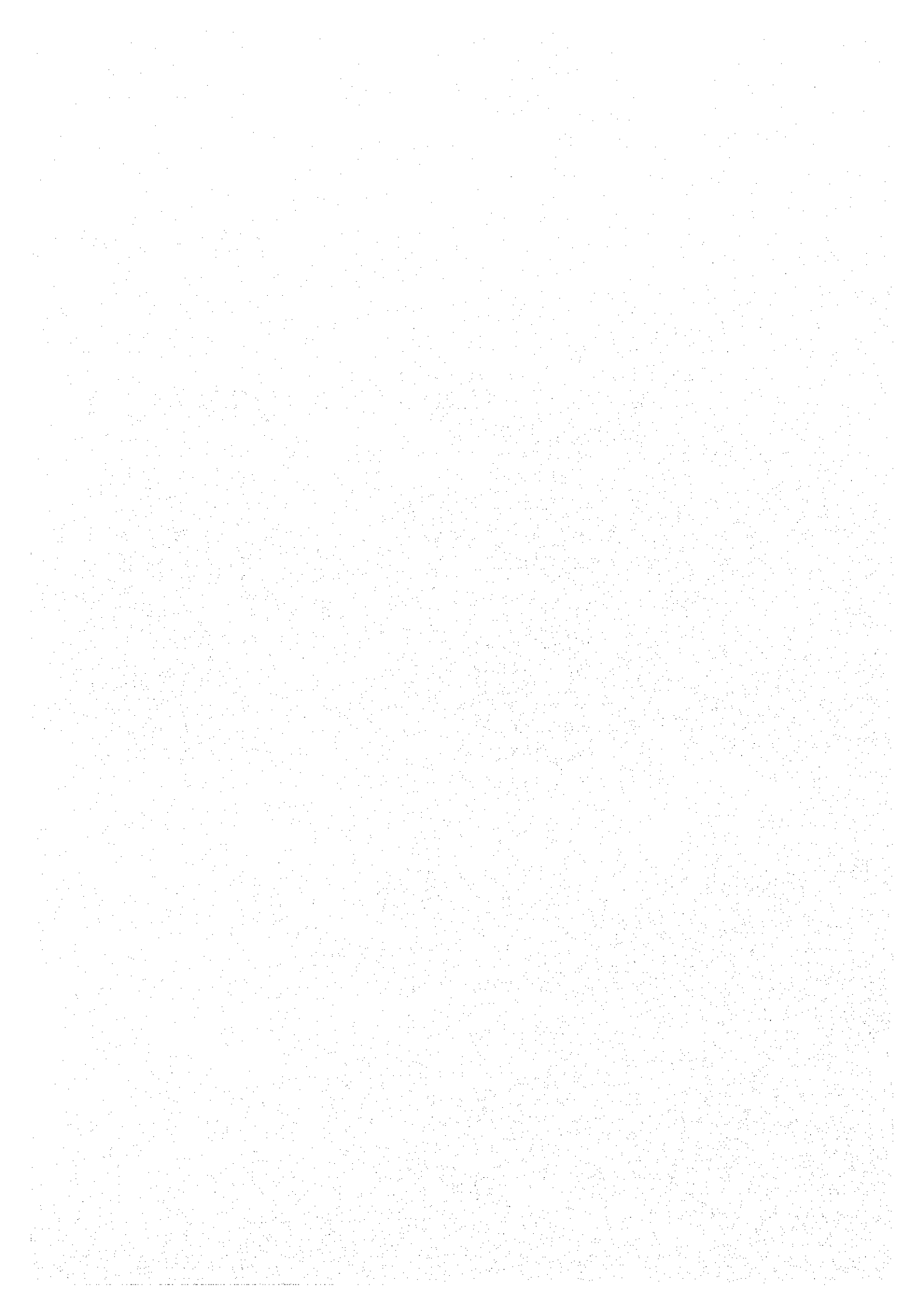


Chapter 3

DESIGN SUMMARY OF SUBSTRUCTURES & FOUNDATIONS

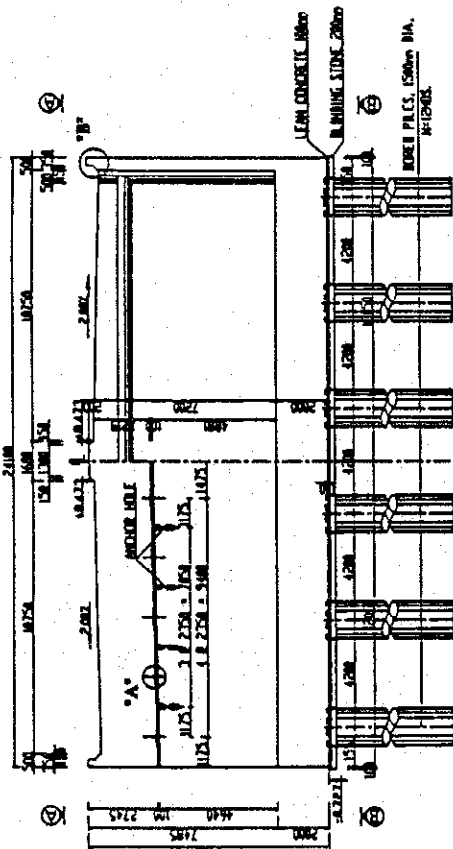
3.1	ABUTMENT	II - 3 - 2
(1)	ABUTMENT, TYPE A1	II - 3 - 2
(2)	ABUTMENT, TYPE A3	II - 3 - 9
(3)	ABUTMENT, TYPE A4	II - 3 - 16
3.2	PIERS	II - 3 - 23
(1)	PIER, TYPE P2	II - 3 - 23
(2)	PIER, TYPE P4	II - 3 - 33
(3)	PIER, TYPE P6	II - 3 - 42
(4)	PIER, TYPE P7	II - 3 - 52
(5)	PIER, TYPE P13	II - 3 - 62
(6)	PIER, TYPE P14	II - 3 - 71



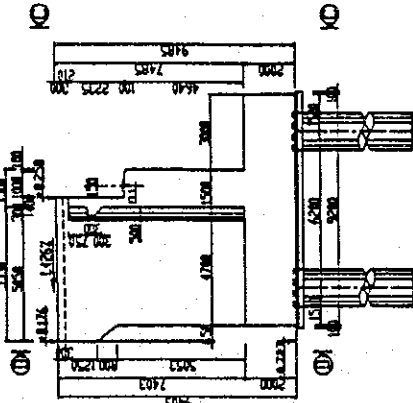
3.1 ABUTMENT
(1) ABUTMENT, TYPE A1

DETAIL OF ABUTMENT A2
(SCALE 1:200)

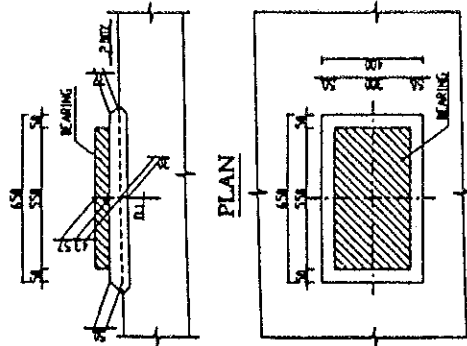
1/2C-C



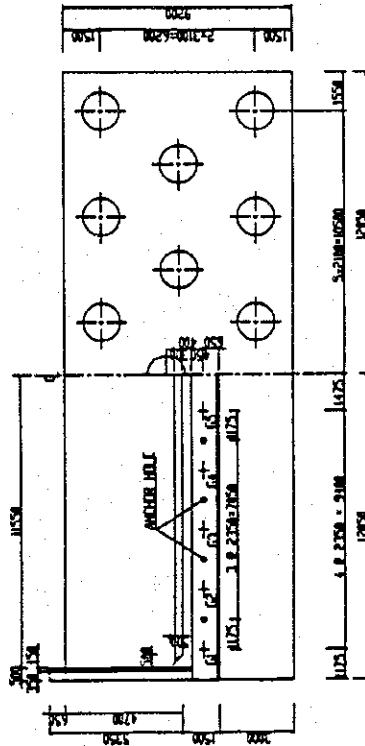
SIDE ELEVATION



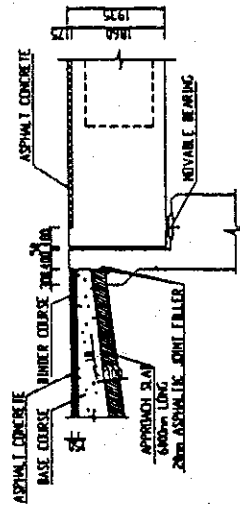
DETAIL 'A'
(SCALE 1:50)



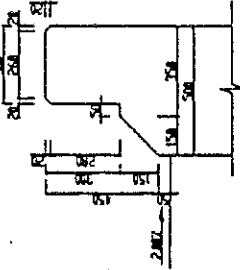
1/2A-A



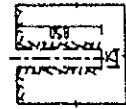
1/2B-B



DETAIL 'B'
(SCALE 1:20)



DETAIL OF ANCHOR HOLE
(SCALE 1:50)



NOTE
FOR STANDARD STRUCTURAL NOTES SEE DRAWING NO.PV/BRI/0030.

GIRDER BEARING SEAT
ELEVATION OF H/L

ABUTMENT	CRUIT PAB	G1	G2	G3	G4	G5
	A1	14.65	14.18	14.15	14.28	14.24

PROJECT NAME DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION PROJECT	IMPLEMENTATION AGENCY JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	EXECUTING AGENCY SOCIALIST REPUBLIC OF VIET NAM MINISTRY OF TRANSPORT (MOT)	JICA STUDY TEAM NIPPON KOKI CO.,LTD.	PREPARED BY T. Yamamoto E. A. F.	CHECKED BY K. Mitamura E. A. F.	APPROVED BY K. Endo V. Ueda	DRAWING TITLE LACE TRA VA BRIDGE ABUTMENTS ABUTMENT A1-GENERAL VIEW	DWG NO. P1/182/003
				DATE 209/2000		DATE 3/10/2000		

2. LOAD COMBINATIONS LARGE TRAVA ABUTMENT A2 (H=9.2 M)

Abutment DC 1487 T $e_x = -0.01$ m $e_y = 0.55$ m

Nos	Items	Pz			Hx			My			Notes
		n=1	n<1	n>1	n=1	n<1	n>1	n=1	n<1	n>1	
Permanent load											
1	Superstructure - DC (n=0.9,1.25)	330	297	413				182	163	227	
2	Wearing surface - DW (n=0.65,1.5)	33	21	50				18	12	27	
3	Abutment - DC (n=0.9,1.25)	1,487	1,338	1,859				-17	-15	-21	
4	Horizontal earth pressure - EH (n=0.9,1.35)				525	379	872	1,610	1,163	2,674	
5	Horizontal earth pressure - E _{AE} (n=0.9,1.35)				660	487	1,074	2,023	1,495	3,295	
6	Vertical earth pressure - EV (n=0.9,1.35)	1,076	968	1,452				-2,259	-2,033	-3,050	
Transient Loads											
7	Live load - LL (n=0.5,1.75)	157	79	275				86	43	151	
	a- Main load	104	52	182				57	29	100	
	b- Sub load	53	27	93				29	15	51	
8	Dynamic load allowance - IM (n=0.5,1.75)	52	26	91				28	14	50	
	a- Main load	34	17	60				19	9	33	
	b- Sub load	17	9	31				10	5	17	
9	Live load surcharge - LS (n=0.9,1.35)				60	43	100	276	200	459	
10	Braking force - BR (n=0.5,1.75)				19	10	33	190	95	333	25% of Japanese Load - p1
11	Friction force - FR (n=1)										f=0.05
	a- Dead load				0	0	0	0	0	0	
	b- Dead load + Live load				0	0	0	0	0	0	
12	Earthquake - EQ (n=1)				215			675			12% of Dead load

LOAD COMBINATION TABLE

Load combinations	Pz	Hx	My
1	4139	1005	850
2	2,625	972	1,260
3	4,139	389	-1,586
4	3,878	1,398	1,764
5	2,729	1,398	2,708

- Combination 1 $1.25DC + 1.5DW + 1.35EV + 1.35EH + 1.75LL + 1.75IM + 1.35LS + 1.75BR + 1FR(b)$
- Combination 2 $0.9DC + 0.65DW + 0.9EV + 1.35EH + 1.35LS + 1FR(a)$
- Combination 3 $1.25DC + 1.5DW + 1.35EV + 0.9EH + 1.75LL + 1.75IM + 0.9LS - 1.75BR - 1FR(b)$
- Combination 4 $1.25DC + 1.5DW + 1.35EV + 1.35EAE + 0.5LL + 1.35LS + 0.5BR + 1FR(b) + 1EQ$
- Combination 5 $0.9DC + 0.65DW + 0.9EV + 1.35EAE + 0.5LL + 1.35LS + 0.5BR + 1FR(b) + EQ$

Bridge name **LARGE TRAVA - A2**

Pile Type Dia = 1500 mm Length = 58.0 m

Bearing Capacity $Q_s = \underline{12756 \text{ kN}}$ $Q_{ult} = \underline{18057 \text{ kN}}$

Longitudinal direction

Load Combination	Displacement δ (mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	12.2	30	4616	7963	2149	-5757	OK
Strength I-2	12	30	3468	7963	823	-5757	OK
Strength I-3	3.6	30	3470	7963	3295	-5757	OK
Extremme Event I-1	17.2	20	5056	7963	1282	-5757	O.K
Extremme Event I-2	17.8	20	4396	7963	64	-5757	OK

WALL

Section A-A (h = 150 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = ϕ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 30 cm ² (D=2.2cm, 8 Nos)
						A's = 8 cm ² (D=1.6cm, 4 Nos)
1	460	612	1363	1422	OK	$\rho_s = A_s/A_c = 0.0020$
2	434	578			OK	$\rho_{min} = 0.03 f_c/f_y = 0.0018$
3	203	270			OK	$\therefore \rho_s > \rho_{min} \text{ ----- O.K}$
4	590	785			OK	$c/d_e = 0.04$
5	598	795			OK	$\therefore c/d_e < 0.42 \text{ ----- O.K}$

Section B-B (h = 40 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = ϕ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 12 cm ² (D=1.4cm, 8 Nos)
						A's = 6 cm ² (D=1.4cm, 4 Nos)
1	54	72	98	98	OK	$\rho_s = A_s/A_c = 0.0031$
					OK	$\rho_{min} = 0.03 f_c/f_y = 0.0018$
					OK	$\therefore \rho_s > \rho_{min} \text{ ----- O.K}$
					OK	$c/d_e = 0.05$
					OK	$\therefore c/d_e < 0.42 \text{ ----- O.K}$

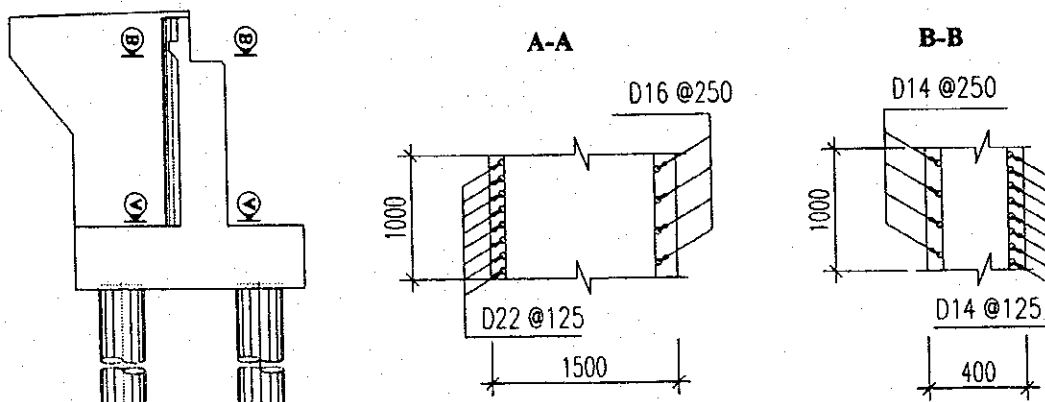
FOR SERVICE LIMIT STATE

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
1	72.28	159.4	98.8	229.5	OK

Stress

	Actual	Allowable	Remark
f _c tensile =	1.31 (MPa)	$f_r = 0.63 \cdot (f_c)^{0.5} = 3.03$ (MPa)	OK
f _c compress =	1.34 (MPa)	$f_{ca} = 0.4f_c = 9.41$ (MPa)	OK
f _s =	4.92 (MPa)	$f_{sa} = 0.6f_y = 229.48$ (MPa)	OK



FOOTING

B abutment

24.10 (m)

SECTION C-C TOP FIBRE

(h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 39 cm ² (D=2.5cm, 8 Nos) A's = 39 cm ² (D=2.5cm, 8 Nos)
1	346	460	2422	2363	OK	ρs = As/Ac = 0.0020
2	847	1126			ρ min = 0.03 f'c/fy = 0.0018	
3	0	0			∴ ρs > ρ min — O.K	
4	734	977			c/de = 0.00	
5	1187	1578			∴ c/de < 0.42 — O.K	

SECTION C-C BOTTOM FIBRE

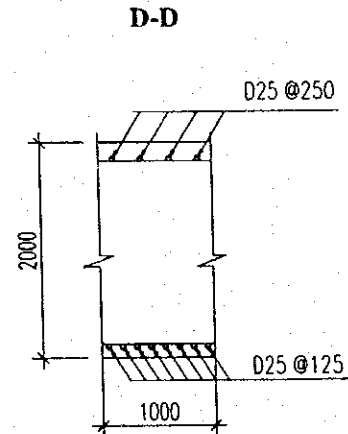
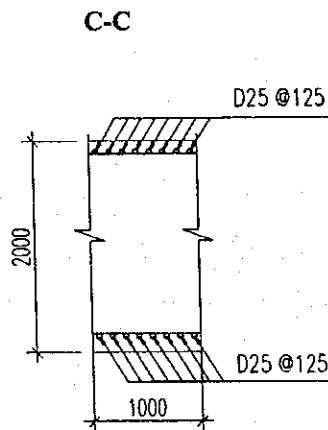
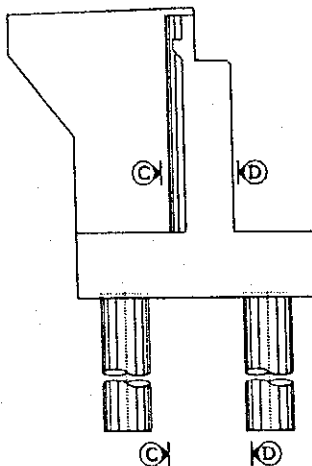
(h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 39 cm ² (D=2.5cm, 8 Nos) A's = 39 cm ² (D=2.5cm, 8 Nos)
1	1085	1443	2422	2363	OK	ρs = As/Ac = 0.0020
2	664	883			ρ min = 0.03 f'c/fy = 0.0018	
3	571	760			∴ ρs > ρ min — O.K	
4	1282	1705			c/de = 0.00	
5	1080	1436			∴ c/de < 0.42 — O.K	

SECTION D-D BOTTOM FIBRE

(h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 39 cm ² (D=2.5cm, 8 Nos) A's = 20 cm ² (D=2.5cm, 4 Nos)
1	1448	1926	2422	2422	OK	ρs = As/Ac = 0.0020
2	1096	1458			ρ min = 0.03 f'c/fy = 0.0018	
3	1020	1356			∴ ρs > ρ min — O.K	
4	1612	2145			c/de = 0.02	
5	1443	1919			∴ c/de < 0.42 — O.K	



**PILE (1,1) SECTION
NOMINAL RESISTANCES**

		Z=0 m		Z=11m		Z=18m		Remark
		Atual	Allowable	Atual	Allowable	Atual	Allowable	
Reinforcement	(mm)	30-D32		16-D28		16-D25		
Area As	(cm ²)	241.27		98.52		78.54		
Combination 1	P (kN)	2149	6508	2149	11765	2149	30277	OK
	M (kN·m)	2081	6303	1035	5665	221	3110	OK
Combination 2	P (kN)	823	2044	823	2163	823	21643	OK
	M (kN·m)	1945	4829	1000	2629	211	5545	OK
Combination 3	P (kN)	3295	20793	3295	29652	3295	34301	OK
	M (kN·m)	1100	6942	400	3600	95	990	OK
Combination 4	P (kN)	1282	2240	1282	2480	1282	22726	O.K
	M (kN·m)	2806	4903	1439	2783	303	5373	O.K
Combination 5	P (kN)	65	97	65	68	65	300	O.K
	M (kN·m)	2661	3994	1439	1522	299	1385	O.K

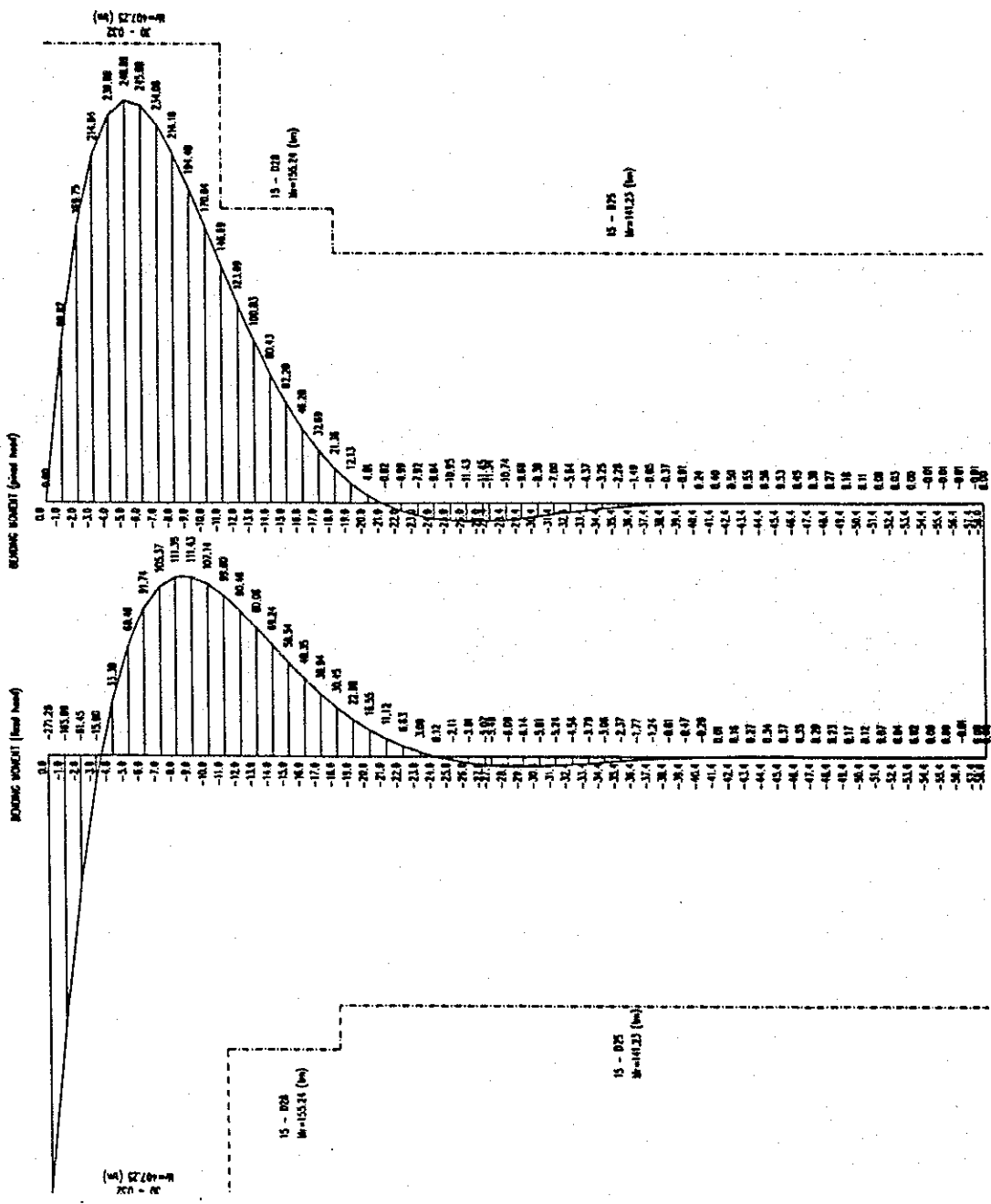
STRESS

	Stress of reinforcement δs (MPa)		Stress of concrete δc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
Combination 1	135.3	220.6	8.41	12.26	OK
Combination 2	177.8	220.6	7.97	12.26	OK
Combination 3	-57.8	220.6	4.43	12.26	OK
Combination 4	252.1	294.2	11.49	14.71	OK
Combination 5	292.8	294.2	10.88	14.71	OK

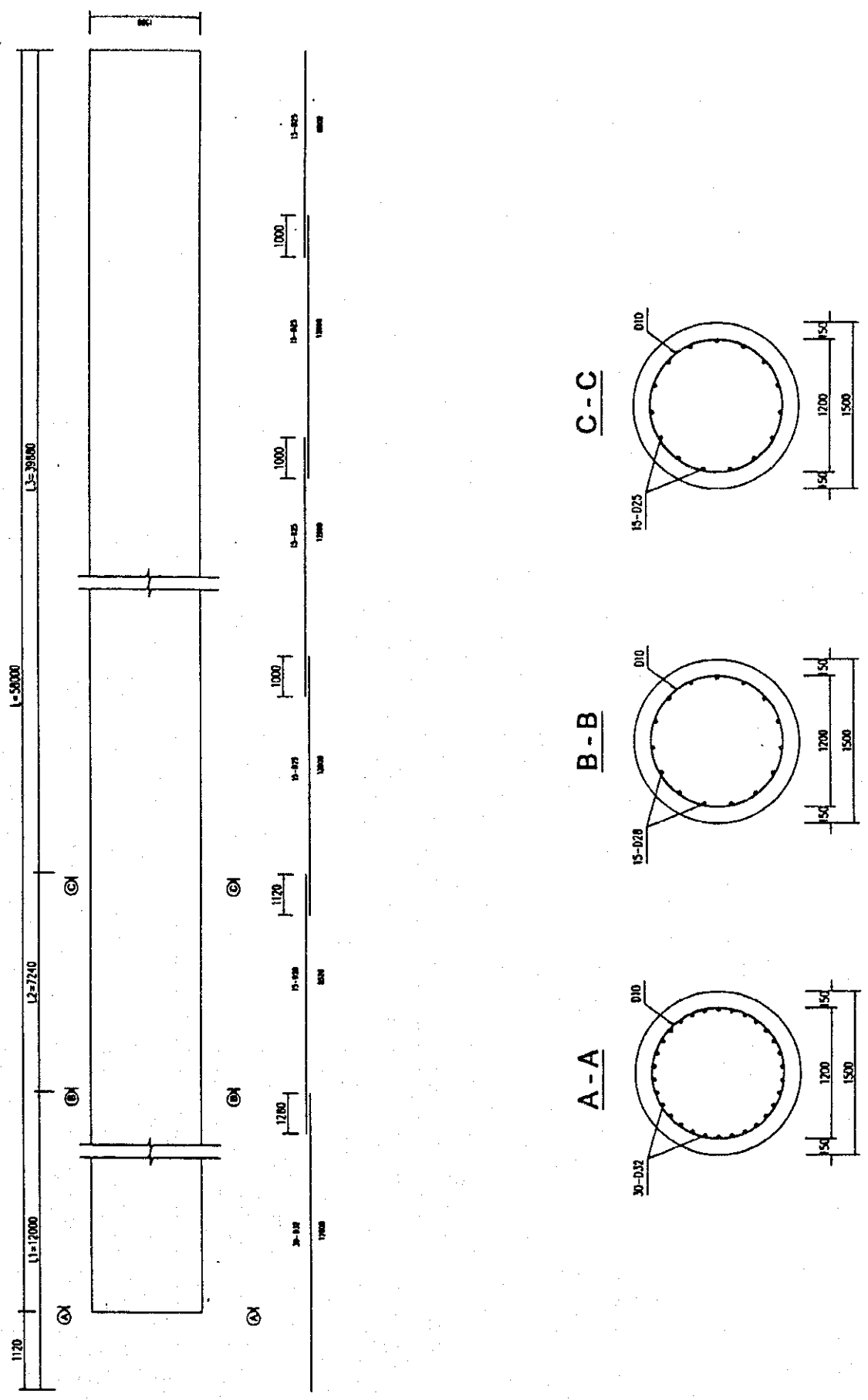
STRESS OF PILE CAP

	Actual (MPa)	Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} = 2.86$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.25$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 6.92$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.48$	$\tau_a = 0.88$	OK

