EARTHQUAKE RECONSTRUCTION AND REHABILITATION AUTHORITY (ERRA)
THE ISLAMIC REPUBLIC OF PAKISTAN

No.

URGENT REHABILITATION PROJECT: WEST BANK BYPASS DESIGN

UNDER

THE URGENT DEVELOPMENT STUDY ON REHABILITATION AND RECONSTRUCTION IN MUZAFFARABAD CITY

IN

THE ISLAMIC REPUBLIC OF PAKISTAN

FINAL REPORT

Appendix E:

Structural Calculation (Three Small Bridges)

MARCH 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

SD
JR
08-014

APPENDIX E
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Design Calculation of No.1 Bridge

Structural Calculation of Small bridge No.1

Contents

1. DESIGN CRITERIA

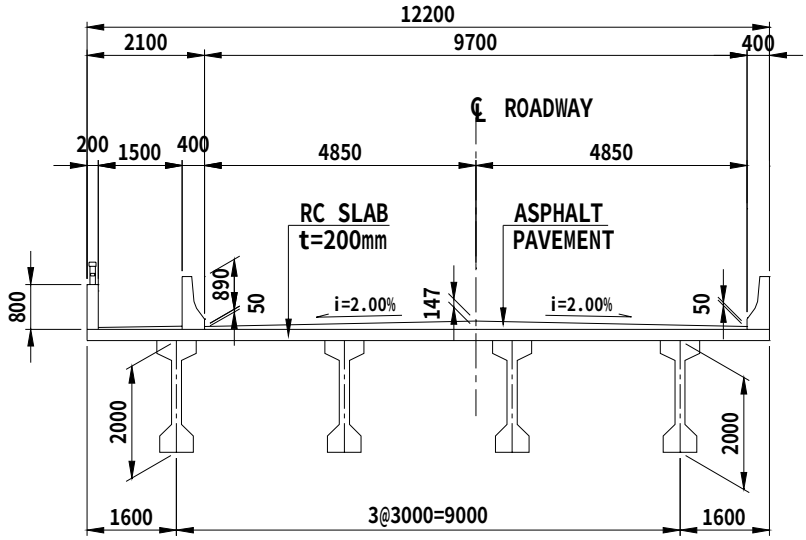
1.1 Design Criteria

Design Criteria of three small bridge(No.1) are shown as follows.

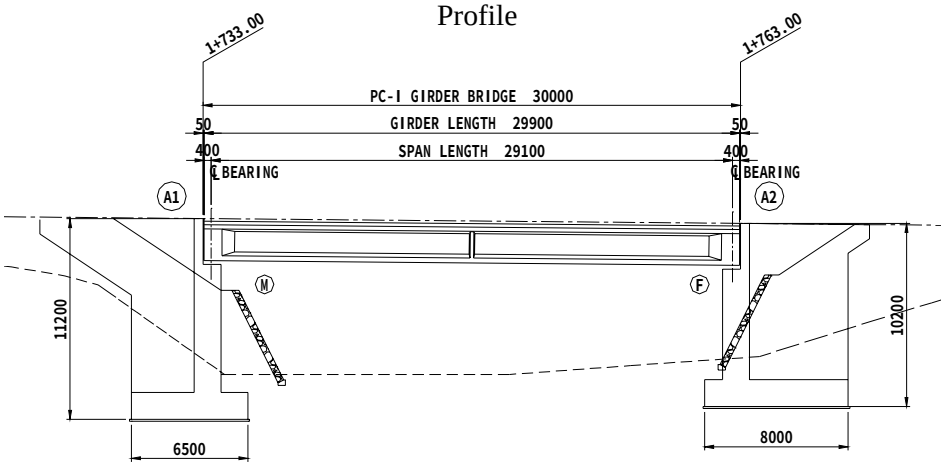
Superstructure	: Single Span PC-I Girder
Bridge Length	: 30.000m
Girder Length	: 29.900m
Span Length	: 29.100
Bridge Width	: 12.200m
Effective Width	: Carriage Way 9.70m
	: Foot Way 1.50m
Live Load	: Class-A, Class-AA
Curvature	: R=∞
Gradient	: i=0.909% ↘
Super Elevation	: i = 2.000% ↙ ↘ 2.820%
Skew Angle	: θ = 90 deg
Support Condition	: A1 Movable support
	: A2 Fixed Support
Asphalt Pavement	: Carriage Way 80mm～
	Foot Way 30mm～

