \times {}^{2}/_{3} + \frac{1}{10} \omega d\ \ell^{2} \right\} \times 1.5 \times 1.1$$

$$= \left\{ 0.8(0.12 \times 1.60 + 0.07) \times 100 \times {}^{2}/_{3} + \frac{1}{10} \times 4.72 \times 1.60^{2} \right\} \times 1.5 \times 1.1$$

$$= 25.1^{KNm/m}$$

c) moment of each fulcrum :

$$M \fallingdotseq \left\{ (0.15\ell + 0.125) P + \frac{1}{10} \omega d\ \ell^{2} \right\} \times 1.5 \times 1.1$$

$$= \left\{ (0.15 \times 1.60 + 0.125) \times 100 \times {}^{2}/_{3} + \frac{1}{10} \times 4.72 \times 1.60^{2} \right\} \times 1.5 \times 1.1$$

$$= 44.1^{KNm/m}$$

2. Calculation of stress

a) middle span $b = 100^{cm}$ $h = 200$ $d = 15.0$ $d' = 5.0$

$$As = Y_{12} - 200^{ctc} = 1.131/0.200 = 5.655\ cm^{2}$$

$$P = \frac{5.655}{100 \times 15.0} \times 100 = 0.377\ \%$$

$$x = \frac{0.87 \times 41000 \times 5.655}{0.40 \times 3000 \times 100} = 1.6^{cm}$$

$$Z = 15.0 - \frac{1}{2} \times 1.6 = 14.2^{cm} < 0.95 \times 15.0 = 14.3^{cm}$$

$$M_{RS} = 0.87 \times 41000 \times 5.655 \times 14.2 \times 10^{-5} = 28.6^{KNm} > 25.1^{KNm}$$

$$M_{RC} = 0.40 \times 3000 \times 100 \times 1.6 \times 14.2 \times 10^{-5} = 27.3^{KNm} > 25.1^{KNm}$$

b) each fulcrum $b = 100^{cm}$ $h = 20$ $d = 16.0$ $d' = 4.0$

$$As = Y_{16} - 200^{ctc} = 2.011/0.200 = 10.055\ cm^2$$

$$P = \frac{10.055}{100 \times 16.0} \times 100 = 0.628\ \%$$

$$X = \frac{0.87 \times 41000 \times 10.550}{0.40 \times 3000 \times 100} = 3.2^{cm}$$

$$Z = 16.0 - \frac{1}{2} \times 3.2 = 14.4^{cm} < 0.95 \times 16.0 = 15.2^{cm}$$

$$M_{RS} = 0.87 \times 41000 \times 10.055 \times 14.4 \times 10^{-5} = 51.6^{KNm} > 44.1^{KNm}$$

$$M_{RC} = 0.40 \times 3000 \times 100 \times 3.2 \times 14.4 \times 10^{-5} = 55.3^{KNm} > 44.1^{KNm}$$ OK

Calculation of Shoe

1) quantity of expantion between .

Girder-edge and Parapet face of abutment

quantity of expantion or shrinkage (maximum)

for temperature : $dt = a \times T \times L = (1.0 \times 10^{-5} \times 15.0 \times L)^{m} = (0.150 \times L)^{mm}$

for shrinkage : $ds = a \times T \times L \times b = (1.0 \times 10^{-5} \times 20.0 \times L \times 0.8) = (0.160 \times L)$ "

for creep : $dc = \frac{P}{E \times A} \times \phi \times L \times b = \frac{750}{2.7 \times 10^{6}} \times 1.9 \times L \times 0.8 = (0.430 \times L)$ "

for other : $do = \quad = 5.0$ "

total $dL = \quad = (0.80L + 5.0)^{mm}$

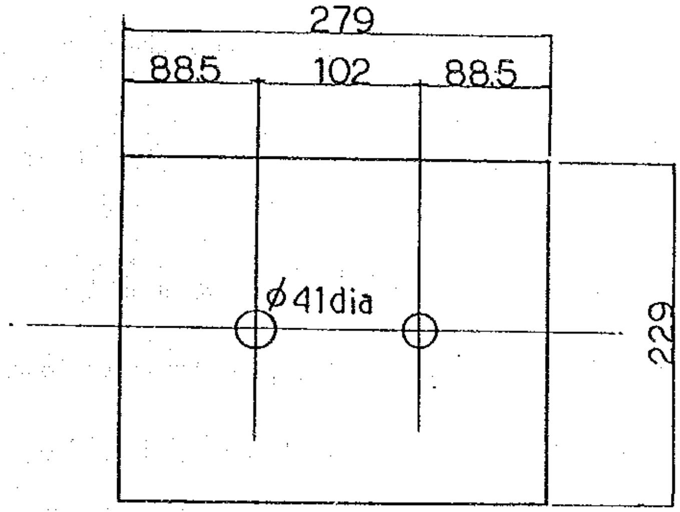
where
- a = coefficient of thermal expantion or shrinkage
- T = quantity of temperature variance
- L = girder length
- b = coefficient of decrease
- E = young's modulus
- $P/A = 0.5 fcu / 2 = 0.5 \times 300 / 2 = 750^{N/cm^2}$
- ϕ = creep factor
- fcu = strength of concrete ($30^{N/mm^2}$)

NO ① Vehicle bridge

calculation of shoe

edge fulcrum (MOV)	Rd = 487.3／3 × 1.1	= 178.7 KN／choe
	RL = 349.7／3 × 1.1	= 128.3 〃
	Rmax =	= 307.0 〃
	∴ dL = (0.80L＋5)=(0.80×15.0＋5)	= 17 mm
middle fulcrum (Fix)	Rd = 1568.5／3×1.1	= 575.2 KN／choe
	RL = 880.5／3×1.1	= 322.8 〃
	Rmax =	= 898.0 〃
	∴ dL = 0	

1) edge fulcrum (mov) shoe = b× a× t = 279mm × 229× 37
(A1, A2)



vertical pressure

$$AS = 27.9\times 22.9 - \frac{\pi}{4}\times 4.1^2\times 2 = 612.5\ cm^2$$

$$VC = \frac{Rmax}{As} = \frac{307.0\times 10^3}{612.5} = 510\ N/cm^2 < Vca = 800\ N/cm^2$$

Doxel bar ----- φ 20mm × 500mm × 2

$$Ab = \frac{\pi}{4}\times 2.0^2\times 2 = 6.283\ cm^2$$

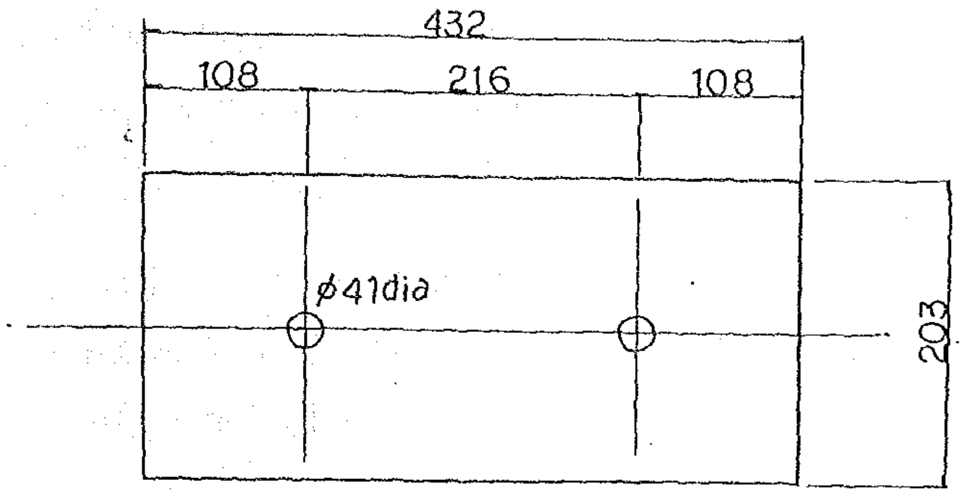
Hd = 178.7×0.15 = 26.8 KN／choe --- temperaature state

shearing stress

$$\tau s = \frac{1.48Hd}{Ab} = \frac{1.43\times 26.8\times 10^3}{6.283} = 6100\ N/cm^2 < 9000\ N/cm^2$$

anchor cap ----- φ 80mm × 250mm × 2 NO／shoe

2) middle fulcrum (Fix) shoe: $b \times a \times t$ = 432mm × 203 × 18
(P1)



Vertical pressure

$$AS = 43.2 \times 20.3 - \frac{\pi}{4} \times 4.1^2 \times 2 = 850.5 \text{ cm}^2$$

$$VC = \frac{Rmax}{AC} = \frac{898.0}{850.5} = 1060 \text{ N/cm}^2 \doteqdot Vca = 1600 \text{ N/cm}^2$$

Dowal bar ----- φ 40mm × 900mm × 2 NO/shoe

$$Ab = \frac{\pi}{4} \times 4.0^2 \times 2 = 25.133 \text{ cm}^2$$

$$Hd = (178.7 \times 2 + 575.2) \times 0.1 = 93.3 \text{ KN/choe seismic state}$$

shearing stress

$$\tau s = \frac{1.65Hd}{Ab} = \frac{1.65 \times 93.3 \times 10^3}{25.133} = 6200 \text{ N/cm}^2 < 9000 \text{ N/cm}^2$$

anchor cap ----- φ 50mm × 450mm × 2 NO/shoe

No.① VEHICLE －Substructure

1. Reaction from superstructure

1) For ABUT (Movable) … S.L.S

· For all width of Abut ($B=7.200^{m}$)

dead load Rd = 487.3 KN/Abut

live load $R\ell$ = 349.7 KN/Abut

total R = 837.0 KN/Abut

For Unit width of Abut

(1) For Vertical load

$$Rd = \frac{1}{7.20} \times 487.3 = 67.678 \ ^{KN/m}$$

$$R\ell = \frac{1}{7.20} \times 349.7 = 48.557 \ ^{KN/m}$$

$$R = \qquad = 116.235 \ ^{KN/m}$$

(2) For Horizontal force for temperature or seismic.

$$H_T = H_D = 67.678 \times 0.15 = 10.152 \ ^{KN/m}$$

2) For Pier (Fixed) … S.L.S

(1) For Vertical load

dead load Rd = 1568.5 ^{KN}

live load $R\ell$ = 880.5 ^{KN}

total R = 2449.0 ^{KN}

(2) For Horizontal load

a) Longitudinal direction

braking load : $H_B = (8 \cdot L + 200)\ \frac{2}{3} = (8 \times 30.0 + 200)\frac{2}{3} = 293.4 \ ^{KN}$

seismic load : $H_D = (2 \times 487.3 + 1568.5) \times 0.10 = 254.3 \ ^{KN}$

b) Crossing direction

Skidding load : $Hs = 250 \times \frac{2}{3} = 166.7 \ ^{KN}$

seismic load : $H_D = 1568.5 \times 0.10 = 156.9 \ ^{KN}$

** NO-1-VEHICLE-ABUT **

(1) SHAPE AND SIZE

H0 =	9.500 (m)	B0 =	5.000 (m)
H1 =	1.200 (m)	B1 =	1.500 (m)
H2 =	0.000 (m)	B2 =	1.100 (m)
H3 =	0.000 (m)	B3 =	0.300 (m)
H4 =	7.500 (m)	B4 =	2.400 (m)
H5 =	0.000 (m)	B5 =	0.800 (m)
H6 =	0.800 (m)	B6 =	0.000 (m)
BW1 =	1.000 (m)	HU1 =	0.500 (m)
BW2 =	1.000 (m)	HU2 =	0.500 (m)
HW1 =	0.500 (m)		
HW2 =	0.500 (m)		

NOTE: THE DIMENSION(t)BE EXCHANG TO DIMENSION(KN) INTO THIS CALCULATION

REACTION OF DEAD LOAD	RL =	48.557 (t)
〃 LIVE LOAD	RD =	67.678 (t)
HORIZONTAL FORCE FOR	HT =	10.152 (t)
TEMPERATURE.SEISMIC	HD =	10.152 (t)
SITUATION OF REACTION	RX =	0.250 (m)
AND HORIZONTAL FORCE	RY =	0.100 (m)
	QL =	34.300 (t/m^2)
	QD =	0.000 (t/m^2)
	KH =	0.10
SEISMIC COEFFICIENT	KHS =	0.00
UNIT VOLUME WEIGHTS		
FOR CONCRETE	GAMC =	23.600 (t/m^3)
FOR BACK FILL	GAM1 =	19.600 (t/m^3)
〃 (UNDER WATER)	GAM1S =	10.800 (t/m^3)
INTERNAL FRICTION ANGLE	FAi =	35.000 (°)
FOR ABOVE TOE SLAB	GAM2 =	18.600 (t/m^3)
〃 (UNDERWATER)	GAM2S =	9.800 (t/m^3)
FOR WATER	WATS =	9.800 (t/m^3)
FOR FOUNDATION GROUND		
COHESIVE DOWER	C =	0.00 (t/m^2)
FRICTION FACTER	tanφB =	0.500
ALLOWABLE PRESSURE	Qa =	350.00 (t/m^2)

CALCULATION OF WEIGHT AND FORCE OR LOAD

(1) CONCRETE

NO.	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
1	8.496	0.850	2.450	8.900	20.815	7.561
4	134.700	19.470	2.050	4.550	399.135	88.589
8	94.400	9.440	2.500	0.400	236.000	3.776
Σ1	297.596	29.760			655.950	99.926

V = X*Y*BW*GAM1
MX = V*X

H = V*KH
MY = H*Y

(2) EARTH

a) BACK FILLING

NO.	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
1	56.448	5.645	3.800	8.900	214.502	50.239
4	352.800	35.280	3.800	4.550	1340.640	160.524
Σ2	409.248	40.925			1555.140	210.763

b) SURCHAGE OF TOE SLAB

NO.	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
6	13.950	0.000	0.750	1.050	10.463	0.000
Σ3	13.950	0.000			10.463	0.000

V = X*Y*BW*GAM1
MX = V*X

H = V*KHS
MY = H*Y

(3) REACTION

STATE	RV(t)	RH(t)	RMX(t·m)	RMY(t·m)
ORDINARY	116.235	0.000	238.282	0.000
TEMPERA-TURE	116.235	10.152	238.282	85.277
SEISMIC	67.678	10.152	138.740	85.277

RMX= RV*X

RMY= RH*Y

(4) EARTH PRESSURE FACTOR

	ORDINARY OR TEMPERAURE		SEISMIC	
SIN (δ)	0.2497	0.2508	0.3056	0.3277
COS (δ)	0.5736	0.2022	0.3007	0.0000
	0.8192	0.9793	0.9537	1.0000

(5) EARTH PRESSURE

	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
	46.672	66.655	5.000	4.750	233.362	316.612
	126.682	180.921	5.000	3.167	633.411	572.917
	94.384	134.794	5.000	4.033	471.918	543.668
	31.234	44.606	5.000	0.641	156.168	28.590
	81.271	257.758	5.000	3.167	406.353	816.233
	60.550	192.040	5.000	4.033	302.750	774.562
	20.037	63.550	5.000	0.641	100.187	40.732

(6) BUOYANCY

	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
	92.610	0.000	3.650	0.000	338.027	0.000
	-61.750	0.000	2.496	0.000	-154.128	0.000
	-61.750	0.000	2.496	0.000	-154.128	0.000

TOTAL OF ACTION FORCE

1. EXCLUDE BUOYANCY

(1) ORDINARY …. FOR FOUNDATION

LOAD	V(t)	H(t)	MX(t·m)	MY(t·m)
Σ1	297.596	0.000	655.950	0.000
Σ2	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	126.682	180.921	633.411	572.917
	116.235	0.000	238.282	0.000
	92.610	0.000	338.027	0.000
Σ3	13.950	0.000	10.463	0.000
TOTAL	1102.990	247.576	3664.640	889.529

√ Mo = ΣMX − ΣMY = 2775.110 (t·m)

(2) ORDINARY FOR INVERSION OR SLIDE

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1(1)	297.596	0.000	655.950	0.000
	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	126.682	180.921	633.411	572.917
	67.678	0.000	138.740	0.000
	13.950	0.000	10.463	0.000
	961.827	247.576	3227.070	889.529

Mo = ΣMX − ΣMY = 2337.540 (t·m)

(3) TEMPERATURE…FOR FOUNDATION

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1(1)	297.596	0.000	655.950	0.000
	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	126.682	180.921	633.411	572.917
	116.235	10.152	238.282	85.277
	92.610	0.000	338.027	0.000
	13.950	0.000	10.463	0.000
	1102.990	257.728	3664.640	974.806

√ Mo = ΣMX − ΣMY = 2689.830 (t·m)

(4) TEMPERATURE…INVERSION OR SLIDE

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1(1)	297.596	0.000	655.950	0.000
	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	126.682	180.921	633.411	572.917
	67.678	10.152	138.740	85.277
	13.950	0.000	10.463	0.000
	961.827	257.728	3227.070	974.806

Mo = ΣMX − ΣMY = 2252.260 (t·m)

(5) SEISMIC

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1(1)	297.596	29.760	655.950	99.926
	409.248	40.925	1555.140	210.763
	81.271	257.758	406.353	816.233
	67.678	10.152	138.740	85.277
	13.950	0.000	10.463	0.000
	869.743	338.594	2766.650	1212.200

√ Mo = ΣMX − ΣMY = 1554.450 (t·m)

2. INCLUDE BUOYANCY

(1) ORDINARY

	V(t)	H(t)	MX(t·m)	MY(t·m)
	297.596	0.000	655.950	0.000
	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	94.384	134.794	471.918	543.668
	31.234	44.606	156.168	28.590
	116.235	0.000	238.282	0.000
	92.610	0.000	338.027	0.000
	13.950	0.000	10.463	0.000
	-61.750	0.000	-154.128	0.000
	1040.180	246.055	3505.180	888.870

Mo = ΣMX − ΣMY = 2616.310 (t·m)

(2) ORDINARY

	V(t)	H(t)	MX(t·m)	MY(t·m)
	297.596	0.000	655.950	0.000
	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	94.384	134.794	471.918	543.668
	31.234	44.606	156.168	28.590
	67.678	0.000	138.740	0.000
	13.950	0.000	10.463	0.000
	-61.750	0.000	-154.128	0.000
	899.012	246.055	3067.620	888.870

Mo = ΣMX − ΣMY = 2178.750 (t·m)

(3) TEMPERATURE

	V(t)	H(t)	MX(t·m)	MY(t·m)
	297.596	0.000	655.950	0.000
	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	94.384	134.794	471.918	543.668
	31.234	44.606	156.168	28.590
	116.235	10.152	238.282	85.277
	92.610	0.000	338.027	0.000
	13.950	0.000	10.463	0.000
	-61.750	0.000	-154.128	0.000
	1040.180	256.207	3505.180	974.147

Mo = ΣMX − ΣMY = 2531.040 (t·m)

(4) TEMPERATURE

	V(t)	H(t)	MX(t·m)	MY(t·m)
	297.596	0.000	655.950	0.000
	409.248	0.000	1555.140	0.000
	46.672	66.655	233.362	316.612
	94.384	134.794	471.918	543.668
	31.234	44.606	156.168	28.590
	67.678	10.152	138.740	85.277
	13.950	0.000	10.463	0.000
	-61.750	0.000	-154.128	0.000
	899.012	256.207	3067.620	974.147

Mo = ΣMX − ΣMY = 2093.470 (t·m)

(5) SEISMIC

	V(t)	H(t)	MX(t·m)	MY(t·m)
	297.596	29.760	655.950	99.926
	409.248	40.925	1555.140	210.763
	60.550	192.040	302.750	774.562
	20.037	63.550	100.187	40.732
	67.678	10.152	138.740	85.277
	13.950	0.000	10.463	0.000
	-61.750	0.000	-154.128	0.000
	807.309	336.427	2609.100	1211.260

$Mo = \Sigma MX - \Sigma MY = 1397.850$ (t·m)

TOTAL FORCE FOR UNDER FONDATION CENTER

LOAD		V(t)	H(t)	Mo(t·m)	e(m)	Mc(t·m)
A	1	1102.990	247.576	2775.110	-0.016	-17.624
	2	961.827	247.576	2337.540	0.070	67.027
	3	1102.990	257.728	2689.830	0.061	67.653
	4	961.827	257.728	2252.260	0.158	152.304
	5	869.743	338.594	1554.450	0.713	619.906
B	1	1040.180	246.055	2616.310	-0.015	-15.868
	2	899.012	246.055	2178.750	0.077	68.783
	3	1040.180	256.207	2531.040	0.067	69.409
	4	899.012	256.207	2093.470	0.171	154.060
	5	807.309	336.427	1397.850	0.769	620.428

$e = B0/2 - Mo/V$: $Mc = V * e$

WHERE

A AND B: EXCLUDE OF BOUYANCY
OR INCLUDE BOUYANCY

1. ORDINARY : FOR FOUNDATION
2. 〃 : FOR INVERSION OR SLIDE
3. TENPERATURE : STATE OF 1
4. 〃 : 〃 2
5. SEISMIC

CALCULATION OF SECURITY FOR DIRECT FOUNDATION

FOR INVERSION

		V(t)	Mc(t·m)	e(m)
A	1	961.827	67.027	0.070 < 0.833
	2	961.827	152.304	0.158 < 0.833
	3	869.743	619.906	0.713 < 1.667
B	1	899.012	68.783	0.077 < 0.833
	2	899.012	154.060	0.171 < 0.833
	3	807.309	620.428	0.769 < 1.667

e = Mc/V

FOR SLIDE

		A'(m^2)	V(t)	Hb(t)	Hu(t)	Fs
A	1	4.86	961.827	247.576	480.91	1.94 > 1.5
	2	4.68	961.827	257.728	480.91	1.87 > 1.5
	3	3.57	869.743	338.594	434.87	1.28 > 1.2
B	1	4.85	899.012	246.055	449.51	1.83 > 1.5
	2	4.66	899.012	256.207	449.51	1.75 > 1.5
	3	3.46	807.309	336.427	403.66	1.20 < 1.2

C = 0.00 (t/m^2) tan(φB) = 0.50

Hu = C*A'+ V*tan(φB)

Fs = Hu/Hb

FOR CONTACT PRESSURE UNDER FOUNDATION

EXCLUDE BOUYANCY

STATE	1	3	5
B (m)	5.000	5.000	5.000
L (m)	1.000	1.000	1.000
V (t)	1102.990	1102.990	869.743
H (t)	247.576	257.728	338.594
Mc (t·m)	-17.624	67.653	619.906
e (m)	-0.016	0.061	0.713
X (m)	5.000	5.000	5.000
Qmax(t/m^2)	224.828	236.835	322.726
Qmin(t/m^2)	216.369	204.362	25.171
	294.000	294.000	441.000

INCLUDE BOUYANCY

STATE	1	3	5
B (m)	5.000	5.000	5.000
L (m)	1.000	1.000	1.000
V (t)	1040.180	1040.180	807.309
H (t)	246.055	256.207	336.427
Mc (t·m)	-15.868	69.409	620.428
e (m)	-0.015	0.067	0.769
X (m)	5.000	5.000	5.000
Qmax(t/m^2)	211.844	224.694	310.365
Qmin(t/m^2)	204.227	191.378	12.559
	294.000	294.000	441.000

Q = V/(B*L) + 6*Mc/(L*B^2)

Q = 2*V/(L*X) :X = 3*(B0/2-Mc/V)

No.① VEHICLE - ABUT

Calculation for Vertical wall ··· U.L.S

1. Action force

(1) state of mormal road ··· only earth pressure

$$M_1 = \frac{1}{6} \times 19.6 \times 0.251 \times 8.70^3 \times 1.5 \times 1.1 = 890.9 \text{ KNm}$$

$$M_2 = \frac{1}{2} \times 34.3 \times \frac{2}{3} \times 0.251 \times 8.70^2 \times 1.5 \times 1.1 = 358.4 \text{ KNm}$$

$$Mu = \quad = 1249.3 \text{ KNm}$$

$$S_1 = \frac{1}{2} \times 19.6 \times 0.251 \times 8.70^2 \times 1.5 \times 1.1 = 307.2 \text{ KN}$$

$$S_2 = 34.3 \times \frac{2}{3} \times 19.6 \times 0.251 \times 8.70 \times 1.5 \times 1.1 = 129.9 \text{ KN}$$

$$Su = \quad = 437.1 \text{ KN}$$

(2) State of temperature and normal load

$$Mu = 1249.3 + 10.152 \times 7.70 \times 1.3 \times 1.1 = 1361.1 \text{ KNm}$$

$$Su = 437.1 + 10.152 \times 1.3 \times 1.1 = 451.6 \text{ KN}$$

(3) State of seismic

$$Mu = \left(\frac{1}{6} \times 19.6 \times 0.328 \times 8.70^3 + 10.152 \times 7.70\right) \times 1.35 \times 1.1 = 1293.2 \text{ KNm}$$

$$Su = \left(\frac{1}{2} \times 19.6 \times 0.328 \times 8.70^3 + 10.152\right) \times 1.35 \times 1.1 = 376.4 \text{ KN}$$

2. Calculation of stress

section $b = 100^{cm}$ $h = 110$ $d = 103.0$ $d' = 7.0$

$As = Y_{32} - 150^{ctc} = 8.042/0.150 = 53.613$ cm

$$P = \frac{53.613}{100 \times 103.0} \times 100 = 0.520\ \%$$

$$x = \frac{0.87 \times 41000 \times 53.613}{0.40 \times 2500 \times 100} = 19.2^{cm}$$

$$Z = 103.0 - \frac{19.2}{2} = 93.4^{cm} < 0.95 \times 101.5 = 96.4^{cm} \quad \text{OK}$$

$M_{RS} = 0.87 \times 41000 \times 53.613 \times 93.4 \times 10^{-5} = 1786.1^{KNm} > Mu = 1361.1^{KNm}$

$M_{RC} = 0.40 \times 2500 \times 100 \times 19.2 \times 93.4 \times 10^{-5} = 1793.3^{KNm} > Mu = 1361.1^{Nm}$

OK

$$Vc = \frac{451.6 \times 10^{3}}{100 \times 103.0} = 43.9 \ \text{N/cm}^2$$

$$< Vca = 50.0 + 15.0 \left(\frac{0.520 - 0.50}{0.50} \right) = 50.6 \ \text{N/cm}^2 \quad \text{OK}$$

No.① VEHICLE - ABUT

Calculation of stability for S.L.S.