COMBINATION 5: PILE (1,1)



PILE PLAN OF ABUTMENT A2 - LARGE TRA VA BRIDGE

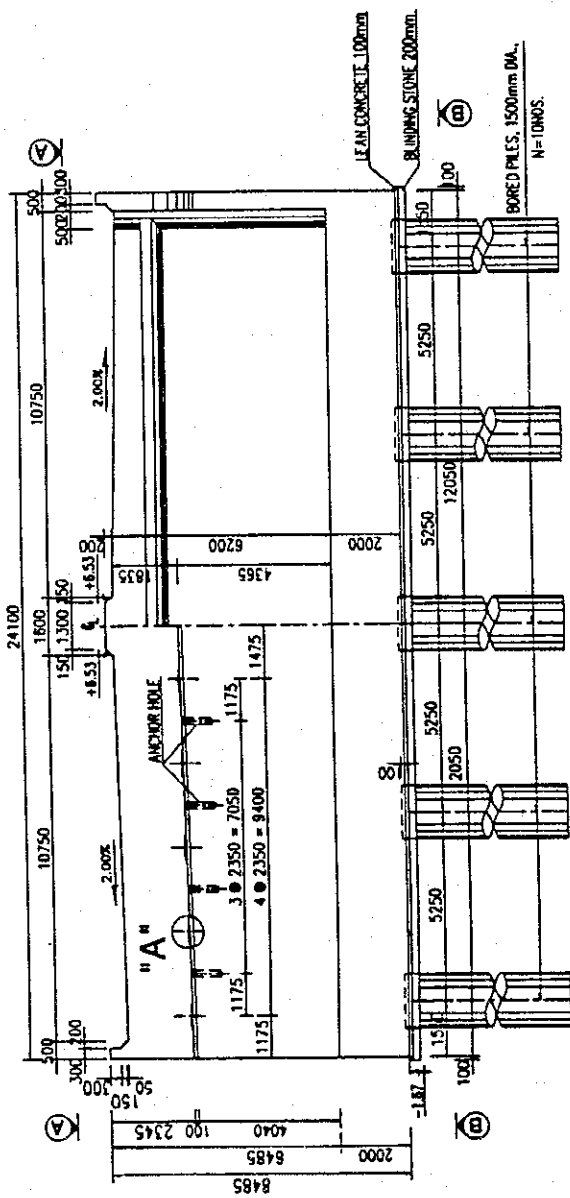


1. GENERAL VIEW ABUTMENT A1 OF SMALL TRA VA BRIDGE

(SCALE 1:200)

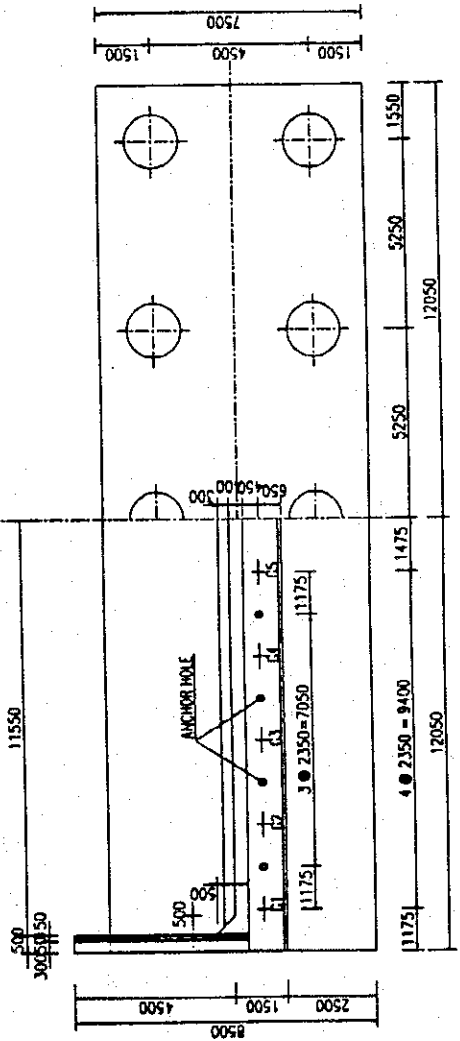
(2) ABUTMENT, TYPE A3
1/2 C - C

1/2 D - D

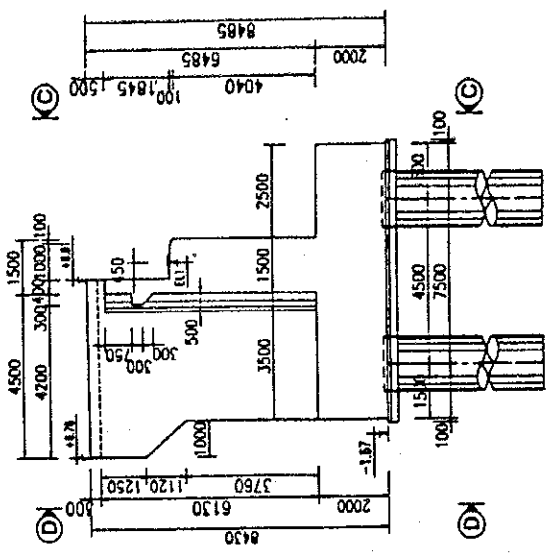


1/2 A - A

1/2 B - B



SIDE ELEVATION



2. LOAD COMBINATIONS - SMALL TRA VA ABUTMENT A1 (H=8.2M)

Abutment DC 1390 T $e_a =$ 0.05 m $e_b =$ 0.60 m

Nos	Items	Pz		Hx		My		Notes	
		n=1	n<1	n>1	n=1	n>1	n=1		n>1
Permanent load									
1	Superstructure - DC (n=0.9,1.25)	369	332	461			221	199	277
2	Wearing surface - DW (n=0.65,1.5)	63	41	95			38	25	57
3	Abutment - DC (n=0.9,1.25)	1,390	1,251	1,738			63	57	79
4	Horizontal earth pressure - EH (n=0.9,1.35)				417	301	693	823	1,894
5	Horizontal earth pressure - EAE (n=0.9,1.35)				524	387	853	1,058	2,333
6	Vertical earth pressure - EV (n=0.9,1.35)	984	886	1,329			-1,969	-1,772	-2,658
Transient Loads									
7	Live load - LL (n= 0.5,1.75)	192	96	337			115	58	202
	a- Main load	130	65	228			78	39	137
	b- Sub load	62	31	109			37	19	65
8	Dynamic load allowance - IM (n=0.5,1.75)	63	32	111			38	19	67
	a- Main load	43	21	75			26	13	45
	b- Sub load	21	10	36			12	6	22
9	Live load surcharge - LS (n=0.9,1.35)				54	39	89	159	365
10	Braking force - BR (n=0.5,1.75)				24	12	43	122	427
11	Friction force - FR (n=1)				0	0	0	0	
	a- Dead load				0	0	0	0	
	b- Dead load + Live load				0	0	0	0	
12	Earthquake - EQ (n=1)				210		611		12% of Dead load

LOAD COMBINATION TABLE

Load combinations	Pz	Hx	My
1	4070	824	707
2	2,510	782	766
3	4,070	297	-1,422
4	3,751	1,164	1,261
5	2,638	1,164	2,016

- Combination 1 $1.25DC + 1.5DW + 1.35EV + 1.35EH + 1.75LL + 1.75IM + 1.35LS + 1.75BR + 1FR(b)$
- Combination 2 $0.9DC + 0.65DW + 0.9EV + 1.35EH + 1.35LS + 1FR(a)$
- Combination 3 $1.25DC + 1.5DW + 1.35EV + 0.9EH + 1.75LL + 1.75IM + 0.9LS - 1.75BR - 1FR(b)$
- Combination 4 $1.25DC + 1.5DW + 1.35EV + 1.35EAE + 0.5LL + 0.5IM + 1.35LS + 0.5BR + 1FR(b) + 1EQ$
- Combination 5 $0.9DC + 0.65DW + 0.9EV + 1.35EAE + 0.5LL + 0.5IM + 1.35LS + 0.5BR + 1FR(b) + EQ$

Bridge name **SMALL TRA VA - A1**

Pile Type Dia = 1500 mm Length = 66.0 m

Bearing Capacity $Q_s = \underline{13397 \text{ kN}}$ $Q_{ult} = \underline{19786 \text{ kN}}$

Longitudinal direction

Load Combination	Displacement δ (mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	11.9	30	5212	8679	2770	-6541	OK
Strength I-2	11.4	30	3654	8679	1269	-6541	OK
Strength I-3	3.2	30	4146	8679	3836	-6541	OK
Extremme Event I-1	17	20	5497	8679	1860	-6541	O.K
Extremme Event I-2	17.5	20	4673	8679	501	-6541	OK

WALL

Section A-A (h = 150 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = ϕ Mn (kN·m)	1.33M <	As = 30 cm ² (D=2.2cm, 8 Nos)
					1.2Mcr or Mr	A's = 8 cm ² (D=1.6cm, 4 Nos)
1	325	432	1363	1422	OK	$\rho_s = A_s/A_c = 0.0020$
2	283	377			OK	$\rho_{min} = 0.03 f_c/f_y = 0.0018$
3	96	128			OK	$\therefore \rho_s > \rho_{min} \text{ --- O.K}$
4	395	525			OK	c/de = 0.04
5	402	534			OK	$\therefore c/de < 0.42 \text{ --- O.K}$

Section B-B (h = 40 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = ϕ Mn (kN·m)	1.33M <	As = 12 cm ² (D=1.4cm, 8 Nos)
					1.2Mcr or Mr	A's = 6 cm ² (D=1.4cm, 4 Nos)
1	54	72	98	98	OK	$\rho_s = A_s/A_c = 0.0031$
					OK	$\rho_{min} = 0.03 f_c/f_y = 0.0018$
					OK	$\therefore \rho_s > \rho_{min} \text{ --- O.K}$
					OK	c/de = 0.05
					OK	$\therefore c/de < 0.42 \text{ --- O.K}$

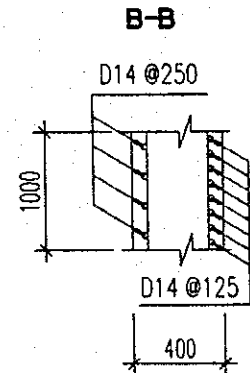
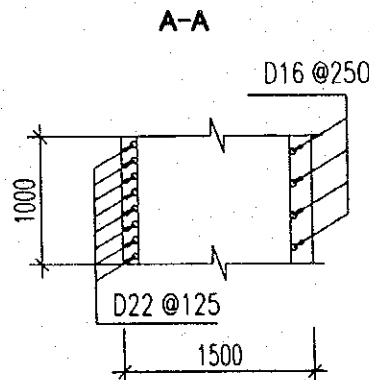
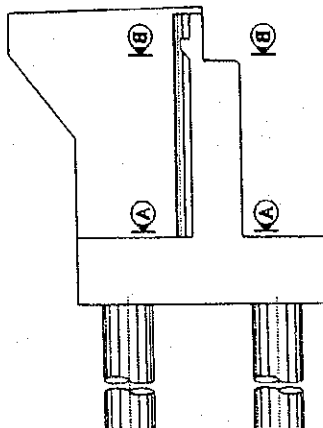
FOR SERVICE LIMIT STATE

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
1	72.28	159.4	98.8	229.5	OK

Stress

	Actual	Allowable	Remark
f _c tensile =	1.31 (MPa)	f _r = 0.63·(f _c) ^{0.5} = 3.03 (MPa)	OK
f _c compress =	1.34 (MPa)	f _{ca} = 0.4f _c = 9.41 (MPa)	OK
f _s =	4.92 (MPa)	f _{sa} = 0.6f _y = 229.48 (MPa)	OK



FOOTING

B abutment

24.10 (m)

SECTION C-C TOP FIBRE (h = 200 cm, b = 100 cm)

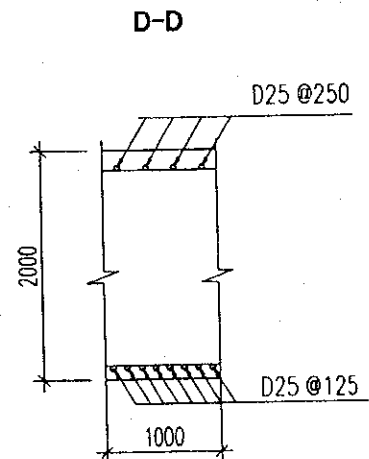
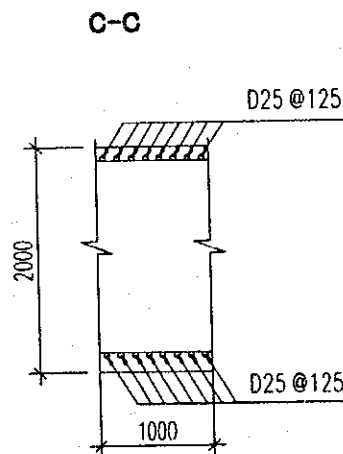
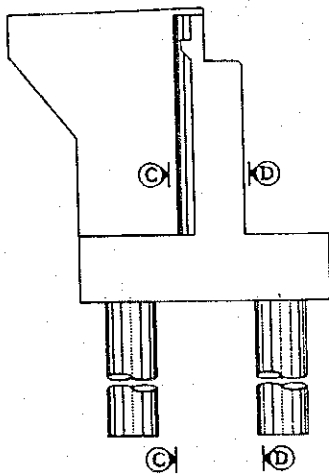
Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	
					As = 39 cm ² (D=2.5cm, 8 Nos)	A's = 39 cm ² (D=2.5cm, 8 Nos)
1	172	229	2422	2363	OK	ρs = As/Ac = 0.0020
2	690	918			OK	ρ min = 0.03 f'c/fy = 0.0018
3	0	0			∴ ρs > ρ min ——— O.K	
4	550	731			OK	c/de = 0.00
5	1009	1342			∴ c/de < 0.42 ——— O.K	

SECTION C-C BOTTOM FIBRE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	
					As = 39 cm ² (D=2.5cm, 8 Nos)	A's = 39 cm ² (D=2.5cm, 8 Nos)
1	1156	1538	2422	2363	OK	ρs = As/Ac = 0.0020
2	615	818			OK	ρ min = 0.03 f'c/fy = 0.0018
3	714	950			∴ ρs > ρ min ——— O.K	
4	1274	1695			OK	c/de = 0.00
5	1038	1380			∴ c/de < 0.42 ——— O.K	

SECTION D-D BOTTOM FIBRE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	
					As = 39 cm ² (D=2.5cm, 8 Nos)	A's = 20 cm ² (D=2.5cm, 4 Nos)
1	852	1133	2422	2422	OK	ρs = As/Ac = 0.0020
2	593	788			OK	ρ min = 0.03 f'c/fy = 0.0018
3	630	838			∴ ρs > ρ min ——— O.K	
4	911	1211			OK	c/de = 0.02
5	804	1069			∴ c/de < 0.42 ——— O.K	



**PILE (1,1) SECTION
NOMINAL RESISTANCES**

		Unit	Z=0 m		Z=11m		Remark
			Atual	Allowable	Atual	Allowable	
Reinforcement		mm	30-D32		16-D25		
Area As		cm ²	241.27		78.54		
Combination 1	P	kN	2770	9314	2770	15877	OK
	M	kN·m	2054	6908	1021	5851	OK
Combination 2	P	kN	1269	3538	1269	4594	OK
	M	kN·m	1932	5386	969	3508	OK
Combination 3	P	kN	3836	23935	3836	30657	OK
	M	kN·m	1045	6522	368	2940	OK
Combination 4	P	kN	1860	4170	1860	5765	O.K
	M	kN·m	2504	5612	1277	3957	O.K
Combination 5	P	kN	501	793	501	527	O.K
	M	kN·m	2716	4297	1443	1516	O.K

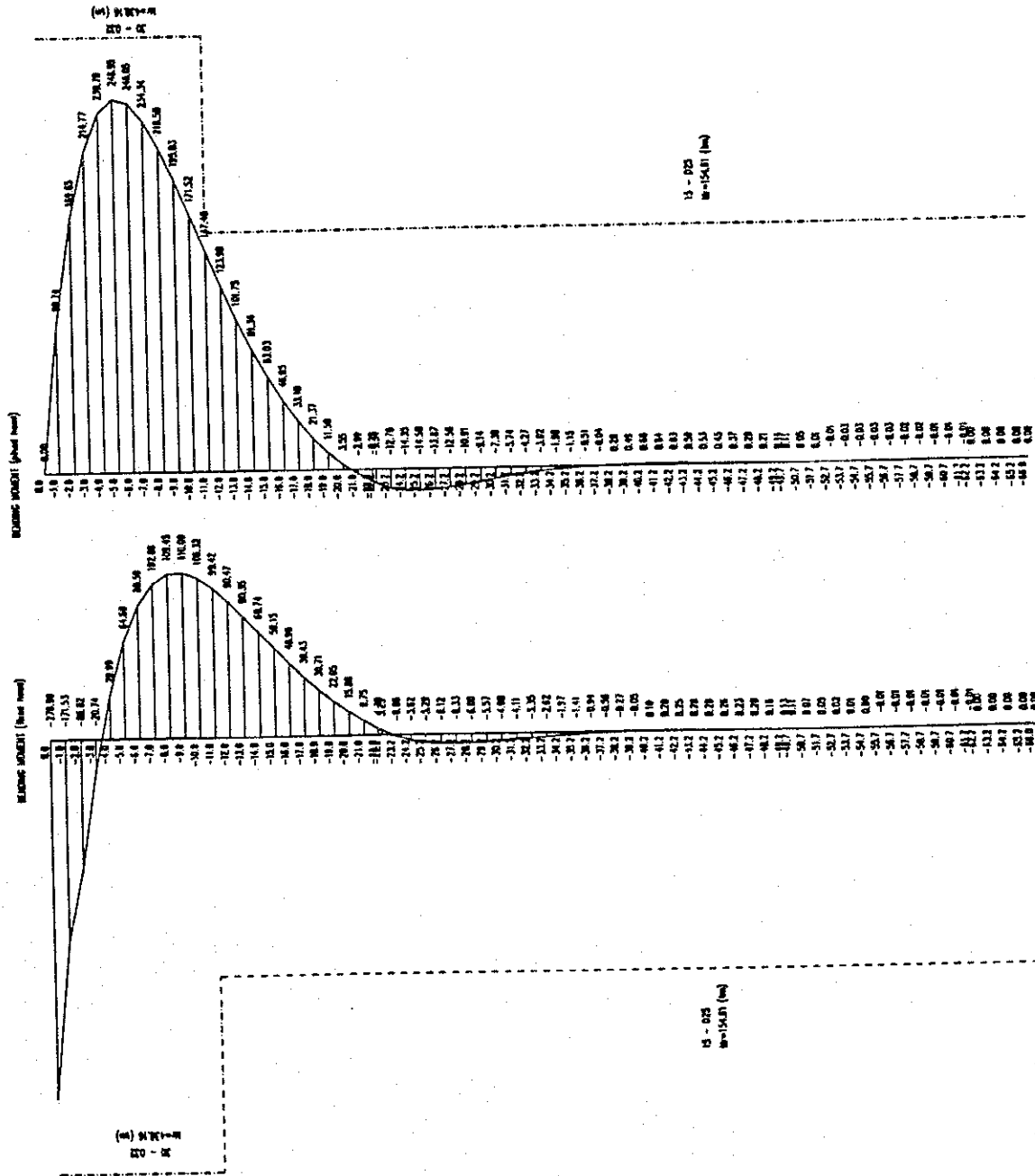
STRESS

	Stress of reinforcement δs (MPa)		Stress of concrete δc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
Combination 1	108.5	220.6	8.21	12.26	OK
Combination 2	156.3	220.6	7.89	12.26	OK
Combination 3	-59.7	220.6	4.49	12.26	OK
Combination 4	231.5	294.2	11.66	14.71	OK
Combination 5	278.3	294.2	11.13	14.71	OK

STRESS OF PILE CAP

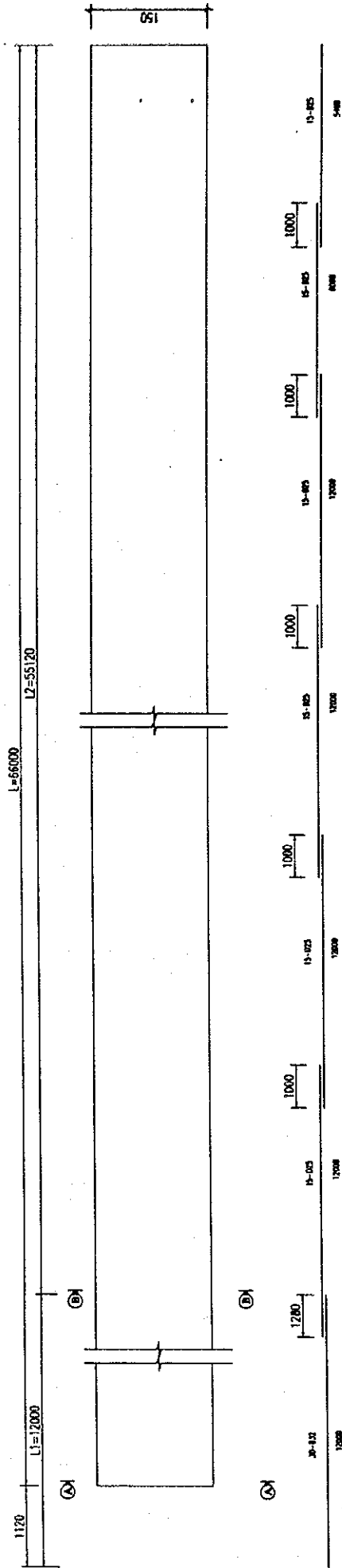
	Actual (MPa)		Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} =$	3.11	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c =$	0.27	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} =$	6.92	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c =$	0.48	$\tau_a = 0.88$	OK

COMBINATION 5 : PILE (1,1)

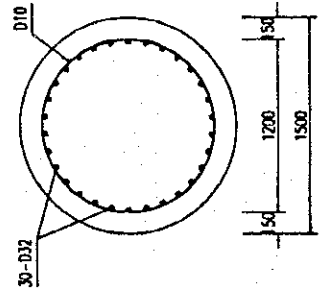


ABUTMENT A1 - SMALL TRA YA BRIDGE

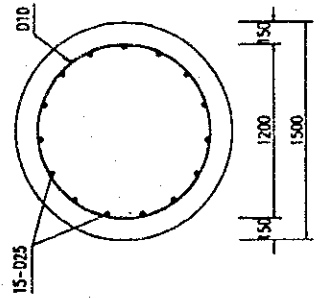
PILE PLAN OF ABUTMENT A1 - SMALL TRA VA BRIDGE



A - A



B - B



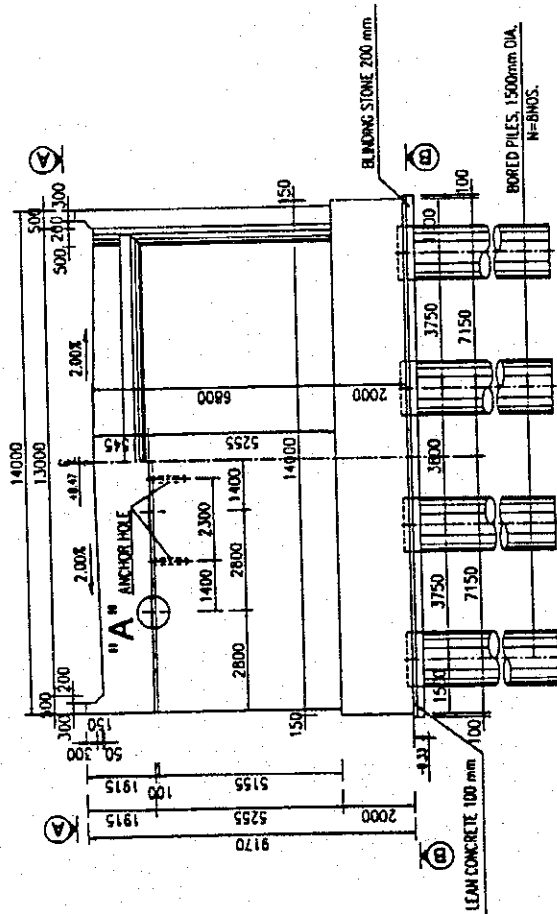
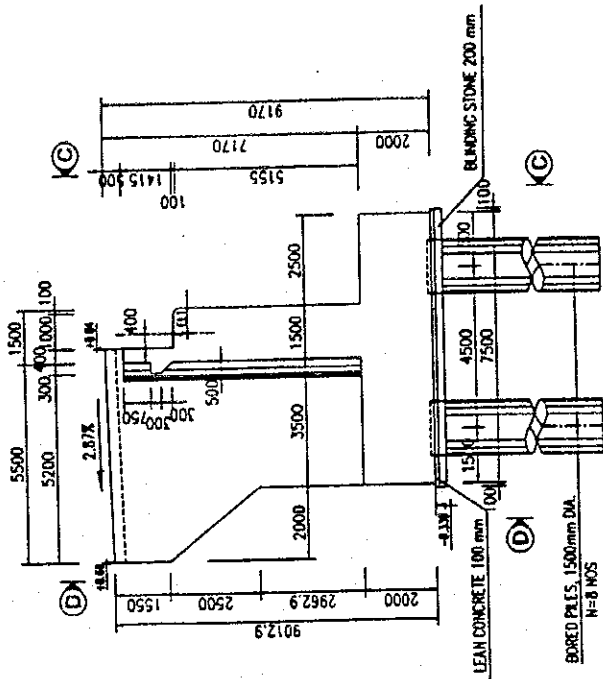
1. GENERAL VIEW ABUTMENT A1 OF INTERCHANGE 2 FLYOVER BRIDGE

(SCALE 1:200)