1.2. General Arrangement of Bridge

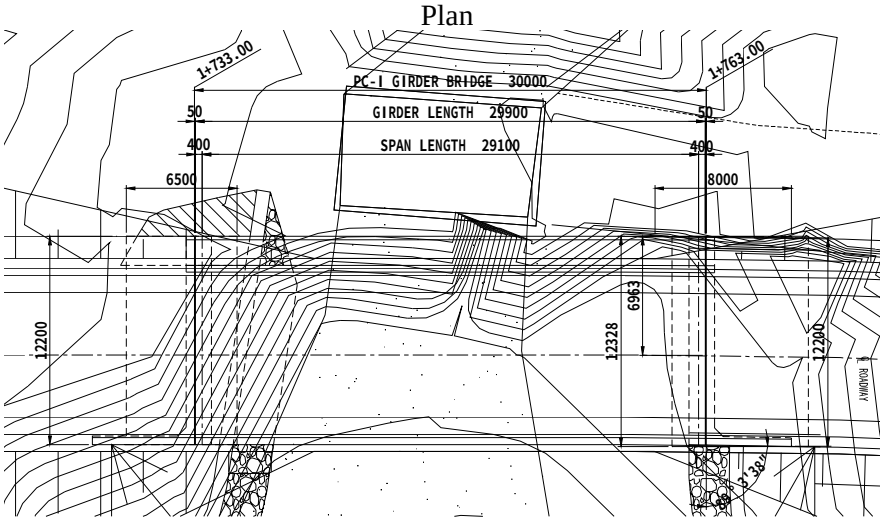
Typical Cross Section



Profile

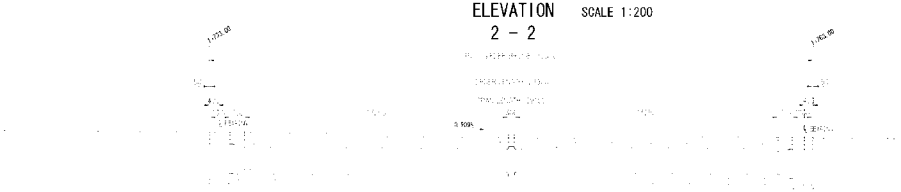


Plan

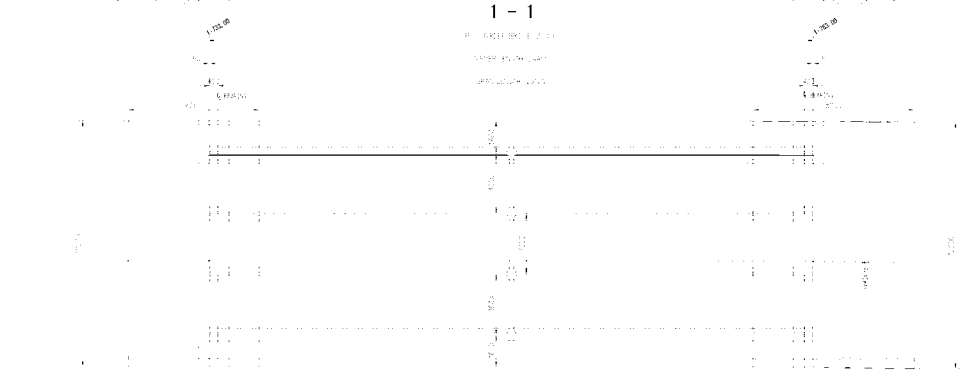


GENERAL ARRANGEMENT OF SUPERSTRUCTURES

ELEVATION SCALE 1:200
2 – 2

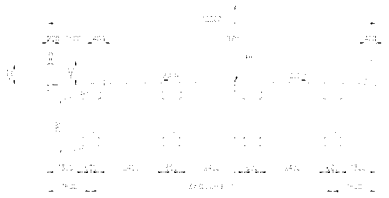


PLAN SCALE 1:200
1 – 1

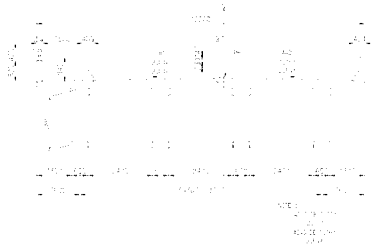


CROSS SECTION SCALE 1:150
3 – 3

INTERMEDIATE DIAPHRAGM SECTION

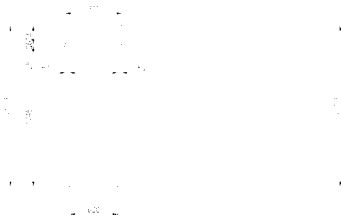


END DIAPHRAGM SECTION



GIRDER SECTION SCALE 1:50
4 – 4

GIRDER END



MIDDLE OF SPAN

INTERMEDIATE DIAPHRAGM PLAN

CONCRETE BARRIER SCALE 1:50
5 – 5

PROJECT NAME:
THE URGENT DEVELOPMENT STUDY ON
REHABILITATION AND RECONSTRUCTION IN MUZAFFARABAD CITY
IN THE ISLAMIC REPUBLIC OF PAKISTAN
(URGENT REHABILITATION PROJECT: WEST BANK BYPASS DESIGN)