1) action force for bottom of Foundation

state / load	Normal	Temperature	Seismic
N^{KN}	1103.0	1103.0	869.8
H^{KN}	247.6	257.8	338.6 ×0.8 = 270.9
M^{KNm}	−17.7≒0	67.7	※ 377.5

※ $\left\{ \frac{5.00}{2} - (2766.7 - 1212.2 \times 0.8) / 869.8 \right\} \times 869.8 = 377.5^{KN/m}$

2) Stability for Foundation

(1) Normal state

$$e = \frac{M}{N} \fallingdotseq 0$$

$$q = \frac{N}{B} = \frac{1103.0}{5.00} = 220.6 \quad KN/m^2 \quad < qa = 300 \quad KN/m^2$$

$$Fs = \frac{N \cdot \mu}{H} = \frac{1103.0 \times 0.50}{247.6} = 2.2 \quad > 1.5 \qquad OK$$

(2) Temperature state

$$e = \frac{M}{N} \fallingdotseq \frac{67.7}{1103.0} = 0.062^m < \frac{B}{6} = \frac{5.00}{6} = 0.833^m$$

$$q = \frac{N}{B}\left(1 \pm \frac{6e}{B}\right) = \frac{1103.0}{5.00}\left(1 \pm \frac{6 \times 0.062}{5.00}\right) = \begin{cases} 237.1 \ KN/m^2 \\ 204.1 \ KN/m^2 \end{cases} < qa = 300 KN/m^2$$

$$Fs = \frac{N \cdot \mu}{H} = \frac{1103.0 \times 0.50}{247.8} = 2.1 \quad > 1.5 \qquad OK$$

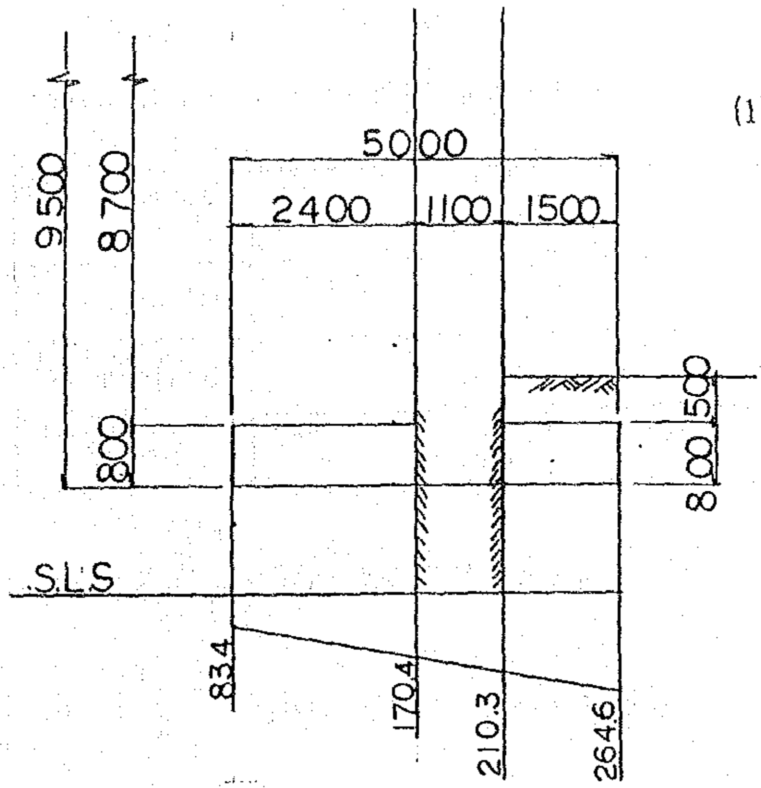
(3) seismic state

$$e = \frac{M}{N} = \frac{377.5}{869.8} = 0.434^m < \frac{B}{6} = 0.833^m$$

$$q = \frac{N}{B}\left(1 \pm \frac{6e}{B}\right) = \frac{869.8}{5.00}\left(1 \pm \frac{6 \times 0.434}{5.00}\right) = \begin{cases} 264.6 \ KN/m^2 \\ 83.4 \ KN/m^2 \end{cases} < qa = 300 KN/m^2$$

$$Fs = \frac{N \cdot \mu}{H} = \frac{869.8 \times 0.50}{270.9} = 1.6 \quad > 1.5$$

3) Calculation of action force for each section ··· seismic state



(1) surcharge load

a) toe footing slab

$$\omega = 23.6 \times 0.80 + 18.6 \times 0.50 = 28.180 \ ^{KN/m}$$

b) heel footing slab

$$\omega = 23.6 \times 0.80 + 19.6 \times 8.70 = 189.400 \ ^{KN/m}$$

(2) Calculation of bending moment and shearing force

a) toe footing slab

$$M = \frac{1.50^2}{6}(2 \times 264.6 + 210.3) - \frac{1.50^2}{2} \times 28.180 = 245.6 \ ^{KNm}$$

$$S = \frac{1.50}{2}(264.6 + 210.3) - 1.50 \times 28.180 = 313.9 \ ^{KN}$$

b) heel footing slab

$$M = \frac{2.40^2}{2} \times 189.400 - \frac{2.40^2}{2}(2 \times 83.4 + 170.4) = 221.8 \ ^{KMm}$$

$$S = 2.40 \times 189.400 - \frac{2.40}{2}(83.4 + 170.4) = 150.0 \ ^{KN}$$

No.① VEHICLE - ABUT

Calculation of stability for U.L.S.

load	N^{KN}	H^{KN}	M^{KNm}
Normal	1103.0×1.2 × 1.05 =1522.2	247.6 ×1.5 ×1.1 = 408.6	※1 216.1
Temperature	1522.2	257.8 ×1.5 ×1.1 = 425.6	※2 356.7
Seismic	869.8 ×1.2 ×1.15 = 1200.4	338.6 ×1.35×1.1 = 502.9	※3 983.1

※1 $M=\left\{\frac{5.00}{2}-(3664.7\times1.38-889.6\times1.65)/1522.2\right\}\times1522.2=216.1^{KNm}$

※2 $M=\left\{\frac{5.00}{2}-(3664.7\times1.38-974.8\times1.65)/1522.2\right\}\times1522.2=356.7^{KNm}$

※3 $M=\left\{\frac{5.00}{2}-(2766.7\times1.38-1212.2\times1.485)/1200.4\right\}\times1200.4=983.1^{KNm}$

Stability for Foundation

(1) Normal state

$$e=\frac{216.1}{1522.2}=0.141^{m}<\frac{B}{6}=\frac{5.00}{6}=0.833^{m}$$

$$q=\frac{1522.2}{5.00}\left(1\pm\frac{6\times0.141}{5.00}\right)=\begin{cases}356.0\ KN/m^2\\253.0\ KN/m^2\end{cases}<qa$$

$$Fs=\frac{1522.2\times0.50}{408.6}=1.8>1.1$$

(2) Temperature state

$$e=\frac{356.7}{1522.2}=0.235^{m}<\frac{B}{6}=0.833^{m}$$

$$q=\frac{1522.2}{5.00}\left(1\pm\frac{6\times0.235}{5.00}\right)=\begin{cases}390.3\ KN/m^2\\218.6\ KN/m^2\end{cases}<qa$$

$$Fs=\frac{1522.2\times0.50}{425.6}=1.7>1.1$$

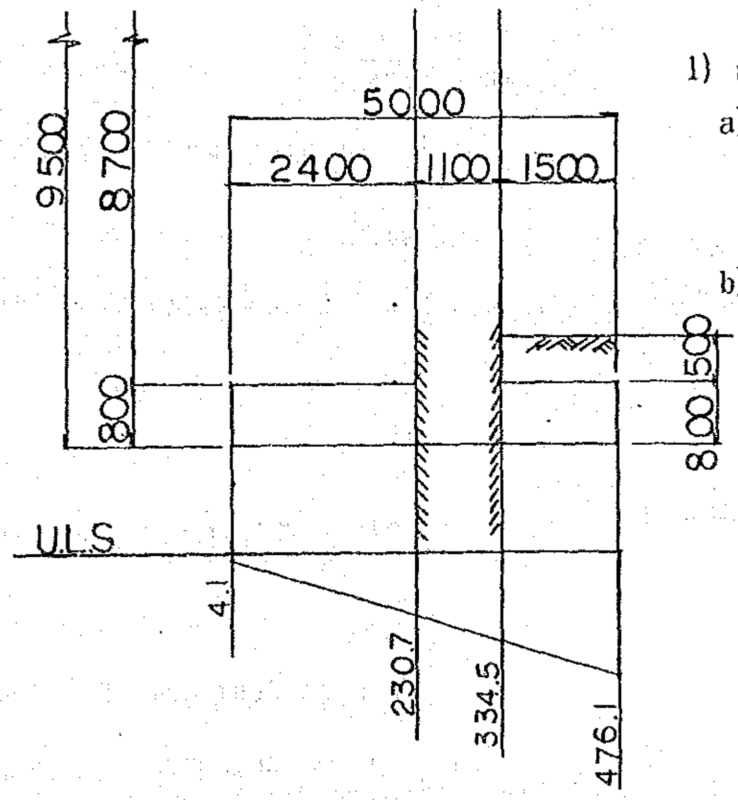
(3) seismic state

$$e = \frac{983.1}{1200.4} = 0.819^m < \frac{B}{6} = 0.833^m$$

$$q = \frac{1200.4}{5.00}\left(1 \pm \frac{6 \times 0.819}{5.00}\right) = \begin{cases} 476.1\ KN/m^2 \\ 4.1\ KN/m^2 \end{cases} < qa$$

$$Fs = \frac{1200.4 \times 0.50}{502.9} = 1.2 > 1.1$$

Calculation of action force for each section … seismic state



1) surcharge load

a) toe footing slab

$\omega = (23.6 \times 0.80 + 18.6 \times 0.50) \times 1.38$

$= 38.888\ KN/m$

b) heel footing slab

$\omega = (23.6 \times 0.80 + 19.6 \times 8.70) \times 1.38$

$= 261.372\ KN/m$

2) Calculation of bending moment and shearing force

a) toe footing slab

$$M = \frac{1.50^2}{6}(2 \times 476.1 + 334.5) - \frac{1.50^2}{2} \times 38.888 = 438.8\ KNm$$

$$S = \frac{1.50}{2}(476.1 + 334.5) - 1.50 \times 38.888 = 549.7\ KN$$

b) heel footing slab

$$M \fallingdotseq \frac{2.40^2}{2} \times 261.372 - \frac{2.40^2}{6}(2 \times 4.1 + 230.7) = 523.4\ KNm$$

$$S = 2.40 \times 261.372 - \frac{2.40}{2}(4.1 + 230.7) = 345.6\ KN$$

No.① VEHICLE - ABUT

Calculation of stress for footing slab (U.L.S)

1) heel footing slab

section $b = 100^{cm}$ $h = 80$ $d = 73.5$ $d' = 6.5$

$As = Y_{25} - 150^{ctc} = 4.909/0.150 = 32.727$ cm

$$P = \frac{32.727}{100 \times 73.5} \times 100 = 0.445\ \%$$

$$\chi = \frac{0.87 \times 41000 \times 32.727}{0.40 \times 2500 \times 100} = 11.8^{cm}$$

$$Z = 73.5 - \frac{11.8}{2} = 67.6^{cm} < 0.95 \times 73.5 = 69.8^{cm}$$

$M_{RS} = 0.87 \times 41000 \times 32.727 \times 67.6 \times 10^{-5} = 789.1^{KNm} > Mu = 523.4^{KNm}$

$M_{RC} = 0.40 \times 2500 \times 100 \times 11.8 \times 67.6 \times 10^{-5} = 797.6^{KNm} > Mu = 532.4^{KNm}$ OK

$$Vc = \frac{345.6 \times 10^3}{100 \times 73.5} = 47.1\ N/cm^2$$

$$< Vca = \left\{ 35.0 + 15.0 \left(\frac{0.445 - 0.25}{0.25} \right) \right\} \times 2 = 93.4\ N/cm^2$$ OK

2) toe footing slab

section $b = 100^{cm}$ $h = 80$ $d = 73.5$ $d' = 6.5$

$As = Y_{25} - 150^{ctc} = 4.909/0.150 = 32.727$ cm

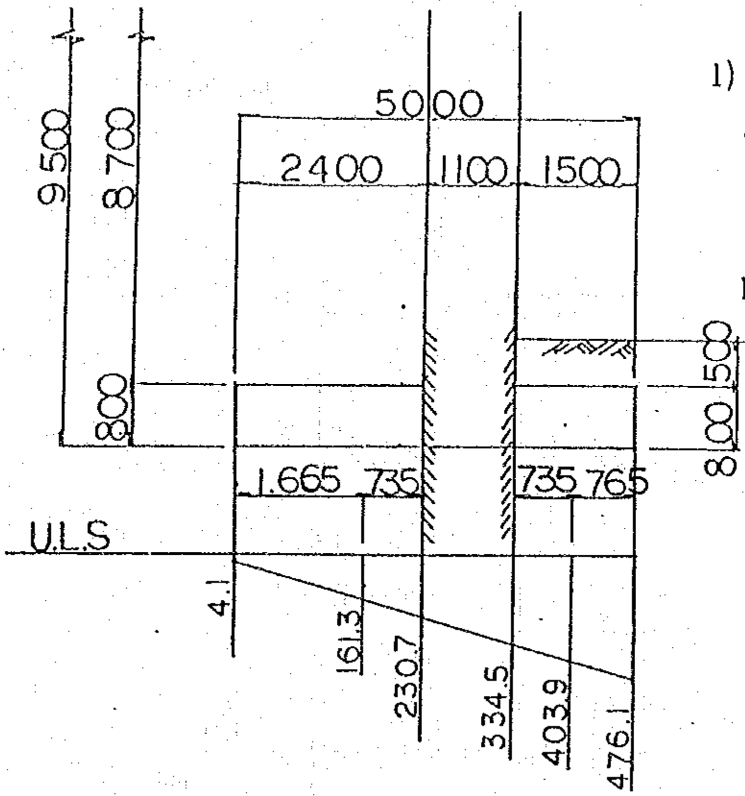
$$P = \frac{32.727}{100 \times 73.5} \times 100 = 0.445\ \%$$

$Mu = 438.8^{KNm} < M_R = 789.1^{KNm}$ … from 1) OK

$$Vc = \frac{549.7 \times 10^3}{100 \times 73.5} = 74.8\ N/cm^2$$

$< Vca = 93.4\ N/cm^2$ … from 1) OK

Calculation of action force for each section … seismic state



1) surcharge load

a) toe footing slab

$\omega = (23.6 \times 0.80 + 18.6 \times 0.50) \times 1.38$

$= 38.888$ KN/m

b) heel footing slab

$\omega = (23.6 \times 0.80 + 19.6 \times 8.70) \times 1.38$

$= 261.372$ KN/m

2) Calculation of shearing force --- Check of Critical section

toe footing slab and heel footing slab

$$St = \frac{0.765}{2}(476.1 + 403.9) - 38.888 \times 0.765 = 306.8 \text{ KN}$$

$$Sh = 261.372 \times 1.665 - \frac{1.665}{2}(4.1 + 161.3) = 297.6 \text{ ″}$$

3) Calculation of Shearing stress

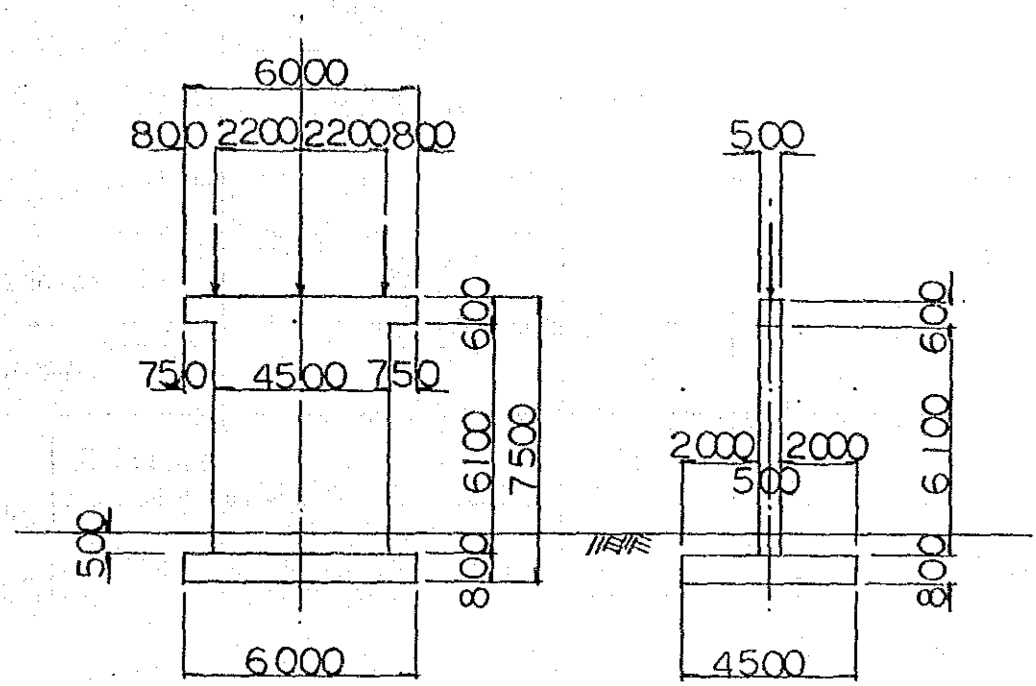
for toe footing slab

$$Vc = \frac{306.8 \times 10^3}{100 \times 73.5} = 32.8 \text{ N/cm}^2$$

$$< Vca = 35.0 + 15.0 \frac{0.445 - 0.25}{0.25} = 46.7 \text{ N/cm}^2 \quad \text{ok}$$

No.① VEHICLE - PIER

1. Shape and size



2. Calculation of pillar

1) Action force for bottom of pillar (S.L.S)

a) Longitudinal direction

load		N KN	H KNm	y m	M = H·y KNm
Super strucuture	Rd	1568.5	–	–	–
	R ℓ	880.5	–	–	–
Pillar		23.6(45 ×6.1+6.0 ×0.6)×0.5=366.4	36.7	3.400	124.8
Braking		–	293.4	6.800	1995.2
Seismic		–	254.3	6.800	1729.2
State	Braking	2815.4	293.4	–	1995.2
	Seismic	1934.9	291.0	–	1854.0

b) Crossing direction

		N^{KN}	H^{KNm}	y^{m}	$M=H\cdot y^{KNm}$
Super · strucuture	Rd	1568.5	—	—	—
	Rℓ	880.5	—	—	—
Pillar		366.4	36.7	3.400	124.8
Skidding		—	166.7	7.600	1267.0
Seismic		—	156.9	7.600	1192.5
State	Skidding	2815.4	166.7	—	1267.0
	Seismic	1934.9	193.6	—	1317.3

2) Action force for bottom of pillar (U.L.S)

a) Longitudinal direction

load / State	N^{KN}	H^{KN}	M^{KNm}
Braking	2815.4×1.2 ×1.15 = 3885.3	293.4 ×1.25×1.1 = 403.5	1995.2×1.25×1.1 = 2743.4
Seismic	1934.9×1.2 ×1.15 = 2670.2	291.0 ×1.5 ×1.1 = 480.2	1854.0×1.5 ×1.1 = 3059.1

b) Crossing direction

load / State	N^{KN}	H^{KN}	M^{KNm}
Skidding	2815.4×1.2 ×1.15 = 3885.3	166.7 ×1.25×1.1 = 229.3	1267.0×1.25×1.1 = 1742.1
Seismic	1934.9×1.2 ×1.15 = 2670.2	193.6 ×1.5 ×1.1 = 319.5	1317.3×1.5 ×1.1 = 2173.6

No.① V E H I C L E － PIER

3) Calculation of stress

a) Longitudibal direction of seismic (U.L.S)

section　b ＝450^{cm}　h ＝50　d ＝42.5　d′＝7.5

$As = As' = Y_{32} - 37^{NO} = 8.042 \times 37 = 297.554\ cm^2$

$Ma = 3059.1 + 2670.2\ (0.425 - \frac{0.50}{2}) = 3526.4\ ^{KNm}$

$x = \frac{(0.87 - 0.72) \times 41000 \times 297.554}{0.40 \times 2500 \times 450} = 4.4^{cm}$

$Z = 42.5 - \frac{4.4}{2} = 40.3^{cm} \leqq 0.95 \times 42.5 = 40.3^{cm}$　OK

$M_{RS} = 0.87 \times 41000 \times 297.554 \times 40.3 \times 10^{-5} = 4277.3^{KNm} > Mu = 3526.4^{KNm}$

$M_{RC} = 0.72 \times 41000 \times 297.554 \times 35.0 + 0.40 \times 2500 \times 450 \times 4.4 \times 40.3)$

$\times 10^{-5} = 3872.3^{KNm} > Mu = 3526.4^{KNm}$

$Asn = A'sn = 297.554 - \frac{2670.2 \times 10^3}{0.87 \times 41000} = 226.7\ cm^2$

$< Asu = A'su = Y_{32} - 29^{NO}(150^{ctc}) = 8.042 \times 29 = 233.16\ cm^2$　OK

$P = \frac{233.16}{450 \times 42.5} \times 100 = 1.209\ \%$

$Vc = \frac{480.2 \times 10^3}{450 \times 42.5} = 25.2\ N/cm^2$

$< Vca = 65.0 + 20.0\ (\frac{1.219 - 1.00}{1.00}) = 69.4\ N/cm^2$　OK

b) Crossing direction

This case is abridge.

** NO-1-VEHICLE-PIER **

INPUT-DATA

(1) SHAPE AND SIZE ---(UNIT: m)

(a) BEAM

BWL =	3.000	BL1 =	0.500
BWR =	3.000	BL2 =	0.000
BW1 =	0.750	BL3 =	0.000
BW2 =	0.750	BL4 =	0.000
H2 =	0.600		
H3 =	0.000		
H4 =	0.000		

(b) PILLAR (RECTANGULAR)

CWU =	4.000	CR =	0.250
CWL =	4.000	CRL =	0.250
H1 =	5.900		

NOTE: THE DIMENSION(t) BE EXCHANG TO DIMENSION(KN) INTO THIS CALCULATION

(c) FOOTING

WF =	6.000	WFL =	3.000
BF =	4.500	BFL =	2.250
FH =	0.800	DH =	0.000

(d) OTHER

WH1 =	0.000	WH2 =	0.000
GH =	0.500		

(2) LOAD-CASE DIRECTION

a) LONGITUDINAL - NORMAL, BRAKING, SEISMIC
b) CROSSING - 〃 , SKIDDING, 〃

(3) UNIT VOLUME WEIGHT

CONCRETE γc = 23.600 (t/m^3)
BACKFILL γs = 18.600 (t/m^3)
〃 $\gamma s'$ = 9.800 (t/m^3)---UNDER WATER
WATER γw = 9.800 (t/m^3)

(4) COEFFICIENT OF SEISMIC

Kh = 0.10 --- STRUCTURE
Khs = 0.00 --- BACKFILL

WEIGHT OF STRUCTURE AND SURCHARGE OF SOIL

(1) BEAM AND PILLAR FOR BOTTOM OF PILLAR

No.	V (t)	H (t)	X (m)	Y (m)	Mx(t·m)	My(t·m)
1	21.24	2.12	1.500	6.200	31.86	13.17
2	21.24	2.12	-1.500	6.200	-31.86	13.17
3	0.00	0.00	2.500	5.900	0.00	0.00
4	0.00	0.00	-2.500	5.900	0.00	0.00
5	0.00	0.00	1.125	5.900	0.00	0.00
6	0.00	0.00	-1.125	5.900	0.00	0.00
7	0.00	0.00	0.000	0.000	0.00	0.00
8	0.00	0.00	0.000	0.000	0.00	0.00
9	305.82	30.58	0.000	2.950	0.00	90.22
WD	348.30	34.83	—	—	0.00	116.55

(2) FOUNDATION

No.	V (t)	H (t)	X (m)	Y (m)	Mx(t·m)	My(t·m)
1	0.00	0.00	0.917	0.800	0.00	0.00
2	0.00	0.00	-0.917	0.800	0.00	0.00
3	0.00	0.00	0.000	0.800	0.00	0.00
4	509.76	50.98	0.000	0.400	0.00	20.39
WF	509.76	50.98	—	—	0.00	20.39

(3) SURCHARGE OF SOIL

NO.	V (t)	X (m)	Mx(t·m)
1	3.49	0.000	0.00
2	3.49	0.000	0.00
3	111.60	1.250	139.50
4	111.60	-1.250	-139.50
5	0.00	1.583	0.00
6	0.00	-1.583	0.00
7	0.50	0.000	0.00
WS	230.67	—	0.00

REACTION FROM SUPERSTRUCTURE

(1) REACTION FROM SUPERSTRUCTURE

	(a)	(b)
	1568.50	1568.50
	880.50	880.50
	—	0.000
Σ R	2449.00	2449.00
	0.00	166.70
	293.40	—
	254.30	156.90
	0.900	0.900

(a) :LONGITUDINAL DIRECTION
(b) :CROSSING DIRECTION

REACTION OF VERTICAL
DEAD LOAD: Rd
LIVE LOAD: Rd
SITUATION

HORIZOTAL FORCE
NORMAL STATE OR SKIDDING
BRAKING STATE
SEISMIC STATE

ACTION FORCE FOR BOTTOM OF PILLAR (S.r.S)

LONGITHDINAL DIRECTION

(1) NORMAL STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
ΣR	2449.00	0.00	0.000	0.000	0.00	0.00
WD	348.30	0.00	0.000	0.000	0.00	0.00
TOTAL (NL)	2797.30	0.00	—	—	0.00	0.00

: Mo = ΣMx + ΣMy = 0.00 (t·m)

(2) BRAKING STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
ΣR	2449.00	293.40	0.000	7.400	0.00	2171.16
WD	348.30	0.00	0.000	0.000	0.00	0.00
TOTAL (Br.)	2797.30	293.40	—	—	0.00	2171.16

: Mo = ΣMx + ΣMy = 2171.16 (t·m)

(3) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
Rd	1568.50	254.30	0.000	7.400	0.00	1881.82
WD	348.30	34.83	0.000	3.346	0.00	116.55
TOTAL (SL)	1916.80	289.13	—	—	0.00	1998.37

: Mo = ΣMx + ΣMy = 1998.37 (t·m)

CROSSING DIRECTION

(1) SKIDDING STETE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
ΣR	2449.00	166.70	0.000	7.400	0.00	1233.58
WD	348.30	0.00	0.000	0.000	0.00	0.00
TOTAL (KC)	2797.30	166.70	—	—	0.00	1233.58

: Mo = ΣMx + ΣMy = 1233.58 (t·m)

(2) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
Rd	1568.50	156.90	0.000	7.400	0.00	1161.06
WD	348.30	34.83	0.000	3.346	0.00	116.55
TOTAL (SC)	1916.80	191.73	—	—	0.00	1277.61

: Mo = ΣMx + ΣMy = 1277.61 (t·m)

ACTION FORCE FOR BOTTOM OF FOUNDATION

BUOYANCY

	NOMAL	SEISMIC
PILLAR	0.00	0.00
FOOTING	-21.60	-211.68
SLAB	0.00	0.00
	-21.60	-211.68

LONGITUDINAL DIRECTION

(1) NORMAL STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
TOTAL(NL)	2797.30	0.00	—	—	0.00	0.00
	—	—	—	—	0.00	0.00
WF	509.76	0.00	0.000	0.000	0.00	0.00
WE	230.67	0.00	0.000	0.000	0.00	0.00
WU	-21.60	—	—	—	—	—
TOTAL						
A	3537.73	0.00	—	—	0.00	0.00
B	3516.13	0.00	—	—	0.00	0.00