ABUTMENT, TYPE A4

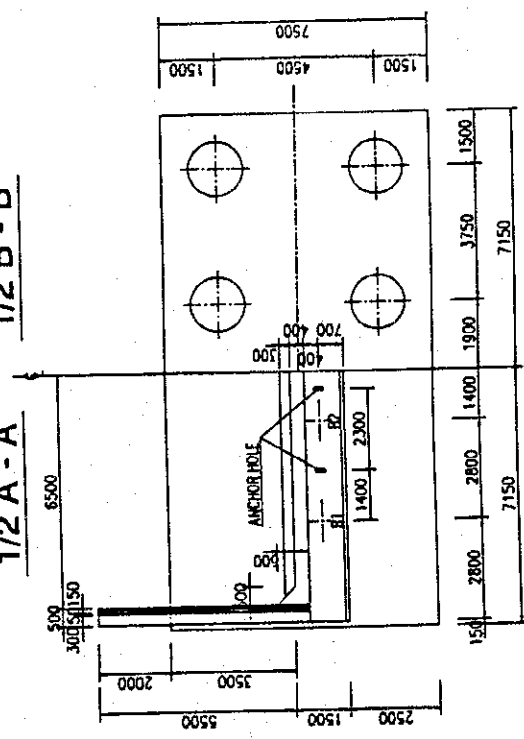
1/2 C - C 1/2 D - D

SIZE ELEVATION



1/2 B - B

1/2 A - A



2. LOAD COMBINATIONS - NH54 ABUTMENT

Abutment DC 1062 T $e_s = 0.08$ m $e_s = 0.65$ m S $D_{\text{foun}} = 2.5$ m

Nos	Items	Pz			Hx			My			Mx			Notes
		n=1	n<1	n>1	n=1	N<1	n>1	n=1	n<1	n>1	n=1	n=1	n>1	
	Permanent load													
1	Superstructure - DC (n=0.9,1.25)	285	257	356				157	141	196				
2	Wearing surface - DW (n=0.65,1.5)	37	24	56				20	13	31				
3	Abutment - DC (n=0.9,1.25)	1,062	956	1,327				85	76	106				
4	Horizontal earth pressure - EH (n=0.9,1.35)				277	200	461	813	587	1,351				
5	Horizontal earth pressure - E _{AE} (n=0.9,1.35)				351	259	571	1,028	760	1,675				
6	Vertical earth pressure - EV (n=0.9,1.35)	695	626	938				-1,494	-1,345	-2,017				
	Transient Loads													
7	Live load - LL (n= 0.5,1.75)	164	47	287				66	19	115	0	0	0	
8	Dynamic load allowance - IM (n=0.5,1.75)	54	16	95				22	6	38	0	0	0	
9	Live load surcharge - LS (n=0.9,1.35)				53	40	83	231	174	366				
10	Braking force - BR (n=0.5,1.75)				28	14	49	329	164	575				25% of Japanese Load - pf f=0.25
11	Friction force - FR (n=1)				0			0						
	a- Dead load													
	b- Dead load + Live load				0			0						
12	Earthquake - EQ (n=1)				160			530						12% of Dead load

LOAD COMBINATION TABLE

Load combinations	Pz	Hx	My	Mx
1	3059	592	760	0.0
2	1862	544	603	0
3	3059	191	-1346	0
4	2740	828	1075	0
5	1924	828	1646	0

- Combination 1 1.25DC + 1.5DW + 1.35EV + 1.35EH + 1.75LL + 1.75IM + 1.35LS + 1.75BR + 1FR(b)
- Combination 2 0.9DC + 0.65DW + 0.9EV + 1.35EH + 1.35LS + 1FR(a)
- Combination 3 1.25DC + 1.5DW + 1.35EV + 0.9EH + 1.75LL + 1.75IM + 0.9LS - 1.75BR - 1FR(b)
- Combination 4 1.25DC + 1.5DW + 1.35EV + 1.35EAE + 0.5LL + 0.5IM + 1.35LS + 0.5BR + 1FR(b) + 1EQ
- Combination 5 0.9DC + 0.65DW + 0.9EV + 1.35EAE + 0.5LL + 0.5IM + 1.35LS + 0.5BR + 1FR(b) + EQ

Bridge name NH.54B I.C -A1

File Type Dia = 1500 mm Length = 71.0 m

Bearing Capacity $Q_s = \underline{14592 \text{ kN}}$ $Q_{ult} = \underline{16978 \text{ kN}}$

Longitudinal direction

Load Combination	Displacement δ (mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	10.9	30	4960	7188	2539	-6708	OK
Strength I-2	9.9	30	3352	7188	1213	-6708	OK
Strength I-3	2.2	30	4067	7188	3433	-6708	OK
Extremme Event I-1	1.53	20	5057	7188	1660	-6708	O.K
Extremme Event I-2	15.7	20	4311	7188	406	-6708	OK

WALL

Section A-A (h = 150 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = ϕ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 30 cm ² (D=2.2cm, 8 Nos)	
						A's = 8 cm ² (D=1.6cm, 4 Nos)	
1	389	518	1363	1422	OK	$\rho_s = A_s/A_c =$	0.0020
2	248	330			$\rho_{min} = 0.03 f_c/f_y =$	0.0018	
3	77	102			$\therefore \rho_s > \rho_{min}$	O.K	
4	384	511			c/de =	0.04	
5	386	513			$\therefore c/de < 0.42$	O.K	

Section B-B (h = 40 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = ϕ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 12 cm ² (D=1.4cm, 8 Nos)	
						A's = 6 cm ² (D=1.4cm, 4 Nos)	
1	54	72	98	98	OK	$\rho_s = A_s/A_c =$	0.0031
					$\rho_{min} = 0.03 f_c/f_y =$	0.0018	
					$\therefore \rho_s > \rho_{min}$	O.K	
					c/de =	0.05	
					$\therefore c/de < 0.42$	O.K	

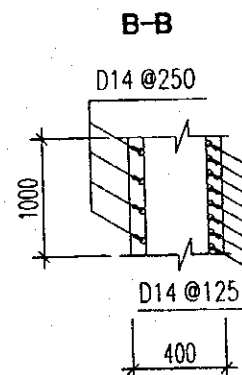
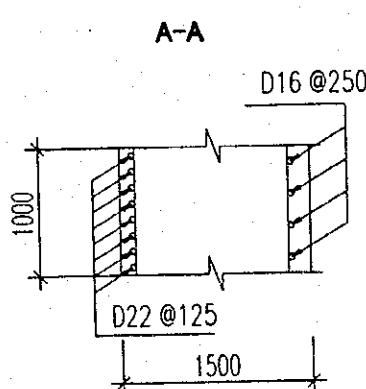
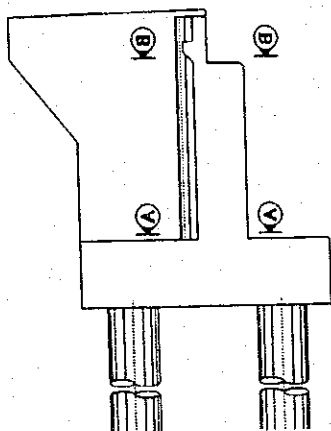
FOR SERVICE LIMIT STATE

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
1	72.28	159.4	98.8	229.5	OK

Stress

	Actual	Allowable	Remark
f _c tensile =	1.31 (MPa)	$f_r = 0.63 \cdot (f_c)^{0.5} =$ 3.03 (MPa)	OK
f _c compress =	1.34 (MPa)	$f_{ca} = 0.4f_c =$ 9.41 (MPa)	OK
f _s =	4.92 (MPa)	$f_{sa} = 0.6f_y =$ 229.48 (MPa)	OK



FOOTING

B abutment

14.00 (m)

SECTION C-C TOP FIBRE (h = 200 cm, b = 100 cm)

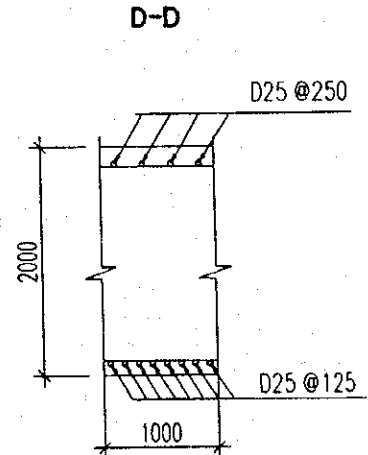
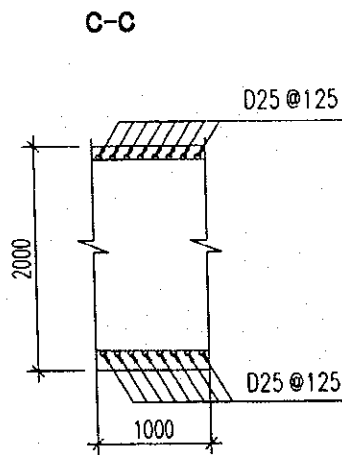
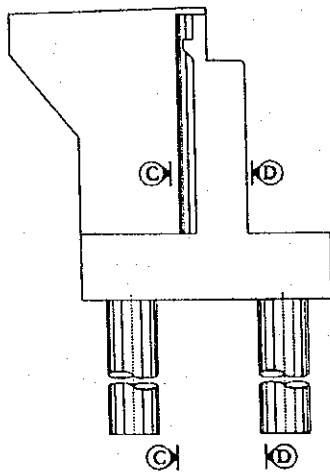
Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 39 cm ² (D=2.5cm, 8 Nos)
						A's = 39 cm ² (D=2.5cm, 8 Nos)
1	211	281	2422	2363	OK	$\rho_s = A_s/A_c = 0.0020$
2	819	1090			$\rho_{min} = 0.03 f_c/f_y = 0.0018$	
3	0	0			∴ $\rho_s > \rho_{min}$ — O.K	
4	714	949			c/de = 0.00	
5	1280	1702			∴ c/de < 0.42 — O.K	

SECTION C-C BOTTOM FIBRE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 39 cm ² (D=2.5cm, 8 Nos)
						A's = 39 cm ² (D=2.5cm, 8 Nos)
1	1547	2058	2422	2363	OK	$\rho_s = A_s/A_c = 0.0020$
2	779	1036			$\rho_{min} = 0.03 f_c/f_y = 0.0018$	
3	1037	1379			∴ $\rho_s > \rho_{min}$ — O.K	
4	1603	2132			c/de = 0.00	
5	1326	1764			∴ c/de < 0.42 — O.K	

SECTION D-D BOTTOM FIBRE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 39 cm ² (D=2.5cm, 8 Nos)
						A's = 20 cm ² (D=2.5cm, 4 Nos)
1	1850	2461	2422	2422	OK	$\rho_s = A_s/A_c = 0.0020$
2	1238	1647			$\rho_{min} = 0.03 f_c/f_y = 0.0018$	
3	1467	1951			∴ $\rho_s > \rho_{min}$ — O.K	
4	1892	2516			c/de = 0.02	
5	1649	2193			∴ c/de < 0.42 — O.K	



**PILE (1,1) SECTION
NOMINAL RESISTANCES**

		Unit	Z=0 m		Z=11m		Remark
			Atual	Allowable	Atual	Allowable	
Reinforcement		mm	32-D28		16-D25		
Area As		cm ²	197.04		78.54		
Combination 1	P	kN	2539	9086	2539	16561	OK
	M	kN·m	1792	6411	913	5956	OK
Combination 2	P	kN	1213	3505	1213	6258	OK
	M	kN·m	1668	4822	839	4331	OK
Combination 3	P	kN	3433	23079	3433	31332	OK
	M	kN·m	937	6302	295	2687	OK
Combination 4	P	kN	1660	3089	1660	5091	O.K
	M	kN·m	2504	4659	1277	3916	O.K
Combination 5	P	kN	406	616	406	567	O.K
	M	kN·m	2374	3600	1277	1785	O.K

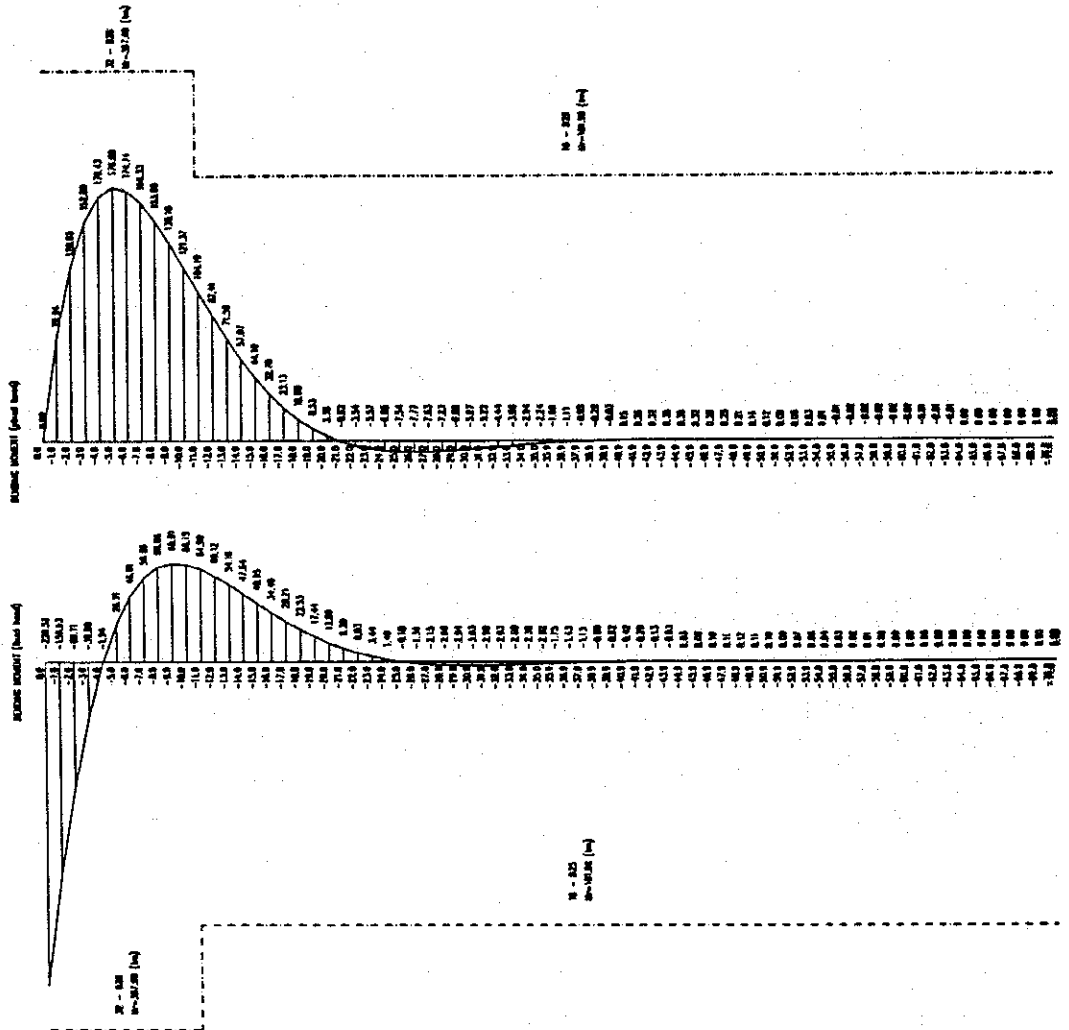
STRESS

	Stress of reinforcement δs (MPa)		Stress of concrete δc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
Combination 1	100.3	220.6	7.54	12.26	OK
Combination 2	146.9	220.6	7.28	12.26	OK
Combination 3	-57.3	220.6	4.29	12.26	OK
Combination 4	228.5	294.2	10.94	14.71	OK
Combination 5	279.1	294.2	10.49	14.71	OK

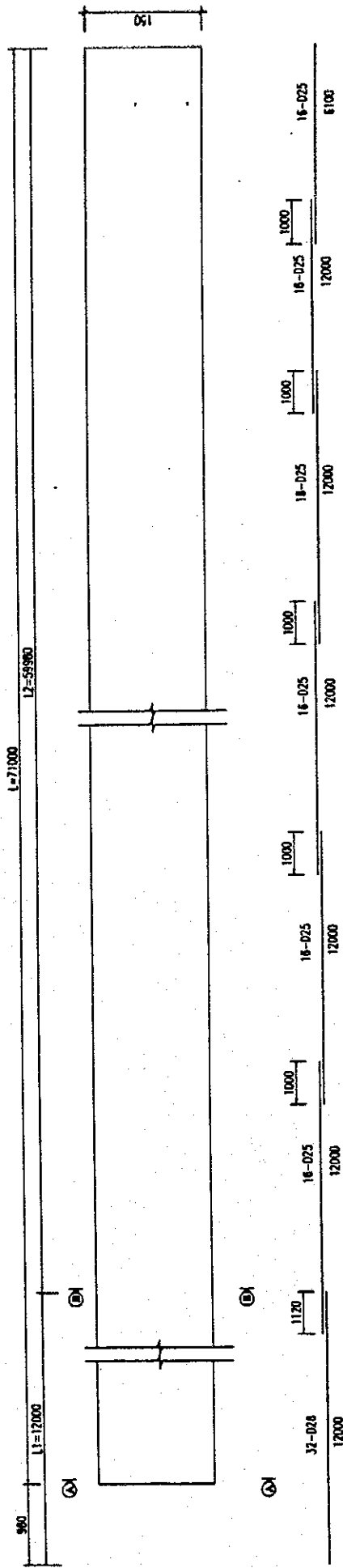
STRESS OF PILE CAP

	Actual (MPa)	Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} = 2.86$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.25$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 6.77$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.42$	$\tau_a = 0.88$	OK

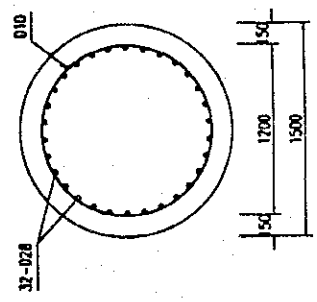
COMBINATION 5: PILE (1,1)



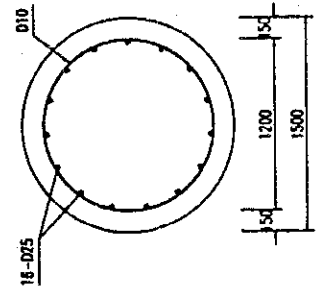
PILE PLAN OF ABUTMENT A1 - NH.54B.I.C BRIDGE



A - A



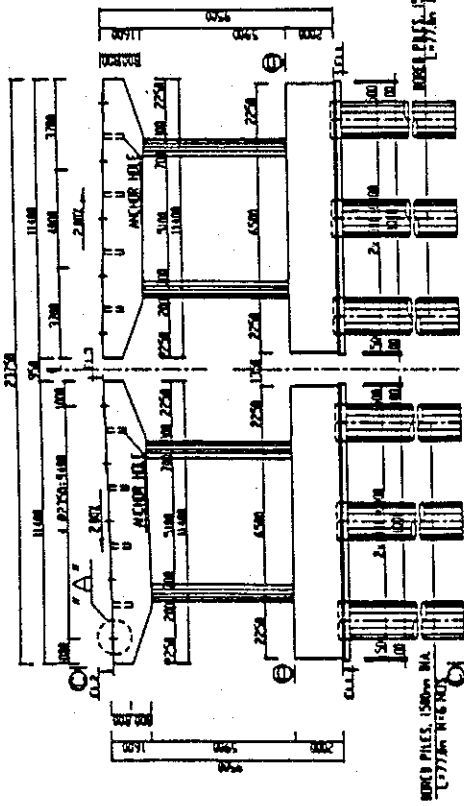
B - B



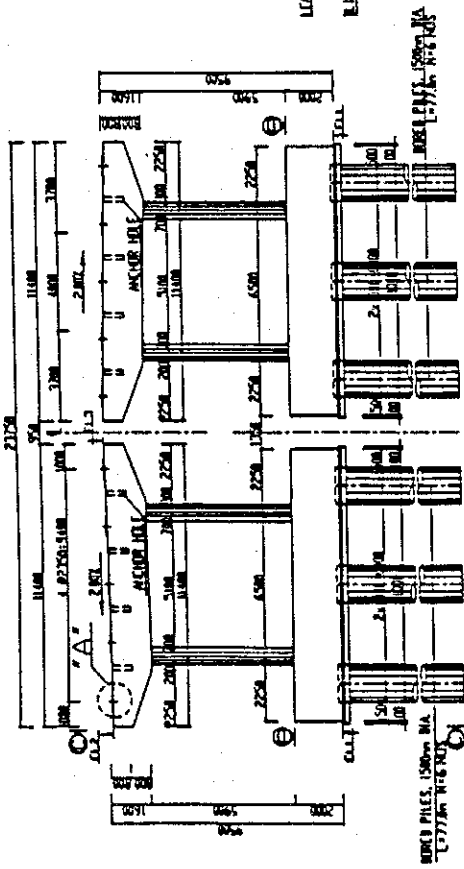
3.2

PIERS (1) PIER, TYPE P2

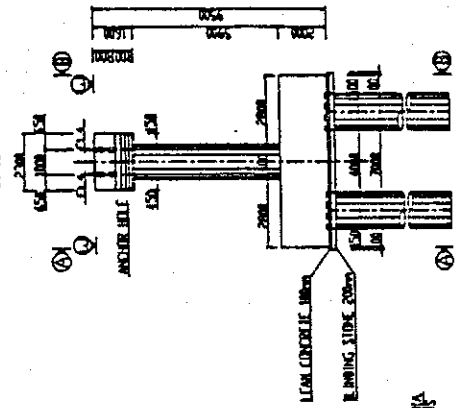
SECTION A-A
SCALE 1:200



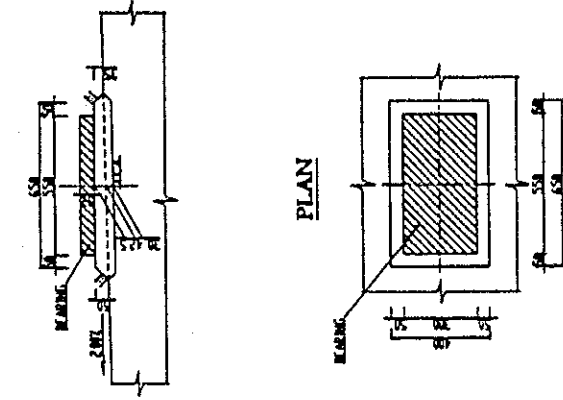
SECTION B-B
SCALE 1:200



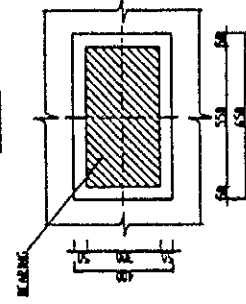
SECTION C-C
SCALE 1:200



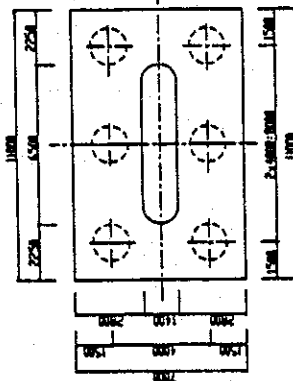
DETAIL A*
SCALE 1:50



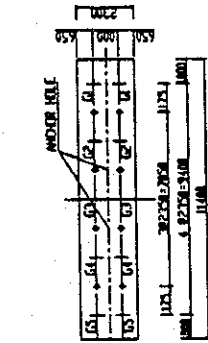
PLAN



SECTION D-D
SCALE 1:200



SECTION B-B
SCALE 1:200



DETAIL OF ANCHOR HOLE
SCALE 1:50

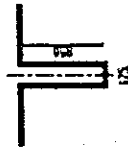


TABLE OF ELEVATION

DIRECTION	PIERS	PCA STUDY TEAM			PREPARED BY			CHECKED BY			APPROVED BY	
		EL1	EL2	EL3	G1	G2	G3	G4	G5	NAME		DATE
HO OR HIHI CITY - CA	P1	-1.51	0.15	0.68	0.57	0.14	0.14	0.27				
CA HIHI-HI OR HIHI CITY	P1	-2.0	0.14	0.16	0.14	0.16	0.16	0.16				
	P2	-2.0	0.14	0.16	0.14	0.16	0.16	0.16				
	P3	-0.5	0.17	0.5	0.17	0.17	0.17	0.17				

NOTES:
FOR STANDARD STRUCTURAL NOTES SEE DRAWING NHP/18/1002.

PROJECT NAME DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION PROJECT	SUPPLEMENTARY AGENCY JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	EXECUTING AGENCY SOCIALIST REPUBLIC OF VIET NAM MINISTRY OF TRANSPORT (MOT) SAIGON PROJECT MANAGEMENT UNIT	PCA STUDY TEAM (Logo) NIPPON KOWI CO., LTD.	PREPARED BY NAME: T. K. ... SIGNATURE: ... DATE: 10/9/2000	CHECKED BY NAME: K. ... SIGNATURE: ... DATE: 10/9/2000	APPROVED BY NAME: K. ... SIGNATURE: ... DATE: 10/9/2000	DWG. NO. P4/18/1002 PIER P1&P2-GENERAL VIEW
----------------------------------------------------------------------------------	-----------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------	------------------------------------------------	---------------------------------------------------------------------	-----------------------------------------------------------------	------------------------------------------------------------------	---------------------------------------------------

2. LOAD COMBINATIONS - TRA ON PIER 1

Nos	Items	Pz		Hx		My		Hy		Mix		Notes
		n=1	n<1	n=1	N<1	n=1	n<1	n=1	n<1	n=1	n>1	
Permanent load												
1	Superstructure - Continuous span	363	301	416		127	105	146				
2	Superstructure - Simple span	379	333	483		-247	-216	-314				
3	Pier	565	509	706								
Transient Loads												
4 Live load - each spans												
a- Continuous span												
	+ Live load - LL(n=0.5,1.75)	157	78	274		55	27	96				
	+ Live load - LL(n=0.8,1.35)	157	125	212		55	44	74				
	+ Dynamic load allowance - IM (n=0.5,1.75)	52	26	90		18	9	32				
	+ Dynamic load allowance - IM (n=0.8,1.35)	52	41	70		18	14	24				
b- Simple span												
	+ Live load - LL(n=0.5,1.75)	131	66	229		-85	-43	-149				
	+ Live load - LL(n=0.8,1.35)	131	105	177		-85	-68	-115				
	+ Dynamic load allowance - IM (n=0.5,1.75)	43	22	76		-28	-14	-49				
	+ Dynamic load allowance - IM (n=0.8,1.35)	43	35	58		-28	-23	-38				
5 Live load - Both spans												
a- Continuous span												
	+ Live load - LL(n=0.5,1.75)	58	29	101		20	10	35				
	+ Live load - LL(n=0.8,1.35)	58	46	78		20	16	27				
	+ Dynamic load allowance - IM (n=0.5,1.75)	19	10	33		7	3	12				
	+ Dynamic load allowance - IM (n=0.8,1.35)	19	15	26		7	5	9				
b- Simple span												
	+ Live load - LL(n=0.5,1.75)	131	66	229		-85	-43	-149				
	+ Live load - LL(n=0.8,1.35)	131	105	177		-85	-68	-115				
	+ Dynamic load allowance - IM (n=0.5,1.75)	43	22	76		-28	-14	-49				
	+ Dynamic load allowance - IM (n=0.8,1.35)	43	35	58		-28	-23	-38				
6 Braking force - BR (n=0.5,1.75)												
	Braking force - BR (n=0.5,1.75)		-19	-9	-33	-188	-94	-330				25% of
Braking force - BR (n=0.8,1.35)												
	Braking force - BR (n=0.8,1.35)		-19	-15	-25	-188	-151	-254				