GOVERNMENT OF PAKISTAN
PRIME MINISTER'S SECRETARIAT (PUBLIC)
EARTHQUAKE RECONSTRUCTION &
REHABILITATION AUTHORITY (ERRA) ISLAMABAD

JICA Japan International Cooperation Agency

NIPPON KOEI CO.,LTD.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	I. MASUDA	S.KOGUCHI	I. NAKAGAWA
SIGNATURE			
DATE	28 Sept. 2007	29 Sept. 2007	1 Oct. 2007

DRAWING TITLE
SMALL BRIDGE NO.1

GENERAL ARRANGEMENT
OF SUPERSTRUCTURE

DATE OF DWG
1 Oct. 2007
SCALE
AS SHOWN
DWG No.
PAC II BR1-3

3. LOADINGS

1) Selfweight of Girder

Wd0 = Ag×γg

Pd0 = Vd0×γg

Wd0 ; Selfweight of Girder(kN/m)

Ag ; Gross Sectiinal Area of Girder (m2)

γg ; Unit Weight of Girder Concrete (kN/m3) = 24.5

Pd0 ; Weight of Diaphragm (kN)

Vd0 ; Volume of Diaphragm(m3)

	Sectional Area of Ag(m2)	Intensity Wd0(kN/m)		Sectional Area of Ag(m2)	Intensity Wd0(kN/m)
(Outer Gider)			(Iside Girder)		
support	1.22425	29.99413	support	1.22425	29.99413
intermediate	0.6793	16.64285	intermediate	0.6793	16.64285

	volume Vd0(m3)	Intensity Pd0(kN)
Diaphragm	0.21798	5.34051

2) Weight of Cross Beam

Pd1 = Vd1×γc

Pd1 ; Load Intensity (kN)

Vd1 ; Volume of Cross Baem (m3)

γc ; Unit Weight of Cross Beam Concrete (kN/m3) = 24.5

Number of Coss Beam	G- 1 Vd1(m3)	Pd1(kN)	G- 2 Vd1(m3)	Pd1(kN)	G- 3 Vd1(m3)	Pd1(kN)	G- 4 Vd1(m3)	Pd1(kN)
C1	1.910208	46.8001	3.820416	93.6002	3.820416	93.6002	1.910208	46.8001
C5	0.532613	13.04901	1.065225	26.09801	1.065225	26.09801	0.532613	13.04901
C9	1.910208	46.8001	3.820416	93.6002	3.820416	93.6002	1.910208	46.8001

3) Deck Slab

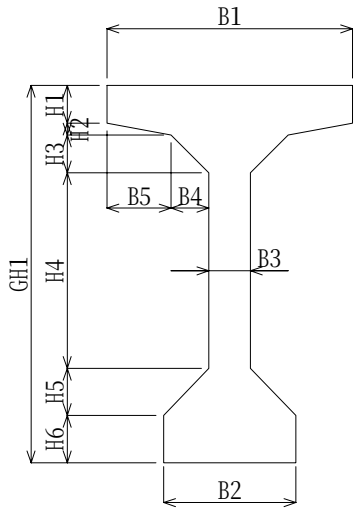
Wd2 = At×γs

Wd2 ; Load Intensity of Deck Slab (kN/m)

At ; Thickness of Deck Slab (m)

γs ; Unit Weight of Deck Slab Concrete (kN/m3) = 24.5

Wd2 = 0.20 ×24.5 =4.9 (kN/m2)