: Mo = ΣMx + ΣMy = 0.00 (t·m)

(2) BLAKING STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
TOTAL(BL)	2797.30	293.40	—	—	0.00	2171.16
	—	—	—	—	0.00	234.72
WF	509.76	0.00	0.000	0.000	0.00	0.00
WE	230.67	0.00	0.000	0.000	0.00	0.00
WU	-21.60	—	—	—	—	—
TOTAL						
A	3537.73	293.40	—	—	0.00	2405.88
B	3516.13	293.40	—	—	0.00	2405.88

: Mo = ΣMx + ΣMy = 2405.88 (t·m)

Mvo = Vo*BFD , Mho = Ho*FH

(3) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
TOTAL(Sr)	1916.80	289.13	—	—	0.00	1998.37
	—	—	—	—	0.00	231.30
WF	509.76	50.98	0.000	0.400	0.00	20.39
WE	230.67	0.00	0.000	0.000	0.00	0.00
WU	-211.68	—	—	—	—	—
TOTAL						
A	2657.23	340.11	—	—	0.00	2250.07
B	2445.55	340.11	—	—	0.00	2250.07

: Mo = ΣMx + ΣMy = 2250.07 (t·m)

Mvo = Vo*BFD , Mho = Ho*FH

CROSSING DIRECTION

(1) NORMAL STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
total(kc)	2797.30	166.70	—	—	0.00	1233.58
MHO	—	—	—	—	0.00	133.36
WF	509.76	0.00	0.000	0.000	0.00	0.00
WE	230.67	0.00	0.000	0.000	0.00	0.00
WU	-21.60	—	—	—	—	—
TOTAL						
A	3537.73	166.70	—	—	0.00	1366.94
B	3516.13	166.70	—	—	0.00	1366.94

: $Mo = \Sigma Mx + \Sigma My = 1366.94$ (t·m)

(2) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
total(Sc)	1916.80	191.73	—	—	0.00	1277.61
WHO	—	—	—	—	0.00	153.38
WF	509.76	50.98	0.000	0.400	0.00	20.39
WE	230.67	0.00	0.000	0.000	0.00	0.00
WU	-211.68	—	—	—	—	—
TOTAL						
A	2657.23	242.71	—	—	0.00	1451.39
B	2445.55	242.71	—	—	0.00	1451.39

NOTICE : $Mo = \Sigma Mx + \Sigma My = 1451.39$ (t·m)

$Mvo = Vo*WFD$, $Mho = Ho*FH$

NOTE : TOTAL: A--- EXCLUDE OF BUOYANCY

TOTAL: B--- INCLUDE OF BUOYANCY

(1)

	V(t)	Mc(t·m)	e (m)
	3537.730	1366.940	0.386 < 1.000
	2657.230	1451.390	0.546 < 2.000
	3516.130	1366.940	0.389 < 1.000
	2445.550	1451.390	0.593 < 2.000

e = Mc/V ;

(2)

	V(t)	H(t)	Fs
	3537.730	166.700	10.611 > 1.500
	2657.230	242.706	5.474 > 1.200
	3516.130	166.700	10.546 > 1.500
	2445.550	242.706	5.038 > 1.200

C = 0.00 (t/m^2) , tan(φB)= 0.50

Hu = C*A'+ V*tan(φB)
Fs = Hu/Hb

(3)

B (m)	6.000	6.000	6.000	6.000
L (m)	4.500	4.500	4.500	4.500
V (t)	3537.73	2657.23	3516.13	2445.55
H (t)	166.70	242.71	166.70	242.71
Mc (t·m)	1366.94	1451.39	1366.94	1451.39
e (m)	0.386	0.546	0.389	0.593
X (m)	6.000	6.000	6.000	6.000
Qmax(t/m^2)	181.655	152.171	180.855	144.331
Qmin(t/m^2)	80.400	44.661	79.600	36.821
	294.000		294.000	

Q = V/(B*L) + 6*Mc/(L*B^2)
Q = 2*V/(L*X) , X = 3*(B/2-Mc/V)

Qa = 350.00 (t/m^2)

C = 0.00 (t/m^2)

tan(φB) = 0.5000

(1)

	V(t)	Mc(t·m)	e (m)
	3537.730	0.000	0.000 < 0.750
	3537.730	2405.880	0.680 < 0.750
	2657.230	2250.070	0.847 < 1.500
	3516.130	0.000	0.000 < 0.750
	3516.130	2405.880	0.684 < 0.750
	2445.550	2250.070	0.920 < 1.500

e = Mc/V

(2)

	V(t)	H(t)	Fs
	3537.730	0.000	—
	3537.730	293.400	6.029 > 1.500
	2657.230	340.106	3.906 > 1.200
	3516.130	0.000	—
	3516.130	293.400	5.992 > 1.500
	2445.550	340.106	3.595 > 1.200

C = 0.00 (t/m^2) , tan(φB)= 0.50

Hu = C*A'+ V*tan(φB)
Fs = Hu/Hb

(3)

(a)

B (m)	4.500	4.500	4.500
L (m)	6.000	6.000	6.000
V (t)	3537.73	3537.73	2657.23
H (t)	0.00	293.40	340.11
Mc (t·m)	0.00	2405.88	2250.07
e (m)	0.000	0.680	0.847
X (m)	4.500	4.500	4.210
Qmax(t/m^2)	131.027	249.836	210.406
Qmin(t/m^2)	131.027	12.218	0.000
	294.000		

(b)

B (m)	4.500	4.500	4.500
L (m)	6.000	6.000	6.000
V (t)	3516.13	3516.13	2445.55
H (t)	0.00	293.40	340.11
Mc (t·m)	0.00	2405.88	2250.07
e (m)	0.000	0.684	0.920
X (m)	4.500	4.500	3.990
Qmax(t/m^2)	130.227	249.036	204.317
Qmin(t/m^2)	130.227	11.418	0.000
	294.000		

注) Q = V/(B*L) + 6*Mc/(L*B^2)
Q = 2*V/(L*X) , X = 3*(B/2-Mc/V)

3. Calculation of Foundation

1) Calculation of stability for bottom foundation

(1) Action force

a) Longitudinal direction ··· U.L.S

load / State	N KN	H KN	M KNm
Braking	3537.8×1.2 ×1.15 = 4882.2	293.4 ×1.25×1.1 = 403.5	2405.9×1.25×1.1 = 3308.2
Seismic	2657.3×1.2 ×1.15 = 3667.1	340.2 ×1.5 ×1.1 = 561.4	2250.1×1.5 ×1.1 = 3712.7

b) Crossing direction ··· U.L.S

load / State	N KN	H KN	M KNm
Skidding	3537.8×1.2 ×1.15 = 4882.2	166.7 ×1.25×1.1 = 229.2	1367.0×1.25×1.1 = 1879.7
Seismic	2657.3×1.2 ×1.15 = 3667.1	242.7 ×1.5 ×1.1 = 400.5	1451.4×1.5 ×1.1 = 2394.8

(2) Stability for Foundation

a) Longitudinal direction for U.L.S

(1) Braking state

$$e = \frac{M}{N} = \frac{3308.2}{4882.2} = 0.678^{m} < \frac{B}{6} = \frac{4.50}{6} = 0.75^{m}$$

$$q = \frac{N}{B \cdot L}(1 \pm \frac{6e}{B}) = \frac{4882.2}{4.50 \times 6.00}(1 \pm \frac{6 \times 0.678}{4.50}) = \begin{cases} 344.3\ KN/m^2 \\ 17.4\ KN/m^2 \end{cases} < qa=$$

$$Fs = \frac{N \cdot \mu}{H} = \frac{4882.2 \times 0.50}{403.5} = 6.0 > 1.1$$

(2) seismic state

$$e = \frac{M}{N} = \frac{3712.7}{3667.1} = 1.013^{m} > \frac{B}{6} = 0.75^{m}$$

$$\chi = \frac{B}{2} - e = \frac{4.50}{2} - 1.013 = 1.237\ ^{m}$$

$$q_{max} = \frac{2 \cdot N}{3 \cdot x \cdot L} = \frac{2 \times 3667.1}{3 \times 1.237 \times 6.00} = 329.4\ KN/m^2 < qa=$$

$$Fs = \frac{N \cdot \mu}{H} = \frac{3667.1 \times 0.50}{561.4} = 3.2 > 1.1$$

b) Crossing direction for U.L.S.

(1) Skidding state

$$e = \frac{M}{N} = \frac{1879.7}{4882.2} = 0.386^{m} < \frac{B}{6} = 1.000^{m}$$

$$q = \frac{N}{BL}(1 \pm \frac{6e}{B}) = \frac{4882.2}{6.00 \times 4.50}(1 \pm \frac{6 \times 0.386}{6.00}) = \begin{cases} 250.7\ KN/m^2 \\ 111.0\ KN/m^2 \end{cases} < qa=$$

(2) seismic state

$$e = \frac{M}{N} = \frac{2394.8}{3667.1} = 0.653^{m} < \frac{B}{6} = 1.000^{m}$$

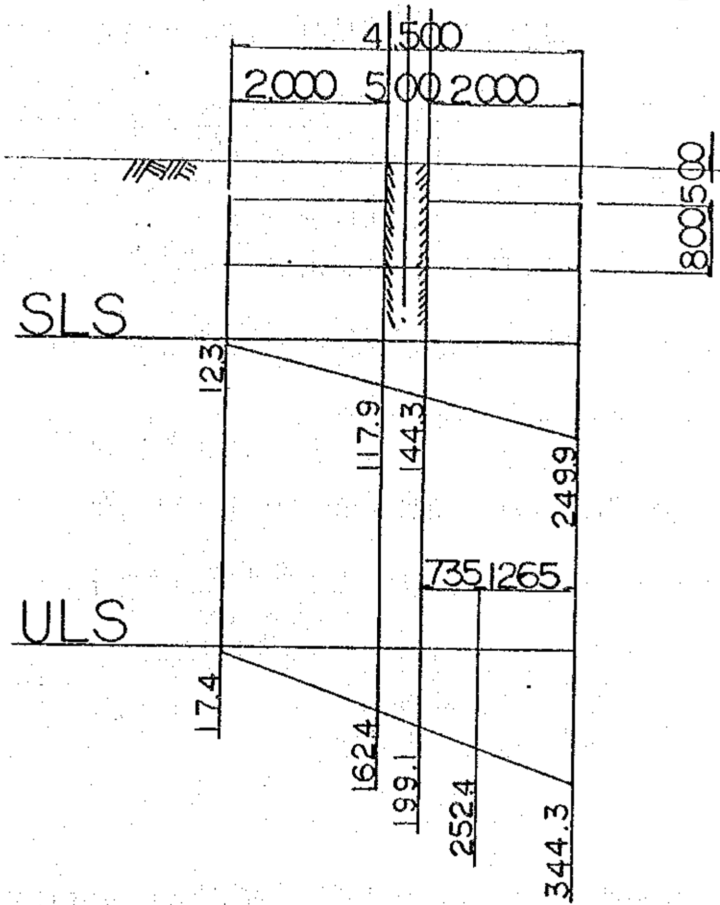
$$q = \frac{N}{BL}(1 \pm \frac{6e}{B}) = \frac{3667.1}{6.00 \times 4.50}(1 \pm \frac{6 \times 0.653}{6.00}) = \begin{cases} 224.5\ KN/m^2 \\ 47.2\ KN/m^2 \end{cases} < qa=$$

$$Fs = \frac{N \cdot \mu}{H} = \frac{3667.1 \times 0.50}{400.5} = 4.5 > 1.1$$

No.① VEHICLE - PIER

Calculation of action force for each section

Longitudinal direction — Braking state



(1) Surcharge load

a) for S.L.S

$\omega = 23.6\times0.80 + 18.6\times0.50$

$= 28.180\ \mathrm{KN/m^2}$

b) for U.L.S

$\omega = (23.6\times0.80 + 18.6\times0.50)$

$\times1.375 = 38.748\ \mathrm{KN/m^2}$

(2) Calculation of bending moment and shearing force

a) for S.L.S

$$M = \frac{2.00^2}{6}(2\times249.9 + 144.3) - \frac{2.00^2}{2}\times28.180 = 373.1\ \mathrm{KNm}$$

$$S = \frac{2.00}{2}(249.9 + 144.3) - 2.00\times28.180 = 337.9\ \mathrm{KN}$$

$$M = \frac{2.00^2}{6}(2\times12.3 + 117.9) - \frac{2.00^2}{2}\times28.180 = -17.8\ \mathrm{KNm}$$

$$S = \frac{2.00}{2}(12.3 + 117.9) - 2.00\times28.180 = 73.9\ \mathrm{KN}$$

b) for U.L.S

$$M = \frac{2.00^2}{6}(2\times344.3 + 199.1) - \frac{2.00^2}{2}\times38.748 \fallingdotseq 514.3\ \mathrm{KNm}$$

$$S = \frac{2.00}{2}(344.3 + 199.1) - 2.00\times38.748 = 465.9\ \mathrm{KN}$$

$$M = \frac{2.00^2}{6}(2\times17.4 + 162.7) - \frac{2.00^2}{2}\times38.748 = 54.1\ \mathrm{KNm}$$

$$S = \frac{2.00}{2}(17.4 + 162.7) - 2.00\times38.748 = 102.6\ \mathrm{KN}$$

Calculation of stress for footing slab … U.S.L

section $b = 100^{cm}$ $h = 80$ $d = 73.5$ $d' = 6.5$

$As = Y_{25} - 150^{ctc} = 4.909/0.15 = 32.727\ cm^2$

$$P = \frac{32.727}{100 \times 73.5} \times 100 = 0.445\ \%$$

$$\chi = \frac{0.87 \times 41000 \times 32.727}{0.40 \times 2500 \times 100} = 11.8^{cm}$$

$$Z = 73.5 - \frac{11.8}{2} = 67.6^{cm} \leqq 0.95 \times 73.5 = 69.8^{cm}$$

$M_{RS} = 0.87 \times 41000 \times 32.727 \times 67.6 \times 10^{-5} = 789.1^{KNm} > Mu =$

$M_{RC} = 0.40 \times 2500 \times 100 \times 11.8 \times 67.6 \times 10^{-5} = 797.6^{KNm} > Mu =$

$$Vc = \frac{465.9 \times 10^3}{100 \times 73.5} = 63.4\ N/cm^2$$

$$< Vca = 35.0 + 15.0 \left(\frac{0.445 - 0.25}{0.25}\right) \times 2 = 93.4\ N/cm^2 \qquad OK$$

Check of Critical section for Shearing force

$$S = \frac{1.265}{2}(344.3 + 252.4) - 1.265 \times 38.748 = 328.4^{KN}$$

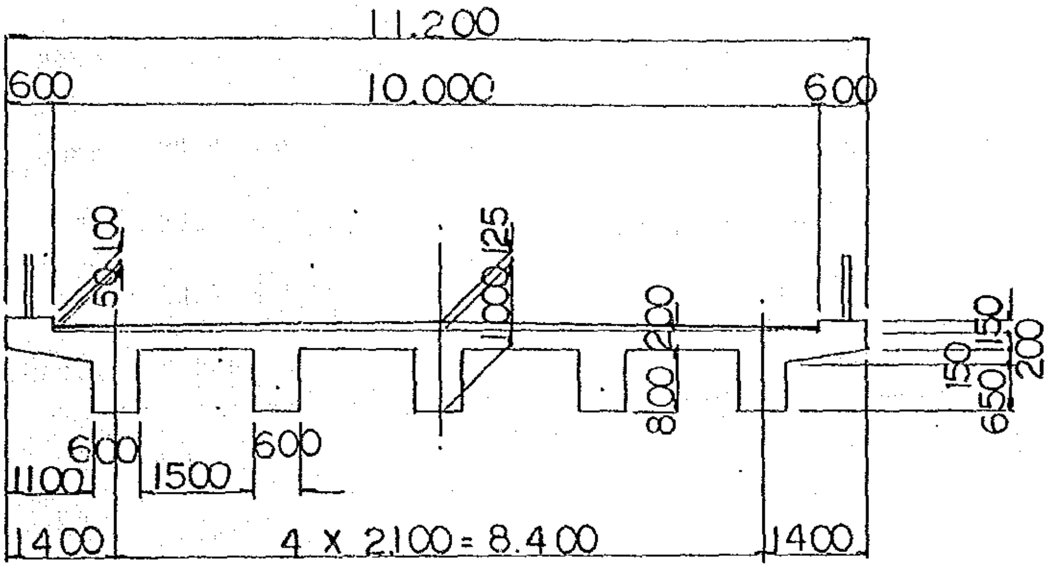
$$Vc = \frac{328.4 \times 10^3}{100 \times 73.5} = 44.7\ N/cm^2$$

$$< Vca = 35.0 + 15.0 \cdot \frac{0.445 - 0.25}{0.25} = 46.7\ N/cm^2 \qquad ok$$

OVER BRIDGE (2) W=10m

No.② VEHICLE BRIDGE …Superstructure

1. Shape and size



2. Factor of section

Shape	$b \times h = A$ (m^2)	y (m)	Ay (m^3)	$I_o = Ay^2 + \frac{bh^3}{12}$ (m^4)
□	11.20 × 0.20=2.240	0.100	0.224	0.0299
□	0.60×0.80×5 = 2.400	0.600	1.440	0.9920
Σ	4.640	−	1.664	1.0219

$$\bar{y} = \frac{\Sigma A y^2}{\Sigma A} = \frac{1.664}{4.640} = 0.358 \ m$$

$$I = I_o - A\bar{y}^2 = 1.0219 - 4.640 \times 0.358^2 = 0.4272 \ m^4$$

3. Load

1) Dead load

pave	: $22.6 \times \frac{0.05+0.125}{2} \times 10.00$	= 19.775	KN/m
conc	: $23.6 \times 0.150 \times 0.600 \times 2$	= 4.248	
〃	: $23.6 \times (11.20 \times 0.20 + 1.10 \times 0.15)$	= 56.758	
〃	: $23.6 \times 0.60 \times 0.80 \times 5$	= 56.640	
guardrall	: 0.980×2	= 1.960	
ωd:		= 139.381	KN/m

2) Live load (HA－load)

U.D.L { loaded length first span $= 14.0 < 30.0$ K=1 ∴ Pu=30.0 KN/lane

U.D.L { loaded length middle support $= 28.0 < 30.0$ K=1 ∴ Pu=30.0 KN/lane

K.E.L … $P_K = 120.0$ KN/lane

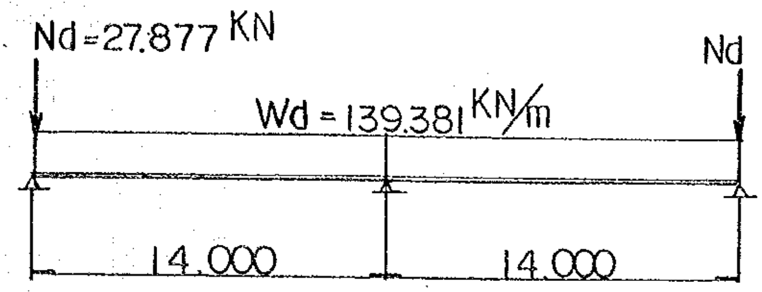
load of all width

for U.D.L $P_u = 30.0 \times (2 + \frac{1}{3}) = 70.0$ KN/m

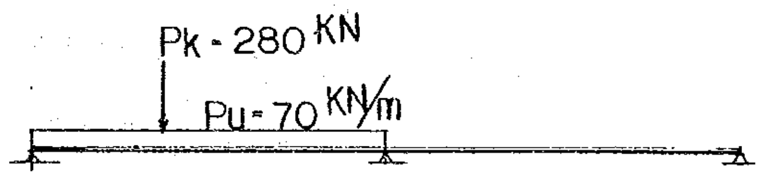
for K.E.L $P_K = 120.0 \times (2 + \frac{1}{3}) = 280.0$ KN/m

3) Loaded figure

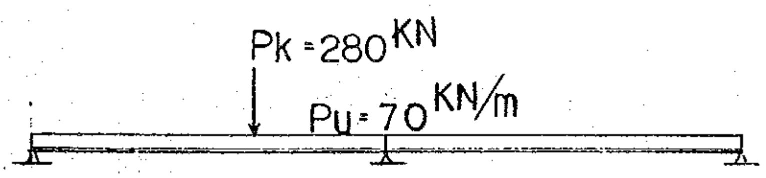
case－1



case－2



case－3



NO 2 Vehicle Br

NOTE: THE DIMENSION(t) BE EXCHANG TO DIMENSION(KN) INTO THIS CALCULATION

No	X (m)	Y (m)
1	0.0000	0.0000
2	14.0000	0.0000
3	28.0000	0.0000

No	I - J	A (m2)	I (m4)	I - J	L (m)	E (t/m2)	EPS
1	1 - 2	4.64000	0.4272	Pin - Fix	14.000	2.70E+07	1.20E-05
2	2 - 3	4.64000	0.4272	Fix - Pin	14.000	2.70E+07	1.20E-05

	X (t/m)	Y (t/m)	M(tm/Rad)
1	Free	Fix	Free
2	Fix	Fix	Free
3	Free	Fix	Free

No		L-No 1 / 11	L-No 2 / 12	L-No 3 / 13	L-No 4 / 14	L-No 5 / 15	L-No 6 / 16	L-No 7 / 17	L-No 8 / 18	L-No 9 / 19	L-No 10 / 20
1	7	1.750	3.500	5.250	7.000	8.750	10.500	12.250			
2	7	1.750	3.500	5.250	7.000	8.750	10.500	12.250			

No. : 1 : Dead load

No	i -j	Li (m)	Lo (m)	Pi (t/m)	Pj (t/m)
1	1- 2	0.001		-27.877	
2	2- 3	13.999		-27.877	
1	1- 2	0.000	14.000	-139.381	-139.381
2	2- 3	0.000	14.000	-139.381	-139.381

ΣV = -3958.422 (t)
ΣH = 0.000 (t)

No. : 2 : HA Live load

No	i -j	Li (m)	Lo (m)	Pi (t/m)	Pj (t/m)
1	1- 2	5.250		-280.000	
1	1- 2	0.000	14.000	-70.000	-70.000

ΣV = -1260.000 (t)
ΣH = 0.000 (t)

No. : 3 : HA Live load

No	i -j	Li (m)	Lo (m)	Pi (t/m)	Pj (t/m)
1	1- 2	8.750		-280.000	
1	1- 2	0.000	14.000	-70.000	-70.000
2	2- 3	0.000	14.000	-70.000	-70.000

ΣV = -2240.000 (t)
ΣH = 0.000 (t)

NO 2 Vehicle Br

	C-No 1 No 4	C-No 2 No 5
No 1	1.3800	1.3800
No 2	1.6500	0.0000
No 3	0.0000	1.6500

No 1 : 4 5

	Case. 1			Case. 2			Case. 3		
No.	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)
1.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.0000
2.	0.00000	0.00000	0.00000	0.00000	0.00000	0.57995	0.00000	0.00000	0.1845
3.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.0000

	Case. 4			Case. 5		
No.	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)	X-DIS.(mm)	Y-DIS.(mm)	ROTA.(mmRad)
1.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.	0.00000	0.00000	0.95691	0.00000	0.00000	0.30440
3.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

	Case. 1			Case. 2			Case. 3		
No.	RX (t)	RY (t)	RM (tm)	RX (t)	RY (t)	RM (tm)	RX (t)	RY (t)	RM (tm)
1.	0.000	759.624	0.000	0.000	581.191	0.000	0.000	445.840	0.000
2.	0.000	2439.170	0.000	0.000	762.617	0.000	0.000	1453.320	0.000
3.	0.000	759.624	0.000	0.000	-83.809	0.000	0.000	340.840	0.000

	Case. 4			Case. 5		
No.	RX (t)	RY (t)	RM (tm)	RX (t)	RY (t)	RM (tm)
1.	0.000	2007.250	0.000	0.000	1783.920	0.000
2.	0.000	4624.380	0.000	0.000	5764.040	0.000
3.	0.000	909.997	0.000	0.000	1610.670	0.000

NO 2 Vehicle Br

			Case 1 Dead load			Case 2 HA Live load			Case 3 HA Live load		
	No	L(m)	M (tm)	S (t)	N (t)	M (tm)	S (t)	N (t)	M (tm)	S (t)	N (t)
1-	2	0.000	0.000	759.624	0.000	0.000	581.191	0.000	0.000	445.840	0.000
*	1	1.750	1067.158	487.831	0.000	909.897	458.691	0.000	673.032	323.340	0.000
*	2	3.500	1707.435	243.914	0.000	1605.420	336.191	0.000	1131.689	200.840	0.000
*	3	5.250	1920.857	-0.003	0.000	2086.567	213.691	0.000	1375.972	78.340	0.000
*	4	7.000	1707.424	-243.920	0.000	1863.340	-188.809	0.000	1405.879	-44.160	0.000
*	5	8.750	1067.138	-487.836	0.000	1425.737	-311.309	0.000	1221.411	-166.660	0.000
*	6	10.500	-0.003	-731.753	0.000	773.760	-433.809	0.000	332.568	-569.160	0.000
*	7	12.250	-1493.999	-975.670	0.000	-92.593	-556.309	0.000	-770.649	-691.660	0.000
2-	1	14.000	-3414.848	-1219.587	0.000	-1173.320	-678.809	0.000	-2088.242	-814.160	0.000
2-	3	0.000	-3414.848	1219.587	0.000	-1173.320	83.809	0.000	-2088.242	639.160	0.000
*	1	1.750	-1493.999	975.670	0.000	-1026.655	83.809	0.000	-1076.899	516.660	0.000
*	2	3.500	-0.003	731.753	0.000	-879.990	83.809	0.000	-279.932	394.160	0.000
*	3	5.250	1067.138	487.836	0.000	-733.325	83.809	0.000	302.661	271.660	0.000
*	4	7.000	1707.424	243.920	0.000	-586.660	83.809	0.000	670.879	149.160	0.000
*	5	8.750	1920.857	0.003	0.000	-439.995	83.809	0.000	824.722	26.660	0.000
*	6	10.500	1707.435	-243.914	0.000	-293.330	83.809	0.000	764.189	-95.840	0.000
*	7	12.250	1067.158	-487.831	0.000	-146.665	83.809	0.000	489.282	-218.340	0.000
3-	2	14.000	0.000	-759.624	0.000	0.000	83.809	0.000	0.000	-340.840	0.000