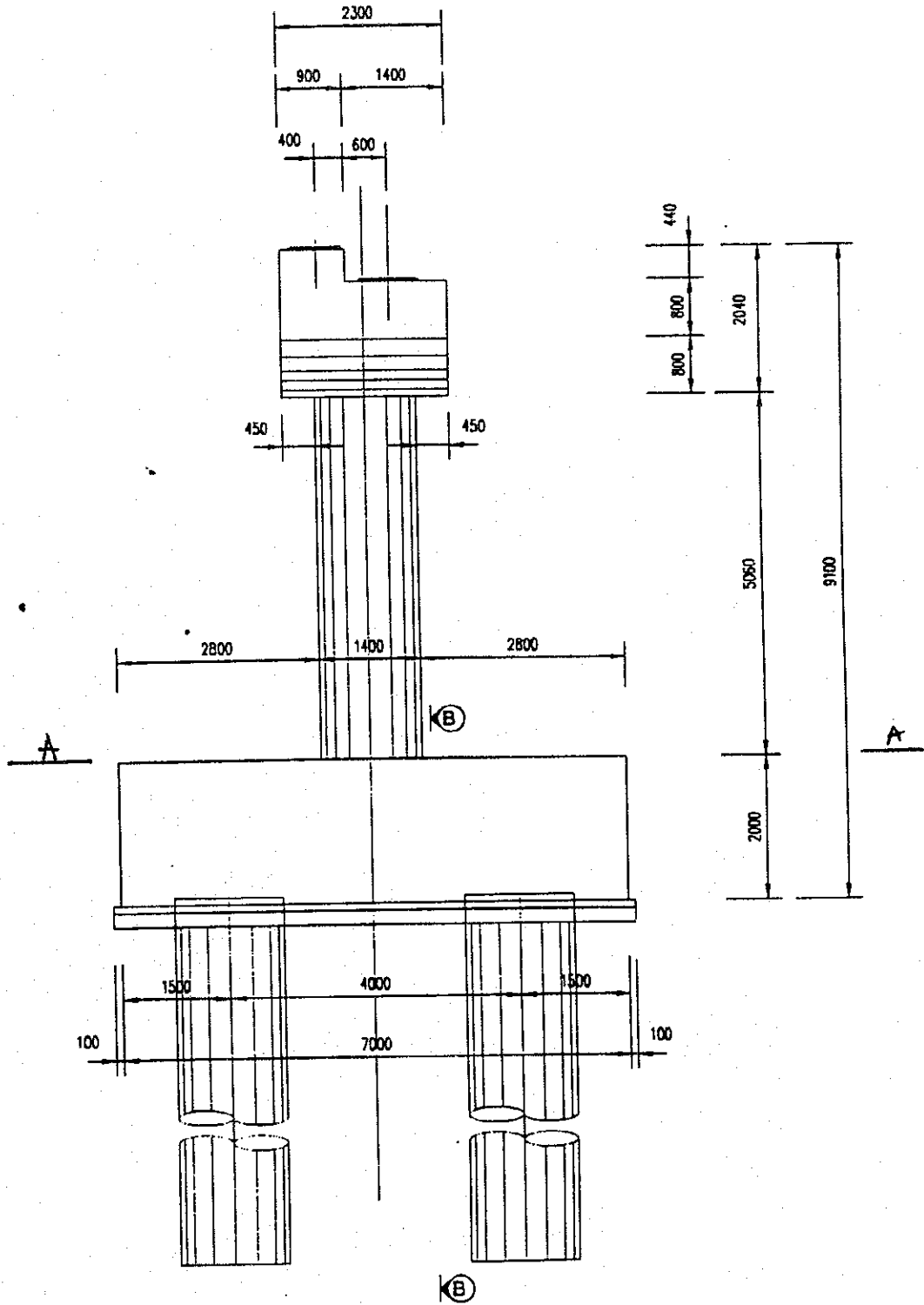
Nos	Items	Pz		Hx		My		Hy		Mx		Notes
		n=1	n>1	n=1	n>1	n<1	n>1	n=1	n>1	n=1	n>1	
7	Earthquake - EQ (n=1)			-195		-136		-157		-849		main load
	+ Pier			-24		-136		-24		-136		
	+ Pile cap			-44		-44		-44		-44		
	+ Superstructure			-127		-955		-89		-668		
				0		0		0		0		
8	Vessel collision force - CV (n=1)											
9	Wind load											
	+ Superstructure (n=0.4, n=1.4) (WS)											
	+ Live load (n=1.0) (WL)											
10	Stream force (WA)											
	+ Pier											
	+ Pile cap											

PIER P1
LOAD COMBINATION TABLE

No	Load combinations	Pz	Hx	My	Hy	Mx
1	STRENGTH-I - 1	2044.6	-32.7	-649.6	0.0	0.0
2	STRENGTH-I - 2	1910.6	-32.7	-696.6	0.0	0.0
3	STRENGTH-III	1,142	0	-111	35	322
4	STRENGTH-V	1,944	-25	-540	17	173
5	EXTREME EVEN-I - 1	1,731	-205	-1,442	-157	-849
6	EXTREME EVEN-I - 2	1,268	-205	-1,384	-157	-849
8	SERVICE-I	1,559	-19	-395	17	173

- 1 STRENGTH-I-1
1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA
- 2 STRENGTH-I-2
1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA
- 3 STRENGTH-III
0.9DC + 0.65DW + 1.0WA + 1.4WS
- 4 STRENGTH-V
1.25DC + 1.5DW + 1.35LL + 1.35IM + 1.35BR + 1.0WA + 0.4WS + 1.0WL
- 5 EXTREME EVEN-I - 1
1.25DC + 1.5DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 6 EXTREME EVEN-I - 2
0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 7 SERVICE-I
1.0DC + 1.0DW + 1.0LL + 1.0IM + 1.0BR + 1.0WA + 0.3WS + 1.0WL + 1.0CV

SIDE VIEW



Bridge name TRA ON-P1

Pile Type Dia = 1500 mm Length = 77.0 m

Bearing Capacity $Q_s = 20867$ kN $Q_{ult} = 23253$ kN

Longitudinal direction

Load Combination	Displacement δ x(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	2.4	30	5737	10219	4288	-8953	OK
Strength I-2	2.5	30	5453	10219	3915	-8953	OK
Strength I-III	0.2	30	2906	10219	2694	-8953	OK
Strength I-V	2.0	30	5361	10219	4171	-8953	OK
Extremme Event I-1	10.2	20	6271	10219	2217	-8953	O.K
Extremme Event I-2	10	20	5080	10219	1137	-8953	OK
Service-I	2.1	15	4287	6541	3357	-5482	OK

Transverse direction

Load Combination	Displacement δ y(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	0	30	5013	10219	5013	-8953	OK
Strength I-2	0	30	4684	10219	4684	-8953	OK
Strength I-III	1.3	30	3065	10219	2535	-8953	OK
Strength I-V	0.7	20	4905	10219	4627	-8953	OK
Extremme Event I-1	5.5	20	5073	10219	3415	-8953	O.K
Extremme Event I-2	5.5	30	3937	6541	2280	-8953	OK
Service-I	1.0	15	3969	6541	3675	-5482	OK

SECTION CALCULATION

A. BODY

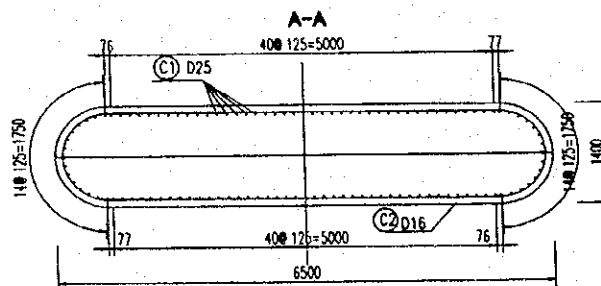
LOAD COMBINATION TABLE

No	Load combinations	Pz	Hx	My	Hy	Mx
1	STRENGTH-I - 1	2066.5	-32.7	-519.0	0.0	0.0
2	STRENGTH-I - 2	1932.5	-32.7	-565.9	0.0	0.0
3	STRENGTH-III	1,158	0	-111	35	253
4	STRENGTH-V	1,966	-25	-439	17	112
5	EXTREME EVEN-I - 1	1,753	-160	-1,058	-113	-579
6	EXTREME EVEN-I - 2	1,284	-160	-1,001	-113	-579
7	EXTREME EVEN-II	0	0	0	0	0
8	SERVICE-I	1,576	-19	-320	17	112

- 1 STRENGTH-I 1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA
- 2 STRENGTH-III 0.9DC + 0.65DW + 1.0WA + 1.4WS
- 3 STRENGTH-V 1.25DC + 1.5DW + 1.35LL + 1.35IM + 1.35BR + 1.0WA + 0.4WS + 1.0WL
- 4 EXTREME EVEN-I - 1 1.25DC + 1.5DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 5 EXTREME EVEN-I - 2 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 6 EXTREME EVEN-II 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0CV
- 7 SERVICE-I 1.0DC + 1.0DW + 1.0LL + 1.0IM + 1.0BR + 1.0WA + 0.3WS + 1.0WL + 1.0CV

SECTION CALCULATION SECTION A - A

Combination		1		2	
		kN.m		kN.m	
Actual Moment	kN.m	5090	20270	9816	12592
Allowable Moment	kN.m	19447	77482	21830	27998
			OK		OK
Reinforcement			D25 @ 125		



FOOTING

B pier

10.50 (m)

STRENGTH & EXTREME EVENT LIMIT STATE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 40 cm ² (D=3.2cm, 5 Nos)
						A's = 11 cm ² (D=2.2cm, 3 Nos)
1	1180	1570	2422	2491	OK	$\rho_s = A_s/A_c = 0.0020$
2	1110	1476			$\rho_{min} = 0.03 f/f_y = 0.0018$	
3	547	727			$\therefore \rho_s > \rho_{min} \text{ ----- O.K}$	
4	1087	1446			$c/de = 0.04$	
5	1313	1746			$\therefore c/de < 0.42 \text{ ----- O.K}$	
6	1085	1443			OK	

SERVICE LIMIT STATE

(h = 200 cm, b = 100 cm)

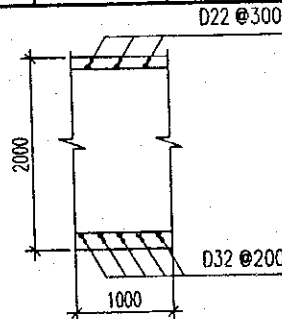
As = 40 cm² (D=3.2cm, 5 Nos) A's = 11 cm² (D=2.2cm, 3 Nos)

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
7	869.46	119	119	229	OK

Stress

Actual		Allowable		Remark
f _c tensile =	1.25 (MPa)	f _r = 0.63·(f _c) ^{0.5} =	3.03 (MPa)	OK
f _c compress =	1.28 (MPa)	f _{ca} = 0.4f _c =	9.41 (MPa)	OK
f _s =	8.08 (MPa)	f _{sa} = 0.6f _y =	229.48 (MPa)	OK



PILE (1,1) SECTION

NOMINAL RESISTANCES

	Unit	Z=5 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area A _s	cm ²	68.72		68.72		
a. Longitudinal direction						
Combination 1	P	kN	4288	32386		OK
	M	kN·m	267	2019		OK
Combination 2	P	kN	3915	31828		OK
	M	kN·m	284	2311		OK
Combination 3	P	kN	2694	34891		OK
	M	kN·m	40	518		OK
Combination 4	P	kN	4171	32907		O.K
	M	kN·m	220	1734		O.K
Combination 5	P	kN	2217	11397		O.K
	M	kN·m	1074	5520		O.K
Combination 6	P	kN	1137	3122		O.K
	M	kN·m	1074	2948		O.K
Combination 7	P	kN	3357	33436		O.K
	M	kN·m	144	1430		O.K

	Unit	Z=5 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		
b. Transverse direction						
Combination 1	P	kN	5013	35807		OK
	M	kN·m	0	0		OK
Combination 2	P	kN	4684	35807		OK
	M	kN·m	0	0		OK
Combination 3	P	kN	2535	31843		OK
	M	kN·m	183	2303		OK
Combination 4	P	kN	4627	34668		O.K
	M	kN·m	89	666		O.K
Combination 5	P	kN	3415	22419		O.K
	M	kN·m	822	5399		O.K
Combination 6	P	kN	2280	16302		O.K
	M	kN·m	822	5879		O.K
Combination 7	P	kN	3675	34210		O.K
	M	kN·m	103	960		O.K

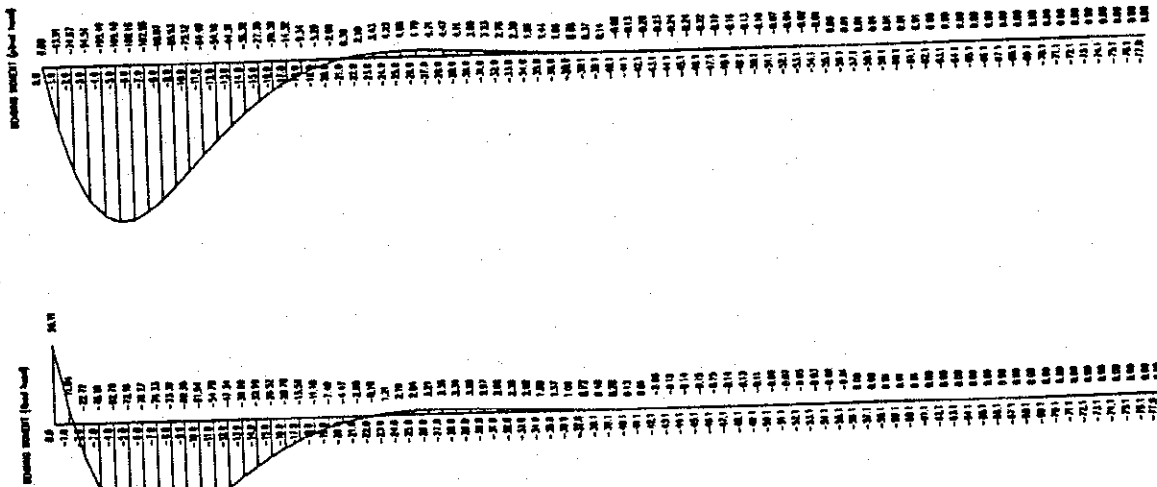
STRESS

	Stress of reinforcement ds (MPa)		Stress of concrete dc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
a. Longitudinal direction					
Combination 1	-55.2	220.6	3.83	12.26	OK
Combination 2	-53.6	220.6	3.76	12.26	OK
Combination 3	-25.3	220.6	1.72	12.26	OK
Combination 4	-50.6	220.6	3.50	12.26	OK
Combination 5	-86.3	294.2	6.35	14.71	OK
Combination 6	175.7	294.2	6.96	14.71	OK
Combination 7	-39.2	176.5	2.70	9.81	OK
b. Transverse direction					
Combination 1	-40.1	220.6	2.68	12.26	OK
Combination 2	-37.5	220.6	2.50	12.26	OK
Combination 3	-31.4	220.6	2.23	12.26	OK
Combination 4	-42.5	220.6	2.88	12.26	OK
Combination 5	-75.1	294.2	5.58	14.71	OK
Combination 6	-66.9	294.2	5.12	14.71	OK
Combination 7	-36.0	176.5	2.47	9.81	OK

STRESS OF PILE CAP

	Actual (MPa)	Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} = 3.55$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.31$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 3.35$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.21$	$\tau_a = 0.88$	OK

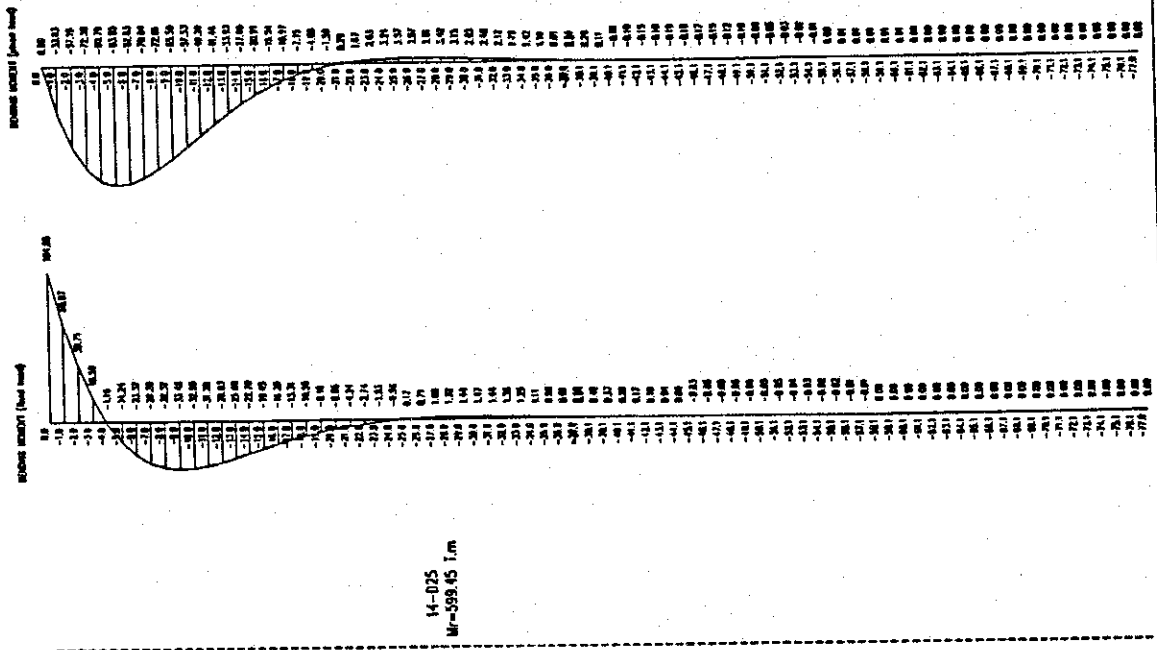
COMBINATION 6 : PILE (1,1)
LONGITUDINAL DIRECTION



PIER P1 - TRA ON BRIDGE

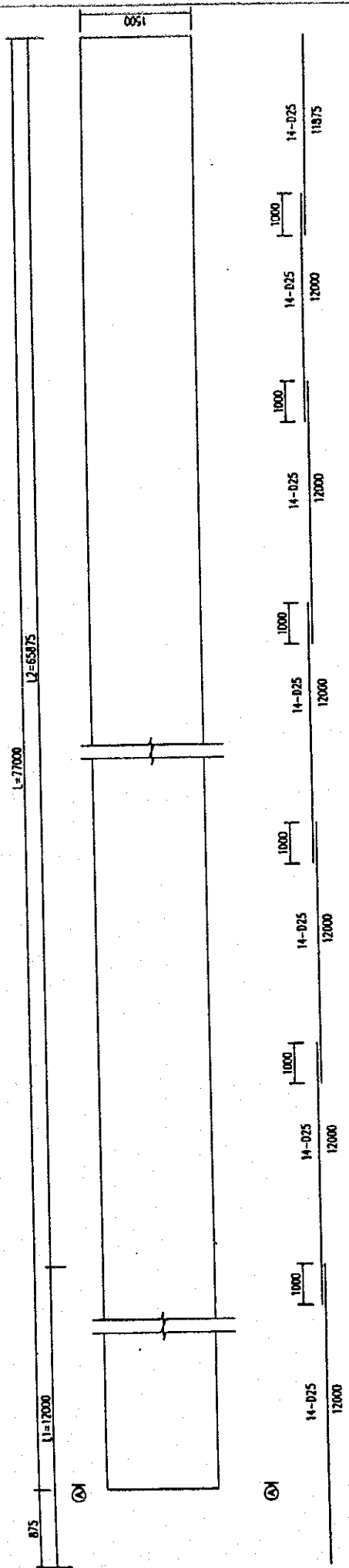
COMBINATION 6 : PILE (1,1)

TRANSVERSE DIRECTION

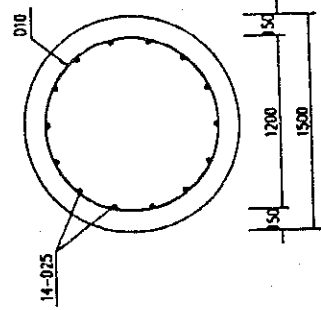


PIER P1 - TRA ON BRIDGE

PILE PLAN OF PIER P1 - TRA ON BRIDGE

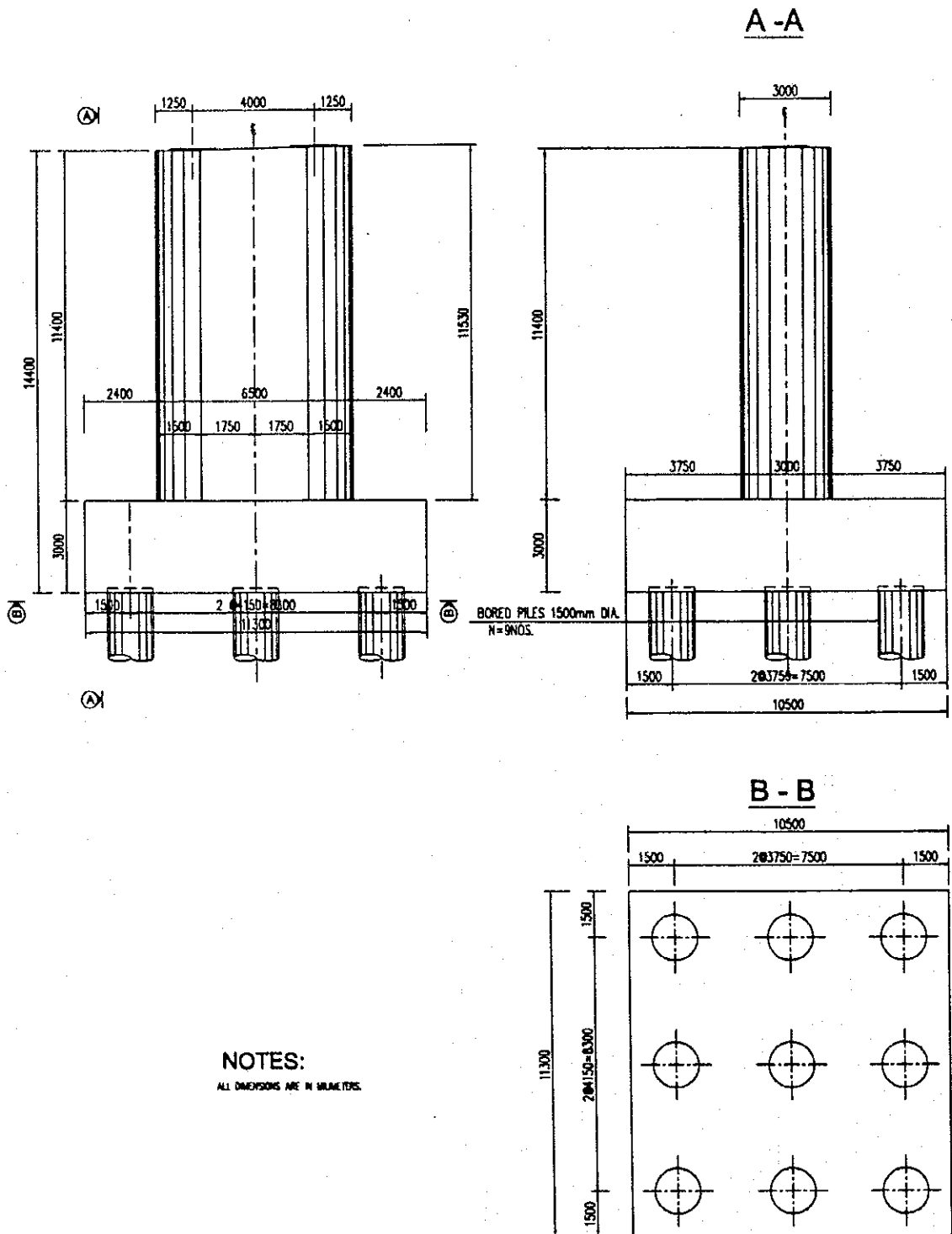


A - A



(2) PIER, TYPE P4

1. GENERAL VIEW OF PIER P2 - TRA ON BRIDGE



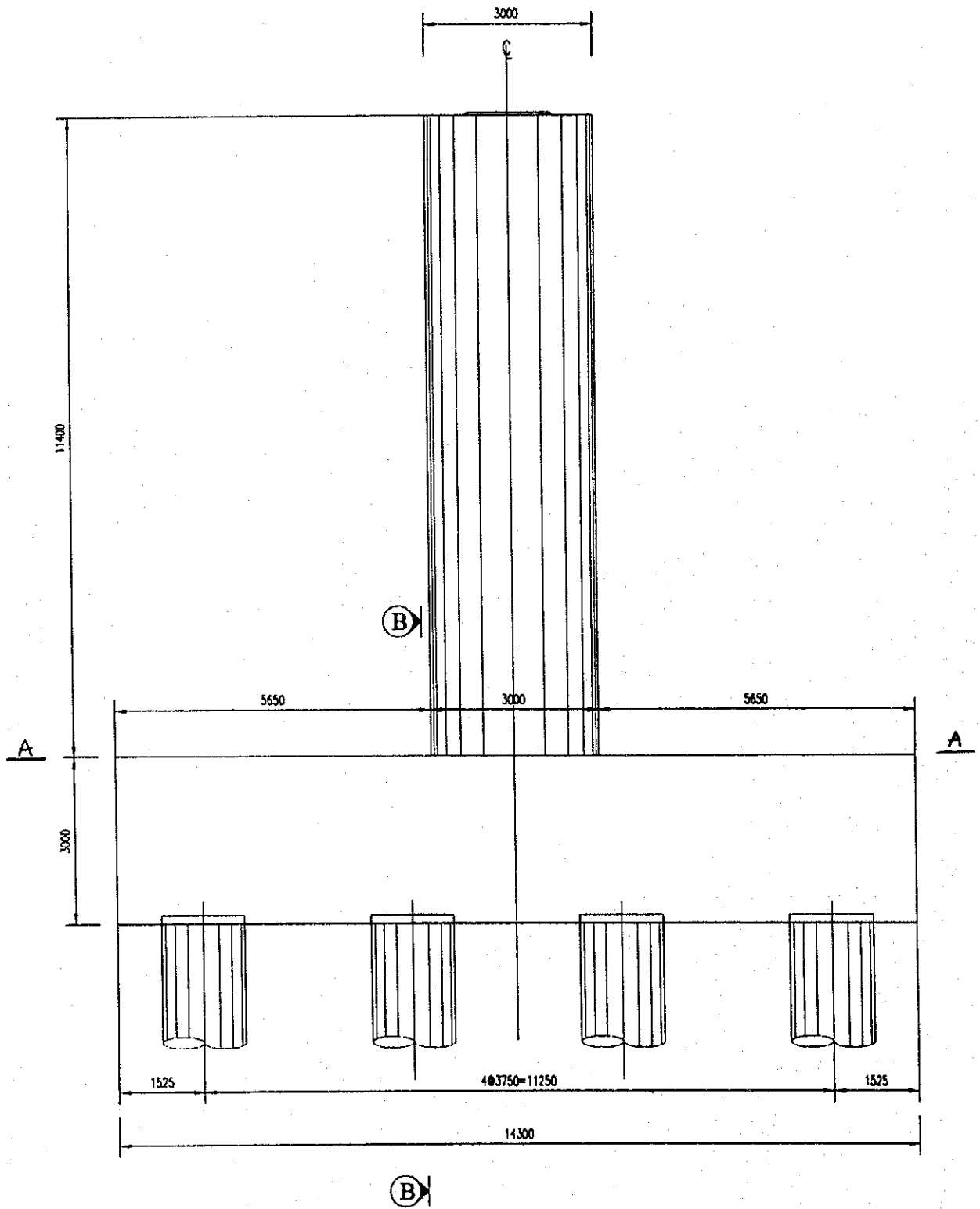
2. LOAD COMBINATIONS - TRA ON PIER 2

Nos	Items	Pz		Hx		My		Hy		Mx		Notes	
		n=1	n>1	n=1	n>1	n=1	n>1	n=1	n>1	n=1	n>1		
	Permanent load												
1	Superstructure - Pier self weigh	3,413	2,950	86	72	108	1,245	1,036	1,553	0	0	0	0
	Transient Loads												
2	Live load - LL(n=0.5,1.75)	339	170	593	48	166	1,368	684	2,394	0	0	0	0
	Live load - LL(n=0.8,1.35)	339	271	458	76	128	1,368	1,094	1,847				
3	Dynamic load allowance - IM (n=0.5,1.75)	112	56	196	31	16	55	451	226	790			
	Dynamic load allowance - IM (n=0.8,1.35)	112	89	151	31	25	42	451	361	609			
4	Braking force - BR (n=0.5,1.75)				57	28	99	1,107	554	1,938			25% of main load
	Braking force - BR (n=0.8,1.35)				57	45	76	1,107	886	1,495			
5	Earthquake - EQ (n=1)			453			5,140			410			4,513
	+ Pier			107			929			107			929
	+ Pile cap			60			90			60			90
	+ Superstructure			286			4,121			243			3,494
6	Vessel collision force - CV (n=1)			166			1,746			333			3,492
7	Wind load												
	+ Superstructure (n=0.4,n=1.4) (WS)									74	30	104	1,360
	+ Live load(n=1.0) (WL)									14			298
8	Stream force (WA)									43			143
	+ Pier									15			100
	+ Pile cap									28			43

LOAD COMBINATION TABLE

No	Load combinations	Pz	Hx	My	Hy	Mx
1	STRENGTH-I	5050.2	428.0	6675.0	43.2	142.9
2	STRENGTH-III	2,950	72	1,036	147	2,047
3	STRENGTH-V	4,870	355	5,504	87	985
4	EXTREME EVEN-I - 1	4,487	652	8,157	453	4,656
5	EXTREME EVEN-I - 2	3,175	616	7,640	453	4,656
6	EXTREME EVEN-II	3,175	330	4,245	376	3,635
7	SERVICE-I	3,863	269	4,172	87	985

- 1 STRENGTH-I
1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA
- 2 STRENGTH-III
0.9DC + 0.65DW + 1.0WA + 1.4WS
- 3 STRENGTH-V
1.25DC + 1.5DW + 1.35LL + 1.35IM + 1.35BR + 1.0WA + 0.4WS + 1.0WL
- 4 EXTREME EVEN-I - 1
1.25DC + 1.5DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 5 EXTREME EVEN-I - 2
0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 6 EXTREME EVEN-II
0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0CV
- 7 SERVICE-I
1.0DC + 1.0DW + 1.0LL + 1.0IM + 1.0BR + 1.0WA + 0.3WS + 1.0WL + 1.0CV



Bridge name **TRA ON-P2**

File Type Dia = 1500 mm Length = 71.0 m

Bearing Capacity Qs = 21321 kN Qult = 23706 kN

Longitudinal direction

Load Combination	Displacement δ x(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I	9	30	8648	10562	2358	-8953	OK
Strength III	1.5	30	3710	10562	2719	-8953	OK
Strength V	7.5	30	7902	10562	2711	-8953	OK
Extremme Event I-1	12.9	20	8898	10562	880	-8953	O.K
Extremme Event I-2	12.2	20	7221	10562	-302	-8953	OK
Extremme Event II	6.6	30	5534	10562	1385	-8953	OK
Service I	8.6	15	6278	6786	2140	-5403	OK

Transverse direction

Load Combination	Displacement δ y(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I	1.1	30	5617	10562	5389	-8953	OK
Strength III	2.8	30	4122	10562	2307	-8953	OK
Strength V	1.6	30	5763	10562	4850	-8953	OK
Extremme Event I-1	8.1	20	7095	10562	2683	-8953	O.K
Extremme Event I-2	8.1	20	5665	10562	1254	-8953	OK
Extremme Event II	6.6	30	5208	10562	1711	-8953	OK
Service I	2.5	15	4692	6786	3727	-5403	OK

SECTION CALCULATION

A. BODY

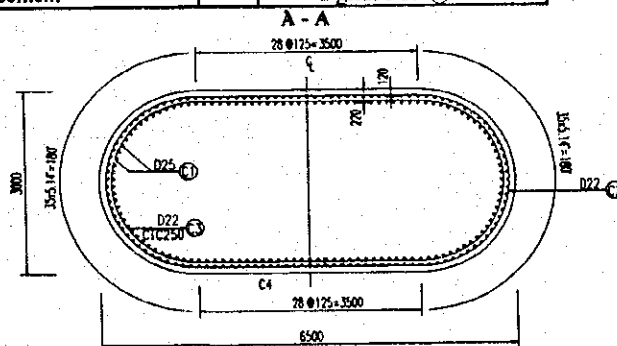
LOAD COMBINATION TABLE

No	Load combinations	Pz	Hx	My	Hy	Mx
1	STRENGTH-I	5451	428.0	5715	43.2	142.9
2	STRENGTH-III	3238	72.0	1036	147.0	1734
3	STRENGTH-V	5271	355.0	4764	87.0	854
4	EXTREME EVEN-I - 1	4887	631.0	6004	491.0	3591
5	EXTREME EVEN-I - 2	3463	595.0	5487	491.0	3591
6	EXTREME EVEN-II	3463	330.0	3472	376.0	2637
7	SERVICE-I	4184	269.0	3623	87.0	854

- 1 STRENGTH-I 1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA
- 2 STRENGTH-III 0.9DC + 0.65DW + 1.0WA + 1.4WS
- 3 STRENGTH-V 1.25DC + 1.5DW + 1.35LL + 1.35IM + 1.35BR + 1.0WA + 0.4WS + 1.0WL
- 4 EXTREME EVEN-I - 1 1.25DC + 1.5DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 5 EXTREME EVEN-I - 2 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 6 EXTREME EVEN-II 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0CV
- 7 SERVICE-I 1.0DC + 1.0DW + 1.0LL + 1.0IM + 1.0BR + 1.0WA + 0.3WS + 1.0WL + 1.0CV

SECTION CALCULATION SECTION A - A

Combination		1	2
Actual Moment	kN.m	58879/47925	53809/33960
Allowable Moment	kN.m	103362/84131	103166/65106
		OK	OK
Reinforcement		2 grids D25 @ 125	



FOOTING

B pier

11.30 (m)

STRENGTH & EXTREME EVENT LIMIT STATE (h = 300 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 64 cm ² (D=3.2cm, 8 Nos)
						A's = 39 cm ² (D=2.5cm, 8 Nos)
1	4562	6068	5452	6041	OK	ρs = As/Ac = 0.0021
2	1782	2369			ρmin = 0.03 f'/fy = 0.0018	
3	4117	5476			∴ ρs > ρmin O.K	
4	4712	6267			c/de = 0.02	
5	3879	5159			∴ c/de < 0.42 O.K	
6	2871	3819			OK	

SERVICE LIMIT STATE

(h = 300 cm, b = 100 cm)

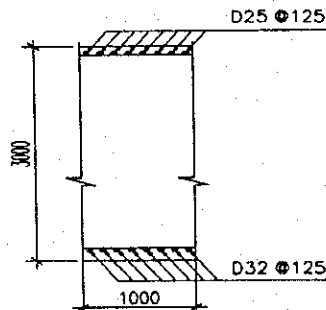
As = 64 cm² (D=3.2cm, 8 Nos) A's = 39 cm² (D=2.5cm, 8 Nos)

Cracking

Combination	M (kN·m)	fsa (MPa)	fs (MPa)	0.6·fy (MPa)	fsa < 0.6·fy
7	3267.48	126	183	229	OK

Stress

Actual		Allowable		Remark
fc tensile =	2.09 (MPa)	fr = 0.63·(fc) ^{0.5} =	3.03 (MPa)	
fc compress =	2.14 (MPa)	fca = 0.4fc =	9.41 (MPa)	OK
fs =	13.71 (MPa)	fsa = 0.6fy =	229.48 (MPa)	OK



PILE (1,1) SECTION

NOMINAL RESISTANCES

	Unit	Z=5 m		Z=11 m		Remark	
		Atual	Allowable	Atual	Allowable		
Reinforcement	mm	28-D25		14-D25			
Area As	cm ²	137.44		68.72			
a. Longitudinal direction							
Combination 1	P	kN	2358	15185	2358	21981	OK
	M	kN·m	996	6416	587	5471	OK
Combination 2	P	kN	2719	34114	2719	33779	OK
	M	kN·m	168	2102	99	1226	OK
Combination 3	P	kN	2711	20326	2711	25827	OK
	M	kN·m	826	6195	487	4638	OK
Combination 4	P	kN	880	1959	880	2703	O.K
	M	kN·m	1518	3377	894	2745	O.K
Combination 5	P	kN	-302	-457	-302	-384	O.K
	M	kN·m	1434	2169	845	1073	O.K
Combination 6	P	kN	1385	11085	1385	17929	O.K
	M	kN·m	768	6147	452	5857	O.K
Combination 7	P	kN	2140	18645	2140	21166	O.K
	M	kN·m	727	6330	565	5587	O.K

	Unit	Z=5 m		Z=11 m		Remark	
		Atual	Allowable	Atual	Allowable		
Reinforcement	mm	28-D25		14-D25			
Area As	cm ²	137.44		68.72			
b. Transverse direction							
Combination 1	P	kN	5389	36330	5389	34792	OK
	M	kN·m	117	787	91	584	OK
Combination 2	P	kN	2307	29079	2307	31018	OK
	M	kN·m	342	4314	202	2710	OK
Combination 3	P	kN	4850	35225	4850	34392	OK
	M	kN·m	203	1472	119	845	OK
Combination 4	P	kN	2683	16316	2683	22933	O.K
	M	kN·m	1055	6412	621	5308	O.K
Combination 5	P	kN	1254	5828	1254	11011	O.K
	M	kN·m	1055	4902	621	5456	O.K
Combination 6	P	kN	1711	12306	1711	19199	O.K
	M	kN·m	875	6296	516	5786	O.K
Combination 7	P	kN	3727	34033	3727	33101	O.K
	M	kN·m	235	2145	183	1624	O.K

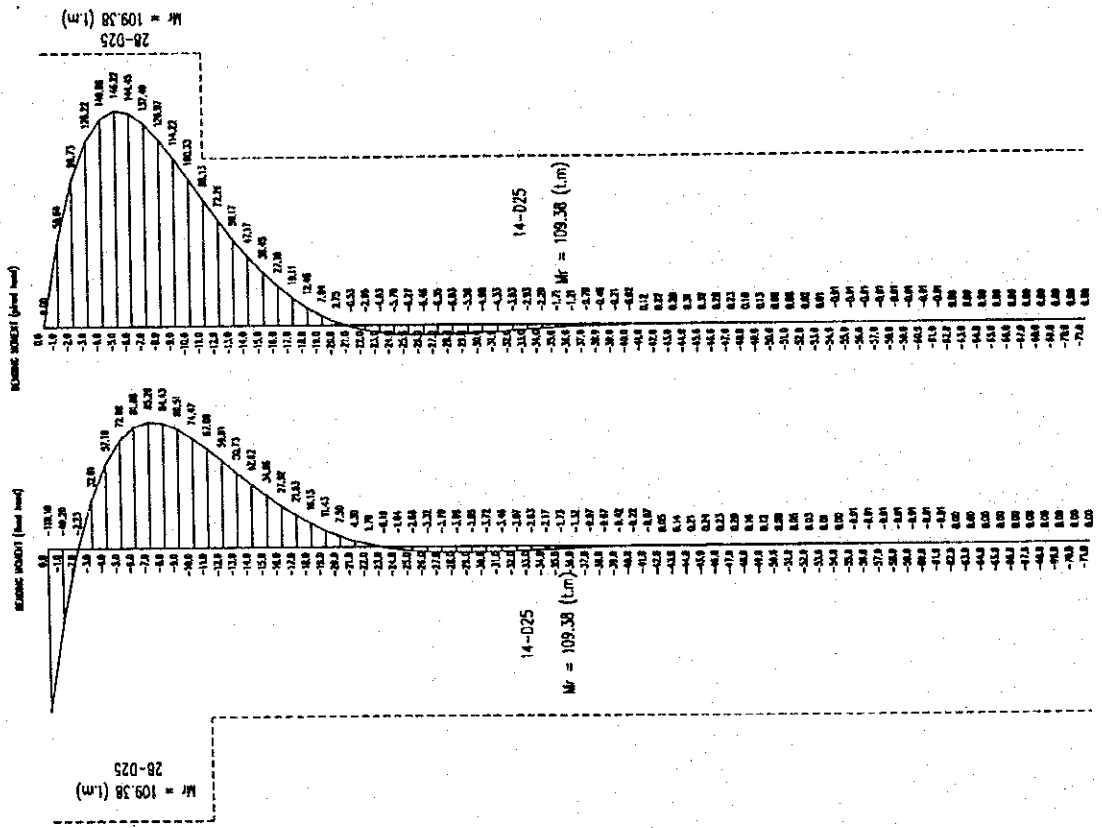
STRESS

	Stress of reinforcement ds (MPa)		Stress of concrete dc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
a. Longitudinal direction					
Combination 1	-96.8	220.6	6.97	12.26	OK
Combination 2	-33.4	220.6	2.31	12.26	OK
Combination 3	-85.8	220.6	6.16	12.26	OK
Combination 4	199.1	220.6	8.07	12.26	OK
Combination 5	280.1	294.2	7.71	14.71	OK
Combination 6	-66.1	294.2	4.81	14.71	OK
Combination 7	-71.0	176.5	5.12	9.81	OK
b. Transverse direction					
Combination 1	0.0	0.0	0.00	0.00	OK
Combination 2	-47.6	220.6	3.26	12.26	OK
Combination 3	-42.0	220.6	2.98	12.26	OK
Combination 4	-50.0	220.6	3.44	12.26	OK
Combination 5	-86.9	220.6	6.34	12.26	OK
Combination 6	-67.0	294.2	4.92	14.71	OK
Combination 7	-43.8	176.5	3.06	9.81	OK

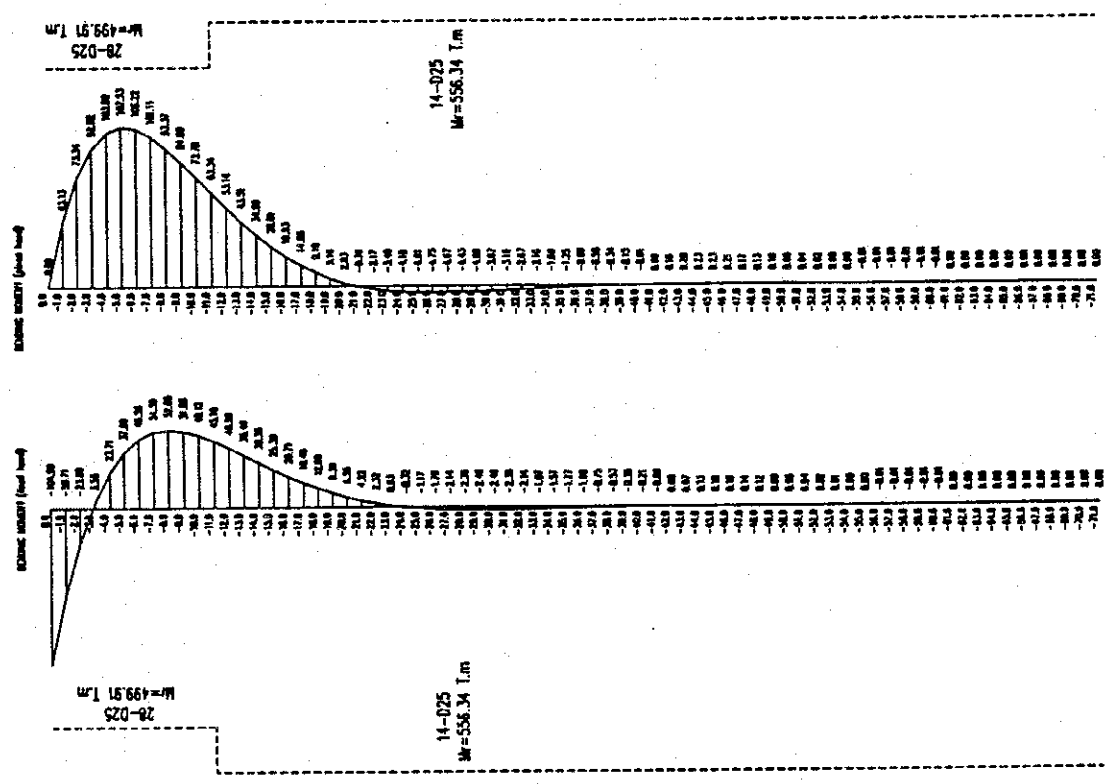
STRESS OF PILE CAP

	Actual (MPa)	Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} = 5.04$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.22$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 4.74$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.30$	$\tau_a = 0.88$	OK

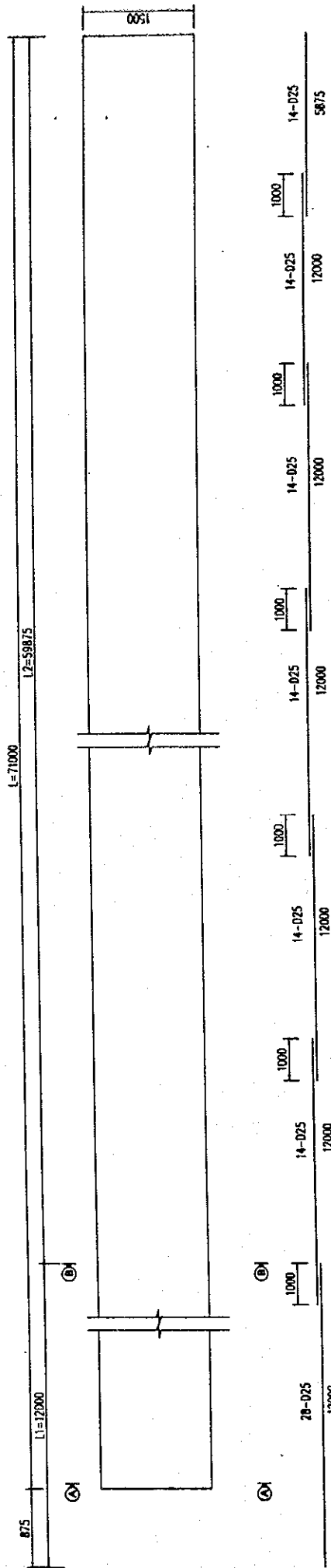
COMBINATION 5: PILE (1,1)
LONGITUDINAL DIRECTION



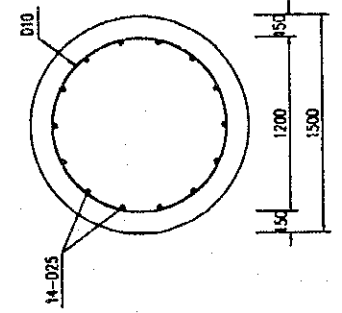
COMBINATION 5 : PILE (1,1)
TRANSVERSE DIRECTION



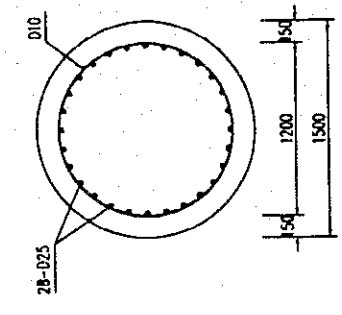
PILE PLAN OF PIER P2 - TRA ON BRIDGE



B - B



A - A

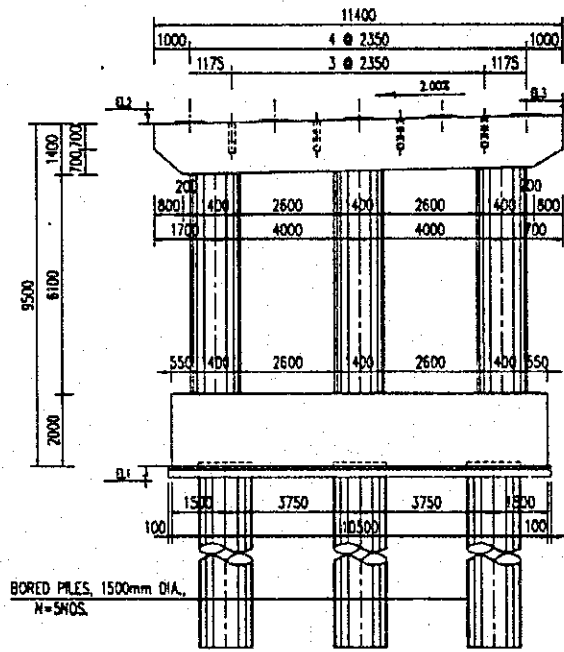


(3) PIER, TYPE P6

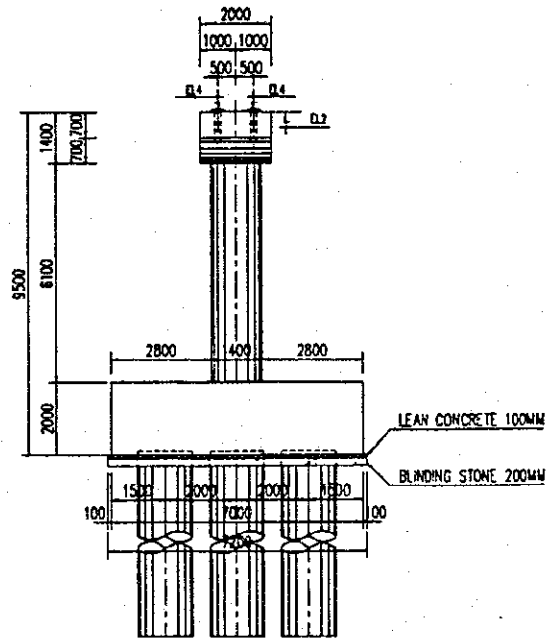
1. GENERAL VIEW PIER P1 OF LARGE TRA VA BRIDGE

SCALE 1:200

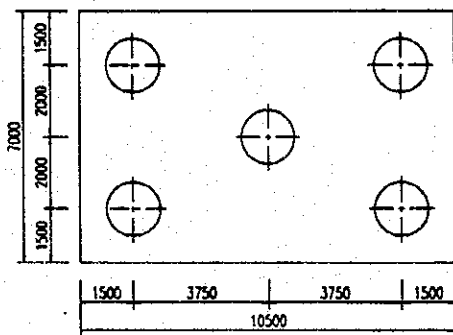
ELEVATION



SIDE VIEW



PILE CAP - PLAN



2. LOAD COMBINATIONS - LARGE TRA VA - PIER 1

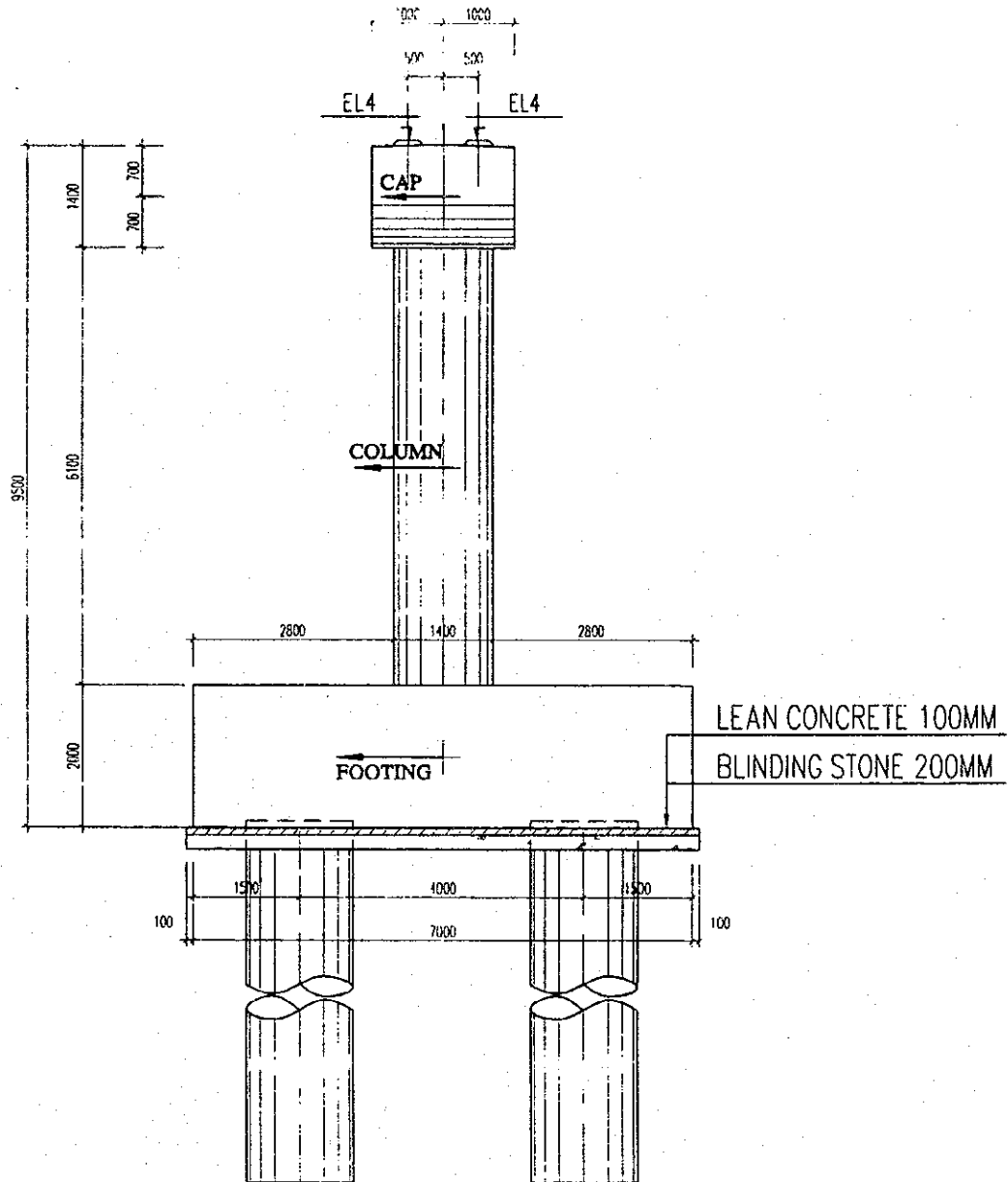
Nos	Items	Pz		Hx		Hy		My		Mx		Notes
		n=1	n>1	n=1	n>1	n=1	n>1	n=1	n>1	n=1	n>1	
Permanent load												
1	Superstructure (stage1) - DC (n=0.9,1.25)											
	+ Left	245	220	306					-110	-99	-138	
	+ Right	244	220	305					110	99	137	
2	Wearing surface (stage2) - DW (n=0.65,1.5)	130	84	194	0.9	0.6	1.2		-20	-13	-30	
	+ Left	87	57	131					-39	-25	-59	
	+ Right	43	28	64					19	12	29	
3	Pier - DC (n=0.9,1.25)	521	469	651					0	0	0	
Transient Loads												
4	Live load - LL (n=0.5,1.75)	188	94	329					37	18	64	-83
	a- Main load	127	64	222					25	12	44	-167
	b- Sub load	61	30	106					12	6	21	167
5	Dynamic load allowance - IM (n=0.5,1.75)	62	31	108					12	6	21	-55
	a- Main load	42	21	73					8	4	14	-110
	b- Sub load	20	10	35					4	5	16	55
6	Braking force - BR (n=0.5,1.75)				13.8	6.9	24.1		186	93	326	
7	Centrifugal force - CE (n=0.5,1.75)											25% of Main Load
	+ Left							12.4	6.2	21.7	168	84
	+ Right							6.2	3.1	10.9	84	42
8	Friction force - FR (n=1)							6.2	3.1	10.9	84	42
	a- Dead load				31							
	b- Dead load + Live load				40							
10	Temperature gradient TG (n=1)											
	a. + 5 degrees	4.8										
	b. Settlement SE (n=1)	-32										
10	Wind load - (n=0.5,1.75)											
	a- Transverse - WS (n=0.4,1.4)							26	10	36	244	98
	b- Longitudinal - WL (n=1)				8							
11	Earthquake - EQ (n=1)											
	a- Transverse							137			881	
	b- Longitudinal				177				1260			

LOAD COMBINATION TABLE

Load combinations	Pz	Hx	Hy	My	Mx
1	1866.2	65.8	38.0	1046.1	-94.0
2	1434.5	55.6	38.0	1004.5	-94.0
3	965.7	31.5	36.4	562.0	244.0
4	1117.6	214.9	137	1658.5	769.7
5	1117.6	38.4	10.9	398.7	-26.9
6	1375.3	63.0	29.5	940.8	190.3

- Combination 1 (STRENGTH - I-1) $1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75CE + 1.75BR + 1FR(a) + 1TG + 1SE$
- Combination 2 (STRENGTH - I-2) $0.9DC + 0.65DW + 1.75(LL + IM + CE + BR) + 1FR(a) + 1TG$
- Combination 3 (STRENGTH - III) $0.9DC + 0.65DW + 1.4*WS + 1FR(a) + 1TG + SE$
- Combination 4 (EXTREME EVENT - I) $0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1FR(a) + 1EQ$
- Combination 5 (EXTREME EVENT - II) $0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5CE + 0.5BR + 1FR(a) + CV$
- Combination 6 (SERVICE - I) $DC + DW + LL + IM + BR + CE + 0.3WS + WL + FR(b) + 0.5TG + 0.5SE$