			Case 4			Case 5		
	No	L(m)	M (tm)	S (t)	N (t)	M (tm)	S (t)	N (t)
1-	2	0.000	0.000	2007.247	0.000	0.000	1783.917	0.000
*	1	1.750	2974.009	1430.047	0.000	2583.182	1206.717	0.000
*	2	3.500	5005.203	891.317	0.000	4223.547	667.987	0.000
*	3	5.250	6093.618	352.587	0.000	4921.135	129.257	0.000
*	4	7.000	5430.756	-648.143	0.000	4675.946	-409.473	0.000
*	5	8.750	3825.116	-1186.874	0.000	3487.978	-948.204	0.000
*	6	10.500	1276.699	-1725.604	0.000	548.733	-1948.934	0.000
*	7	12.250	-2214.496	-2264.334	0.000	-3333.290	-2487.664	0.000
2-	1	14.000	-6648.469	-2803.064	0.000	-8158.090	-3026.394	0.000
2-	3	0.000	-6648.469	1821.314	0.000	-8158.090	2737.644	0.000
*	1	1.750	-3755.700	1484.709	0.000	-3838.602	2198.914	0.000
*	2	3.500	-1451.989	1148.104	0.000	-461.892	1660.184	0.000
*	3	5.250	262.663	811.499	0.000	1972.041	1121.454	0.000
*	4	7.000	1388.256	474.893	0.000	3463.196	582.723	0.000
*	5	8.750	1924.790	138.288	0.000	4011.573	43.993	0.000
*	6	10.500	1872.265	-198.317	0.000	3617.172	-494.737	0.000
*	7	12.250	1230.681	-534.922	0.000	2279.994	-1033.467	0.000
3-	2	14.000	0.000	-909.997	0.000	0.000	-1610.667	0.000

NO 2 Vehicle Br

PICK-UP No. 1 *

No.	L (m)	M. MAXIMUM Case	M (tm)	S (t)	N (t)	M. MINIMUM Case	M (tm)	S (t)	N (t)
1 - 2	0.000	C- 4	0.000	2007.247	0.000	C- 4	0.000	2007.247	0.000
* 1	1.750	C- 4	2974.009	1430.047	0.000	C- 5	2583.182	1206.717	0.000
* 2	3.500	C- 4	5005.203	891.317	0.000	C- 5	4223.547	667.987	0.000
* 3	5.250	C- 4	6093.618	352.587	0.000	C- 5	4921.135	129.257	0.000
* 4	7.000	C- 4	5430.756	-648.143	0.000	C- 5	4675.946	-409.473	0.000
* 5	8.750	C- 4	3825.116	-1186.874	0.000	C- 5	3487.978	-948.204	0.000
* 6	10.500	C- 4	1276.699	-1725.604	0.000	C- 5	548.733	-1948.934	0.000
* 7	12.250	C- 4	-2214.496	-2264.334	0.000	C- 5	-3333.290	-2487.664	0.000
2 - 1	14.000	C- 4	-6648.469	-2803.064	0.000	C- 5	-8158.090	-3026.394	0.000
2 - 3	0.000	C- 4	-6648.469	1821.314	0.000	C- 5	-8158.090	2737.644	0.000
* 1	1.750	C- 4	-3755.700	1484.709	0.000	C- 5	-3838.602	2198.914	0.000
* 2	3.500	C- 5	-461.892	1660.184	0.000	C- 4	-1451.989	1148.104	0.000
* 3	5.250	C- 5	1972.041	1121.454	0.000	C- 4	262.663	811.499	0.000
* 4	7.000	C- 5	3463.196	582.723	0.000	C- 4	1388.256	474.893	0.000
* 5	8.750	C- 5	4011.573	43.993	0.000	C- 4	1924.790	138.288	0.000
* 6	10.500	C- 5	3617.172	-494.737	0.000	C- 4	1872.265	-198.317	0.000
* 7	12.250	C- 5	2279.994	-1033.467	0.000	C- 4	1230.681	-534.922	0.000
3 - 2	14.000	C- 4	0.000	-909.997	0.000	C- 4	0.000	-909.997	0.000

NO 2 Vehicle Br

PICK-UP No. 1 *

No.	L (m)	S. MAXIMUM Case	M (tm)	S (t)	N (t)	S. MINIMUM Case	M (tm)	S (t)	N (t)
1 - 2	0.000	C- 4	0.000	2007.247	0.000	C- 5	0.000	1783.917	0.000
* 1	1.750	C- 4	2974.009	1430.047	0.000	C- 5	2583.182	1206.717	0.000
* 2	3.500	C- 4	5005.203	891.317	0.000	C- 5	4223.547	667.987	0.000
* 3	5.250	C- 4	6093.618	352.587	0.000	C- 5	4921.135	129.257	0.000
* 4	7.000	C- 5	4675.946	-409.473	0.000	C- 4	5430.756	-648.143	0.000
* 5	8.750	C- 5	3487.978	-948.204	0.000	C- 4	3825.116	-1186.874	0.000
* 6	10.500	C- 4	1276.699	-1725.604	0.000	C- 5	548.733	-1948.934	0.000
* 7	12.250	C- 4	-2214.496	-2264.334	0.000	C- 5	-3333.290	-2487.664	0.000
2 - 1	14.000	C- 4	-6648.469	-2803.064	0.000	C- 5	-8158.090	-3026.394	0.000
2 - 3	0.000	C- 5	-8158.090	2737.644	0.000	C- 4	-6648.469	1821.314	0.000
* 1	1.750	C- 5	-3838.602	2198.914	0.000	C- 4	-3755.700	1484.709	0.000
* 2	3.500	C- 5	-461.892	1660.184	0.000	C- 4	-1451.989	1148.104	0.000
* 3	5.250	C- 5	1972.041	1121.454	0.000	C- 4	262.663	811.499	0.000
* 4	7.000	C- 5	3463.196	582.723	0.000	C- 4	1388.256	474.893	0.000
* 5	8.750	C- 4	1924.790	138.288	0.000	C- 5	4011.573	43.993	0.000
* 6	10.500	C- 4	1872.265	-198.317	0.000	C- 5	3617.172	-494.737	0.000
* 7	12.250	C- 4	1230.681	-534.922	0.000	C- 5	2279.994	-1033.467	0.000
3 - 2	14.000	C- 4	0.000	-909.997	0.000	C- 5	0.000	-1610.667	0.000

NO 2 Vehicle Br

PICK-UP No. 1 *

No.	L (m)	N. MAXIMUM Case	M (tm)	S (t)	N (t)	N. MINIMUM Case	M (tm)	S (t)	N (t)
1 - 2	0.000	C- 4	0.000	2007.247	0.000	C- 4	0.000	2007.247	0.000
* 1	1.750	C- 4	2974.009	1430.047	0.000	C- 4	2974.009	1430.047	0.000
* 2	3.500	C- 4	5005.203	891.317	0.000	C- 4	5005.203	891.317	0.000
* 3	5.250	C- 4	6093.618	352.587	0.000	C- 4	6093.618	352.587	0.000
* 4	7.000	C- 4	5430.756	-648.143	0.000	C- 4	5430.756	-648.143	0.000
* 5	8.750	C- 4	3825.116	-1186.874	0.000	C- 4	3825.116	-1186.874	0.000
* 6	10.500	C- 4	1276.699	-1725.604	0.000	C- 4	1276.699	-1725.604	0.000
* 7	12.250	C- 4	-2214.496	-2264.334	0.000	C- 4	-2214.496	-2264.334	0.000
2 - 1	14.000	C- 4	-6648.469	-2803.064	0.000	C- 4	-6648.469	-2803.064	0.000
2 - 3	0.000	C- 4	-6648.469	1821.314	0.000	C- 4	-6648.469	1821.314	0.000
* 1	1.750	C- 4	-3755.700	1484.709	0.000	C- 4	-3755.700	1484.709	0.000
* 2	3.500	C- 4	-1451.989	1148.104	0.000	C- 4	-1451.989	1148.104	0.000
* 3	5.250	C- 4	262.663	811.499	0.000	C- 4	262.663	811.499	0.000
* 4	7.000	C- 4	1388.256	474.893	0.000	C- 4	1388.256	474.893	0.000
* 5	8.750	C- 4	1924.790	138.288	0.000	C- 4	1924.790	138.288	0.000
* 6	10.500	C- 4	1872.265	-198.317	0.000	C- 4	1872.265	-198.317	0.000
* 7	12.250	C- 4	1230.681	-534.922	0.000	C- 4	1230.681	-534.922	0.000
3 - 2	14.000	C- 4	0.000	-909.997	0.000	C- 4	0.000	-909.997	0.000

No.② VEHICLE BRIDGE

1. Calculation for bending moment

1) Middle span

section $b=245^{cm}(b_o=60)$ $h=100$ $d=87.5$ $d'=12.5$

$Mu.max=6093.7/5\times1.05=1279.7$ KNm/Girder

$$As=\left(\begin{array}{l} Y_{32}-4^{NO}=8.042\times4 \\ Y_{25}-4^{NO}=4.909\times4 \end{array}\right)=51.804\ cm^2$$

$$\chi=\frac{0.87\times41000\times51.804}{0.40\times3000\times245}=8.6^{cm}$$

$$Z=87.5-\frac{8.6}{2}=83.2^{cm}\leqq0.95\times87.5=83.2^{cm}$$

$M_{RS}=0.87\times41000\times51.804\times83.2\times10^{-5}=1537.4^{KNm}>Mu=1279.7^{KNm}$

$M_{RC}=0.40\times3000\times245\times8.6\times83.2\times10^{-5}=2103.6^{KNm}>Mu=1279.7^{KNm}$ OK

2) Middle fulcrum

section $b=60^{cm}$ $h=100$ $d=88.5$ $d'=11.5$

$Mu.min=8158.1/5\times1.05=1713.2$ KNm/Girder

$As=Y_{32}-4^{NO}\times2=8.042\times8^{NO}=64.336\ cm^2$

$A's=Y_{32}-4^{NO}=8.042\times4^{NO}=32.168\ cm^2$

$$\chi=\frac{(0.87\times64.336-0.72\times32.168)\times41000}{0.40\times3000\times60}=18.8^{cm}$$

$$Z=88.5-\frac{18.8}{2}=79.1^{cm}\leqq0.95\times88.5=84.1^{cm}$$

$M_{RS}=0.87\times41000\times64.336\times79.1\times10^{-5}=1813.0^{KNm}>Mu=1713.2^{KNm}$

$M_{RC}=(0.72\times41000\times32.168\times81.0+0.40\times3000\times60\times18.8\times79.1)$

$\times10^{-5}=1840.0^{KNm}>Mu=1713.2^{KNm}$ OK

2. Calculation of shearing force

1) Edge fulcrum $S_{u.max} = 1430.1^{KN}/5 \times 1.1 = 371.9$ KN/Girder

section $b = 60^{cm}$ $h = 100$ $d = 87.5$ $d' = 12.5$

$$V_c = \frac{371.9 \times 10^3}{60.0 \times 87.5} = 70.9 \ \text{N/cm}^2$$

$$A_s = \left(\begin{array}{l} Y_{32} - 4^{Nu} \\ Y_{25} - 4^{Nu} \end{array} \right) = 51.804 \ \text{cm}^2$$

$$P = \frac{51.804}{60.0 \times 87.5} \times 100 = 0.987 \ \%$$

$$V_{ca} = 55.0 + 15.0 \left(\frac{0.987 - 0.50}{0.50} \right) = 69.7 \ \text{N/cm}^2 < V_c = 70.9 \ \text{N/cm}^2$$

OUT

2) Middle fulcrum $S_{u.min} = 2487.7^{KN}/5 \times 1.1 = 547.3$ KN/Girder

section $b = 60^{cm}$ $h = 100$ $d = 88.5$ $d' = 11.5$

$$V_c = \frac{547.3 \times 10^3}{60.0 \times 88.5} = 103.1 \ \text{N/cm}^2$$

$$A_s = Y_{32} - 4^{No} \times 2 = 64.336 \ \text{cm}^2$$

$$P = \frac{64.336}{60.0 \times 88.5} \times 100 = 1.212 \ \%$$

$$V_{ca} = 70.0 + 20.0 \left(\frac{1.212 - 1.00}{1.00} \right) = 74.3 \ \text{N/cm}^2 < V_c = 103.1 \ \text{N/cm}^2$$

shearing bar

$Y_{16} - 300^{ctc} \cdots$ $A_v = 2.011 \times 2^{NU} = 4.022$

$$V_s = 0.87 f_y (A_v / b s v) = 0.87 \times 41000 (4.022/60.0 \times 30.0) = 79.7 \ \text{N/cm}^2$$

Edge support

$V_a = V_{ca} + V_{sa} = 69.7 + 79.7 = 149.4 \ \text{N/cm}^2 > V = 70.9 \ \text{N/cm}^2$

Middle suport

$V_a = V_{ca} + V_{sa} = 74.3 + 79.7 = 154.0 \ \text{N/cm}^2 > V = 103.1 \ \text{N/cm}^2$ OK

Calculation of deck slab for No.② Vehicle bridge (U.L.S)

1. Span and bending moment

a) Span : $\ell = (2.100 - 0.60) = 1.500^{m}$

b) moment of middle span :

$$M \fallingdotseq \left\{ 0.8 (0.12\ \ell + 0.07)\ P + \frac{1}{10} \omega d \cdot \ell^2 \right\} \times 1.5 \times 1.1$$

$$= \left\{ 0.8 (0.12 \times 1.50 + 0.07) \times 100 + \frac{1}{10} \times 4.720 \times 1.50^2 \right\} \times 1.5 \times 1.1$$

$$= 34.7^{KN/m}$$

c) moment of middle fulcrum :

$$M \fallingdotseq \left\{ (0.15 \ell + 0.125) P + \frac{1}{10} \omega d \cdot \ell^2 \right\} \times 1.5 \times 1.1$$

$$= \left\{ (0.15 \times 1.50 + 0.125) \times 100 + \frac{1}{10} \times 4.720 \times 1.50^2 \right\} \times 1.5 \times 1.1$$

$$= 59.5^{KN/m}$$

2. Calculation of stress

a) middle span

$b = 100^{cm}$ $h = 20$ $d = 15.0$ $d' = 5.0$

$As = Y_{12} - 150^{ctc} = 1.131/0.150 = 7.540\ cm^2$

$$P = \frac{7.540}{100 \times 15.0} \times 100 = 0.503\ \%$$

$$x = \frac{0.87 \times 41000 \times 7.540}{0.40 \times 3000 \times 100} = 2.4^{cm}$$

$$Z = 15.0 - \frac{2.4}{2} = 13.8^{cm} < 0.95 \times 15.0 = 14.3^{cm} \quad OK$$

$M_{RS} = 0.87 \times 41000 \times 7.540 \times 13.8 \times 10^{-5} = 37.1^{KNm} > Mu = 34.7^{KNm}$

$M_{RC} = 0.40 \times 3000 \times 100 \times 2.4 \times 13.8 \times 10^{-5} = 39.7^{KNm} > Mu = 34.7^{KNm}$ OK

b) middle fulcrum

$b = 100^{cm}$ $h = 20$ $d = 16.0$ $d' = 4.0$

$As = Y_{16} - 150^{ctc} = 2.011/0.150 = 13.407\ cm^2$

$$P = \frac{13.407}{100 \times 16.0} \times 100 = 0.838\ \%$$

$$\chi = \frac{0.87 \times 41000 \times 13.407}{0.40 \times 3000 \times 100} = 4.0^{cm}$$

$$Z = 16.0 - \frac{4.0}{2} = 14.00^{cm} < 0.95 \times 16.0 = 15.2^{cm} \quad OK$$

$M_{RS} = 0.87 \times 41000 \times 13.407 \times 14.00 \times 10^{-5} = 66.9^{KNm} > Mu = 59.5^{KNm}$

$M_{RC} = 0.40 \times 3000 \times 100 \times 4.0 \times 14.00 \times 10^{-5} = 67.2^{KNm} > Mu = 59.5^{KNm}$ OK

Calculation of Shoe

1) quantity of expantion between

Girder-edge and Parapet face of abutment

quantity of expantion or shrinkage (maximum)

for temperature	: $dt = a \times T \times L = (1.0 \times 10^{-5} \times 15.0 \times L)^{m}$	$= (0.150 \times L)^{mm}$	
for shrinkage	: $ds = a \times T \times L \times b = (1.0 \times 10^{-5} \times 20.0 \times L \times 0.8)$	$= (0.160 \times L)$	"
for creep	: $dc = \frac{P}{E \times A} \times \phi \times L \times b = \frac{750}{2.7 \times 10^{6}} \times 1.9 \times L \times 0.8$	$= (0.430 \times L)$	"
for other	: $do =$	$= 5.0$	"
total	$dL =$	$= (0.80L + 5.0)^{mm}$	

where a = coefficient of thermal expantion or shrinkage

T = quantity of temperature variance

L = girder length

b = coefficient of decrease

E = young's modulus

$P/A = 0.5\, fcu/2 = 0.5 \times 300/2 = 750^{N/cm^2}$

ϕ = creep factor

fcu = strength of concrete ($30^{N/mm^2}$)

NO ② Vehicle bridge

edge fulcrum	Rd = 759.7／5 ×1.1	= 167.2 KN／choe	
(MOV)	RL = 581.2／5 ×1.1	= 127.8	〃
	Rmax =	= 295.0	〃
	∴ dL = (0.80L＋5)＝(0.80×14.0＋5)	= 17 mm	
middle fulcrum	Rd = 2439.2／5×1.1	= 536.7 KN／choe	
(Fix)	RL = 1453.4／5×1.1	= 319.8	〃
	Rmax =	= 856.5	〃
	∴ dL = 0		

Notice:this case is apply NO① vehicle

No.② VEHICLE – Substructure

1. Reaction from superstructure

1) For ABUT (Movable) … S.L.S.

(1) For Vertical load ($B=11.200^{m}$)

dead load R_d = 759.624^{KN}

live load R_ℓ = 581.192^{KN}

total load R = 1340.816^{KN}

(2) For Horizontal force for temperature or seismic

$H_T = H_D = 759.624 \times 0.15 = 113.944^{KN}$

2) For Pier (Fixed) … S.L.S.

(1) For Vertical load

dead load R_d = 2439.170^{KN}

live load R_ℓ = 1453.320^{KN}

total R = 3892.490^{KN}

(2) For Horizontal load

a) Longitudinal direction

braking load $H_B = 8 \times 28.0 + 200 = 424.000^{KN}$

seismic load $H_D = (2 \times 759.624 + 2439.170) \times 0.10 = 395.840^{KN}$

b) Crossing direction

skidding load $H_S = \quad = 250.000^{KN}$

seismic load $H_D = 2439.170 \times 0.10 = 243.920^{KN}$

** NO-2-VEHICLE-ABUT **

SHAPE AND SIZE

H0 =	9.500 (m)	B0 =	5.000 (m)
H1 =	1.100 (m)	B1 =	1.500 (m)
H2 =	0.000 (m)	B2 =	1.100 (m)
H3 =	0.000 (m)	B3 =	0.300 (m)
H4 =	7.500 (m)	B4 =	2.400 (m)
H5 =	0.000 (m)	B5 =	0.800 (m)
H6 =	0.900 (m)	B6 =	0.000 (m)
BW1 =	11.200 (m)	HU1 =	0.500 (m)
BW2 =	11.200 (m)	HU2 =	0.500 (m)
HW1 =	0.500 (m)		
HW2 =	0.500 (m)		

NOTE: THE DIMENSION(t) BE EXCHANG TO DIMENSION(KN) INTO THIS CALCULATION

REACTION OF DEAD LOAD	RL =	581.192 (t)
〃 LIVE LOAD	RD =	759.624 (t)
HORIZONTAL FORCE FOR	HT =	113.944 (t)
TEMPERATURE.SEISMIC	HD =	113.944 (t)
SITUATION OF REACTION	RX =	0.350 (m)
AND HORIZONTAL FORCE	RY =	0.100 (m)
	QL =	34.300 (t/m^2)
	QD =	0.000 (t/m^2)
	KH =	0.10
SEISMIC COEFFICIENT	KHS =	0.00
UNIT VOLUME WEIGHTS		
FOR CONCRETE	GAMC =	23.600 (t/m^3)
FOR BACK FILL	GAM1 =	19.600 (t/m^3)
〃 (UNDER WATER)	GAM1S =	10.800 (t/m^3)
INTERNALFRICTIONANGLE	FAi =	35.000 (°)
FOR ABOVE TOE SLAB	GAM2 =	18.600 (t/m^3)
〃 (UNDERWATER)	GAM2S =	9.800 (t/m^3)
FOR WATER	WATS =	9.800 (t/m^3)

CALCULATION OF WEIGHT AND FORCE OR LOAD

(1) CONCRETE

NO.	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
1	87.226	8.723	2.450	8.950	213.703	78.067
4	2180.640	218.064	2.050	4.650	4470.310	1014.000
8	1189.440	118.944	2.500	0.450	2973.600	53.525
Σ1	3457.310	345.731			7657.610	1145.590

V = X*Y*BW*GAM1　　H = V*KH
MX = V*X　　MY = H*Y

(2) EARTH

a) BACK FILLING

NO.	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
1	579.533	57.953	3.800	8.950	2202.220	518.682
4	3951.360	395.136	3.800	4.650	15015.200	1837.380
Σ2	4530.890	453.089			17217.400	2356.050

b) SURCHAG OF TOE SLAB

NO.	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
6	156.240	0.000	0.750	1.150	117.180	0.000
Σ3	156.240	0.000			117.180	0.000

V = X*Y*BW*GAM1　　H = V*KHS
MX = V*X　　MY = H*Y

(3) REACTION

STATE	RV(t)	RH(t)	RMX(t·m)	RMY(t·m)
ordinary	1340.820	0.000	2614.590	0.000
TemPerature	1340.820	113.944	2614.590	968.524
Seismic	759.624	113.944	1481.270	968.524

RMX= RV*X　　RMY= RH*Y

(4) EARTH PRESSURE FACTOR

	Ordinary or TemPerature		Seismic	
	0.2497	0.2508	0.3056	0.3277
SIN (δ)	0.5736	0.2022	0.3007	0.0000
COS (δ)	0.8192	0.9793	0.9537	1.0000

(5) EARTH PRESSURE

	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
	522.731	746.538	5.000	4.750	2613.660	3546.060
	1418.840	2026.320	5.000	3.167	7094.210	6416.670
	1031.470	1473.090	5.000	4.100	5157.350	6039.680
	373.537	533.466	5.000	0.689	1867.680	367.768
	910.231	2886.890	5.000	3.167	4551.160	9141.810
	661.720	2098.710	5.000	4.100	3308.600	8604.710
	239.635	760.027	5.000	0.689	1198.180	523.958

(6) BUOYANCY

	V(t)	H(t)	X(m)	Y(m)	MX(t·m)	MY(t·m)
	1037.230	0.000	3.650	0.000	3785.900	0.000
	-746.480	0.000	2.496	0.000	-1863.430	0.000
	-746.480	0.000	2.496	0.000	-1863.430	0.000

TOTAL OF ACTION FORCE

1. EXCLUDE BUOYANCY

(1) ORDINARY --- FOR FOUNDATION

LOAD	V(t)	H(t)	MX(t·m)	MY(t·m)
Σ1	3457.310	0.000	7657.610	0.000
Σ2	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1418.840	2026.320	7094.210	6416.670
	1340.820	0.000	2614.590	0.000
	1037.230	0.000	3785.900	0.000
	156.240	0.000	117.180	0.000
TOTAL	12464.100	2772.860	41100.500	9962.730

Mo = ΣMX − ΣMY = 31137.800 (t·m)

(2) ORDINARY --- FOR INVERSION OR SLIDE

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1 (1)	3457.310	0.000	7657.610	0.000
	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1418.840	2026.320	7094.210	6416.670
	759.624	0.000	1481.270	0.000
	156.240	0.000	117.180	0.000
	10845.600	2772.860	36181.300	9962.730

Mo = ΣMX − ΣMY = 26218.600 (t·m)

(3) TEMPERATURE --- FOR FOUNDATION

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1 (1)	3457.310	0.000	7657.610	0.000
	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1418.840	2026.320	7094.210	6416.670
	1340.820	113.944	2614.590	968.524
	1037.230	0.000	3785.900	0.000
	156.240	0.000	117.180	0.000
	12464.100	2886.800	41100.500	10931.300

Mo = ΣMX − ΣMY = 30169.300 (t·m)

(4) TEMPERATURE --- INVERSION OR SLIDE

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1 (1)	3457.310	0.000	7657.610	0.000
	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1418.840	2026.320	7094.210	6416.670
	759.624	113.944	1481.270	968.524
	156.240	0.000	117.180	0.000
	10845.600	2886.800	36181.300	10931.300

Mo = ΣMX − ΣMY = 25250.100 (t·m)

(5) SEISMIC

	V(t)	H(t)	MX(t·m)	MY(t·m)
SAME 1 (1)	3457.310	345.731	7657.610	1145.590
	4530.890	453.089	17217.400	2356.060
	910.231	2886.890	4551.160	9141.810
	759.624	113.944	1481.270	968.524
	156.240	0.000	117.180	0.000
	9814.290	3799.650	31024.600	13612.000

Mo = ΣMX − ΣMY = 17412.600 (t·m)

2. INCLUDE BUOYANCY

(1) ORDINARY

	V(t)	H(t)	MX(t·m)	MY(t·m)
	3457.310	0.000	7657.610	0.000
	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1031.470	1473.090	5157.350	6039.680
	373.537	533.466	1867.680	367.768
	1340.820	0.000	2614.590	0.000
	1037.230	0.000	3785.900	0.000
	156.240	0.000	117.180	0.000
	-746.480	0.000	-1863.430	0.000
	11703.700	2753.100	39167.900	9953.510

$Mo = \Sigma MX - \Sigma MY = 29214.400$ (t·m)

(2) ORDINARY

	V(t)	H(t)	MX(t·m)	MY(t·m)
	3457.310	0.000	7657.610	0.000
	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1031.470	1473.090	5157.350	6039.680
	373.537	533.466	1867.680	367.768
	759.624	0.000	1481.270	0.000
	156.240	0.000	117.180	0.000
	-746.480	0.000	-1863.430	0.000
	10085.300	2753.100	34248.700	9953.510

$Mo = \Sigma MX - \Sigma MY = 24295.200$ (t·m)

(3) TEMPERATURE

	V(t)	H(t)	MX(t·m)	MY(t·m)
	3457.310	0.000	7657.610	0.000
	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1031.470	1473.090	5157.350	6039.680
	373.537	533.466	1867.680	367.768
	1340.820	113.944	2614.590	968.524
	1037.230	0.000	3785.900	0.000
	156.240	0.000	117.180	0.000
	-746.480	0.000	-1863.430	0.000
	11703.700	2867.040	39167.900	10922.000

$Mo = \Sigma MX - \Sigma MY = 28245.900$ (t·m)

(4) TEMPERATURE

	V(t)	H(t)	MX(t·m)	MY(t·m)
	3457.310	0.000	7657.610	0.000
	4530.890	0.000	17217.400	0.000
	522.731	746.538	2613.660	3546.060
	1031.470	1473.090	5157.350	6039.680
	373.537	533.466	1867.680	367.768
	759.624	113.944	1481.270	968.524
	156.240	0.000	117.180	0.000
	-746.480	0.000	-1863.430	0.000
	10085.300	2867.040	34248.700	10922.000

$Mo = \Sigma MX - \Sigma MY = 23326.700$ (t·m)

(5) SEISMIC

	V(t)	H(t)	MX(t·m)	MY(t·m)
	3457.310	345.731	7657.610	1145.590
	4530.890	453.089	17217.400	2356.060
	661.720	2098.710	3308.600	8604.710
	239.635	750.027	1198.180	523.958
	759.624	113.944	1481.270	968.524
	156.240	0.000	117.180	0.000
	-746.480	0.000	-1863.430	0.000
	9058.940	3771.500	29116.800	13598.900

$$Mo = \Sigma MX - \Sigma MY = 15518.000 \ (t \cdot m)$$

TOTAL FORCE FOR UNDER FOUNDATION CENTER

LOAD	V(t)	H(t)	Mo(t·m)	e(m)	Mc(t·m)
A					
1	12464.100	2772.860	31137.800	0.002	22.335
2	10845.600	2772.860	26218.600	0.083	895.496
3	12464.100	2886.800	30169.300	0.079	990.857
4	10845.600	2886.800	25250.100	0.172	1864.020
5	9814.290	3799.650	17412.600	0.726	7123.110
B					
1	11703.700	2753.100	29214.400	0.004	44.934
2	10085.300	2753.100	24295.200	0.091	918.097
3	11703.700	2867.040	28245.900	0.087	1013.460
4	10085.300	2867.040	23326.700	0.187	1886.620
5	9058.940	3771.500	15518.000	0.787	7129.400

$e = B0/2 - Mo/V \quad : \quad Mc = V * e$

WHERE

A AND B:EXCLUDE OF BOUYANCY
OR INCLUDE BOUYANCY

1. ORDINARY : FOR FOUNDATION
2. 〃 : FOR INVERSION OR SLIDE
3. TENPERATURE : STATE OF 1
4. 〃 : 〃 2
5. SEISMIC

2) Factor of calculation for reaction of piles.