PIER P1



Bridge name **LARGE TRAVA - P1**

Pile Type Dia = 1500 mm Length = 60.0 m

Bearing Capacity Qs = 12765 kN Qult = 15151 kN

Longitudinal direction

Load Combination	Displacement δ x(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	3.9	30	4796	6482	2525	-5815	OK
Strength I-2	3.6	30	3881	6482	1746	-5815	OK
Strength III	2.0	30	2493	6482	1295	-5815	OK
Extremme Event I	9.5	20	4322	6482	62	-5815	O.K
Extremme Event II	1.9	30	2664	6482	1719	-5815	OK
Service I	5.3	15	3813	4109	1582	-5815	OK

Longitudinal direction

Load Combination	Displacement δ y(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	0.9	30	3679	6482	3641	-5815	OK
Strength I-2	0.9	30	2832	6482	2795	-5815	OK
Strength III	1.1	30	2110	6482	1678	-5815	OK
Extremme Event I	4.0	20	2917	6482	1467	-5815	O.K
Extremme Event II	0.3	30	2197	6482	2186	-5815	OK
Service I	1.4	15	2882	4109	2513	-5815	OK

SECTION CALCULATION

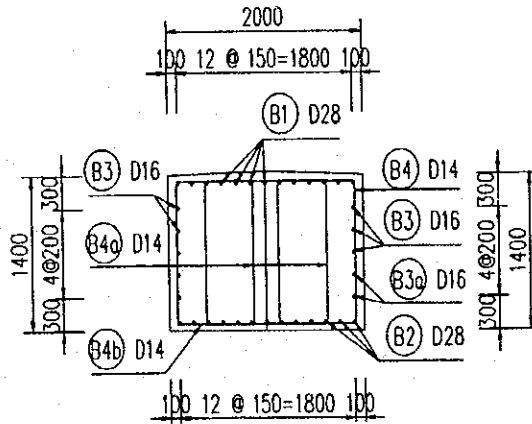
A. PIER CAP

i) Section Calculation for Flexure

		value	ELE	LOAD	LOC	NOD	Remark
Moment	M+ (kN·m)	1116.04	3	STRENGTH II	1.65	4	Mr >= min(1.2Mcr; 1.33M)
	M- (kN·m)	-2073.5	2	STRENGTH II	0.7	3	
Width	W (cm)	200.0					
Height	h (cm)	140.0					
Cover concrete tensile	d (cm)	7.5					
Cover concrete compression	d' (cm)	7.5					
Bar arrangement tensile	Dia. (mm)	28.0					
	Pitch (mm)	150.0					
	As (cm ²)	80.0					
Bar arrangement compression	Dia. (mm)	28.0					
	Pitch (mm)	150.0					
	As (cm ²)	80.0					
Allowable Moment	Mr+(kN·m)	3442.1					OK, SF=1.45
Allowable Moment	Mr-(kN·m)	3442					OK, SF=1.45

ii) Section Calculation for Shear

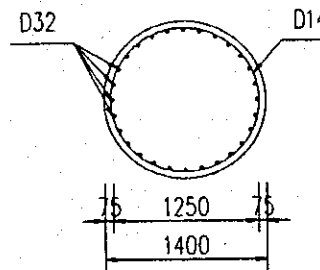
		Section	ELE	LOAD	LOC	NOD	Remark
Moment	M (kN·m)	-2073.13	2	STRENGHT II	0.7	3	OK, SF= 1.01
Shear	Q (kN)	2930.9	2	STRENGHT II	0.7	3	
Width	W (cm)	200					
Height	h (cm)	140					
Cover concrete tensile	d (cm)	7.5					
Cover concrete compression	d' (cm)	7.5					
Dia of shear reinforcement	D (mm)	14.0					
Pitch of shear reinforcement	s (mm)	200					
Arear of shear reinforcement	Av (cm ²)	9.24					
Allowable Shear	Vr (kN)	302.90					



B. COLUMN

		Section	ELE	LOAD	LOC	NOD	Remark
Moment	M (kN·m)	2585.6	9	EXTREME I	6.8	10	OK, SF= 1.99
Axial	P (kN)	-2561.9	9	EXTREME I	6.8	10	
Diameter	W (cm)	140					
Cover concrete tensile	d (cm)	7.5					
Cover concrete compression	d' (cm)	7.5					
Dia of reinforcement	D (mm)	32.0					
Number of bars	No (mm)	28.0					
Pitch of shear reinforcement	s (mm)	140					
Arear of shear reinforcement	Av (cm ²)	225.19					
Allowable Compressive	Pr (kN)	-5099.8					
Allowable Moment	Mr (kN·m)	5147.1					

$r_s = A_s / A_c = 0.0089$ (17 nos. tensile)
 $r_{min} = 0.135 f_c / f_y = 0.0083$
 Checking $r_s > r_{min}$ OK



FOOTING

B pier

10.50 (m)

STRENGTH & EXTREME EVENT LIMIT STATE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 40 cm ² (D=3.2cm, 5 Nos)
						A's = 11 cm ² (D=2.2cm, 3 Nos)
1	947	1260	2422	2491	OK	ρs = As/Ac = 0.0020
2	788	1048			ρ min = 0.03 f/fy = 0.00185	
3	444	591			∴ ρs > ρ min — O.K	
4	897	1193			c/de = 0.04	
5	487	647			∴ c/de < 0.42 — O.K	
6	0	0			OK	

SERVICE LIMIT STATE

(h = 200 cm, b = 100 cm)

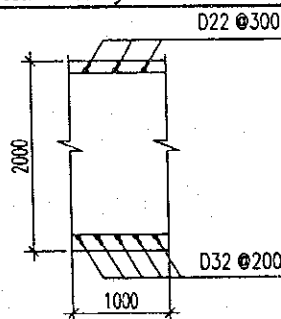
As = 40 cm² (D=3.2cm, 5 Nos) A's = 11 cm² (D=2.2cm, 3 Nos)

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
6	751.88	119	103	229	OK

Stress

Actual		Allowable		Remark
f _c tensile =	1.08 (MPa)	f _r = 0.63·(f _c) ^{0.5} =	3.03 (MPa)	OK
f _c compress =	1.11 (MPa)	f _{ca} = 0.4f _c =	9.41 (MPa)	OK
f _s =	6.99 (MPa)	f _{sa} = 0.6f _y =	229.48 (MPa)	OK



PILE (1,1) SECTION

NOMINAL RESISTANCES

	Unit	Z=6 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		
a. Longitudinal direction						
Combination 1	P	kN	2525	26884		OK
	M	kN·m	406	4322		OK
Combination 2	P	kN	1746	23743		OK
	M	kN·m	379	5153		OK
Combination 3	P	kN	1295	26696		OK
	M	kN·m	213	4381		OK
Combination 4	P	kN	62	94		O.K
	M	kN·m	890	1354		O.K
Combination 5	P	kN	1719	30257		O.K
	M	kN·m	174	3061		O.K
Combination 6	P	kN	1582	23341		O.K
	M	kN·m	355	5236		O.K

	Unit	Z=6 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		
b. Transverse direction						
Combination 1	P	kN	3641	33414		OK
	M	kN·m	157	1443		OK
Combination 2	P	kN	2795	32713		OK
	M	kN·m	157	1841		OK
Combination 3	P	kN	1678	30880		OK
	M	kN·m	151	2776		OK
Combination 4	P	kN	1467	15135		O.K
	M	kN·m	568	5855		O.K
Combination 5	P	kN	2187	34597		O.K
	M	kN·m	45	713		O.K
Combination 6	P	kN	2513	32587		O.K
	M	kN·m	147	1910		O.K

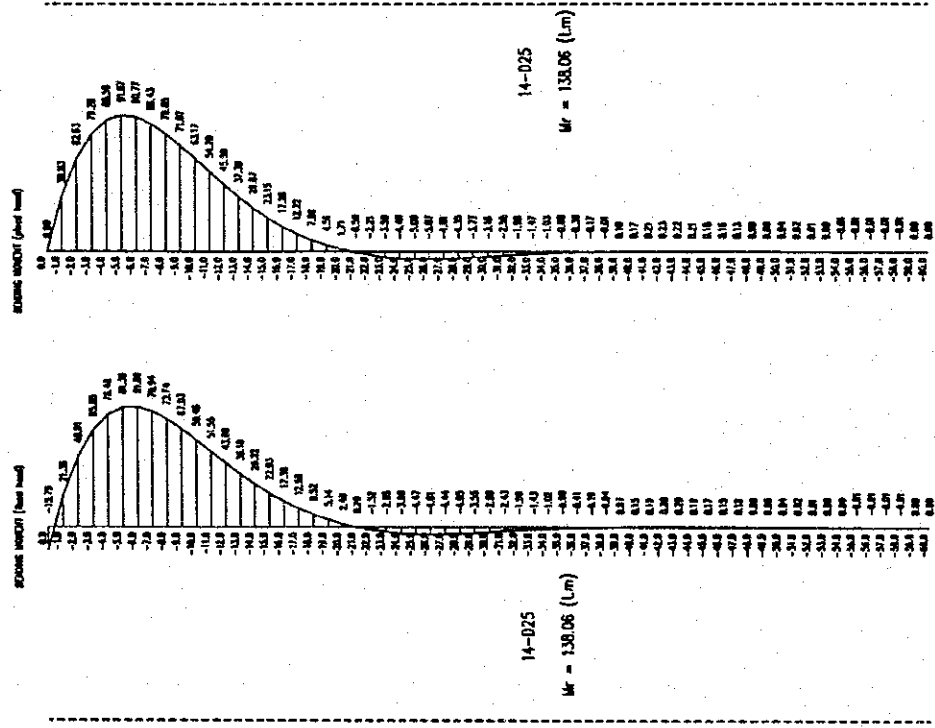
STRESS

	Stress of reinforcement ds (MPa)		Stress of concrete dc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
a. Longitudinal direction					
Combination 1	-53.3	220.6	3.80	12.26	OK
Combination 2	-45.4	220.6	3.27	12.26	OK
Combination 3	-28.0	220.6	2.00	12.26	OK
Combination 4	290.0	294.2	6.83	14.71	OK
Combination 5	-27.3	294.2	1.92	14.71	OK
Combination 6	-42.5	176.5	3.03	9.81	OK
Combination 7	0.0	0.0	0.00	0.00	OK
b. Transverse direction					
Combination 1	0.0	0.0	0.00	0.00	OK
Combination 2	-37.6	220.6	2.64	12.26	OK
Combination 3	-30.8	220.6	2.19	12.26	OK
Combination 4	-22.6	220.6	1.60	12.26	OK
Combination 5	-45.9	294.2	3.43	14.71	OK
Combination 6	-29.1	176.5	2.04	9.81	OK
Combination 7	0.0	0.0	0.00	0.00	OK

STRESS OF PILE CAP

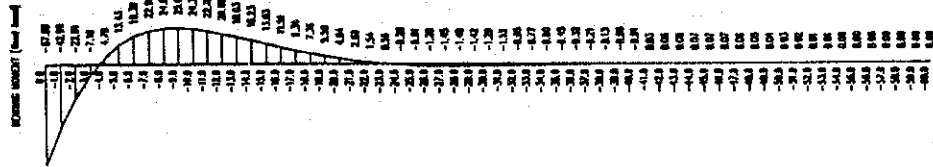
	Actual (MPa)	Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} = 2.71$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.24$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 2.81$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.18$	$\tau_a = 0.88$	OK

COMBINATION 4 : PILE (1,1)
LONGITUDINAL DIRECTION

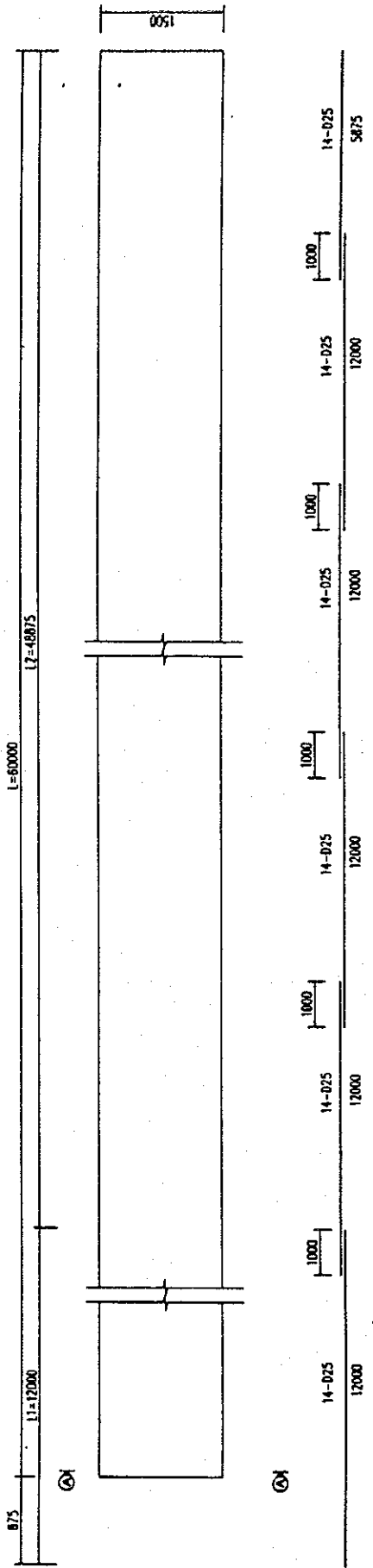


COMBINATION 4 : PILE (1,1)

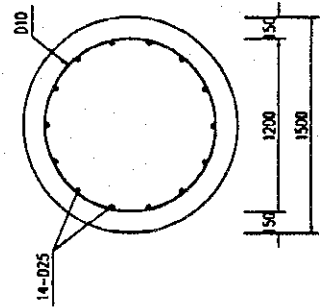
TRANSVERSE DIRECTION



PILE PLAN OF PIER P1 - LARGE TRA VA BRIDGE



A - A

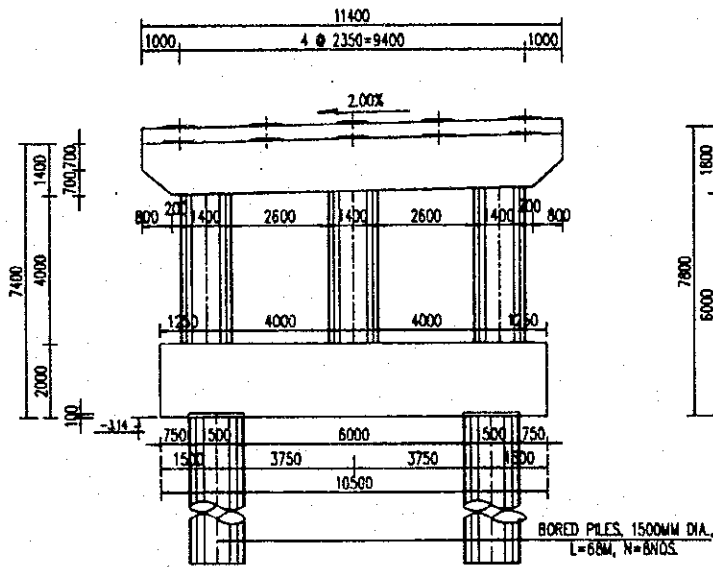


(4) PIER, TYPE P7

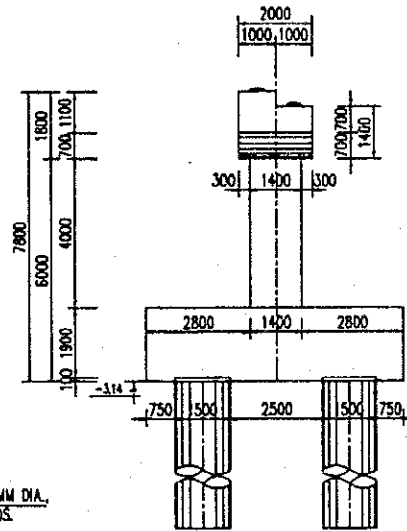
1. GENERAL VIEW PIERS P2 OF SMALL TRA VA BRIDGE

(SCALE 1:200)

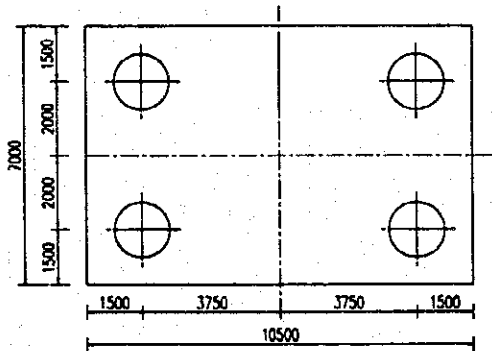
ELEVATION



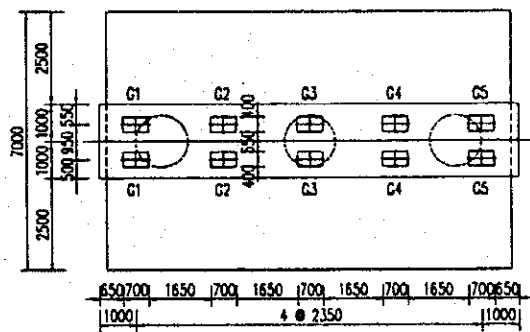
SIDE VIEW



HALF PLAN PILE FOOTING



HALF PLAN



NOTES

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE INDICATED.

2. LOAD COMBINATIONS - SMALL TRA VA - PIER 2

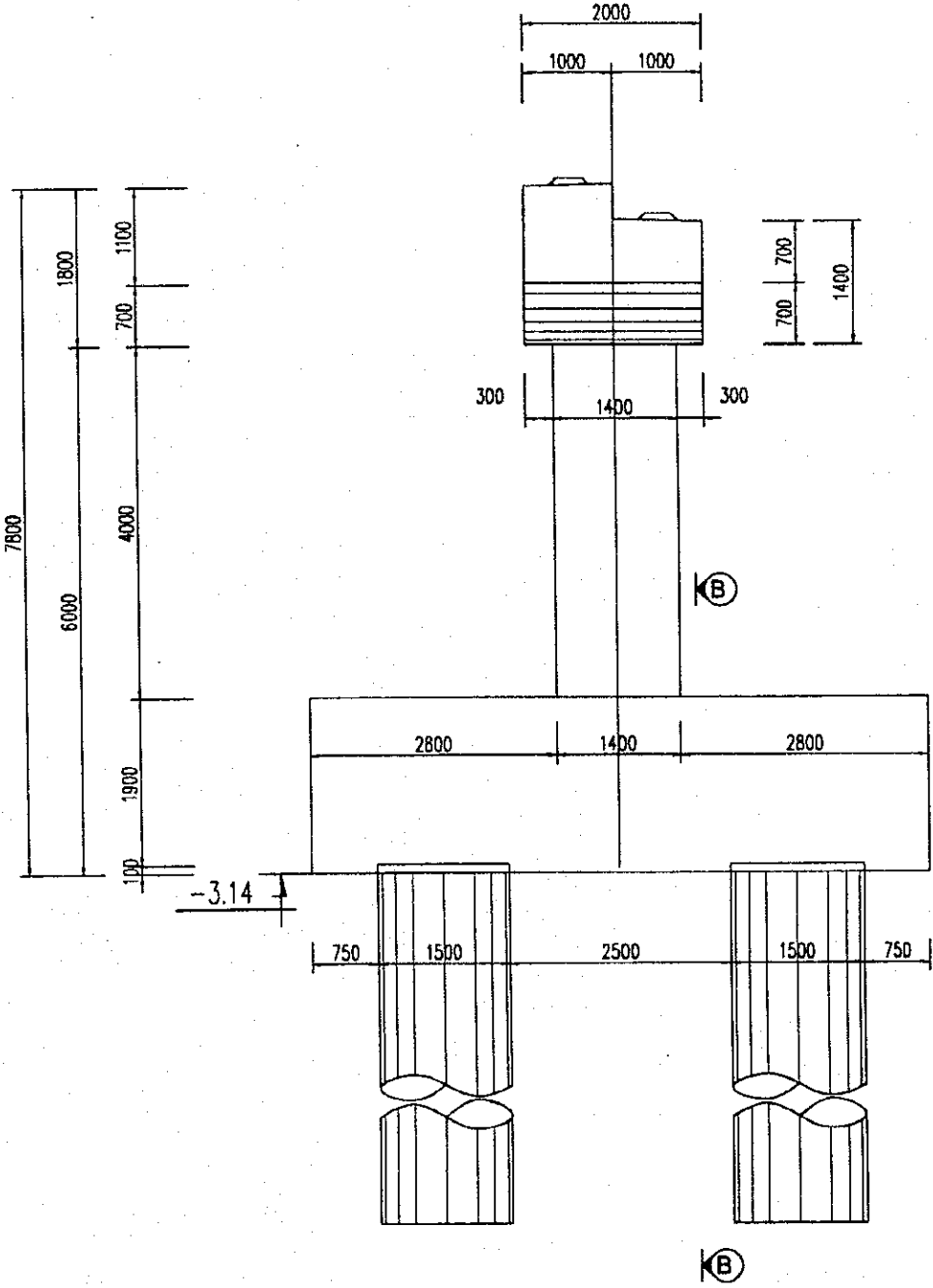
Nos	Items	Pz		Hx		Hy		My		Mx		Notes
		n=1	n>1	n<1	n>1	n<1	n>1	n=1	n>1	n=1	n>1	
Permanent load												
1	Superstructure (stage1) - DC (n=0.9,1.25)	303	273									
	+ Left	184	166									
	+ Right	127	83	1.4	0.9	1.6						
2	Wearing surface (stage2) - DW (n=0.65,1.5)	95	62	142								
	+ Left	33	21	49								
	+ Right	502	452	628								
3	Pier - DC (n=0.9,1.25)											
Transient Loads												
4	Live load - LL (n=0.5,1.75)	194	97	340								
	a- Main load	132	66	230	3	2	6					
	b- Sub load	63	31	110	3	1	5					
5	Dynamic load allowance - IM (n=0.5,1.75)	64	32	112								
	a- Main load	43	22	76								
	b- Sub load	21	10	36								
6	Braking force - BR (n=0.5,1.75)			13.8	6.9	24.1						25% of Main Load
7	Centrifugal force - CE (n=0.5,1.75)						12.4	6.2	21.7			
	+ Left						7.4	3.7	13.0			
	+ Right						5.0	2.5	8.8			
8	Friction force - FR (n=1)											
	a- Dead load			31						228		
	b- Dead load + Live load			40						299		
9	Vessel collision load - CV (n=1)											
	a- Transverse						0					
	b- Longitudinal									0		
10	Temperature gradient TG (n=1)											
	a. 12.5 degrees to 7.5 degrees	7		18						130		
11	Settlement SE (n=1)	23								30		
10	Wind load - (n=0.5,1.75)											
	a- Transverse - WS (n=0.4, 1.4)						56	22	78			
	b- Longitudinal - WL (n=1)									41		
11	Earthquake - EQ (n=1)											
	a- Transverse			184			134					
	b- Longitudinal									1,049		

LOAD COMBINATION TABLE

Load combinations	Pz	Hx	Hy	My	Mx
1	1911.2	82.2	38.0	897.4	-148.5
2	1433.1	72.5	38.0	810.6	-148.5
3	1004.2	48.4	77.9	332.7	320.0
4	1102.6	221.6	134	1366.7	579.1
5	1102.6	37.6	10.9	317.6	-42.4
6	1390.9	70.0	38.4	717.5	235.1

- Combination 1 (STRENGTH - I-I)
 - Combination 2 (STRENGTH - I-2)
 - Combination 3 (STRENGTH - III)
 - Combination 4 (EXTREME EVENT - I)
 - Combination 5 (EXTREME EVENT - II)
 - Combination 6 (SERVICE - I)
- $1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75CE + 1.75BR + IFR(b) + ITG + ISE$
 $0.9DC + 0.65DW + 1.75(LL + IM + CE + BR) + IFR(a) + TG$
 $0.9DC + 0.65DW + 1.4*WS + IFR(a) + TG + SE$
 $0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + IFR(a) + IEQ$
 $0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5CE + 0.5BR + IFR(a) + CV$
 $DC + DW + LL + IM + BR + CE + 0.3WS + WL + FR(b) + 0.5TG + 0.5SE$

PIER P2



Bridge name **SMALL TRA VA -P2**

Pile Type Dia = 1500 mm Length = 64.0 m

Bearing Capacity Qs = 11262 kN Qult = 17588 kN

Longitudinal direction

Load Combination	Displacement δ x(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	4.7	30	5798	7620	3573	-5757	OK
Strength I-2	4.2	30	4513	7620	2514	-5757	OK
Strength III	2.4	30	2931	7620	1993	-5757	OK
Extremme Event I	10.7	20	4701	7620	706	-5757	O.K
Extremme Event II	2	30	3124	7620	2283	-5757	OK
Service I	5.9	15	4388	4844	2432	-3707	OK

Longitudinal direction

Load Combination	Displacement δ y(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I-1	1.1	30	4699	7620	4672	-5757	OK
Strength I-2	1.1	30	3527	7620	3500	-5757	OK
Strength III	2.7	30	2811	7620	2113	-5757	OK
Extremme Event I	4.6	20	3321	7620	2085	-5757	O.K
Extremme Event II	0.3	30	2707	7620	2699	-5757	OK
Service I	2.2	15	3646	4844	3174	-3707	OK

SECTION CALCULATION

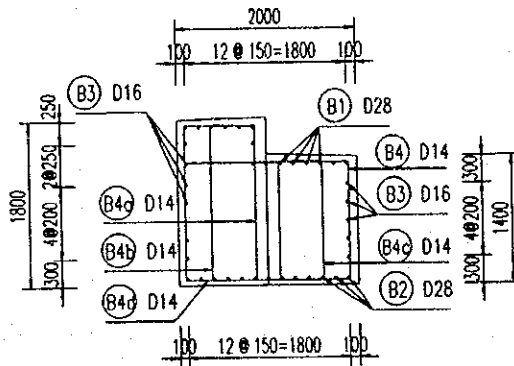
A. PIER CAP

i) Section Calculation for Flexure

		value	ELE	LOAD	LOC	NOD	Remark
Moment	M+ (kN·m)	1179.94	3	STRENGTH II	1.65	4	Mr >= min(1.2Mr; 1.33M)
	M- (kN·m)	-2158.1	2	STRENGTH II	0.7	3	
Width	W (cm)	200.0					
Height	h (cm)	140.0					
Cover concrete tensile	d (cm)	7.5					
Cover concrete compression	d' (cm)	7.5					
Bar arrangement tensile	Dia. (mm)	28.0					
	Pitch (mm)	150.0					
	As (cm ²)	80.1					
Bar arrangement compression	Dia. (mm)	28.0					
	Pitch (mm)	150.0					
	As (cm ²)	80.1					
Allowable Moment	Mr+(kN·m)	3442.1					OK, SF=1.45
Allowable Moment	Mr-(kN·m)	3442					OK, SF=1.45

ii) Section Calculation for Shear

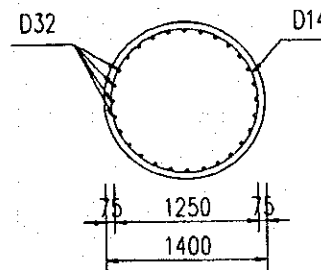
		Section	ELE	LOAD	LOC	NOD	Remark
Moment	M (kN·m)	-2158.15	2	STRENGHT II	0.7	3	OK, SF= 1.11
Shear	Q (kN)	3051.8	2	STRENGHT II	0.7	3	
Width	W (cm)	200					
Height	h (cm)	140					
Cover concrete tensile	d (cm)	7.5					
Cover concrete compression	d' (cm)	7.5					
Dia of shear reinforcement	D (mm)	14.0					
Pitch of shear reinforcement	s (mm)	200					
Arear of shear reinforcement	Av (cm2)	9.24					
Allowable Shear	Vr (kN)	302.90					



B. COLUMN

		Section	ELE	LOAD	LOC	NOD	Remark
Moment	M (kN·m)	3047.0	9	EXTREME I	5.5	10	OK, SF= 1.61
Axial	P (kN)	2530.8	9	EXTREME I	5.5	10	
Diameter	W (cm)	140					
Cover concrete tensile	d (cm)	7.5					
Cover concrete compression	d' (cm)	7.5					
Dia of reinforcement	D (mm)	32.0					
Number of bars	No (mm)	28.0					
Pitch of shear reinforcement	s (mm)	140					
Arear of shear reinforcement	Av (cm2)	225.19					
Allowable Compressive	Pr (kN)	4078.1					
Allowable Moment	Mr (kN·m)	4910.1					

$r_s = A_s / A_c = 0.0089$ (17 nos. tensile)
 $r_{min} = 0.135 f_c / f_y = 0.0083$
 Checking $r_s > r_{min}$ OK



FOOTING

B pier

10.50 (m)

STRENGTH & EXTREME EVENT LIMIT STATE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 40 cm ² (D=3.2cm, 5 Nos)
						A's = 11 cm ² (D=2.2cm, 3 Nos)
1	1195	1590	2422	2491	OK	ρs = As/Ac = 0.0020
2	944	1256			ρmin = 0.03 f/fy = 0.0018	
3	553	735			∴ ρs > ρmin O.K	
4	991	1318			c/de = 0.04	
5	600	799			∴ c/de < 0.42 O.K	
6	0	0			OK	

SERVICE LIMIT STATE

(h = 200 cm, b = 100 cm)

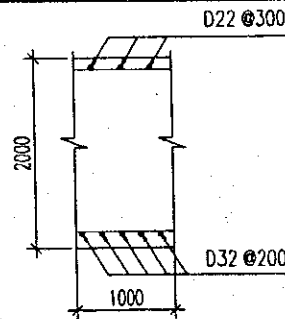
As = 40 cm² (D=3.2cm, 5 Nos) A's = 11 cm² (D=2.2cm, 3 Nos)

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
6	894.46	119	122	229	OK

Stress

Actual		Allowable		Remark
f _c tensile =	1.29 (MPa)	f _r = 0.63·(f _c) ^{0.5} =	3.03 (MPa)	OK
f _c compress =	1.32 (MPa)	f _{ca} = 0.4f _c =	9.41 (MPa)	OK
f _s =	8.31 (MPa)	f _{sa} = 0.6f _y =	229.48 (MPa)	OK



PILE (1,1) SECTION

NOMINAL RESISTANCES

	Unit	Z=5 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		

a. Longitudinal direction

Combination 1	P	kN	3573	29168		OK
	M	kN·m	431	3522		OK
Combination 2	P	kN	2514	27432		OK
	M	kN·m	380	4152		OK
Combination 3	P	kN	1993	28788		OK
	M	kN·m	254	3671		OK
Combination 4	P	kN	706	1197		O.K
	M	kN·m	1163	1974		O.K
Combination 5	P	kN	2283	31068		O.K
	M	kN·m	197	2687		O.K
Combination 6	P	kN	2432	26042		O.K
	M	kN·m	427	4577		O.K

	Unit	Z=5 m		Z≠ m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		

b. Transverse direction

Combination 1	P	kN	4672	33440			OK
	M	kN·m	199	1428			OK
Combination 2	P	kN	3500	32674			OK
	M	kN·m	199	1863			OK
Combination 3	P	kN	2113	25046			OK
	M	kN·m	409	4848			OK
Combination 4	P	kN	2085	17414			O.K
	M	kN·m	703	5873			O.K
Combination 5	P	kN	2699	34567			O.K
	M	kN·m	57	732			O.K
Combination 6	P	kN	3174	31760			O.K
	M	kN·m	234	2346			O.K

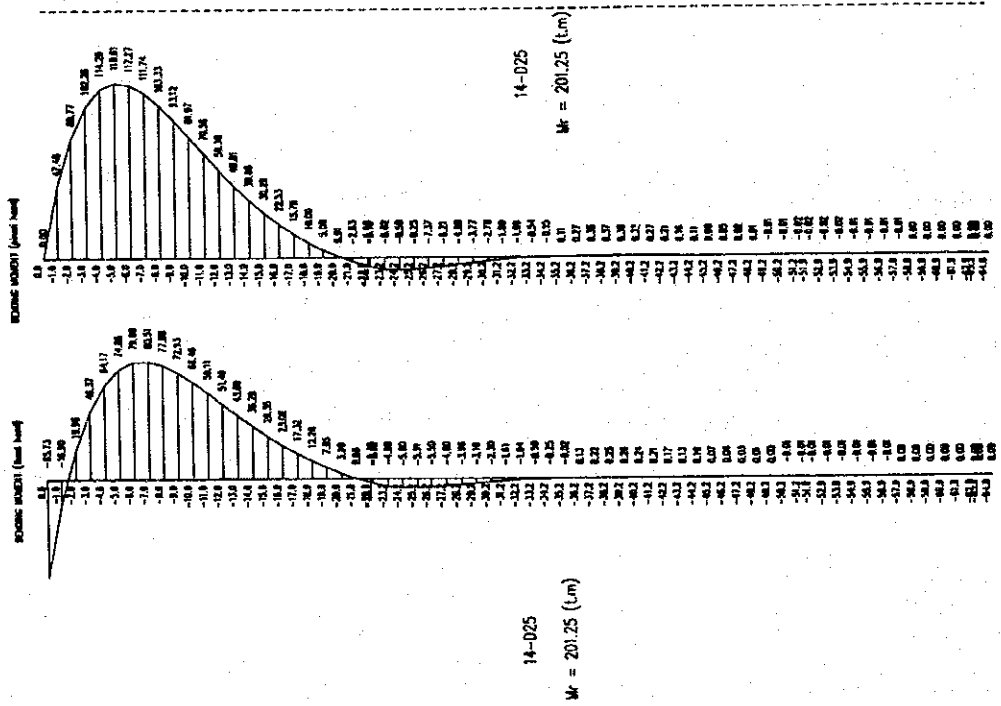
STRESS

	Stress of reinforcement ds (MPa)		Stress of concrete dc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
a. Longitudinal direction					
Combination 1	-60.9	220.6	4.31	12.26	OK
Combination 2	-48.9	220.6	3.47	12.26	OK
Combination 3	-32.0	220.6	2.28	12.26	OK
Combination 4	270.6	220.6	8.23	12.26	OK
Combination 5	-31.7	294.2	2.22	14.71	OK
Combination 6	-49.9	176.5	3.57	9.81	OK
b. Transverse direction					
Combination 1	0.0	0.0	0.00	0.00	OK
Combination 2	-48.2	220.6	3.38	12.26	OK
Combination 3	-38.8	220.6	2.76	12.26	OK
Combination 4	-40.2	220.6	2.97	12.26	OK
Combination 5	-57.8	220.6	4.42	12.26	OK
Combination 6	-39.6	176.5	2.81	9.81	OK

STRESS OF PILE CAP

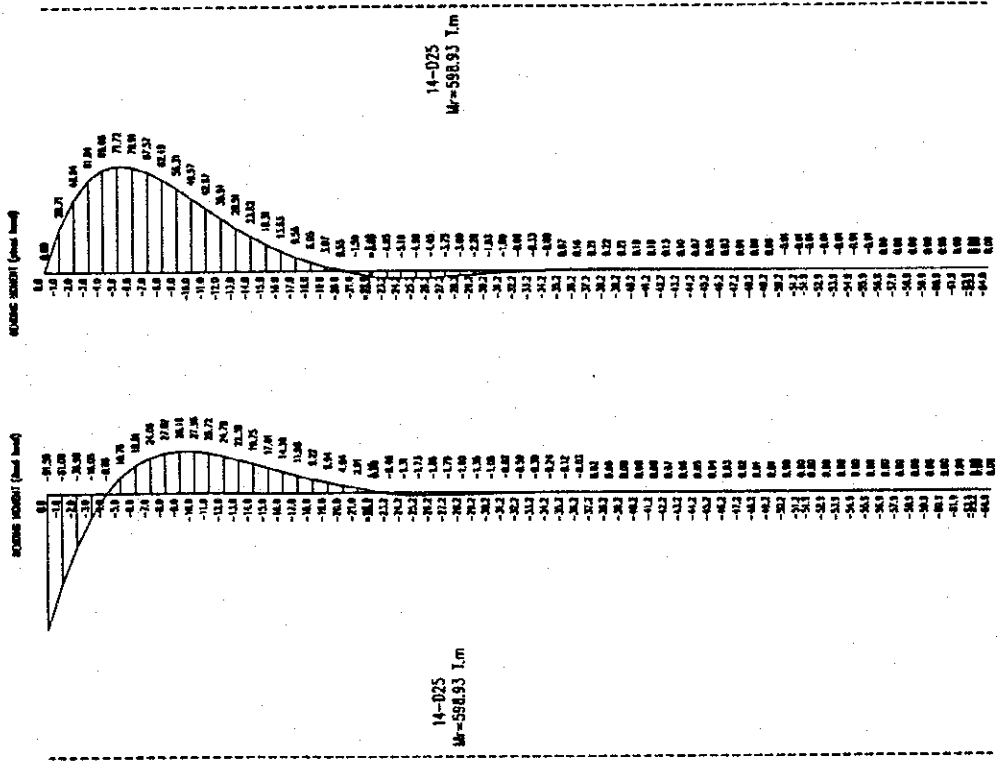
	Actual (MPa)	Allowable (MPa)	Remark
Vertical Bearing Pressure	$\sigma_{cv} = 3.28$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.29$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 3.62$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.23$	$\tau_a = 0.88$	OK

COMBINATION 4 : PILE (1,1)
LONGITUDINAL DIRECTION

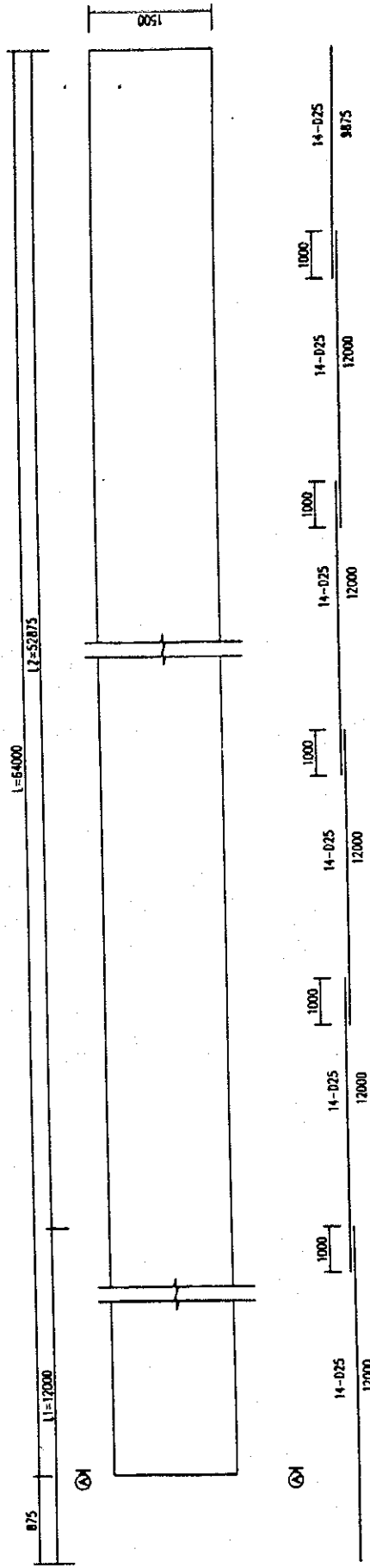


COMBINATION 4 : PILE (1,1)

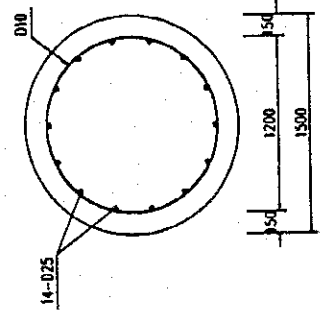
TRANSVERSE DIRECTION



PILE PLAN OF PIER P2 - SMALL TRA VA BRIDGE



A - A

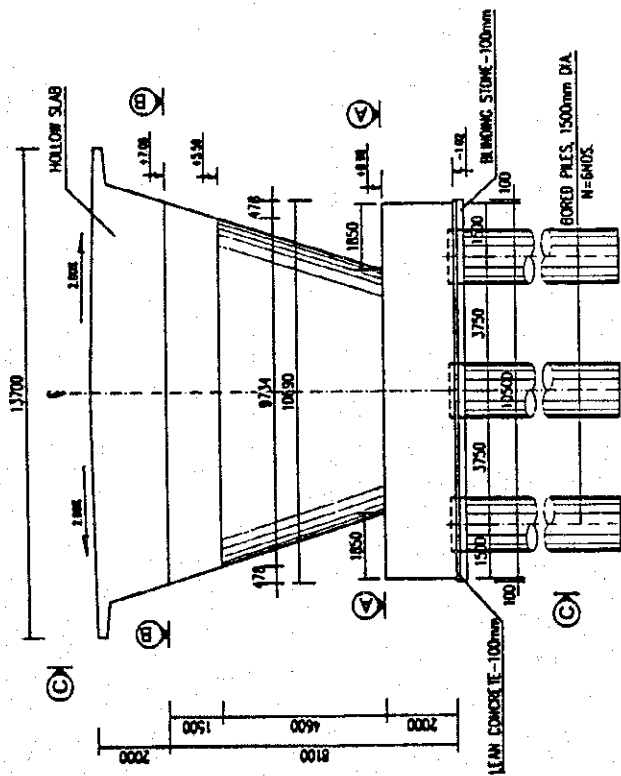


1. GENERAL VIEW PIER P2 OF INTERCHANGE 2 FLYOVER BRIDGE

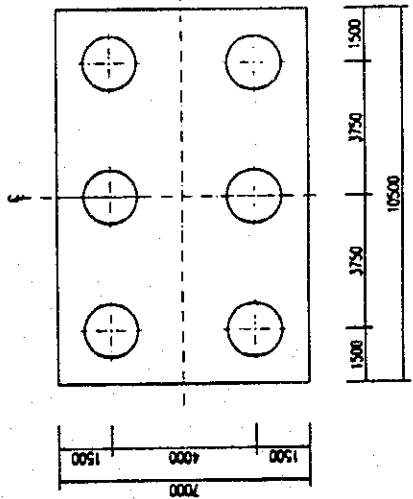
(5) PIER, TYPE P13

(SCALE 1:200)

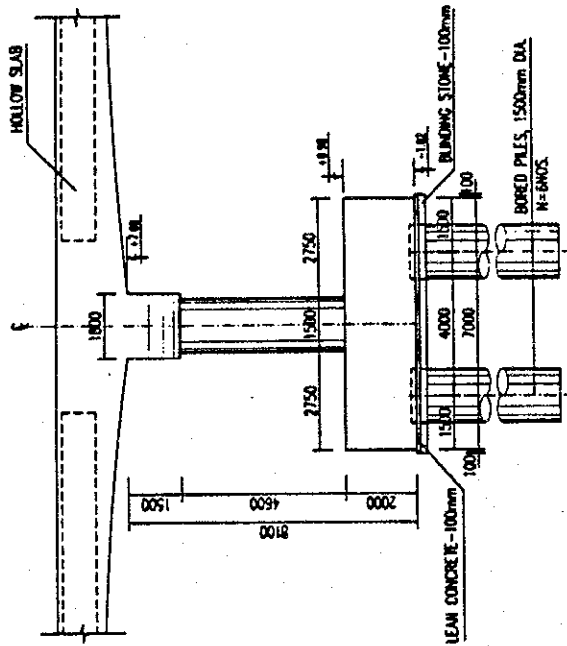
PIER ELEVATION



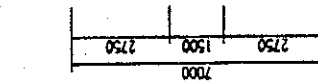
PIER CAP - PLAN



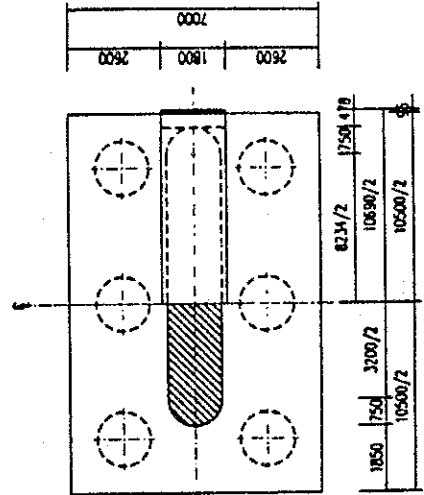
C - C



1/2 A - A



1/2 B - B



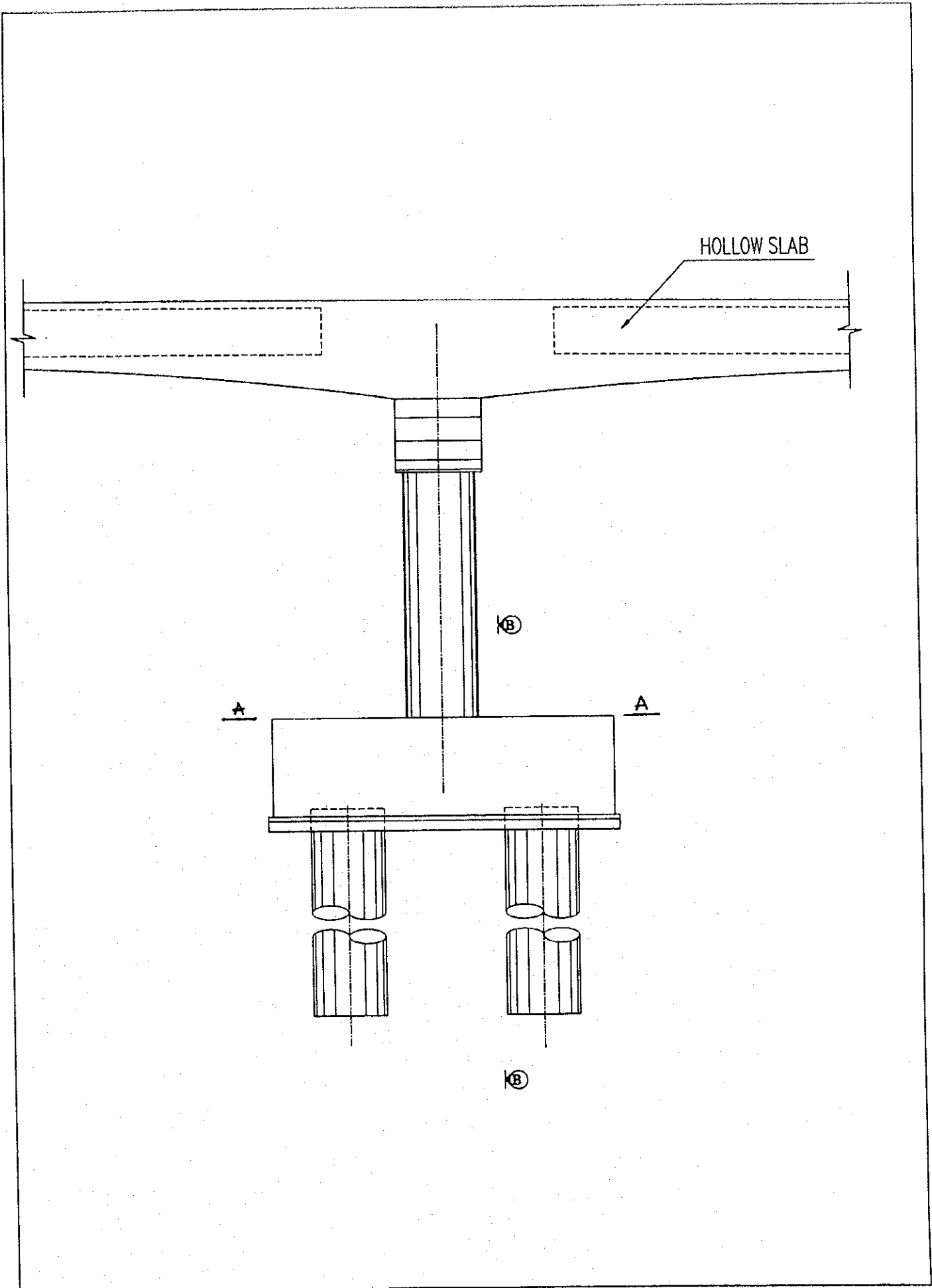
LOAD COMBINATIONS - NH54 PIER 2

Nos	Items	Pz		Mz		Hx		My		Hy		Mx		Notes
		n=1	n>1	n=1	n>1	n=1	n>1	n=1	n>1	n=1	n>1	n=1	n>1	
	Permanent load													
1	Superstructure - Pier self weigh	1,935	2,448	0	0	41	36	53	200	174	256	0	0	0
	Transient Loads													
2	Live load - LL(n=0.5,1.75)	313	548	0	0	28	14	49	108	54	189	0	0	0
	Live load - LL(n=0.8,1.35)	313	423			28	22	38	108	86	146			
3	Dynamic load allowance - IM (n=0.5,1.75)	103	181			9	5	16	36	18	62			
	Dynamic load allowance - IM (n=0.8,1.35)	103	139			9	7	12	36	29	48			25% of
4	Braking force - BR (n=0.5,1.75)					52	26	91	539	269	943			
	Braking force - BR (n=0.8,1.35)					52	42	70	539	431	727			
5	Earthquake - EQ (n=1)					141			790			141		790
	+ Pier body					25			134			25		134
	+ Pile cap					44			44			44		44
	+ Superstructure					72			612			72		612
6	Vehicular collision force - CT (n=1)					180			688			180		688
7	Uniform temperature - TU (n=0.5,1,1.2)					17			143					
8	Shrinkage - SH (n=0.5,1,1.2)					26			218					
9	Wind load													
	+ Superstructure (n=0.4,n=1.4) (WS)											9	4	13
	+ Live load(n=1.0) (WL)											4		53

LOAD COMBINATION TABLE - PIERS P2 & P3 - INTERCHANGE 2 FLYOVER BRIDGE

No	Load combinations	Pz	Mz	Hx	My	Hy	Mx
1	STRENGTH-I	3177	0	230	1631	0	0
2	STRENGTH-III	1713	0	57	354	13	115
3	STRENGTH-V	3010	0	194	1358	8	86
4	EXTREME EVEN-I - 1	2656	0	238	1388	141	790
5	EXTREME EVEN-I - 2	1921	0	221	1305	141	790
6	EXTREME EVEN-II	1921	0	260	1564	180	688
7	SERVICE-I	2352	0	173	1244	8	86

- 1 STRENGTH-I
1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA + 0.5TU + 0.5SH
- 2 STRENGTH-III
0.9DC + 0.65DW + 1.0WA + 1.4WS + 0.5TU + 0.5SH
- 3 STRENGTH-V
1.25DC + 1.5DW + 1.35LL + 1.35IM + 1.35BR + 1.0WA + 0.4WS + 1.0WL + 0.5TU + 0.5SH
- 4 EXTREME EVEN-I - 1
1.25DC + 1.5DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 5 EXTREME EVEN-I - 2
0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 6 EXTREME EVEN-II
0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0CV
- 7 SERVICE-I
1.0DC + 1.0DW + 1.0LL + 1.0IM + 1.0BR + 1.0WA + 0.3WS + 1.0WL + 1.0CV + 1.0TU + 1.0SH



Bridge name NH.54B1.C - P2

Pile Type Dia = 1500 mm Length = 75.0 m

Bearing Capacity Qs = 17811 kN Qult = 20197 kN

Longitudinal direction

Load Combination	Displacement δx (mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I	7.6	30	6716	8728	3669	-7885	OK
Strength III	1.8	30	3145	8728	2454	-7885	OK
Strength V	6.4	30	6193	8728	3646	-7885	OK
Extremme Event I-1	7.5	20	5727	8728	2955	-7885	O.K
Extremme Event I-2	7.0	20	4437	8728	1843	-7885	OK
Extremme Event II	8.3	30	4684	8728	1595	-7885	OK
Service I	8.8	15	5115	5551	2573	-4923	OK

Longitudinal direction

Load Combination	Displacement δy (mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I	0	30	5193	8728	5193	-7885	OK
Strength III	0.4	30	2892	8728	2708	-7885	OK
Strength V	0.2	30	4985	8728	4854	-7885	OK
Extremme Event I-1	3.6	20	5074	8728	3608	-7885	O.K
Extremme Event I-2	3.6	20	3873	8728	2406	-7885	OK
Extremme Event II	4.3	30	3889	8728	2390	-7885	OK
Service I	0.4	15	3914	5551	3774	-4923	OK

SECTION CALCULATION

A. BODY

LOAD COMBINATION TABLE

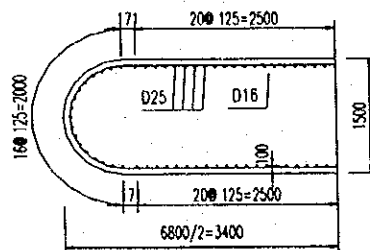
No	Load combinations	Pz	Hx	My	Hy	Mx
1	STRENGTH-I	2717	230	1406	0	0
2	STRENGTH-III	1382	57	312	13	90
3	STRENGTH-V	2551	194	1175	8	70
4	EXTREME EVEN-I - 1	2197	194	1098	97	552
5	EXTREME EVEN-I - 2	1590	177	1015	97	552
6	EXTREME EVEN-II	1590	260	1067	180	328
7	SERVICE-I	1984	173	1054	8	70

- 1 STRENGTH-I 1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA + 0.5TU + 0.5SH
- 2 STRENGTH-III 0.9DC + 0.65DW + 1.0WA + 1.4WS + 0.5TU + 0.5SH
- 3 STRENGTH-V 1.25DC + 1.5DW + 1.35LL + 1.35IM + 1.35BR + 1.0WA + 0.4WS + 1.0WL + 0.5TU + 0.5SH
- 4 EXTREME EVEN-I - 1 1.25DC + 1.5DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 5 EXTREME EVEN-I - 2 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 6 EXTREME EVEN-II 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0CV
- 7 SERVICE-I 1.0DC + 1.0DW + 1.0LL + 1.0IM + 1.0BR + 1.0WA + 0.3WS + 1.0WL + 1.0CV + 1.0TU + 1.0SH

SECTION CALCULATION SECTION A - A

Combination		1	2
Actual Moment	kN.m	13788	26645
Allowable Moment	kN.m	29312	56653
		OK	OK
Reinforcement		D25 @ 125	

A - A



FOOTING

B pier

10.50 (m)

STRENGTH & EXTREME EVENT LIMIT STATE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 49 cm ² (D=2.8cm, 8 Nos)
						A's = 19 cm ² (D=2.2cm, 5 Nos)
1	2167	2882	2422	2981	OK	$\rho_s = A_s/A_c = 0.0025$
2	957	1272			$\rho_{min} = 0.03 f/f_y = 0.0018$	
3	1980	2634			∴ $\rho_s > \rho_{min}$ ——— O.K	
4	1814	2412			$c/d_e = 0.04$	
5	1418	1886			∴ $c/d_e < 0.42$ ——— O.K	
6	1506	2003			OK	

SERVICE LIMIT STATE

(h = 200 cm, b = 100 cm)

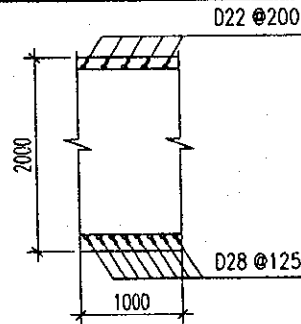
As = 49 cm² (D=2.8cm, 8 Nos) A's = 19 cm² (D=2.2cm, 5 Nos)

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
7	1641.34	132	186	229	OK

Stress

Actual		Allowable		Remark
f _c tensile =	2.35 (MPa)	f _t = 0.63·(f _c) ^{0.5} =	3.03 (MPa)	OK
f _c compress =	2.42 (MPa)	f _{ca} = 0.4f _c =	9.41 (MPa)	OK
f _s =	14.68 (MPa)	f _{sa} = 0.6f _y =	229.48 (MPa)	OK