SPP − $\phi 500^{mm} \times 9^{mm} \times 8.500^{m}$

$$Ap = \frac{\pi}{4}(0.500^2 - 0.482^2) = 0.01388 \ m^2$$

$$Ip = \frac{\pi}{64}(0.500^4 - 0.482^4) = 0.000418 \ m^4$$

$$Ep = 20.58 \times 10^7 \ KN/m^2$$

$$K_H = \alpha E_o D^{-\frac{3}{4}} = 0.8 \times 7 \times 5 \times 50^{-\frac{3}{4}} \times 9.8 = 14.6 \ N/cm^3 = 14600 \ KN/m^3$$

$$Kv = \alpha \frac{Ap \ Ep}{\ell}$$

where

$$\alpha = 0.027\frac{\ell}{D} + 0.200$$

$$= 0.027 \times \frac{8.50}{0.50} + 0.200 = 0.659$$

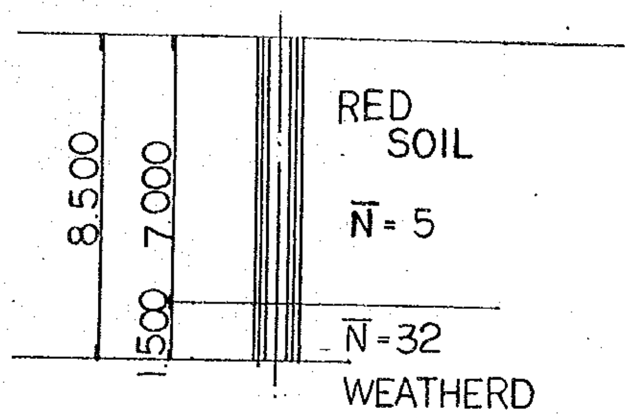
$$\therefore Kv = 0.659 \times \frac{0.01388 \times 20.58 \times 10^7}{8.5}$$

$$= 2.215 \times 10^5 \ KN/m = 221500 \ KN/m$$

$$B = \sqrt[4]{\frac{K \cdot D}{4EI}} = \sqrt[4]{\frac{14600 \times 0.50}{4 \times 20.58 \times 10^7 \times 0.000418}} = 0.382 \ m^{-1}$$

2. Factor for pile of Foundation

1) Vertical force for ground of a front of piles.



From Meyerhof formula

$$Ru = \left(40NA + \frac{Nc}{2} Ac \right) \times 9.8$$

$$= \left\{ 40 \times 32 \times \frac{\pi \times 0.50}{4} + \pi \times 0.50 \left(\frac{5}{2} \times 7.00 + \frac{32}{2} \times 1.50 \right) \right\} \times 9.8$$

$$= (251.3 + 65.2) \times 9.8$$

$$= 3101.7 \text{ KN/a pile}$$

allowable strength of a front ground

$$Ra = \frac{1}{n} Ru = \frac{1}{3} \times 3101.7 = 1035 \text{ KN/a pile} \fallingdotseq 1000 \text{ KN/a pile}$$

D =	0.5000000	(m)
I =	0.0041800	(m^4)
E =	2.060E+07	(t/m^2)
Kv=	221500.0	(t/m)

	(m)	(t/m^3)
1	8.50	14600.00

	(m)		
1	1.875	8	0.0
2	0.000	4	0.0
3	-1.875	8	0.0

K1 =	19201.4	(t/m)
K2 =	25102.5	(t/rad.)
K3 =	25102.5	(t·m/m)
K4 =	65554.0	(t·m/rad.)

(t)	1000.00	1500.00
(t)	-200.00	-300.00
(t)	200.00	300.00
(mm)	15.00	25.00

V = 12464.100 (t)
H = 2886.800 (t)
M = 990.857 (t·m)

δx = 7.992180 (mm)
δy = 2.813560 (mm)
α = 0.363338 (m.rad)

	X (m)	(t)	(t)	(t·m)
1	1.875	774.10	144.34	-176.81
2	0.000	623.20	144.34	-176.81
3	-1.875	472.30	144.34	-176.81

V = 12464.100 (t)
H = 2772.860 (t)
M = 22.335 (t·m)

δx = 7.584070 (mm)
δy = 2.813560 (mm)
α = 0.278126 (m.rad)

	X (m)	(t)	(t)	(t·m)
1	1.875	738.71	138.64	-172.15
2	0.000	623.20	138.64	-172.15
3	-1.875	507.69	138.64	-172.15

V = 9814.290 (t)
H = 3799.650 (t)
M = 7123.110 (t·m)

δx = 11.099500 (mm)
δy = 2.215420 (mm)
α = 0.921947 (m.rad)

	X (m)	(t)	(t)	(t·m)
1	1.875	873.61	189.98	-218.19
2	0.000	490.72	189.98	-218.19
3	-1.875	107.82	189.98	-218.19

V = 11703.700 (t)
H = 2753.100 (t)
M = 44.934 (t·m)

δx = 7.532300 (mm)
δy = 2.641930 (mm)
α = 0.277880 (m.rad)

	X (m)	(t)	(t)	(t·m)
1	1.875	700.59	137.66	-170.86
2	0.000	585.19	137.66	-170.86
3	-1.875	469.78	137.66	-170.86

V = 11703.700 (t)
H = 2867.040 (t)
M = 1013.460 (t·m)

δx = 7.940410 (mm)
δy = 2.641930 (mm)
α = 0.363092 (m.rad)

	X (m)	(t)	(t)	(t·m)
1	1.875	735.98	143.35	-175.52
2	0.000	585.19	143.35	-175.52
3	-1.875	434.39	143.35	-175.52

V = 9058.940 (t)
H = 3771.500 (t)
M = 7129.400 (t·m)

δx = 11.023200 (mm)
δy = 2.044910 (mm)
α = 0.919620 (m.rad)

	X (m)	(t)	(t)	(t·m)
1	1.875	834.88	188.58	-216.43
2	0.000	452.95	188.58	-216.43
3	-1.875	71.02	188.58	-216.43

Calculation of stability for foundation pile

1) Action force for foundation bottom …U.L.S.

load / State	N^{KN}	H^{KN}	M^{KNm}
Normal	12464.1×1.380 = 17200.5	2772.9 ×1.65 = 4575.3	※ 2721.2
Temperature	17200.5	2886.8 ×1.65 = 4763.3	※ 4319.2
Seismic	9814.3×1.380 = 13543.8	3799.7×1.35×1.1 = 5642.6	※ 11259.4

※1 $M = \left\{ \frac{5.00}{2} - (41100.5 \times 1.380 - 9962.8 \times 1.65)/17200.5 \right\} \times 17200.5$
$= 2721.2^{KNM}$

※2 $M = \left\{ \frac{5.00}{2} - (41100.5 \times 1.380 - 10931.3 \times 1.65)/17200.5 \right\} \times 17200.5$
$= 4319.2^{KNM}$

※3 $M = \left\{ \frac{5.00}{2} - (31024.6 \times 1.380 - 13612.0 \times 1.485)/13543.8 \right\} \times 13543.8$
$= 11259.4^{KNM}$

** NO 2 VEHICLE-ABUT ** ULS

D =	0.500	(m	)
L =	8.500	(m	)
Ho=	0.000	(m	)
I =	0.0004180	(m^4	)
E =	%20.500E+07	(t/m^2)	
Kh=	14600.00	(t/m^3)	
Kv=	221500.00	(t/m	)

β = 0.38202 (m^-1)

β*L = 3.24715 > 3.0

1	1.875	8	0.0
2	0.000	4	0.0
3	-1.875	8	0.0

K1 =	19177.8	(t/m)
K2 =	25042.5	(t/rad.)
K3 =	25042.5	(t·m/m)
K4 =	65318.3	(t·m/rad.)

(t)	1500.00	1500.00
(t)	-300.00	-300.00
(t)	300.00	300.00
(mm)	25.00	25.00

V =	17200.500	(t)
H =	4575.300	(t)
M =	2721.200	(t·m)

δx =	12.794600	(mm)
δy =	3.882730	(mm)
α =	0.663196	(m.rad)

	(m)	(t)	(t)	(t·m)
1	1.875	1135.46	228.77	-277.09
2	0.000	860.03	228.77	-277.09
3	-1.875	584.59	228.77	-277.09

V = 17200.500 (t)
H = 4763.300 (t)
M = 4319.200 (t·m)

δx = 13.468400 (mm)
δy = 3.882730 (mm)
α = 0.803794 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.875	1193.85	238.17	-284.78
2	0.000	860.03	238.17	-284.78
3	-1.875	526.20	238.17	-284.78

V = 13543.800 (t)
H = 5642.600 (t)
M = 11259.400 (t·m)

δx = 16.566400 (mm)
δy = 3.057290 (mm)
α = 1.420680 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.875	1267.21	282.13	-322.07
2	0.000	677.19	282.13	-322.07
3	-1.875	87.17	282.13	-322.07

Calculation of stress for each section

A. Vertical wall

a) State of normal load (earth pressure only)

$$M_1 = \frac{1}{6} \times 19.6 \times 0.251 \times 8.60^3 \times 1.5 \times 1.1 = 860.6 \text{ KNm/m}$$

$$M_2 = \frac{1}{2} \times 34.3 \times 0.251 \times 8.60^2 \times 1.5 \times 1.1 = 525.4 \text{ KNm/m}$$

$$M = \qquad = 1386.0 \text{ KNm/m}$$

$$S_1 = \frac{1}{2} \times 19.6 \times 0.251 \times 8.60^2 \times 1.5 \times 1.1 = 300.2 \text{ KN/m}$$

$$S_2 = 34.3 \times 0.251 \times 8.6 \times 1.5 \times 1.1 = 122.2 \text{ KN/m}$$

$$S = \qquad = 422.4 \text{ KN/m}$$

b) State of temperature and normal load

$$M = 1386.0 + 113.944/11.2 \times 7.60 \times 1.3 \times 1.1 = 1496.6 \text{ KNm/m}$$

$$S = 422.4 + 113.944/11.2 \times 1.3 \times 1.1 = 437.0 \text{ KNm/m}$$

c) State of seismic load

$$M = \left\{ \frac{1}{6} \times 19.6 \times 0.328 \times 8.60^3 + 113.944/11.20 \times 7.60 \right\} \times 1.35 \times 1.1 = 1126.9 \text{ KNm/m}$$

$$S = \left\{ \frac{1}{2} \times 19.6 \times 0.328 \times 8.60^2 + 113.944/11.20 \right\} \times 1.35 \times 1.1 = 368.2 \text{ KNm/m}$$

d) Calculation of stress

this case is abridge from No.① Vehicle-Abutment

$$A_s = Y_{32} - 150^{ctc} = 8.042/0.150 = 53.613 \text{ cm}^2$$

$$P = \frac{53.613}{100 \times 103.0} \times 100 = 0.520 \text{ \%}$$

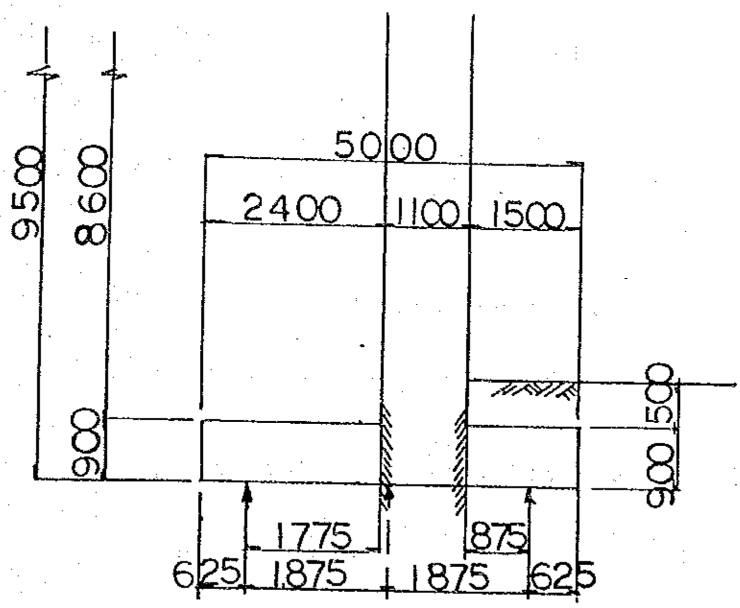
$$\therefore M_{Ra} = 1786.1^{KNm} > M_u = 1496.6^{KNm} \quad \text{OK}$$

$$V_c = \frac{437.0 \times 10^3}{100 \times 103.0} = 42.5 \text{ N/cm}^2 < V_{ca} = 50.6 \text{ N/cm}^2 \quad \text{OK}$$

No.② VEHICLE - ABUT-

Calculation for Footing slab (S.L.S.)

1) Shape and size



2) Surcharge load

a) toe footing slab

$\omega = 23.6 \times 0.90 + 18.6 \times 0.50 \quad = \quad 30.540$ KN/m

b) heel footing slab

$\omega = 23.6 \times 0.90 + 19.6 \times 8.60 \quad = \quad 189.800$ KN/m

3) Calculation of bending moment and shearing force

a) toe footing slab ··· Seismic state

$M = 8 \times 873.6 \times 0.875 / 11.20 - \frac{1.50^2}{2} \times 30.540 \quad = \quad 511.7$ KNm/m

$S = 8 \times 873.6 / 11.20 - 1.50 \times 30.540 \quad = \quad 578.2$ KNm/m

b) heel footing slab ··· Seismic state

$M = \frac{2.40^2}{2} \times 189.800 - 8 \times 107.8 \times 1.775 / 11.20 \quad = \quad 410.0$ KNm/m

$S = 2.40 \times 189.800 - 8 \times 107.8 / 11.20 \quad = \quad 378.5$ KNm/m

Calculation for footing slab (U.L.S.)

1) Surcharge load

a) toe footing slab

$$\omega = (23.6 \times 0.90 + 18.6 \times 0.50) \times 1.2 \times 1.15 = 42.145 \ \mathrm{KN/m}$$

b) heel footing slab

$$\omega = (23.6 \times 0.90 + 19.6 \times 8.60) \times 1.2 \times 1.15 = 261.924 \ \mathrm{KN/m}$$

2) Calculation of bending moment and shearing force

a) toe footing slab … Seismic state

$$M = 8 \times 1267.2 \times 0.875 / 11.20 - \frac{1.50^2}{2} \times 42.145 = 744.6 \ \mathrm{KNm/m}$$

$$S = 8 \times 1267.2 / 11.20 - 1.50 \times 42.145 = 841.9 \ \mathrm{KNm/m}$$

b) heel footing slab … Seismic state

$$M = \frac{2.40^2}{2} \times 261.924 - 8 \times 87.2 \times 1.775 / 11.20 = 643.8 \ \mathrm{KNm/m}$$

$$S = 2.40 \times 261.924 - 8 \times 87.2 / 11.20 = 566.4 \ \mathrm{KNm/m}$$

Calculation of stress for footing slab

1) For toe footing slab (U.L.S.)

section $b = 100^{cm}$ $h = 90$ $d = 75.0$ $d' = 15.0$

$As = Y_{25} - 150^{ctc} = 4.909/0.150 = 32.727\ cm^2$

$$P = \frac{32.727}{100 \times 75.0} \times 100 = 0.436\ \%$$

$$x = \frac{0.87 \times 41000 \times 32.727}{0.40 \times 2500 \times 100} = 11.8^{cm}$$

$$Z = 75.0 - \frac{11.8}{2} = 69.1^{cm} < 0.95 \times 75.0 = 71.2^{cm}$$

$M_{RS} = 0.87 \times 41000 \times 32.727 \times 69.1 \times 10^{-5} = 806.7^{KNm} > Mu = 744.6^{KNm}$

$M_{RC} = 0.40 \times 2500 \times 100 \times 11.8 \times 69.1 \times 10^{-5} = 815.4^{KNm} > Mu = 744.6^{KNm}$ OK

$$Vc = \frac{841.9 \times 10^3}{100 \times 75.0} = 112.3\ N/cm^2$$

$$< Vca = \left\{ 35.0 + 15.0 \left(\frac{0.436 - 0.25}{0.25} \right) \right\} \times 2 = 92.3\ N/cm^2$$

shearing bar

$$A_{sv} = \frac{100(112.3 - 92.3) \times 60.0}{0.87 \times 41000} = 3.4\ cm^2$$

$< Y_{16} -$ Utype $\cdots As = 2.011 \times 2 = 4.022\ cm^2$ OK

2) For heel footing slab (U.L.S.)

section $b = 100^{cm}$ $h = 90$ $d = 82.5$ $d' = 7.5$

$$As = Y_{25} - 150^{ctc} = 32.727\ cm^2$$

$$P = \frac{32.727}{100 \times 82.5} \times 100 = 0.397\ \%$$

$$x = \frac{0.87 \times 41000 \times 32.727}{0.40 \times 2500 \times 100} = 11.8^{cm}$$

$$Z = 82.5 - \frac{11.8}{2} = 76.6^{cm} < 0.95 \times 82.5 = 78.4^{cm} \quad OK$$

$$M_{RS} = 0.87 \times 41000 \times 32.727 \times 76.6 \times 10^{-5} = 894.3^{KNm} > Mu = 643.8^{KNm}$$

$$M_{RC} = 0.40 \times 2500 \times 100 \times 11.8 \times 76.6 \times 10^{-5} = 903.8^{KNm} > Mu = 643.8^{KNm} \quad OK$$

$$Vc = \frac{566.4 \times 10^3}{100 \times 82.5} = 68.7\ N/cm^2$$

$$< Vca = \left\{ 35.0 + 15.0 \left(\frac{0.397 - 0.25}{0.25} \right) \right\} \times 2 = 87.6\ N/cm^2 \quad OK$$

Calculation of foundation pile

1) For S.L.S.

a) state of temperature

factor of pile

$500^{mm} \times 9^{mm} \times 8.500^{m}$

$E = 2.06 \times 10^{8}$ N/cm²

$Ap = 138.8$ cm²

$Z = 1670$ cm³

$$\sigma c = \frac{N}{Ap} + \frac{M}{Zp}$$

$$= \frac{774.1 \times 10^{3}}{138.8 \times 0.80} + \frac{176.8 \times 10^{5}}{1674 \times 0.80}$$

$$= 6971 + 13202 = 20173 \text{ N/cm}^2 < \sigma ca = 24000 \text{ N/cm}^2$$

b) state of seismic

$$\sigma c = \frac{873.6 \times 10^{3}}{138.8 \times 0.80} + \frac{218.2 \times 10^{5}}{1674 \times 0.80}$$

$$= 7868 + 16292 = 24160 \text{ N/cm}^2 \fallingdotseq \sigma ca = 24000 \text{ N/cm}^2$$

2) For U.L.S.

a) state of temperature

$$\sigma c = \frac{1193.9 \times 10^{3}}{138.8 \times 0.80} + \frac{284.8 \times 10^{5}}{1674 \times 0.80}$$

$$= 10752 + 21266 = 32018 \text{ N/cm}^2 < \sigma ca = 36000 \text{ N/cm}^2$$

b) state of seismic

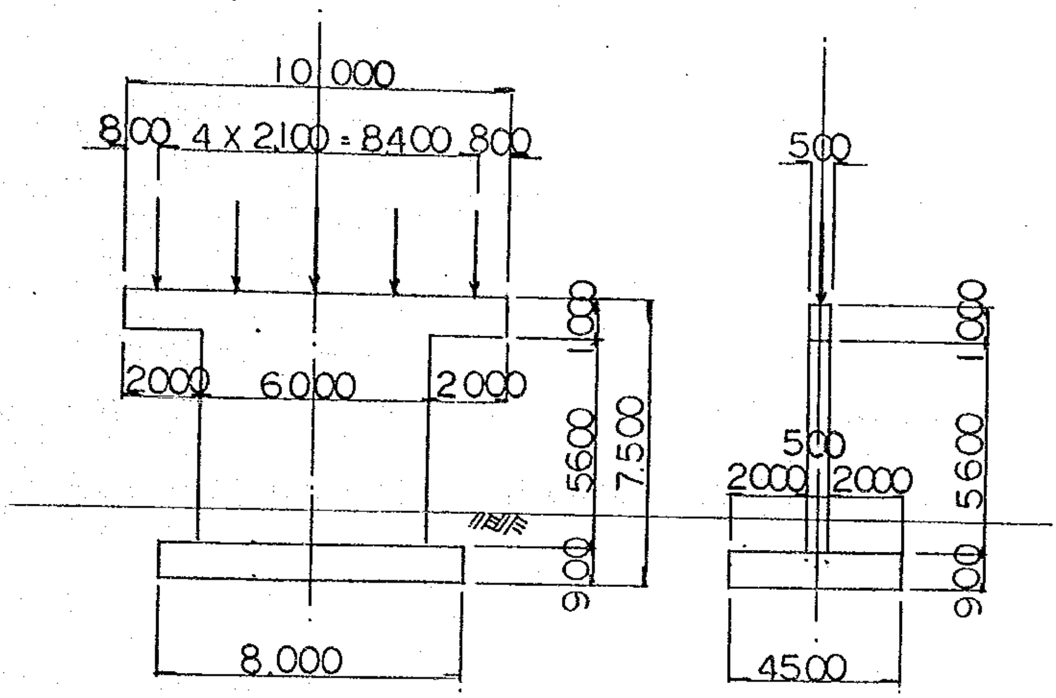
$$\sigma c = \frac{1267.2 \times 10^{3}}{138.8 \times 0.80} + \frac{322.1 \times 10^{5}}{1674 \times 0.80}$$

$$= 11412 + 24052 = 35464 \text{ N/cm}^2 < \sigma ca = 36000 \text{ N/cm}^2$$

No.② VEHICLE －PIER－

Calculation of Beam

1) Shape and size



2) Load from superstructure

Rd =	2439.170 ／5 × 1.1	= 536.6	KN/shoes
Rℓ =	1453.320 ／5 × 1.1	= 319.8	KN/shoes
R =		= 856.4	KN/shoes

3) Calculation of bending moment and shearing force

a) for S.L.S

M = 856.4×1.20 ≒1027.7 KNm

S = 856.4 ≒ 856.4 KNm

b) for U.L.S

M = (536.6×1.38+319.8×1.65) ×1.20 = 1521.8 KNm

S = 536.6×1.38+319.8×1.65 = 1268.2 KNm

4) Calculation of stress

section $b = 50^{cm}$ $h = 100$ $d = 87.5$ $d' = 12.5$

a) for S.L.S.

$As = Y_{32} - 4^{NO} \times 2 = 8.042/8^{NO} = 64.336\ cm^2\ (As' = Y_{25} - 4^{NO} = 19.636\ cm^2)$

$$P = \frac{64.336}{50 \times 87.5} \times 100 = 1.470\ \%$$

$$x = \frac{0.80 \times 41000 \times 64.336}{\frac{1}{2} \times 0.50 \times 2500 \times 50} = 67.5^{cm}$$

$$Z = 87.5 - \frac{67.5}{3} = 65.0^{cm} < 0.95 \times 87.5 = 83.1^{cm}$$

$$M_{RS} = 0.80 \times 41000 \times 64.336 \times 65.0 \times 10^{-5} = 1371.6^{KNm} > Ms = 1027.7^{KNm}$$

$$M_{RC} = \frac{1}{2} \times 0.50 \times 2500 \times 50 \times 67.5 \times 65.0 \times 10^{-5} = 1371.1^{KNm} > Ms = 1027.7^{KNm}$$

b) for U.L.S.

$$x = \frac{(0.87 \times 64.336 \times 0.72 \times 19.636) \times 41000}{0.40 \times 2500 \times 50} = 34.4^{cm}$$

$$Z = 87.5 - \frac{34.4}{2} = 70.3^{cm} < 0.95 \times 87.5 = 83.1^{cm}$$

$$M_{RS} = 0.87 \times 41000 \times 64.336 \times 70.3 \times 10^{-5} = 1613.3^{KNm} > Mu = 1521.8^{KNm}$$

$$M_{RC} = (0.72 \times 41000 \times 19.636 \times 79.5 + 0.40 \times 2500 \times 50 \times 34.4 \times 70.3)$$

$$\times 10^{-5} = 1670.0^{KNm} > Mu = 1521.8^{KNm}\ \text{OK}$$

$$Vc = \frac{1268.2 \times 10^3}{50 \times 87.5} = 289.9\ \ N/cm^2$$

$$< Vca = \left\{ 65.0 + 20.0 \left(\frac{1.470 - 1.00}{1.00} \right) \right\} \frac{2 \times 87.5}{1200} = 108.5\ N/cm^2\ \ \text{OUT}$$

shearing bar … $Y_{16} - 150^{ctc} = 2.011 \times 2 = 4.022\ cm^2$

$$Vs = 0.87 \times 41000 \times 4.022 / 50 \times 15.0 = 191.2\ \ N/cm^2$$

$$\therefore\ Vs + Vca = 191.2 + 108.5 = 299.7\ N/cm^2 > Vc = 289.9\ N/cm^2\ \ \text{OK}$$

No.② VEHICLE - PIER

Calculation of pillar

Action force from output of computer (U.L.S.)