**PILE (1,1) SECTION
NOMINAL RESISTANCES**

	Unit	Z=5 m		Z= m		Remark
		Actual	Allowable	Actual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		
a. Longitudinal direction						
Combination 1	P	kN	3669	23645		OK
	M	kN·m	803	5174		OK
Combination 2	P	kN	2454	31362		OK
	M	kN·m	199	2544		OK
Combination 3	P	kN	3646	25482		OK
	M	kN·m	677	4733		OK
Combination 4	P	kN	2955	20247		O.K
	M	kN·m	831	5694		O.K
Combination 5	P	kN	1843	13827		O.K
	M	kN·m	772	5790		O.K
Combination 6	P	kN	1595	8685		O.K
	M	kN·m	908	4948		O.K
Combination 7	P	kN	2573	20719		O.K
	M	kN·m	701	5642		O.K

	Unit	Z=5 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		
b. Transverse direction						
Combination 1	P	kN	5193	35807		OK
	M	kN·m	0	0		OK
Combination 2	P	kN	2708	34792		OK
	M	kN·m	45	584		OK
Combination 3	P	kN	4854	35351		OK
	M	kN·m	28	202		OK
Combination 4	P	kN	3608	28266		O.K
	M	kN·m	492	3858		O.K
Combination 5	P	kN	2406	24433		O.K
	M	kN·m	492	4998		O.K
Combination 6	P	kN	2390	21221		O.K
	M	kN·m	629	5580		O.K
Combination 7	P	kN	3774	35207		O.K
	M	kN·m	32	302		O.K

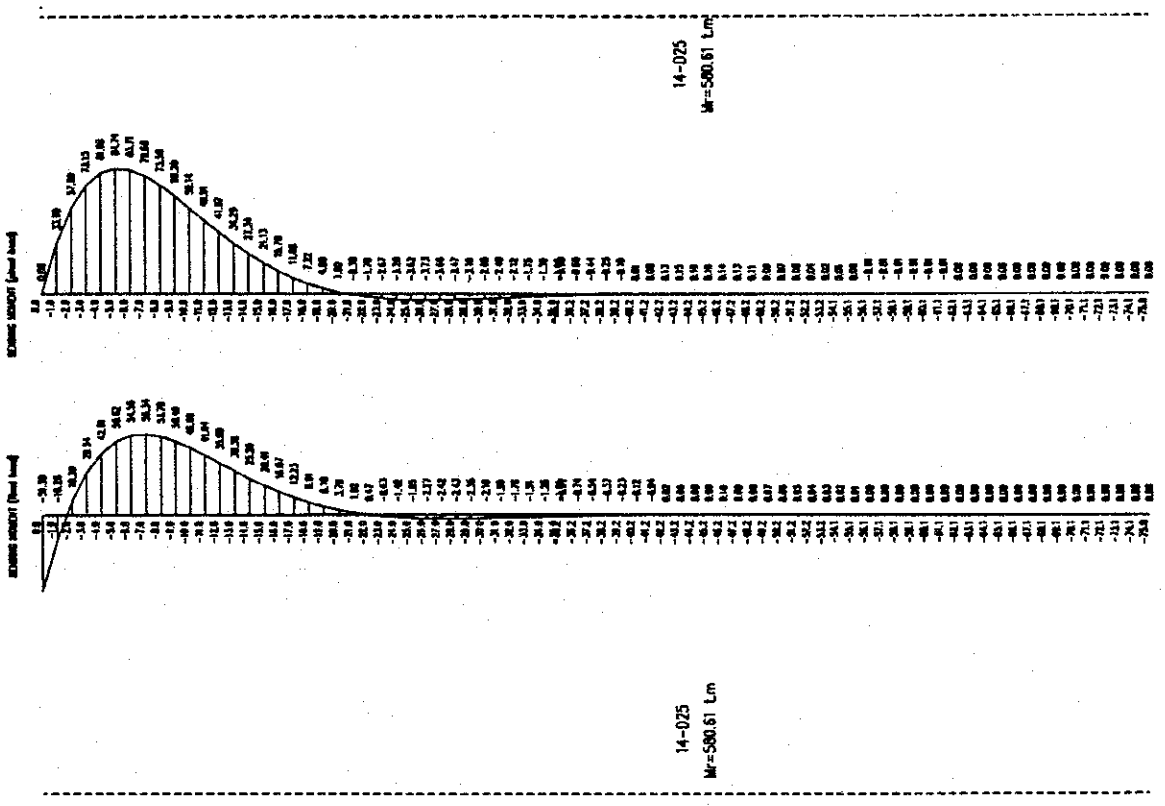
STRESS

	Stress of reinforcement ds (MPa)		Stress of concrete dc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
a. Longitudinal direction					
Combination 1	-80.8	220.6	5.83	12.26	OK
Combination 2	-31.9	220.6	2.24	12.26	OK
Combination 3	-72.4	220.6	5.21	12.26	OK
Combination 4	-73.8	220.6	5.38	12.26	OK
Combination 5	-61.5	294.2	4.53	14.71	OK
Combination 6	72.6	294.2	4.07	14.71	OK
Combination 7	-65.1	176.5	4.75	9.81	OK
b. Transverse direction					
Combination 1	0.0	0.0	0.00	0.00	OK
Combination 2	-41.6	220.6	2.78	12.26	OK
Combination 3	-24.7	220.6	1.67	12.26	OK
Combination 4	-40.9	220.6	2.74	12.26	OK
Combination 5	-58.9	220.6	4.23	12.26	OK
Combination 6	-56.3	294.2	4.18	14.71	OK
Combination 7	-32.5	176.5	2.19	9.81	OK

STRESS OF PILE CAP

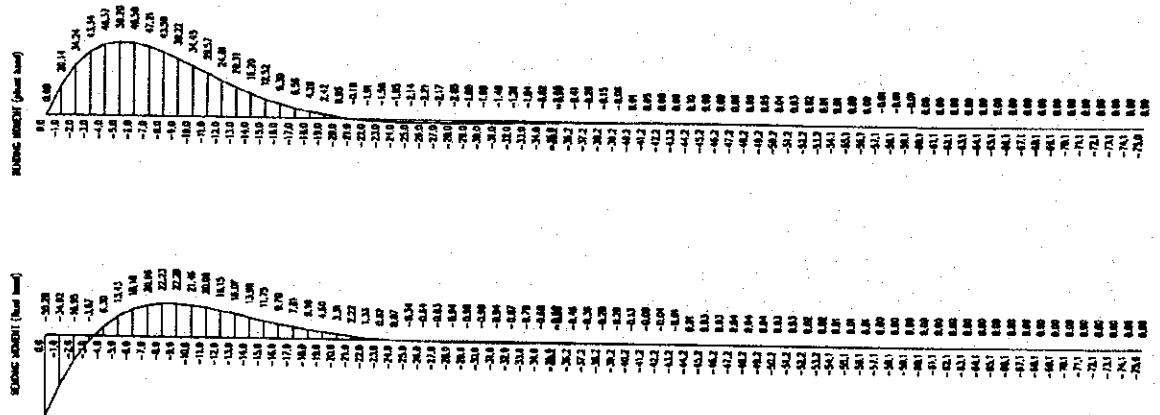
	Actual (MPa)	Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} = 3.80$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.33$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 2.59$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.16$	$\tau_a = 0.88$	OK

COMBINATION 4: PILE (1,1)
LONGITUDINAL DIRECTION

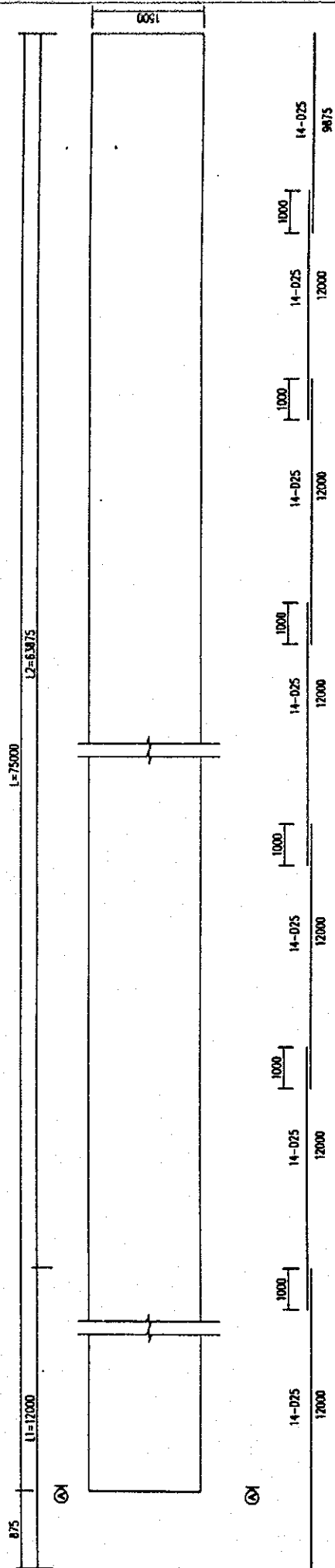


COMBINATION 4 : PILE (1,1)

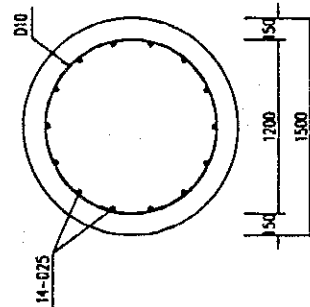
TRANSVERSE DIRECTION



PILE PLAN OF PIER P2 - NH.54B.I.C BRIDGE



A - A

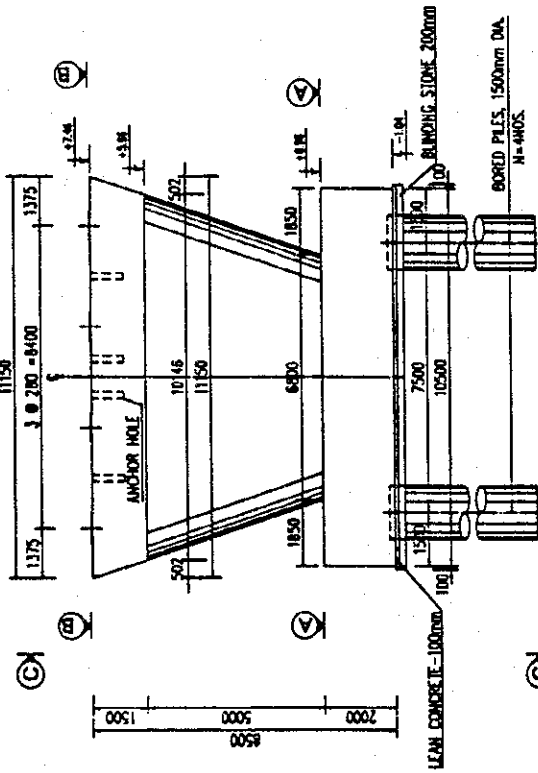


(6) PIER, TYPE P14

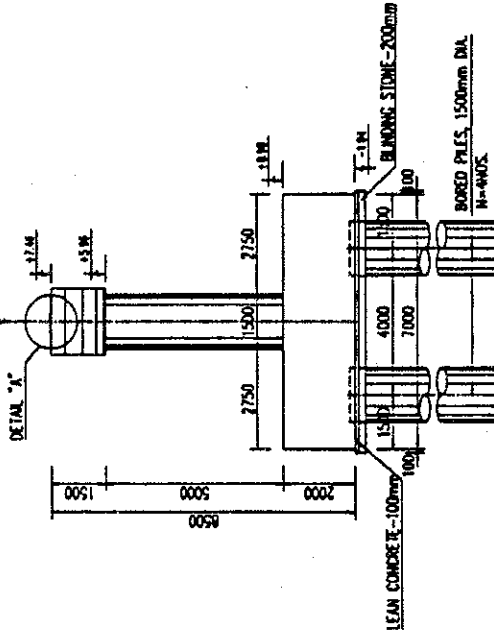
1. GENERAL VIEW PIER P1 OF INTERCHANGE 2 FLYOVER BRIDGE

(SCALE 1:200)

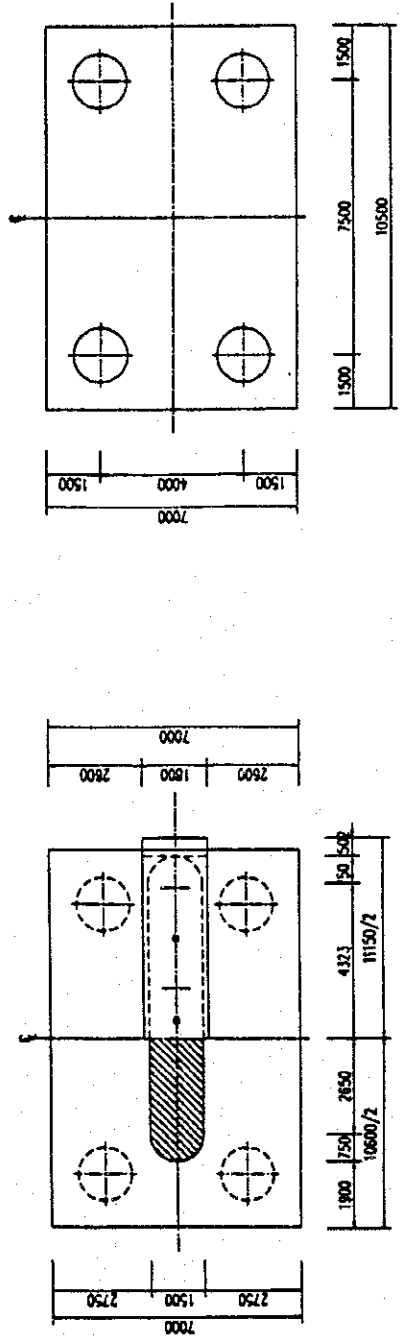
PIER ELEVATION

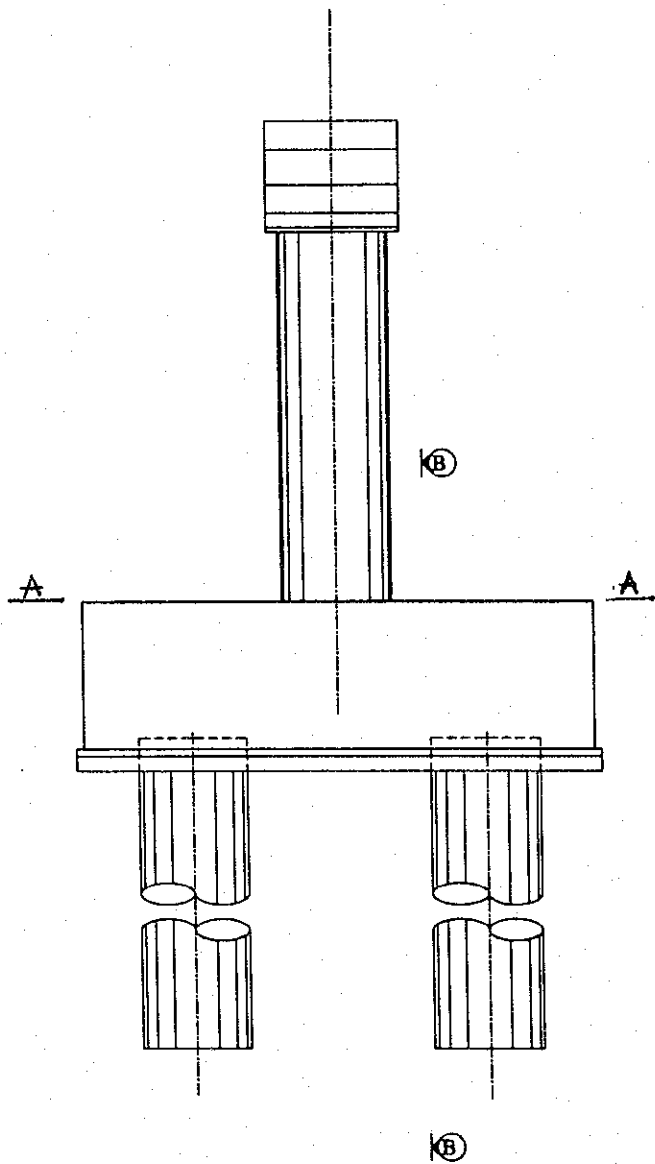


C - C



1/2 A - A 1/2 B - B





Bridge name NH.54B I.C-P1

Pile Type Dia = 1500 mm Length = 75.0 m

Bearing Capacity Qs = 17824 kN Qult = 20210 kN

Longitudinal direction

Load Combination	Displacement δ x(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I	4.6	30	7094	8728	4968	-7885	OK
Strength III	0	30	3067	8728	3067	-7885	OK
Strength V	3.6	30	6479	8728	4838	-7885	OK
Extremme Event I-1	8.6	20	6510	8728	3223	-7885	O.K
Extremme Event I-2	8.6	20	5176	8728	1890	-7885	OK
Extremme Event II	1.3	30	3838	8728	3228	-7885	OK
Service I	4.0	15	5067	5551	3744	-4923	OK

Longitudinal direction

Load Combination	Displacement δ y(mm)		Bearing Capacity (kN)		Uplift Capacity (kN)		Remarks
	Actual	Allowable	Pmax	Allowable	Pmin	Allowable	
Strength I	0	30	6031	8728	6031	-7885	OK
Strength III	0.4	30	3147	8728	2987	-7885	OK
Strength V	0.3	30	5715	8728	5601	-7885	OK
Extremme Event I-1	6.0	20	5834	8728	3899	-7885	O.K
Extremme Event I-2	6.0	20	4500	8728	2566	-7885	OK
Extremme Event II	0	30	3533	8728	3533	-7885	OK
Service I	0.4	15	4466	5551	4345	-4923	OK

SECTION CALCULATION

A. BODY

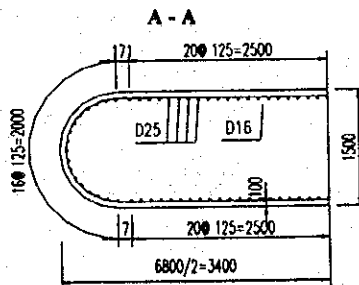
LOAD COMBINATION TABLE

No	Load combinations	Pz	Hx	My	Hy	Mx
1	STRENGTH-I	1997	83	672	0	0
2	STRENGTH-III	917	0	0	11	75
3	STRENGTH-V	1844	64	518	7	57
4	EXTREME EVEN-I - 1	1521	133	824	125	739
5	EXTREME EVEN-I - 2	1108	133	824	125	739
6	EXTREME EVEN-II	1108	24	192	0	0
7	SERVICE-I	1426	48	384	7	57

- 1 STRENGTH-I 1.25DC + 1.5DW + 1.75LL + 1.75IM + 1.75BR + 1.0WA
- 2 STRENGTH-III 0.9DC + 0.65DW + 1.0WA + 1.4WS
- 3 STRENGTH-V 1.25DC + 1.5DW + 1.35LL + 1.35IM + 1.35BR + 1.0WA + 0.4WS + 1.0WL
- 4 EXTREME EVEN-I - 1 1.25DC + 1.5DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 5 EXTREME EVEN-I - 2 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0EQ
- 6 EXTREME EVEN-II 0.9DC + 0.65DW + 0.5LL + 0.5IM + 0.5BR + 1.0WA + 1.0CV
- 7 SERVICE-I 1.0DC + 1.0DW + 1.0LL + 1.0IM + 1.0BR + 1.0WA + 0.3WS + 1.0WL + 1.0CV

SECTION CALCULATION SECTION A - A

Combination		1		2	
Actual Moment	kN.m	682	19584	8081	10866
Allowable Moment	kN.m	27616	82072	32480	43679
			OK		OK
Reinforcement		D25 @ 125			



FOOTING

B pier

10.50 (m)

STRENGTH & EXTREME EVENT LIMIT STATE (h = 200 cm, b = 100 cm)

Combination	M (kN·m)	1.33M (kN·m)	1.2Mcr (kN·m)	Mr = φ Mn (kN·m)	1.33M < 1.2Mcr or Mr	As = 39 cm ² (D=2.5cm, 8 Nos)
						A's = 19 cm ² (D=2.2cm, 5 Nos)
1	1457	1938	2422	2373	OK	ρs = As/Ac = 0.0020
2	563	749			ρ min = 0.03 f'/fy = 0.0018	
3	1311	1743			∴ ρs > ρ min — O.K	
4	1318	1753			c/de = 0.02	
5	1065	1417			∴ c/de < 0.42 — O.K	
6	747	993			OK	

SERVICE LIMIT STATE

(h = 200 cm, b = 100 cm)

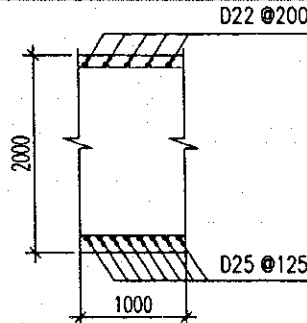
As = 39 cm² (D=2.5cm, 8 Nos) A's = 19 cm² (D=2.2cm, 5 Nos)

Cracking

Combination	M (kN·m)	f _{sa} (MPa)	f _s (MPa)	0.6·f _y (MPa)	f _{sa} < 0.6·f _y
7	1021.07	132	144	229	OK

Stress

	Actual	Allowable	Remark
f _c tensile =	1.48 (MPa)	f _r = 0.63·(f _c) ^{0.5} = 3.03 (MPa)	OK
f _c compress =	1.51 (MPa)	f _{ca} = 0.4f _c = 9.41 (MPa)	OK
f _s =	9.22 (MPa)	f _{sa} = 0.6f _y = 229.48 (MPa)	OK



PILE (1,1) SECTION

NOMINAL RESISTANCES

	Unit	Z=5 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		
a. Longitudinal direction						
Combination 1	P	kN	4968	31013		OK
	M	kN·m	435	2713		OK
Combination 2	P	kN	3067	35807		OK
	M	kN·m	0	0		OK
Combination 3	P	kN	4838	32008		OK
	M	kN·m	335	2218		OK
Combination 4	P	kN	3223	19914		O.K
	M	kN·m	927	5727		O.K
Combination 5	P	kN	1890	11181		O.K
	M	kN·m	927	5485		O.K
Combination 6	P	kN	3228	33637		O.K
	M	kN·m	126	1311		O.K
Combination 7	P	kN	3744	31538		O.K
	M	kN·m	292	2457		O.K

	Unit	Z=5 m		Z= m		Remark
		Atual	Allowable	Atual	Allowable	
Reinforcement	mm	14-D25		14-D25		
Area As	cm ²	68.72		68.72		
b. Transverse direction						
Combination 1	P	kN	6031	35807		OK
	M	kN·m	0	0		OK
Combination 2	P	kN	2987	34661		OK
	M	kN·m	58	670		OK
Combination 3	P	kN	5601	35308		OK
	M	kN·m	37	232		OK
Combination 4	P	kN	3899	23103		O.K
	M	kN·m	890	5275		O.K
Combination 5	P	kN	2566	16934		O.K
	M	kN·m	890	5877		O.K
Combination 6	P	kN	3533	35807		O.K
	M	kN·m	0	0		O.K
Combination 7	P	kN	4345	35144		O.K
	M	kN·m	43	346		O.K

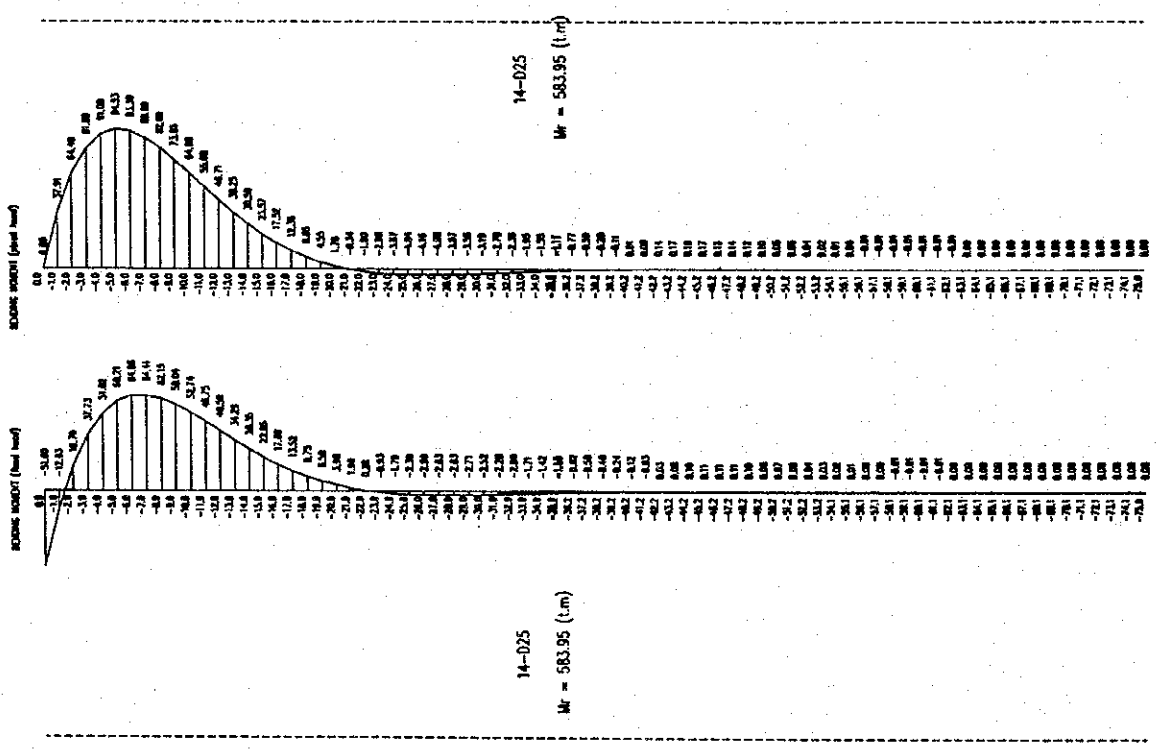
STRESS

	Stress of reinforcement ds (MPa)		Stress of concrete dc (MPa)		Remark
	Actual	Allowable	Actual	Allowable	
a. Longitudinal direction					
Combination 1	-71.4	220.6	5.00	12.26	OK
Combination 2	-24.6	220.6	1.64	12.26	OK
Combination 3	-63.2	220.6	4.39	12.26	OK
Combination 4	-83.3	220.6	6.07	12.26	OK
Combination 5	-72.6	294.2	5.36	14.71	OK
Combination 6	-35.0	294.2	2.40	14.71	OK
Combination 7	-50.6	176.5	3.54	9.81	OK
b. Transverse direction					
Combination 1	0.0	0.0	0.00	0.00	OK
Combination 2	-48.3	220.6	3.22	12.26	OK
Combination 3	-27.4	220.6	1.86	12.26	OK
Combination 4	-47.1	220.6	3.16	12.26	OK
Combination 5	-83.3	220.6	6.17	12.26	OK
Combination 6	-28.3	294.2	1.88	14.71	OK
Combination 7	-37.5	176.5	2.53	9.81	OK

STRESS OF PILE CAP

	Actual (MPa)	Allowable (MPa)	Remak
Vertical Bearing Pressure	$\sigma_{cv} = 4.01$	$\sigma_{ca} = 0.5 \times \sigma_{ck} = 11.77$	OK
Vertical Punching Shear	$\tau_c = 0.35$	$\tau_a = 0.88$	OK
Horizontal Bearing Pressure	$\sigma_{ch} = 2.89$	$\sigma'_{ca} = 0.3 \times \sigma_{ck} = 7.06$	OK
Horizontal Bearing Pressure	$\tau_c = 0.18$	$\tau_a = 0.88$	OK

COMBINATION 4: PILE (1,1)
LONGITUDINAL DIRECTION



COMBINATION 4 : PILE (1,1)

TRANSVERSE DIRECTION