Longitudinal direction for seismic

$N = 2953.65 \times 1.380 = 4076.0^{KN}$

$H = 447.29 \times 1.650 = 738.0^{KN}$

$M = 2835.12 \times 1.650 = 4678.0^{KNm}$

Calculation of stress

section $b = 600^{cm}$ $h = 50$ $d = 42.5$ $d' = 7.5$

$As = A's = Y_{32} - 100^{ctc}(60^{NO}) = 8.042/60^{NO} = 482.520\ cm^2$

$Ma = 4678.0 - 4076.0\,(0.425 - \frac{50}{2}) = 5391.3^{KNm}$

$\chi = \frac{(0.87-0.72) \times 41000 \times 482.520}{0.40 \times 2500 \times 600} = 5.0^{cm}$

$Z = 42.5 - \frac{5.0}{2} = 40.0^{cm} \leqq 0.95 \times 42.5 = 40.4^{cm}$

$M_{RS} = 0.87 \times 41000 \times 482.520 \times 40.0 \times 10^{-5} = 6884.6^{KNm} > Ma = 5391.3^{KNm}$

$M_{RC} = (0.72 \times 41000 \times 482.520 \times 35.0 + 0.40 \times 2500 \times 600 \times 5.0 \times 40.0)$
$\times 10^{-5} = 6185.4^{KNm} > Ma = 5391.3^{KNm}$ OK

$Asn = A'sn = 482.520 - \frac{4076.0 \times 10^3}{0.87 \times 41000} = 368.3\ cm^2$

$< Asu = A'su = Y_{32} - 125^{ctc}(47^{NO}) = 8.042 \times 47 = 378.0^{KNm}$ OK

$P = \frac{378.0}{600 \times 42.5} \times 100 = 1.482\ \%$

$Vc = \frac{738.0 \times 10^3}{600 \times 42.5} = 29.0\ N/cm^2$

$< Vca = 65.0 + 20.0\,(\frac{1.482 - 1.00}{1.00}) = 74.6\ N/cm^2$ OK

INPUT-DATA

(1) SHAPE AND SIZE --(UNIT : m)

(a) BEAM

BWL =	5.000	BL1 =	0.500
BWR =	5.000	BL2 =	0.000
BW1 =	2.000	BL3 =	0.000
BW2 =	2.000	BL4 =	0.000
H2 =	1.000		
H3 =	0.000		
H4 =	0.000		

NOTE: THE DIMENSION(t) BE EXCHANG TO DIMENSION(KN) INTO THIS CALCULATION

(b) PILLAR (RECTANGULAR)

CWU =	6.000	CLU =	0.500
CWL =	6.000	CLL =	0.500
H1 =	5.600		

(c) FOOTING

WF =	8.000	WFL =	4.000
BF =	4.500	BFL =	2.250
FH =	0.900	DH =	0.000

(d) OTHER

WH1 =	0.000	WH2 =	0.000
GH =	1.000		

(2) LOAD-CASE

DIRECTION

a) LONGITUDINAL - NORMAL, BRAKING, SEISMIC,

b) CROSSING - 〃 , SKIDDING, 〃 ,

(3) UNIT VOLUME WEIGHT

CONCRETE γc = 23.600 (t/m^3)

BACKFILL γs = 18.600 (t/m^3)

〃 $\gamma s'$ = 9.800 (t/m^3) --- UNDER WATER

WATER γw = 9.800 (t/m^3)

(4) COEFFICIENT OF SEISMIC

Kh = 0.10 --- STRUCTURE

Khs = 0.00 --- BACK-FILL

WEIGHT OF STRUCTURE AND SURCHARGE OF SOIL

(1) BEAM AND PILLAR FOR BOTTOM OF PILLAR

No.	V (t)	H (t)	X (m)	Y (m)	Mx(t·m)	My(t·m)
1	59.00	5.90	2.500	6.100	147.50	35.99
2	59.00	5.90	-2.500	6.100	-147.50	35.99
3	0.00	0.00	3.667	5.600	0.00	0.00
4	0.00	0.00	-3.667	5.600	0.00	0.00
5	0.00	0.00	1.500	5.600	0.00	0.00
6	0.00	0.00	-1.500	5.600	0.00	0.00
7	0.00	0.00	0.000	0.000	0.00	0.00
8	0.00	0.00	0.000	0.000	0.00	0.00
9	396.48	39.65	0.000	2.800	0.00	111.01
WD	514.48	51.45	—	—	0.00	182.99

(2) FOUNDATION

No.	V (t)	H (t)	X (m)	Y (m)	Mx(t·m)	My(t·m)
1	0.00	0.00	0.917	0.900	0.00	0.00
2	0.00	0.00	-0.917	0.900	0.00	0.00
3	0.00	0.00	0.000	0.900	0.00	0.00
4	764.64	76.46	0.000	0.450	0.00	34.41
WF	764.64	76.46	—	—	0.00	34.41

(3) SURCHARGE OF SOIL

NO.	V (t)	X (m)	Mx(t·m)
1	9.30	0.000	0.00
2	9.30	0.000	0.00
3	297.60	1.250	372.00
4	297.60	-1.250	-372.00
5	0.00	1.583	0.00
6	0.00	-1.583	0.00
7	0.00	0.000	0.00
WS	613.80	—	0.00

REACTION FROM SUPERSTRUCTURE

(1) REACTION FROM SUPERSTRCTURE

(a): LONGITUDINAL DIRECTION
(b): CROSSING DIRECTION

	(a)	(b)	
			REACTION OF VERTICAL
	2439.17	2439.17	DEAD LOAD : Rd
	1453.32	1453.32	LIVE LOAD : RL
	—	0.000	SITUATION
Σ R	3892.49	3892.49	
			HORIZONTAL FORCE
	0.00	250.00	NORMAL STATE OR SKIDDING
	424.00	—	BRAKING STATE
	395.84	243.92	SEISMIC STATE
	0.100	0.900	

ACTION FORCE FOR BOTTOM OF PILLAR (S.r.S)

LONGITHDINAL DIRECTION

(1) NORMAL STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
ΣR	3892.49	0.00	0.000	0.000	0.00	0.00
WD	514.48	0.00	0.000	0.000	0.00	0.00
total (NL)	4406.97	0.00	—	—	0.00	0.00

: Mo = ΣMx + ΣMy = 0.00 (t·m)

(2) BRAKING STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
ΣR	3892.49	424.00	0.000	6.700	0.00	2840.80
WD	514.48	0.00	0.000	0.000	0.00	0.00
total(Br)	4406.97	424.00	—	—	0.00	2840.80

: Mo = ΣMx + ΣMy = 2840.80 (t·m)

(3) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
Rd	2439.17	395.84	0.000	6.700	0.00	2652.13
WD	514.48	51.45	0.000	3.557	0.00	182.99
total(SL)	2953.65	447.29	—	—	0.00	2835.12

: Mo = ΣMx + ΣMy = 2835.12 (t·m)

CROSSING DIRECTION

(1) SKIDDING STEATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
ΣR	3892.49	250.00	0.000	7.500	0.00	1875.00
WD	514.48	0.00	0.000	0.000	0.00	0.00
total(Kc)	4406.97	250.00	—	—	0.00	1875.00

: Mo = ΣMx + ΣMy = 1875.00 (t·m)

(2) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
Rd	2439.17	243.92	0.000	7.500	0.00	1829.40
WD	514.48	51.45	0.000	3.557	0.00	182.99
total(Sc)	2953.65	295.37	—	—	0.00	2012.39

: Mo = ΣMx + ΣMy = 2012.39 (t·m)

ACTION FORCE FOR BOTTOM OF FOUNDATION

BUOYANCY

	NOMAL	SEISMIC
PILLAR	0.00	0.00
FOOTING	-32.40	-317.52
SLAB	0.00	0.00
Wu	-32.40	-317.52

LONGITUDINAL DIRECTION

(1) NORMAL STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
total(NL)	4406.97	0.00	—	—	0.00	0.00
	—	—	—	—	0.00	0.00
WF	764.64	0.00	0.000	0.000	0.00	0.00
WE	613.80	0.00	0.000	0.000	0.00	0.00
WU	-32.40	—	—	—	—	—
TOTAL						
A	5785.41	0.00	—	—	0.00	0.00
B	5753.01	0.00	—	—	0.00	0.00

: Mo = ΣMx + ΣMy = 0.00 (t·m)

(2) BLAKING STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
total(BL)	4406.97	424.00	—	—	0.00	2840.80
	—	—	—	—	0.00	381.60
WF	764.64	0.00	0.000	0.000	0.00	0.00
WE	613.80	0.00	0.000	0.000	0.00	0.00
WU	-32.40	—	—	—	—	—
TOTAL						
A	5785.41	424.00	—	—	0.00	3222.40
B	5753.01	424.00	—	—	0.00	3222.40

: Mo = ΣMx + ΣMy = 3222.40 (t·m)

(3) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
total(Sr)	2953.65	447.29	—	—	0.00	2835.12
	—	—	—	—	0.00	402.56
WF	764.64	76.46	0.000	0.450	0.00	34.41
WE	613.80	0.00	0.000	0.000	0.00	0.00
WU	-317.52	—	—	—	—	—
TOTAL						
A	4332.09	523.75	—	—	0.00	3272.09
B	4014.57	523.75	—	—	0.00	3272.09

: Mo = ΣMx + ΣMy = 3272.09 (t·m)

Mvo = Vo*BFD , Mho = Ho*FH

CROSSING DIRECTION

(1) NORMAL STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
total(kc)	4406.97	250.00	—	—	0.00	1875.00
MHO	—	—	—	—	0.00	225.00
WF	764.64	0.00	0.000	0.000	0.00	0.00
WE	613.80	0.00	0.000	0.000	0.00	0.00
WU	-32.40	—	—	—	—	—
TOTAL						
A	5785.41	250.00	—	—	0.00	2100.00
B	5753.01	250.00	—	—	0.00	2100.00

(2) SEISMIC STATE

	V (t)	H (t)	X (m)	Y (m)	Mx (t·m)	My (t·m)
total(Sc)	2953.65	295.37	—	—	0.00	2012.39
WHO	—	—	—	—	0.00	265.83
WF	764.64	76.46	0.000	0.450	0.00	34.41
WE	613.80	0.00	0.000	0.000	0.00	0.00
WU	-317.52	—	—	—	—	—
TOTAL						
A	4332.09	371.83	—	—	0.00	2312.63
B	4014.57	371.83	—	—	0.00	2312.63

NOTICE : Mho = Ho*FH

NOTE : TOTAL : A··· EXCLUDE OF BUOYANCY

TOTAL : B··· INCLUDE OF BUOYANCY

CALCULATION OF STABILITY FOR PILE OF FOUNDATION···SLS

INPUT DATA OF PILE

CONDITION OF PILE : FIXED OF PILE HEAD

CONDITION OF PILE : HINGE OF PILE FRONT

DIAMETER OF PILE D = 0.5000000 (m)

FACTOR OF PILE
- I = 0.0004180 (m^4)
- E = 20.50000*10^7 (t/m^2)
- Kv = 221500.0 (t/m)

CONDITION OF GROUND

NUMBER OF LAYER	DEPTH (m)	SPRINGFACTOR OF HRIZONTAL (t/m^3)
1	8.50	14600.00

ARRANGEMENT

LONGITUDINAL DIRECTION

NUMBER OF LINE	DISTANCE	NUMBER	ANGLE
1	1.600	4	0.0
2	-1.600	4	0.0

CROSSING DIRECTION

NUMBER OF LINE	DISTANCE	NUMBER	ANGLE
1	3.300	2	0.0
2	1.100	2	0.0
3	-1.100	2	0.0
4	-3.300	2	0.0

SPRING FACTOR OF CROSSING DIRECTION

FIXED OF PILE HEAD

K1 =	18733.9	(t/m)
K2 =	24647.3	(t/rad.)
K3 =	24647.3	(t.m/m)
K4 =	64789.0	(t·m/rad.)

ALLOWABLE VALUE

		S.L.S	U.L.S
VERTICAL FORCE=PUSH	(t)	1000.00	1500.00
=PULL	(t)	-200.00	-300.00
HORIZONTAL FORCE	(t)	200.00	300.00
DEFLECTION	(mm)	15.00	25.00

RESULT OF CALCULATION

LONGITUDINAL DIRECTION

(1) NORMAL STATE

ACTION LOAD

VERTICAL FORCE V = 5785.410 (t)

HORIZONTAL FORCE H = 0.000 (t)

MOMENT M = 0.000 (t·m)

FIXED OF PILEHEAD

DEFLECTION

HORIZONTAL δx = 0.000000 (mm)

VERTICAL δy = 3.264900 (mm)

ROTATION ANGLE α = 0.000000 (m.rad)

REACTION FOR PILES

LINE	DISTANCE (m)	VERTICAL (t)	HORIZONTAL (t)	MOMENT (t·m)
1	1.600	723.18	0.00	0.00
2	-1.600	723.18	0.00	0.00

(2) BRAKING STATE

V = 5785.410 (t)

H = 424.000 (t)

M = 3222.400 (t·m)

δx = 3.866280 (mm)

δy = 3.264900 (mm)

α = 0.788336 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	1002.56	53.00	-44.22
2	-1.600	443.79	53.00	-44.22

(3) SEISMIC STATE

V = 4332.090 (t)

H = 523.752 (t)

M = 3272.090 (t·m)

δx = 4.581510 (mm)

δy = 2.444750 (mm)

α = 0.826067 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	834.27	65.47	-59.40
2	-1.600	248.75	65.47	-59.40

LONGITUDINAL DIRECTION···INCLUDE OF BUOYANCY

(1) NOMAL STATE

V = 5753.010 (t)
H = 0.000 (t)
M = 0.000 (t·m)

δx ≐ 0.000000 (mm)
δy = 3.246620 (mm)
α = 0.000000 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	719.13	0.00	0.00
2	-1.600	719.13	0.00	0.00

(2)BRAKING STATE

V = 5753.010 (t)
H = 424.000 (t)
M = 3222.400 (t·m)

δx = 3.866280 (mm)
δy = 3.246620 (mm)
α = 0.788336 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	998.51	53.00	-44.22
2	-1.600	439.74	53.00	-44.22

(3) SEISMIC STATE

V = 4014.570 (t)
H = 523.752 (t)
M = 3272.090 (t·m)

δx = 4.581510 (mm)
δy = 2.265560 (mm)
α = 0.826067 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	794.58	65.47	-59.40
2	-1.600	209.06	65.47	-59.40

CROSSING DIRECTION

(1) SKIDDING STATE

V = 5785.410 (t)
H = 250.000 (t)
M = 2100.000 (t·m)

δx = 1.959160 (mm)
δy = 3.264900 (mm)
α = 0.221223 (m.rad)

	(m)	(t)	(t)	(t·m)
1	3.300	884.88	31.25	-33.96
2	1.100	777.08	31.25	-33.96
3	-1.100	669.28	31.25	-33.96
4	-3.300	561.47	31.25	-33.96

(2) SEISMIC STATE

V = 4332.090 (t)
H = 371.832 (t)
M = 2312.630 (t·m)

δx = 2.816760 (mm)
δy = 2.444750 (mm)
α = 0.255188 (m.rad)

	(m)	(t)	(t)	(t·m)
1	3.300	728.04	46.48	-52.89
2	1.100	603.69	46.48	-52.89
3	-1.100	479.34	46.48	-52.89
4	-3.300	354.98	46.48	-52.89

CROSSING DIPECTION···INCLUDE OF BUOYANCY

(1) SKIDDING STATE

V = 5753.010 (t)
H = 250.000 (t)
M = 2100.000 (t·m)

δx = 1.959160 (mm)
δy = 3.246620 (mm)
α = 0.221223 (m.rad)

	(m)	(t)	(t)	(t·m)
1	3.300	880.83	31.25	-33.96
2	1.100	773.03	31.25	-33.96
3	-1.100	665.23	31.25	-33.96
4	-3.300	557.42	31.25	-33.96

(2) SEISMIC STATE

V = 4014.570 (t)
H = 371.832 (t)
M = 2312.630 (t·m)

δx = 2.816760 (mm)
δy = 2.265560 (mm)
α = 0.255188 (m.rad)

	(m)	(t)	(t)	(t·m)
1	3.300	688.35	46.48	-52.89
2	1.100	564.00	46.48	-52.89
3	-1.100	439.65	46.48	-52.89
4	-3.300	315.29	46.48	-52.89

CALCULATION OF STABILITY FOR PILE OF FOUNDATION··· U.L.S

D =	0.500	(m)
L =	8.500	(m)
Ho=	0.000	(m)
I =	0.0004180	(m^4)
E =	20.500E+07	(t/m^2)
Kh=	14600.00	(t/m^3)
Kv=	221500.00	(t/m)

β = 0.37904 (m^-1)
β*L = 3.22183 > 3.0

1	1.600	4	0.0
2	-1.600	4	0.0

1	3.300	2	0.0
2	1.100	2	0.0
3	-1.100	2	0.0
4	-3.300	2	0.0

K1 =	18733.9	(t/m)
K2 =	24647.3	(t/rad.)
K3 =	24647.3	(t·m/m)
K4 =	64789.0	(t·m/rad.)

(t)	1500.00	1500.00
(t)	-300.00	-300.00
(t)	300.00	300.00
(mm)	25.00	25.00

No.① VEHICLE －PIER－

Calculation of stability for foundation pile

1) Action force for foundation bottom …U.L.S.

(1) Longitudinal direction

load / State	N^{KN}	H^{KN}	M^{KNm}
Normal	5785.4 ×1.380 = 7983.9	－	－
Braking	7983.9	424.0×1.375 = 583.0	3222.4 ×1.375 = 4430.8
Seismic	4332.1×1.380 = 5978.3	523.8×1.65 = 863.8	3272.1 ×1.65 = 5399.0

(1) Crossing direction

load / State	N^{KN}	H^{KN}	M^{KNm}
Skidding	7983.9	250.0×1.375 = 343.8	2100.0 ×1.375 = 2887.5
Seismic	5978.3	371.9×1.65 = 613.7	2312.7 ×1.65 = 3816.0

LONGITUDINAL DIRECTION · · INCLUDE OF BUOYANCY

(1) NORMAL STATE

V =	7978.300	(t)
H =	0.000	(t)
M =	0.000	(t·m)

δx =	0.000000	(mm)
δy =	4.502430	(mm)
α =	0.000000	(m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	997.29	0.00	0.00
2	-1.600	997.29	0.00	0.00

(2) BRAKING STATE

V =	7983.900	(t)
H =	583.000	(t)
M =	4430.800	(t·m)

δx =	5.316140	(mm)
δy =	4.505590	(mm)
α =	1.083960	(m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	1382.14	72.88	-60.80
2	-1.600	613.83	72.88	-60.80

(3) SEISMIC STATE

V =	5978.300	(t)
H =	863.800	(t)
M =	5399.000	(t·m)

δx =	7.556760	(mm)
δy =	3.373760	(mm)
α =	1.362910	(m.rad)

	(m)	(t)	(t)	(t·m)
1	1.600	1230.30	107.98	-97.95
2	-1.600	264.27	107.98	-97.95

CROSSING DIRECTION···INCLUDE OF BUOYANCY

(1) SKIDDING STATE

V =	7983.900	(t)
H =	343.800	(t)
M =	2887.500	(t·m)

δx =	2.694180	(mm)
δy =	4.505590	(mm)
α =	0.304187	(m.rad)

	(m)	(t)	(t)	(t·m)
1	3.300	1220.33	42.98	-46.70
2	1.100	1072.10	42.98	-46.70
3	-1.100	923.87	42.98	-46.70
4	-3.300	775.64	42.98	-46.70

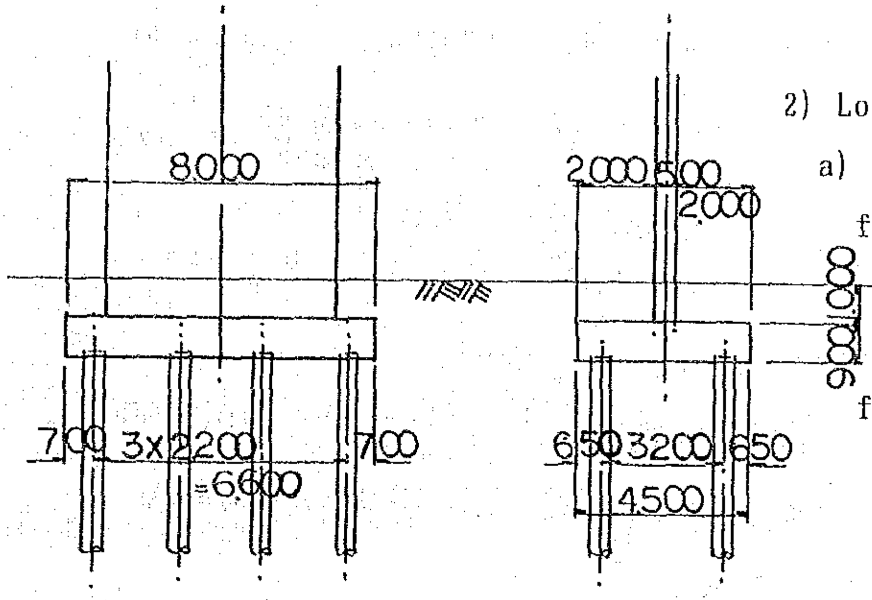
(2) SEISMIC STATE

V =	5978.300	(t)
H =	613.700	(t)
M =	3816.000	(t·m)

δx =	4.648880	(mm)
δy =	3.373760	(mm)
α =	0.421096	(m.rad)

	(m)	(t)	(t)	(t·m)
1	3.300	1055.09	76.71	-87.30
2	1.100	849.89	76.71	-87.30
3	-1.100	644.69	76.71	-87.30
4	-3.300	439.49	76.71	-87.30

Calculation of stress for footing of foundation



2) Load for Longitudinal direction

a) Surcharge

for S.L.S

$\omega = (23.6 \times 0.90 + 18.6 \times 1.00) \times 8.00 = 318.720$ KN/m

for U.L.S

$\omega = 318.720 \times 1.380 = 439.834$ KN/m

3) Calculation of bending moment and shearing force

a) Braking state (S.L.S)

$$M = 4 \times 1002.6 \times 1.35 - \frac{2.00^2}{2} \times 318.720 = 4776.6 \text{ KNm}$$

$$S = 4 \times 1002.6 - 2.00 \times 318.720 = 3373.0 \text{ KN}$$

b) Braking state (U.L.S)

$$M = 4 \times 1382.2 \times 1.35 - \frac{2.00^2}{2} \times 439.834 = 6584.3 \text{ KNm}$$

$$S = 4 \times 1382.2 - 2.00 \times 439.834 = 4649.2 \text{ KN}$$

4) Calculation of stress

a) for U.L.S.

section $b = 800^{cm}$ $h = 90$ $d = 75.0$ $d' = 15.0$

$$As = Y_{25} - 125^{ctc} (63^{NO}) = 4.909 \times 63^{NO} = 309.267 \text{ cm}^2$$

$$P = \frac{309.267}{800 \times 75} \times 100 = 0.515 \%$$

$$x = \frac{0.87 \times 41000 \times 309.267}{0.40 \times 2500 \times 800} = 13.8^{cm}$$

$$Z = 75.0 - \frac{13.8}{2} = 68.1^{cm} < 0.95 \times 75.0 = 71.2^{cm} \quad \text{OK}$$

$M_{RS} = 0.87 \times 41000 \times 309.267 \times 68.1 \times 10^{-5} = 7512.5^{KNm} > Mu = 6584.3^{KNm}$

$M_{RC} = 0.40 \times 2500 \times 800 \times 13.8 \times 68.1 \times 10^{-5} = 7518.2^{KNm} > Mu = 6584.3^{KNm}$

OK

$$Vc = \frac{4649.2 \times 10^3}{800 \times 75.0} = 77.5 \quad N/cm^2$$

$$< Vca = \left\{ 50.0 + 15.0 \left(\frac{0.515 - 0.50}{0.50} \right) \right\} \frac{2 \times 75.0}{135.0} = 56.0 \; N/cm^2 \quad \text{OUT}$$

Shearing bar ... Y16 - 28 no × 500 ctc = 2.011 × 28 = 56.3 cm^2

$Vs = 0.87 \times 41000 \times 56.3 / 800 \times 50.0 = 50.2 \; N/cm^2$

$\therefore \; Vs + Vca = 50.2 + 56.0 = 106.2 \; N/cm^2 > Vc = 77.5 \; N/cm^2$ OK

b) for S.L.S.

$$x = \frac{0.80 \times 41000 \times 309.267}{\frac{1}{2} \times 0.50 \times 2500 \times 800} = 20.4^{cm}$$

$$Z = 75.0 - \frac{20.4}{3} = 68.2^{cm} < 0.95 \times 75.0 = 71.2^{cm}$$

$M_{RS} = 0.80 \times 41000 \times 309.267 \times 68.2 \times 10^{-5} = 6918.2^{KNm} > Ms = 4776.6^{KNm}$

$M_{RC} = \frac{1}{2} \times 0.50 \times 2500 \times 800 \times 20.4 \times 68.2 \times 10^{-5} = 6956.4^{KNm}$

$> Ms = 4776.6^{KNm}$ OK

No.② VEHICLE －PIER－

Calculation of piles of foundation (U.L.S)

a) factor of pile

$\phi 500 \times 9 \times 8.500^{m}$ … SPP

$$Ap = \frac{\pi}{4}(50.0^2 - 48.2^2) = 138.8\ cm^2$$

$$Ip = \frac{\pi}{64}(50.0^4 - 48.2^4) = 41850\ cm^2$$

$$Zp = \frac{Ip}{D/2} = \frac{41850}{50.0} \times 2 = 1674\ cm^2$$

b) for Braking state

$$\sigma c = \frac{N}{Ap} + \frac{M}{Zp} = \frac{1382.2 \times 10^3}{138.8 \times 0.80} + \frac{60.8 \times 10^5}{1674 \times 0.80}$$

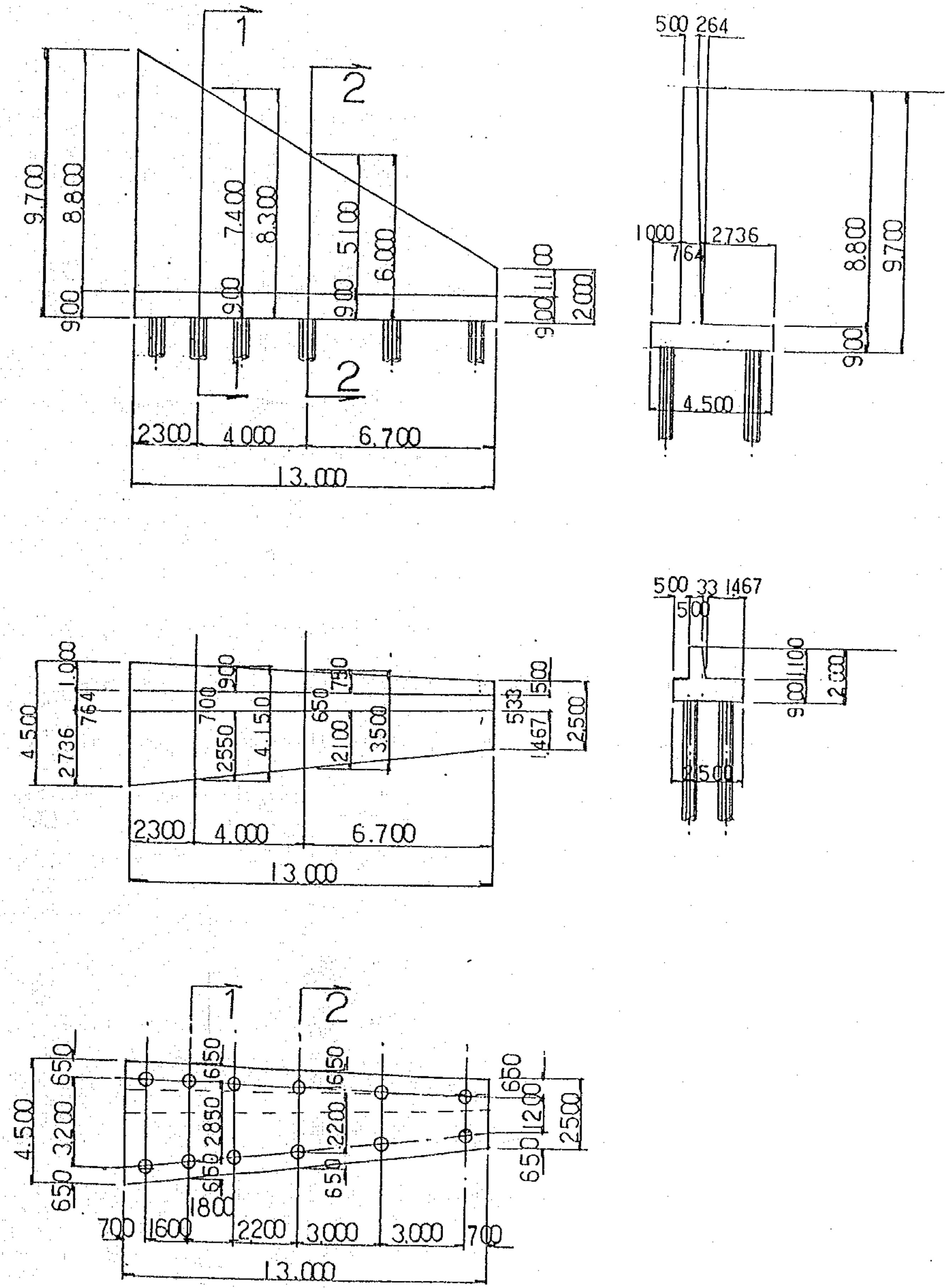
$$= 12448 + 4540 \fallingdotseq 16700\ N/cm^2 < \sigma ca = 29500\ N/cm^2$$

c) for Seismic state

$$\sigma c = \frac{N}{Ap} + \frac{M}{Zp} = \frac{1230.3 \times 10^3}{138.8 \times 0.80} + \frac{98.0 \times 10^5}{1674 \times 0.80}$$

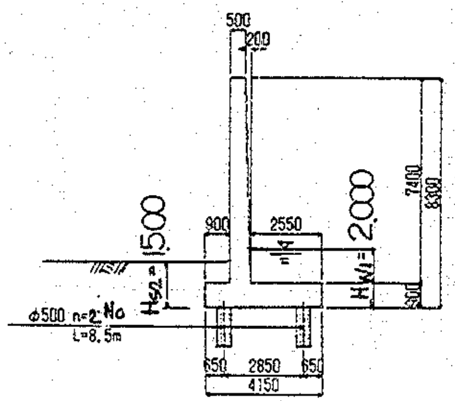
$$= 11080 + 7318 = 18400\ N/cm^2 < \sigma ca = 29500\ N/cm^2$$

RETAINING WALL OF NO② VEHICLE BRIDGE



CALCULATION OF RETAINING WALL FOR NO-2 VEHICLE BRIDGE

(2)



GAMC =	23.600	(t/m^3)
GAM1 =	19.600	(t/m^3)
GAM1S =	10.780	(t/m^3)
FAi =	30.000	(°)
GAM2 =	18.600	(t/m^3)
GAM2S =	9.780	(t/m^3)
WATS =	9.800	(t/m^3)

β = 0.000 (°)

HS2 = 1.500 (m)

HW1 = 2.000 (m)

NOTE: THE DIMENSION(t) BE EXCHANG TO DIMENSION(KN) INTO THIS CALCULATION

ϕ : 30.000 (°)

δ :

= 0.000 (°)

β : 0.000 (°)

θ : 0.000 (°)

$$Ka = \frac{\cos^2(\phi-\theta)}{\cos^2\theta*\cos(\theta+\delta)*\left[1+\sqrt{\frac{(\sin(\phi+\delta)*\sin(\phi-\beta))}{(\cos(\theta+\delta)*\cos(\theta-\beta))}}\right]^2}$$

= 0.333

Ka : 0.333

δ : 0.000 (°)

θ : 0.000 (°)

H : 8.300 (m)

γo : 19.600 (t/m^3)

C : 0.000 (t/m^2)

Q : 0.000 (t/m^2)

$p = Ka*\gamma o*H - 2*C*\sqrt{Ka} + Ka*Q$

p1 = 0.000 (t/m^2)

p2 = 54.227 (t/m^2)

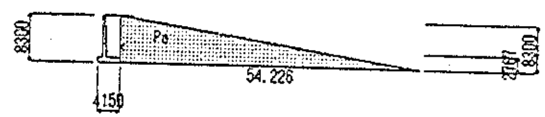
P = (p1+p2) * H / 2 = 225.041 (t/m)

Ph = 225.041 (t/m)

Pv = 0.000 (t/m)

y = 2.767 (m)

x = 0.000 (m)



Ka :	0.333
δ :	0.000 (°)
θ :	0.000 (°)
H :	8.300 (m)
Hw :	2.000 (m)
h1 :	6.300 (m)
γo :	
γ	19.600 (t/m^3)
γw	10.780 (t/m^3)
C :	0.000 (t/m^2)
Q :	0.000 (t/m^2)

$p = Ka*\gamma o*H - 2*C*\sqrt{Ka} + Ka*Q$

p1 = 0.000 (t/m^2)

p2 = 41.160 (t/m^2)

p3 = 48.347 (t/m^2)

P1 = (p1+p2) * h1 / 2 = 129.654 (t/m)

P2 = (p2+p3) * Hw / 2 = 89.507 (t/m)

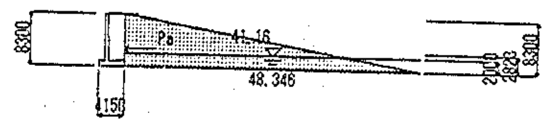
P = P1 + P2 = 219.161 (t/m)

Ph = 219.161 (t/m)

Pv = 0.000 (t/m)

y = 2.823 (m)

x = 0.000 (m)



(1)

NO.	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
1	88.146	0.000	2.075	0.450	182.903	0.000
6	87.320	0.000	1.150	4.600	100.418	0.000
7	17.464	0.000	1.467	3.367	25.614	0.000
	192.930	0.000			308.935	0.000

V = Xi*Yi*GAMC　　H = V*KH1
Mx = V*x　　My = H*y

(2)

NO.	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
2	14.504	0.000	1.533	5.833	22.240	0.000
3	369.852	0.000	2.875	4.600	1063.320	0.000
	384.356	0.000			1085.560	0.000

V = Xi*Yi*GAM1　　H = V*KH1
Mx = V*x　　My = H*y

(3)

NO.	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
2	10.044	0.000	0.450	0.000	4.520	0.000
	10.044	0.000			4.520	0.000

V = Xi*Yi*GAM2　　H = V*KH2
Mx = V*x　　My = H*y

(4)

	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
	0.000	225.041	4.150	2.767	0.000	622.613
	0.000	219.161	4.150	2.823	0.000	618.693

(5)

	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
	-43.989		1.935		-85.129	
	-27.649		2.868		-79.286	
	-5.292		0.450		-2.381	
	-76.930		2.168		-166.796	

1.

(1)

	V(t)	H(t)	Mx(t·m)	My(t·m)
	192.930 384.356 10.044 0.000	 225.041	308.935 1085.560 4.520 0.000	 622.613
	587.330	225.041	1399.020	622.613

Mo = ΣMx - ΣMy = 776.406 (t·m)

	V(t)	H(t)	e(m)	Mc(t·m)
	587.330	225.041	0.753	442.304
	510.400	219.161	0.873	445.550

e = B0/2 - Mo/V : Mc = V * e

B0 :
e :

1 :
3 :

1.70 (m)

	V(t)	H(t)	e(m)	Mc(t·m)
	998.461	382.569	0.753	751.916
	867.680	372.573	0.873	757.435

2.

(1)

	V(t)	H(t)	Mx(t·m)	My(t·m)
	192.930 384.356 10.044 0.000 -76.930	 219.161 	308.935 1085.560 4.520 0.000 -166.796	 618.693
	510.400	219.161	1232.220	618.693

Mo = ΣMx - ΣMy = 613.530 (t·m)

SKK ϕ 500mm × 8500m × 9mm

$A = 138.8 \times 0.90 = 125\ cm^2$

$I = 41800 \times 0.90 = 37600\ cm^4$

$Z = 1670 \times 0.90 = 1500\ cm^3$

$E = 2.1 \times 10^6\ N/cm^2 = 20.58 \times 10^6\ N/cm^2 = 2.058 \times 10^8\ KN/cm^2$

$KH = \alpha E_o D^{-\frac{3}{4}} = 0.8 \times (7 \times 5) \times 500^{-\frac{3}{4}} = 1.489\ Kg/cm^3 = 14.6\ KN/cm^3 = 14600\ KN/m^3$

$KV = \alpha \dfrac{A_P E_P}{L}$ where $\alpha = 0.027 \dfrac{L}{D} + 0.200 = 0.659$

$= 0.659 \times \dfrac{138.8 \times 10^{-4} \times 2.058 \times 10^8}{8.50} = 22.146 \times 10^4\ KN/m = 221500\ KN/m$

$\beta = \sqrt[4]{\dfrac{KHD}{4EI}} = \sqrt[4]{\dfrac{14600 \times 0.500}{4 \times 2.058 \times 10^8 \times 4.18 \times 10^{-4}}} = 0.382\ m^{-1}$

D =	0.5000000	(m)
I =	0.0041800	(m^4)
E =	2.100E+07	(t/m^2)
Kv=	221500.0	(t/m)

	(m)	(t/m^3)
1	8.50	14600.00

	(m)		
1	1.425	1	0.0
2	-1.425	1	0.0

K1 =	19294.6	(t/m)
K2 =	25341.2	(t/rad.)
K3 =	25341.2	(t·m/m)
K4 =	66493.8	(t·m/rad.)

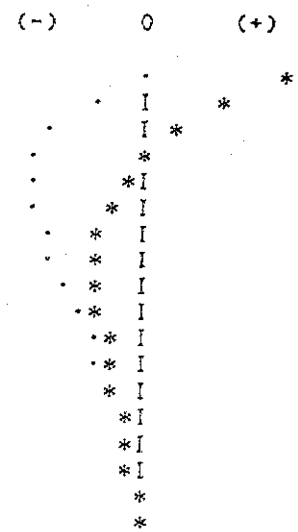
(t)	1000.00	0.00
(t)	0.00	0.00
(t)	200.00	0.00
(mm)	15.00	0.00

V =	998.461	(t)
H =	382.569	(t)
M =	751.916	(t·m)

δx	=	11.619400	(mm)
δy	=	2.253860	(mm)
α	=	1.298540	(m.rad)

	(m)	(t)	(t)	(t·m)
1	1.425	909.10	191.29	-208.10
2	-1.425	89.36	191.29	-208.10

(m)	(t·m)	(t)		(t·m)	(t)
0.00	208.10	191.29	:	0.00	191.29
0.50	122.83	150.38	:	-78.68	125.70
1.00	57.05	113.48	:	-127.92	73.43
1.50	8.52	81.53	:	-154.15	33.40
2.00	-25.36	54.85	:	-163.11	4.14
2.50	-47.20	33.37	:	-159.81	-16.00
3.00	-59.53	16.71	:	-148.36	-28.68
3.50	-64.63	4.32	:	-132.10	-35.53
4.00	-64.46	-4.46	:	-113.56	-37.98
4.50	-60.66	-10.29	:	-94.63	-37.33
5.00	-54.54	-13.83	:	-76.57	-34.65
5.50	-47.11	-15.67	:	-60.17	-30.83
6.00	-39.07	-16.33	:	-45.82	-26.58
6.50	-30.90	-16.28	:	-33.57	-22.45
7.00	-22.85	-15.87	:	-23.27	-18.86
7.50	-15.04	-15.38	:	-14.57	-16.11
8.00	-7.46	-15.00	:	-6.99	-14.38
8.50	0.00	-14.87	:	0.00	-13.79



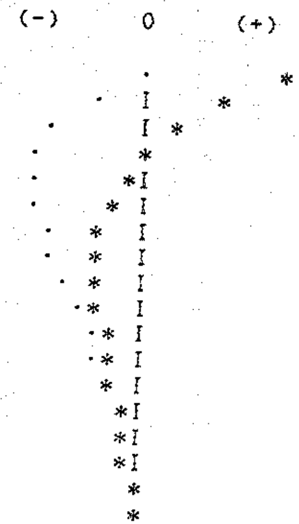
Mmax = 208.10 t·m : Mmax = -162.41 t·m
lm = 0.00 m : lm = 2.07 m

V =	867.680	(t)	
H =	372.573	(t)	
M =	757.435	(t·m)	

δx =	11.350000	(mm)	
δy =	1.958650	(mm)	
α =	1.290660	(m.rad)	

	(m)	(t)	(t)	(t·m)
1	1.425	841.22	186.29	-201.80
2	-1.425	26.46	186.29	-201.80

(m)	(t·m)	(t)	:	(t·m)	(t)
0.00	201.80	186.29	:	0.00	186.29
0.50	118.78	146.35	:	-76.62	122.42
1.00	54.79	110.35	:	-124.58	71.51
1.50	7.62	79.20	:	-150.12	32.52
2.00	-25.27	53.21	:	-158.85	4.03
2.50	-46.44	32.30	:	-155.63	-15.58
3.00	-58.35	16.09	:	-144.48	-27.93
3.50	-63.22	4.04	:	-128.64	-34.60
4.00	-62.98	-4.48	:	-110.60	-36.99
4.50	-59.21	-10.14	:	-92.16	-36.35
5.00	-53.21	-13.55	:	-74.57	-33.74
5.50	-45.93	-15.32	:	-58.60	-30.02
6.00	-38.08	-15.95	:	-44.62	-25.88
6.50	-30.10	-15.88	:	-32.70	-21.87
7.00	-22.26	-15.47	:	-22.67	-18.37
7.50	-14.65	-14.98	:	-14.19	-15.69
8.00	-7.26	-14.61	:	-6.81	-14.00
8.50	0.00	-14.47	:	0.00	-13.43



Mmax = 201.80 t·m : Mmax = -158.16 t·m
lm = 0.00 m : lm = 2.07 m

calculation of reaction for foundation pile (U, L, S)

section (1)

load	V(KN)	H(KN)	MX(KNm)	MY(KNm)
concrete of stucture, surcherge of heel slab and toe slab	587.330×1.7 ×1.2×1.15	—	1399.02×1.7 ×1.2×1.15	—
earth pressure	—	225.041×1.7 ×1.5×1.10	—	622.613×1.7 ×1.5×1.10
total	1377.9	660.0	3282.1	1825.8

$$e = \frac{4.150}{2} - \frac{3282.1 - 1825.8}{1377.9} = 1.018 \text{ m}$$

$$Me = 1377.9 \times 1.018 = 1402.7 \text{ KNm}$$

D =	0.500	(m	)
L =	8.500	(m	)
Ho=	0.000	(m	)
I =	0.0041800	(m^4	)
E =	2.060E+07	(t/m^2)	
Kh=	14600.00	(t/m^3)	
Kv=	221500.00	(t/m	)

β = 0.38155 (m^-1)

β*L = 3.24320 > 3.0

1	1.425	1	0.0
2	-1.425	1	0.0

K1 =	19201.4	(t/m)
K2 =	25102.5	(t/rad.)
K3 =	25102.5	(t·m/m)
K4 =	65554.0	(t·m/rad.)

(t)	1500.00	1500.00
(t)	100.00	100.00
(t)	500.00	500.00
(mm)	25.00	25.00

V = 1377.900 (t)
H = 660.000 (t)
M = 1402.700 (t·m)

δx = 20.255394 (mm)
δy = 3.110384 (mm)
α = 2.347610 (m.rad)

1	1.425	1429.94	330.00	-354.57
2	-1.425	-52.04	330.00	-354.57

(m)	(t·m)	(t)		(t·m)	(t)	(-) 0 (+)
0.00	354.57	330.00	:	0.00	330.00	. . *
0.50	207.62	258.77	:	-135.59	216.34	. I *
1.00	94.61	194.65	:	-220.21	125.87	. I *
1.50	11.51	139.25	:	-265.02	56.70	. *
2.00	-46.20	93.14	:	-280.04	6.26	. *I
2.50	-83.14	56.12	:	-273.93	-28.33	. * I
3.00	-103.72	27.51	:	-253.86	-50.02	. * I
3.50	-111.89	6.32	:	-225.59	-61.60	. * I
4.00	-111.09	-8.58	:	-193.51	-65.61	. * I
4.50	-104.16	-18.39	:	-160.86	-64.27	.* I
5.00	-93.36	-24.24	:	-129.82	-59.46	.* I
5.50	-80.40	-27.18	:	-101.72	-52.72	.* I
6.00	-66.51	-28.13	:	-77.21	-45.27	* I
6.50	-52.47	-27.87	:	-56.40	-38.07	*I
7.00	-38.74	-27.03	:	-38.98	-31.81	*I
7.50	-25.46	-26.09	:	-24.34	-27.02	*I
8.00	-12.61	-25.39	:	-11.67	-24.01	*
8.50	0.00	-25.13	:	0.00	-22.99	*

calculation of foundationpile for section (1)

factor of pile : ϕ 500mm × 9mm × 8500m

$E = 2058 \times 10^{7}$ N／cm^2

$Ap = 138.8\ cm^2$

$Z = 1670\ cm^3$

Stress for

bending moment and axis force Mmax = 208.10 KNm Nmax = 909.10 KN

$$S.L.S\quad \sigma = \frac{Nmax}{Ap} + \frac{Mmax}{z}$$

$$= \frac{909.1\times10^{3}}{138.8\times0.9} + \frac{208.10\times10^{5}}{1670\times0.9}$$

$$= 7277.5 + 13845.6 = 21120\ N/cm^2 < 24000\ N/cm^2$$

$$U.L.S\quad \sigma = \frac{1430.0\times10^{3}}{138.8\times0.9} + \frac{354.6\times10^{5}}{1670\times0.9}$$

$$= 11447.4 + 23592.8 = 35040\ N/cm^2 < 41000\times0.87 = 35670\ N/cm^2$$

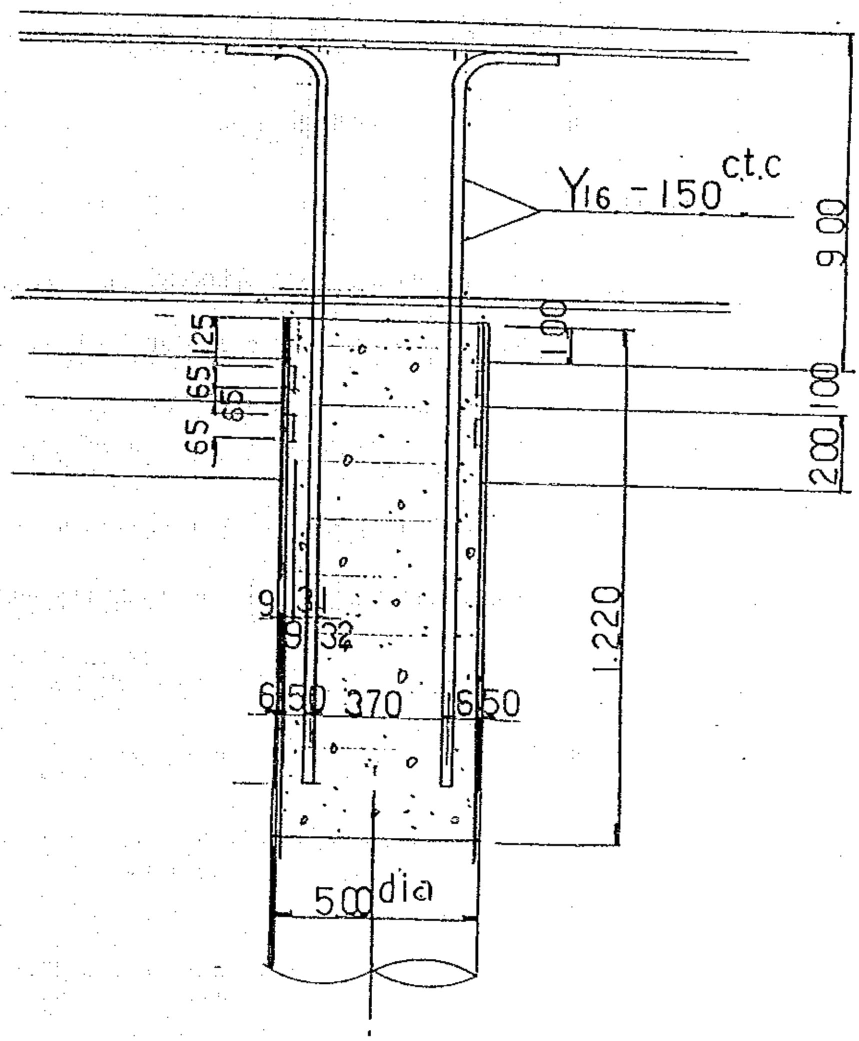
Calculation of join-bar.
with Pile head and Footing slab

1. stress

M	[ ]	354.60
N	[	1430.00
S	[	0.00
R	[cm]	32.50
Rs	[cm]	18.50
As	[cm^2]-Y32-12no	=96.510
n = Es/Ec		15.00
P=As/(π*R^2)		2.908
e = M/N	[cm]	24.80
e / R		0.763
Rs / R		0.569
φ	[rad.]	1.636
M'=M+N*R	[ ]	819.35
c		0.700
s		0.332
z		0.407
σc	[/cm^2]	1671.9
σs	[/cm^2]	11869.2
τc	[/cm^2]	0.00
τm	[/cm^2]	0.00
σca	[/cm^2]	2000.0
σsa	[/cm^2]	35700.0
τa	[/cm^2]	0.00

Resisting moment

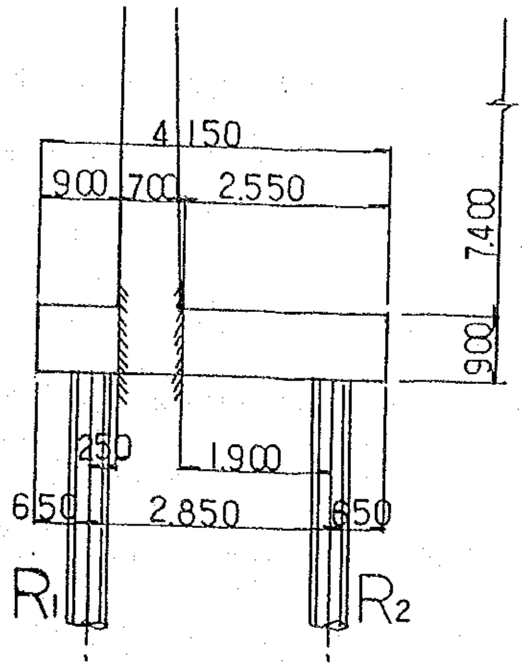
R	[cm]	32.50
Rs	[cm]	18.50
As	[cm^2]	96.510
N	[ ]	1430.00
σck	[/cm^2]	2500.0
σsy	[/cm^2]	30000.0
Yg	[cm]	32.50
X	[cm]	23.30
Ec		0.003500
Esc		0.001423
Est		-0.004171
C	[ ]	1710.130
Cs	[ ]	61.921
Ts	[ ]	-342.054
Mru	[ ]	409.69



DETAIL OF PILE HEAD

Calculation of each section

1) S.L.S



(1) Surcharge or Reaction of Pile

W1 = 23.6×0.90+18.6×0.60 = 32.40 KN/m

W2 = 23.6×0.90+19.6×7.40 = 166.280 KN/m

R1 = 909.10 KN/1.7 = 534.8 KN/m

R2 = 89.36 KN/1.7 = 52.6 KN/m

(2) Caluculation of bending moment and shearing force

a) Vertical wall

$$M = \frac{1}{6} \times 19.6 \times 0.333 \times 7.40^3 = 440.8 \text{ KNm}$$

$$S = \frac{1}{2} \times 19.6 \times 0.333 \times 7.40^2 = 178.7 \text{ KN}$$

b) toe footing slab

$$M = 534.8 \times 0.25 - \frac{0.90^2}{2} \times 32.40 = 120.6 \text{ KNm}$$

$$S = 534.8 \times 0.25 - 0.90 \times 32.40 = 505.7 \text{ KN}$$

C) heel footing slab

$$M = \frac{2.550^2}{2} \times 166.280 - 52.6 \times 1.90 = 440.7 \text{ KNm}$$

$$S = 2.55 \times 166.280 - 52.6 \times 1.90 = 324.1 \text{ KN}$$

2) U, L, S

(1) Surcharge or Reaction of Pile

$W1 = 1.2 \times 1.15 \times 32400 = 44.712\ KN/m$

$W2 = 1.2 \times 1.15 \times 166.280 = 229.467\ KN/m$

$R1 = 1429.940\ KN/1.7 = 841.2\ KN/m$

$R2 = -52.040\ KN/1.7 = -30.6\ KN/m$

(2) Caluculation of bending moment and shearing force

a) Vertical wall

$M = 440.8 \times 1.5 \times 1.15 = 760.4\ KNm$

$S = 178.7 \times 1.5 \times 1.15 = 308.3\ KN$

b) toe footing slab

$$M = 841.2 \times 0.25 - \frac{0.90^2}{2} \times 44.712 = 192.2\ KNm$$

$$S = 841.2 \times 0.25 - 0.90 \times 44.712 = 801.0\ KN$$

C) heel footing slab

$$M = \frac{2.55^2}{2} \times 229.467 + 30.6 \times 1.90 = 804.1\ KNm$$

$$S = 2.55 \times 229.467 + 30.6 \times 1.90 = 643.3\ KN$$

d) calculation of stress (U,L,S)

(a) Vertical wall

b=100cm h=72cm d=65.5 d'=6.5

As = Y25−125 ctc = 4.909／0.125 = 39.272 cm^2

$$P = \frac{39.272}{100\times 65.5}\times 100 = 0.600\%$$

$$X = \frac{0.87\times 41000\times 39.272}{0.40\times 2500\times 100} = 14.0 \text{ cm}$$

$$Z = 65.5 - \frac{1}{2}\times 14.0 = 58.5 \text{ cm} < 0.95\times 65.5 = 62.2 \text{ cm}$$

$$MRS = 0.87\times 41000\times 39.272\times 58.5\times 10^{-5} = 819.5 \text{ KNm} > 760.4 \text{ KNm}$$

$$MRC = 0.40\times 2500\times 100\times 14.0\times 58.5\times 10^{-5} = 819.0 \text{ KNm} > 760.4 \text{ KNm}$$ OK

b) toe footing slab

b=100cm h=40cm d=83.5 d'=6.5

As = Y25−125 ctc = 4.909／0.125 = 39.272 cm^2

$$P = \frac{39.272}{100\times 83.5}\times 100 = 0.470\%$$

$$\tau a = \{35.0+15.0\frac{(0.470-0.25)}{0.25}\}\times 2 = 96.4 \text{ N/cm}^2$$

$$\tau = \frac{801.0\times 10^3}{100\times 83.5} = 96.0 \text{ N/cm}^2 < \tau a = 96.4 \text{ N/cm}^2$$

C) heel footing slab

b=100cm h=90cm d=83.5 d'=6.5

As = Y25−125 ctc = 4.909／0.125 = 39.272 cm^2

$$P = \frac{39.272}{100\times 83.5}\times 100 = 0.470\%$$

$$X = \frac{0.87\times 41000\times 39.272}{0.40\times 2500\times 100} = 14.0 \text{ cm}$$

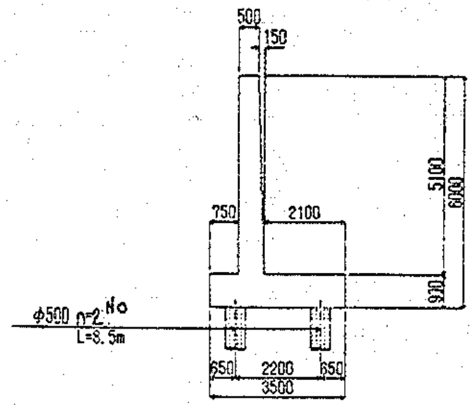
$$Z = 83.5-14.0 = 76.5 \text{ cm} < 0.95\times 83.5 = 79.3 \text{ cm}^2$$ OK

$$MRS = 0.87\times 41000\times 39.272\times 76.5\times 10^{-5} = 1071.6 \text{ KNm} > 804.1 \text{ KNm}$$

$$MRC = 0.40\times 2500\times 100\times 14.0\times 76.5\times 10^{-5} = 1071.0 \text{ KNm} > 804.1 \text{ KNm}$$ OK

$$\tau = \frac{643.3\times 10^3}{100\times 83.5} = 77.1 \text{ N/cm}^2 < \tau a = 96.0 \text{ N/cm}^2$$

(1)



GAMC = 23.600 (t/m^3)

GAM1 = 19.600 (t/m^3)

GAM1S = 10.780 (t/m^3)

FAi = 30.000 (°)

GAM2 = 18.600 (t/m^3)

GAM2S = 9.780 (t/m^3)

WATS = 9.800 (t/m^3)

(2)

β = 0.000 (°)

HS2 = 1.500 (m)

HW1 = 2.000 (m)

ϕ : 30.000 (°)

δ :

= 0.000 (°)

β : 0.000 (°)

θ : 0.000 (°)

$$Ka = \frac{\cos^2(\phi-\theta)}{\cos^2\theta * \cos(\theta+\delta) * \left[1 + \sqrt{\frac{(\sin(\phi+\delta)*\sin(\phi-\beta))}{(\cos(\theta+\delta)*\cos(\theta-\beta))}} \right]^2}$$

= 0.333

Ka	0.333
δ	0.000 (°)
θ	0.000 (°)
H	6.000 (m)
γo	19.600 (t/m^3)
C	0.000 (t/m^2)
Q	0.000 (t/m^2)

$p = Ka*\gamma o*H - 2*C*\sqrt{Ka} + Ka*Q$

p1 = 0.000 (t/m^2)

p2 = 39.200 (t/m^2)

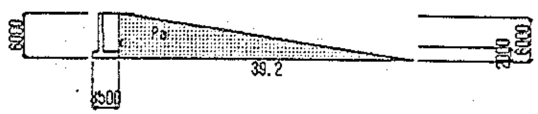
P = (p1+p2) * H / 2 = 117.600 (t/m)

Ph = 117.600 (t/m)

Pv = 0.000 (t/m)

y = 2.000 (m)

x = 0.000 (m)



Ka :	0.333	
δ :	0.000	(°)
θ :	0.000	(°)
H :	6.000	(m)
Hw :	2.000	(m)
h1 :	4.000	(m)
γo :		
γ	19.600	(t/m^3)
γw	10.780	(t/m^3)
C :	0.000	(t/m^2)
Q :	0.000	(t/m^2)

$p = Ka*\gamma o*H - 2*C*\sqrt{Ka} + Ka*Q$

p1 = 0.000 (t/m^2)

p2 = 26.133 (t/m^2)

p3 = 33.320 (t/m^2)

P1 = (p1+p2) * h1 / 2 = 52.267 (t/m)

P2 = (p2+p3) * Hw / 2 = 59.453 (t/m)

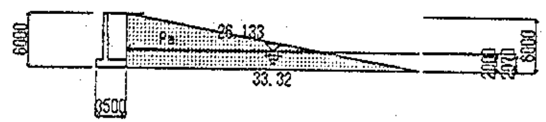
P = P1 + P2 = 111.720 (t/m)

Ph = 111.720 (t/m)

Pv = 0.000 (t/m)

y = 2.070 (m)

x = 0.000 (m)



(1)

NO.	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
1	74.340	0.000	1.750	0.450	130.095	0.000
6	60.180	0.000	1.000	3.450	60.180	0.000
7	9.027	0.000	1.300	2.600	11.735	0.000
	143.547	0.000			202.010	0.000

V = Xi*Yi*GAMC   H = V*KH1
Mx = V*x   My = H*y

(2)

NO.	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
2	7.497	0.000	1.350	4.300	10.121	0.000
3	209.916	0.000	2.450	3.450	514.294	0.000
	217.413	0.000			524.415	0.000

V = Xi*Yi*GAM1   H = V*KH1
Mx = V*x   My = H*y

(3)

NO.	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
2	8.370	0.000	0.375	0.000	3.139	0.000
	8.370	0.000			3.139	0.000

V = Xi*Yi*GAM2   H = V*KH2
Mx = V*x   My = H*y

(4)

	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
	0.000	117.600	3.500	2.000	0.000	235.200
	0.000	111.720	3.500	2.070	0.000	231.280

(5)

	V(t)	H(t)	x(m)	y(m)	Mx(t·m)	My(t·m)
	-37.703		1.626		-61.313	
	-22.812		2.442		-55.705	
	-4.410		0.375		-1.654	
	-64.925		1.828		-118.672	

1.

(1)

	V(t)	H(t)	Mx(t·m)	My(t·m)
	143.547		202.010	
	217.413		524.415	
	8.370		3.139	
	0.000	117.600	0.000	235.200
	369.330	117.600	729.564	235.200

Mo = ΣMx - ΣMy = 494.364 (t·m)

	V(t)	H(t)	e(m)	Mc(t·m)
	369.330	117.600	0.411	151.963
	304.405	111.720	0.503	153.097

e = B0/2 - Mo/V : Mc = V * e

B0 :
e :

1 :
3 :

	V(t)	H(t)	Mx(t·m)	My(t·m)
	143.547		202.010	
	217.413		524.415	
	8.370		3.139	
	0.000	111.720	0.000	231.280
	-64.925		-118.672	
	304.405	111.720	610.892	231.280

Mo = ΣMx - ΣMy = 379.612 (t·m)

	V(t)	H(t)	e(m)	Mc(t·m)
	960.258	305.760	0.411	395.105
	791.453	290.472	0.503	398.051

D =	0.5000000	(m)	
I =	0.0041800	(m^4)	
E =	2.100E+07	(t/m^2)	
Kv=	221500.0	(t/m)	

(m)	(t/m^3)
8.50	14600.00

	X (m)		
1	1.100	1	0.0
2	-1.100	1	0.0

K1 =	19294.6	(t/m)
K2 =	25341.2	(t/rad.)
K3 =	25341.2	(t·m/m)
K4 =	66493.8	(t·m/rad.)

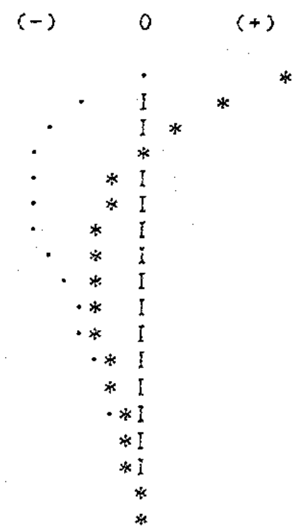
(t)	1000.00	0.00
(t)	0.00	0.00
(t)	200.00	0.00
(mm)	15.00	0.00

V =	960.258	(t)
H =	305.760	(t)
M =	395.105	(t·m)

δx =	9.660290	(mm)
δy =	2.167630	(mm)
α =	1.322400	(m.rad)

	(m)	(t)	(t)	(t·m)
1	1.100	802.33	152.88	-156.87
2	-1.100	157.93	152.88	-156.87

(m)	(t·m)	(t)		(t·m)	(t)
0.00	156.87	152.88	:	0.00	152.88
0.50	89.01	119.07	:	-62.88	100.46
1.00	37.20	88.88	:	-102.24	58.69
1.50	-0.58	62.97	:	-123.20	26.69
2.00	-26.52	41.54	:	-130.37	3.31
2.50	-42.84	24.43	:	-127.72	-12.78
3.00	-51.62	11.30	:	-118.57	-22.92
3.50	-54.72	1.64	:	-105.57	-28.39
4.00	-53.74	-5.09	:	-90.76	-30.36
4.50	-50.02	-9.45	:	-75.63	-29.83
5.00	-44.59	-12.00	:	-61.20	-27.69
5.50	-38.25	-13.21	:	-48.09	-24.64
6.00	-31.53	-13.52	:	-36.62	-21.24
6.50	-24.82	-13.29	:	-26.83	-17.95
7.00	-18.28	-12.82	:	-18.60	-15.08
7.50	-12.00	-12.32	:	-11.64	-12.87
8.00	-5.94	-11.96	:	-5.59	-11.49
8.50	0.00	-11.83	:	0.00	-11.02



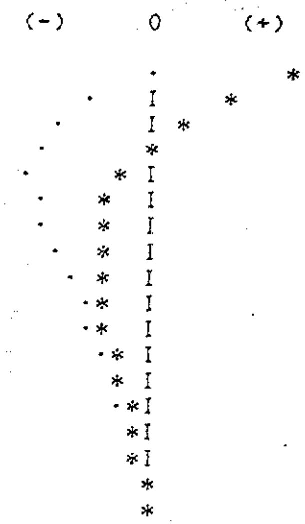
Mmax = 156.87 t·m : Mmax = -129.80 t·m
lm = 0.00 m : lm = 2.07 m

V =	791.453	(t)
H =	290.472	(t)
M =	398.051	(t·m)

δx =	9.226770	(mm)
δy =	1.786580	(mm)
α =	1.293970	(m.rad)

	X (m)	(t)	(t)	(t·m)
1	1.100	711.00	145.24	-147.78
2	-1.100	80.45	145.24	-147.78

(m)	(t·m)	(t)		(t·m)	(t)
0.00	147.78	145.24	:	0.00	145.24
0.50	83.35	112.97	:	-59.74	95.44
1.00	34.22	84.19	:	-97.13	55.75
1.50	-1.53	59.53	:	-117.04	25.36
2.00	-26.02	39.15	:	-123.85	3.14
2.50	-41.37	22.91	:	-121.34	-12.15
3.00	-49.57	10.46	:	-112.64	-21.78
3.50	-52.39	1.32	:	-100.30	-26.97
4.00	-51.35	-5.04	:	-86.22	-28.84
4.50	-47.73	-9.14	:	-71.85	-28.34
5.00	-42.50	-11.52	:	-58.14	-26.31
5.50	-36.41	-12.64	:	-45.69	-23.40
6.00	-30.00	-12.90	:	-34.79	-20.18
6.50	-23.59	-12.66	:	-25.49	-17.05
7.00	-17.37	-12.19	:	-17.67	-14.32
7.50	-11.40	-11.71	:	-11.06	-12.23
8.00	-5.64	-11.36	:	-5.31	-10.92
8.50	0.00	-11.24	:	0.00	-10.47



Mmax = 147.78 t·m : Mmax = -123.31 t·m
lm = 0.00 m : lm = 2.07 m

Section(2)

calculation of riaction for foundation pile (U,L,S)

load	N(KN)	H(KN)	MX(KNm)	Mg(KNm)
concrete of stucture, surcherge of heel slab and toe slab	369.330×2.6 ×1.2×1.15 =1325.156	—	729.564×2.6 ×1.2×1.15 =2617.676	—
earth pressure	—	117.6×2.6 ×1.5×1.10 =527.436	—	235.200×2.6 ×1.5×1.10 =1054.872
total	1325.2	527.5	2617.7	1054.9

$$e = \frac{3500}{2} - \frac{2617.7-1054.9}{1325.2} = 0.571 \text{ m}$$

$$Me = 1325.2 \times 0.571 = 756.7 \text{ KNm}$$

D =	0.500	(m	)
L =	8.500	(m	)
Ho=	0.000	(m	)
I =	0.0041800	(m^4	)
E =	2.060E+07	(t/m^2)	
Kh=	14600.00	(t/m^3)	
Kv=	221500.00	(t/m	)

β = 0.38155 (m^-1)

$\beta*L$ = 3.24320 > 3.0 .....

	(m)		
1	1.100	1	0.0
2	-1.100	1	0.0

K1 =	19201.4	(t/m)
K2 =	25102.5	(t/rad.)
K3 =	25102.5	(t·m/m)
K4 =	65554.0	(t·m/rad.)

(t)	1500.00	1500.00
(t)	100.00	100.00
(t)	500.00	500.00
(mm)	25.00	25.00

V = 1325.200 (t)
H = 527.500 (t)
M = 756.700 (t·m)

δx = 16.879493 (mm)
δy = 2.991422 (mm)
α = 2.404504 (m.rad)

	(m)	(t)	(t)	(t·m)
1	1.100	1248.46	263.75	-266.09
2	-1.100	76.74	263.75	-266.09

(m)	(t·m)	(t)		(t·m)	(t)	(-) 0 (+)
0.00	266.09	263.75	:	0.00	263.75	· *
0.50	149.20	204.75	:	-108.37	172.91	· I *
1.00	60.26	152.22	:	-176.00	100.60	· I *
1.50	-4.29	107.27	:	-211.82	45.32	· *
2.00	-48.33	70.20	:	-223.82	5.01	· * I
2.50	-75.76	40.73	:	-218.93	-22.65	· * I
3.00	-90.22	18.21	:	-202.89	-39.98	· * I
3.50	-94.97	1.74	:	-180.30	-49.24	· * I
4.00	-92.81	-9.64	:	-154.66	-52.44	· * I
4.50	-86.01	-16.94	:	-128.57	-51.37	·* I
5.00	-76.39	-21.09	:	-103.75	-47.53	·* I
5.50	-65.30	-22.97	:	-81.30	-42.14	·* I
6.00	-53.68	-23.32	:	-61.71	-36.18	* I
6.50	-42.13	-22.77	:	-45.08	-30.43	·*I
7.00	-30.97	-21.83	:	-31.16	-25.43	*I
7.50	-20.30	-20.89	:	-19.46	-21.59	*I
8.00	-10.03	-20.22	:	-9.32	-19.19	*
8.50	0.00	-19.98	:	0.00	-18.37	*

Calculation of fundation pile ----- section (2)

factor of pile $\phi 500 \times 9 \times 8500$

$E = 2058 \times 10^{8}\ KN/cm^2$

$Ap = 138.8\ cm^2$

$Z = 1670\ cm^3$

Stress for berding moment and axis force

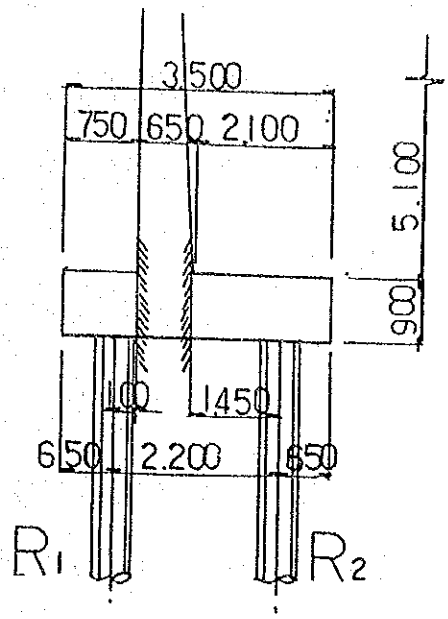
$$S.L.S\quad \sigma = \frac{802.33 \times 10^3}{138.80 \times 0.9} + \frac{156.87 \times 10^5}{1670 \times 0.9}$$

$$= 6422.8 + 10437.2 = 16860\ N/cm^2 \quad < \quad 24000\ N/cm^2$$

$$S.L.S\quad \sigma = \frac{1248.46 \times 10^3}{138.80 \times 0.9} + \frac{266.09 \times 10^5}{1670 \times 0.9}$$

$$= 9994.1 + 17703.9 = 27700\ N/cm^2 \quad < \quad 41000 \times 0.87 = 35600\ N/cm^2$$

Section (2)



U.L.S

(1) Surcharge

W1 = (23.6×0.90+18.6×0.60)×1.2×1.15 = 44.712 KN/m

W2 = (23.6×0.90+19.6×5.10)×1.2×1.15 = 167.256 KN/m

R1 = 1248.46 KN/2.60m = 480.2 KN/m

R2 = 76.74 KN/2.60m = 29.5 KN/m

(2) Calculation of bending moment and shearing force

a) Vertical wall

$$M = \frac{1}{6} \times 19.6 \times 0.333 \times 5.10^3 \times 1.5 \times 1.15 = 248.9 \text{ KNm}$$

$$S = \frac{1}{2} \times 19.6 \times 0.333 \times 5.10^2 \times 1.5 \times 1.15 = 146.4 \text{ KN}$$

b) toe footing slab

M = =

S = 480.2 = 480.2 KN

C) heel footing slab

$$M = \frac{2.10^2}{2} \times 167.256 - 29.5 \times 1.45 = 326.1 \text{ KNm}$$

$$S = 2.10 \times 167.256 - 29.5 \times 1.45 = 326.0 \text{ KN}$$

d)calculation of stress for each section (U.L.S)

a) Vertical wall

b=100cm h=65cm d=58.5 d'=6.5

As = Y25－250 ^{ctc} = 4.909／0.250 = 19.635 cm^2

$$P = \frac{19.635}{100\times 58.5}\times 100 = 0.335\%$$

$$X = \frac{0.87\times 41000\times 19.635}{0.40\times 2500\times 100} = 7.00 \text{ cm}$$

$$Z = 58.5 - \frac{1}{2}\times 7.00 = 55.0 \text{ cm} < 0.95\times 58.5 = 55.6 \text{ cm}$$

$$MRS = 0.87\times 41000\times 19.635\times 55.0\times 10^{-5} = 385.2 \text{ KNm} > 248.9 \text{ KNm}$$

$$MRC = 0.40\times 2500\times 100\times 7.0\times 55.0\times 10^{-5} = 385.0 \text{ KNm} > 248.9 \text{ KNm}$$ OK

b) toe footing slab

b=100cm h=90cm d=83.5 d'=6.5

As = Y25－250 ^{ctc} = 19.635 cm^2

$$P = \frac{19.636}{100\times 83.5}\times 100 = 0.235\% > 0.15\%$$

$$\tau = \frac{480.2\times 10^3}{100\times 83.5} = 57.5 \text{ N/cm}^2 < \tau a = 35.0\times \frac{0.235}{0.25}\times 2 = 65.8 \text{ N/cm}^2$$

C) heel footing slab

b=100cm h=90cm d=83.5 d'=6.5

As = Y25－250 ^{ctc} = 19.636 cm^2

$$P = \frac{19.636}{100\times 83.5}\times 100 = 0.235\% > 0.15\%$$

$$X = \frac{0.87\times 41000\times 19.636}{0.40\times 2500\times 100} = 7.00 \text{ cm}$$

$$Z = 83.5 - \frac{1}{2}\times 7.00 = 8.00 \text{ cm} \doteqdot 0.95\times 83.5 \doteqdot 80 \text{ cm}$$ OK

$$MRS = 0.87\times 41000\times 19.636\times 80.0\times 10^{-5} = 560.0 \text{ KNm} > 326.1 \text{ KNm}$$

$$MRC = 0.40\times 2500\times 100\times 7.00\times 80.0\times 10^{-5} = 560.0 \text{ KNm} > 326.1 \text{ KNm}$$ OK

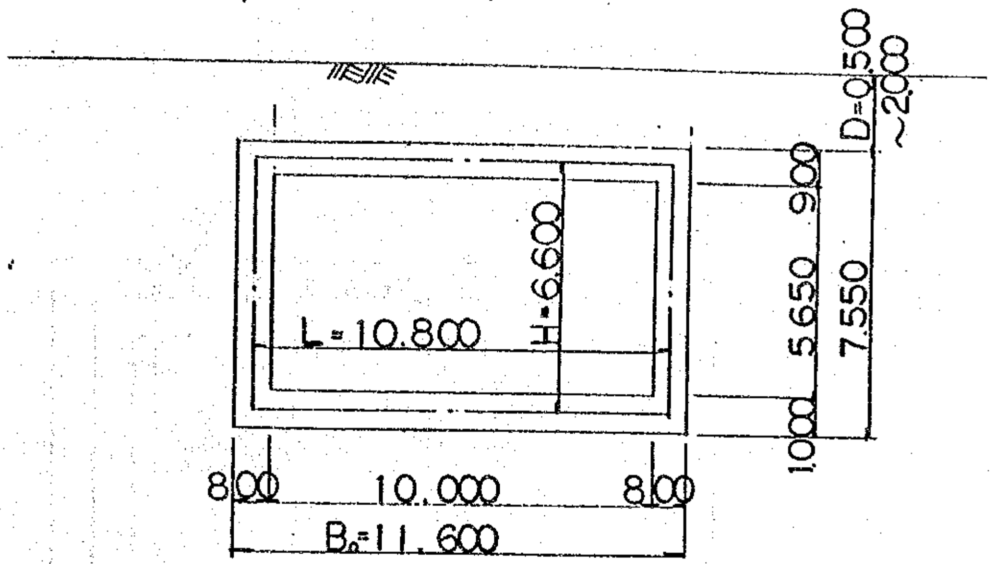
$$\tau = \frac{326.0\times 10^3}{100\times 83.5} = 39.1 \text{ N/cm}^2 < \tau a = 65.8 \text{ N/cm}^2$$

CALUCULATION OF

BOX CULVERTS

NO ① BOX·CULVERT FOR RORD

1) Shape and Size



Where

D^m= depth of asphalt and similar surface soil.

2) Factor of section

$A = 1.00 \times 0.80 = 0.8000\ m^2$

$I = \frac{1.00 \times 0.80^3}{12} = 0.04267 m^4$

$A = 1.00 \times 0.90 = 0.9000\ m^2$

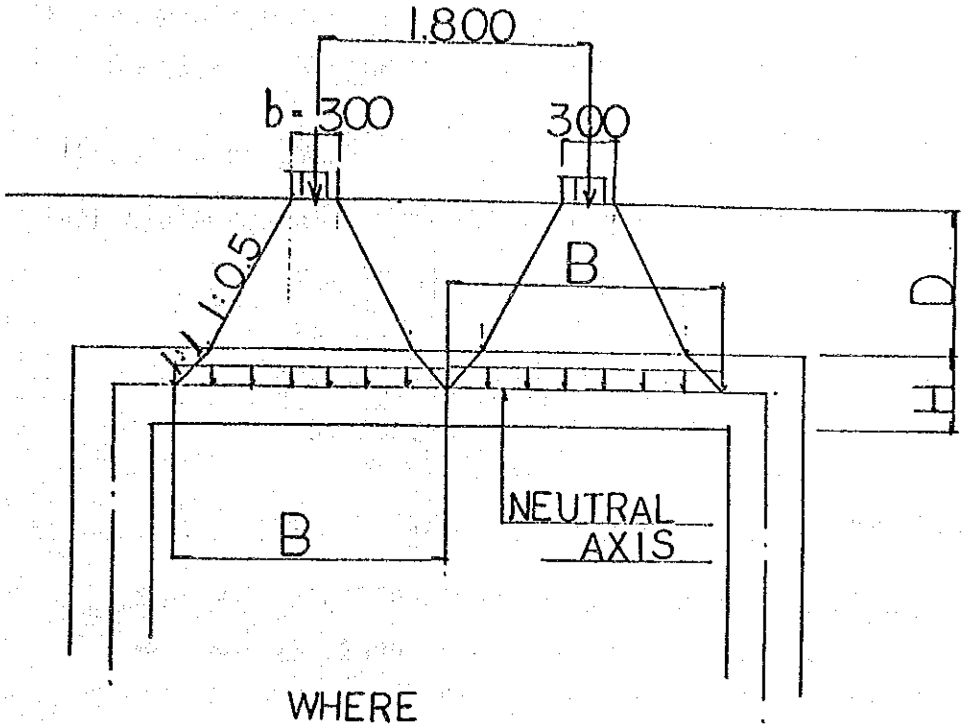
$I = \frac{1.00 \times 0.90^3}{12} = 0.06075\ m^4$

$A = 1.00 \times 1.00 = 1.0000\ m^2$

$I = \frac{1.00 \times 1.00^3}{12} = 0.08333 m^4$

$Ec = 25\ KN/mm^2 = 2.5 \times 10^7\ KN/m^2$

LIVE LOAD --- HB loading



WHERE

D = DEPTH OF ASPHALT AND SIMILAR SURFACE SOIL

H = DEPTH OF CONCRTE SLAB

DISPERSAL OF WHEEL

$$B^{m} = b + D + H$$

LOADED STRENGTH

$$P = \frac{100.0 \times Uno}{B \times L} \quad (KN/m^2)$$

WHERE

Uno = NUMBER OF UNITS = 30

L = WIDTH OF HB-VEHICLE = 3.500^{m}