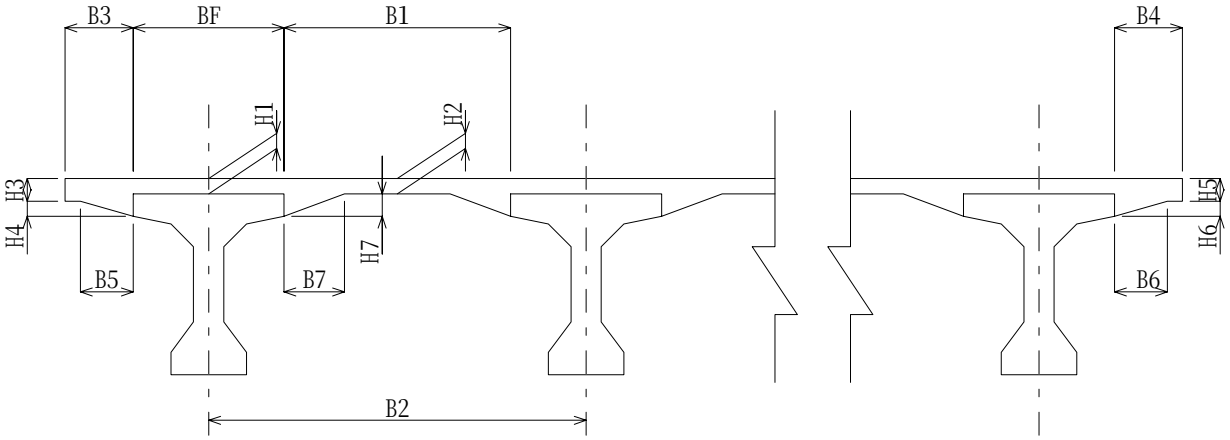
B1 = 0.700(m)
B2 = 0.600(m)
H1 = 0.230(m)
H6 = 0.290(m)

Girder Dimension (G1)

	B3 (m)	B4 (m)	B5 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	GH1 (m)
C1	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000
C2	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C3	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C4	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C5	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C6	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C7	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C8	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C9	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000

Girder Dimension (G2)

	B3 (m)	B4 (m)	B5 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	GH1 (m)
C1	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000
C2	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C3	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C4	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C5	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C6	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C7	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C8	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C9	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000



BF = 0.700(m)

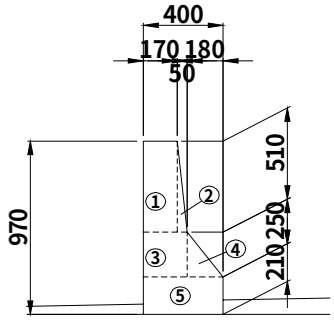
Deck Slab Dimension

	H1 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	H6 (m)	H7 (m)	B3 (m)	B4 (m)	B5 (m)	B6 (m)	B7 (m)
C1	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C2	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C3	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C4	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C5	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C6	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C7	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C8	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C9	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001

	G- 1		G- 2		G- 3	
	B1 (m)	B2 (m)	B1 (m)	B2 (m)	B1 (m)	B2 (m)
C1	2.300	3.000	2.300	3.000	2.300	3.000
C2	2.300	3.000	2.300	3.000	2.300	3.000
C3	2.300	3.000	2.300	3.000	2.300	3.000
C4	2.300	3.000	2.300	3.000	2.300	3.000
C5	2.300	3.000	2.300	3.000	2.300	3.000
C6	2.300	3.000	2.300	3.000	2.300	3.000
C7	2.300	3.000	2.300	3.000	2.300	3.000
C8	2.300	3.000	2.300	3.000	2.300	3.000
C9	2.300	3.000	2.300	3.000	2.300	3.000

3) Surfacing

a. Parapet of Carriage Way



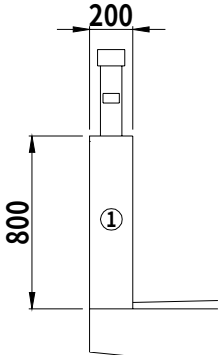
	A	X	AX
①	0.170×0.510×1.0=0.087	0.085	0.007
②	0.050×0.510×0.5=0.013	0.187	0.002
③	0.220×0.250×1.0=0.055	0.110	0.006
④	0.180×0.250×0.5=0.023	0.280	0.006
⑤	0.400×0.210×1.0=0.084	0.200	0.017
計	0.261		0.038

X = ∑AX/∑A = 0.146 m

P = 0.261 × 24.5 = 6.393 kN/m

b. Parapet of Foot Way

Concrete barrier



	A	X	AX
①	0.200×0.800×1.0=0.160	0.100	0.01600
Total	0.160		0.01600

X = ∑AX/∑A = 0.1 m

P = 0.160 × 24.5 = 3.92 kN/m

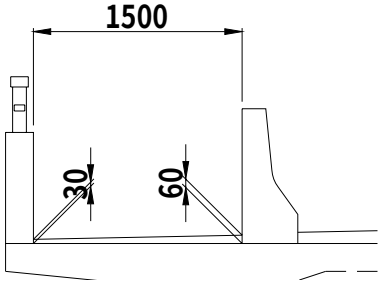
M = 0.100 × 3.920 = 0.392 kN・m/m

Steel Railing

W= 0.300kN/m

c. Asphalt Pavement

Foot Way (t=30mm~60mm)

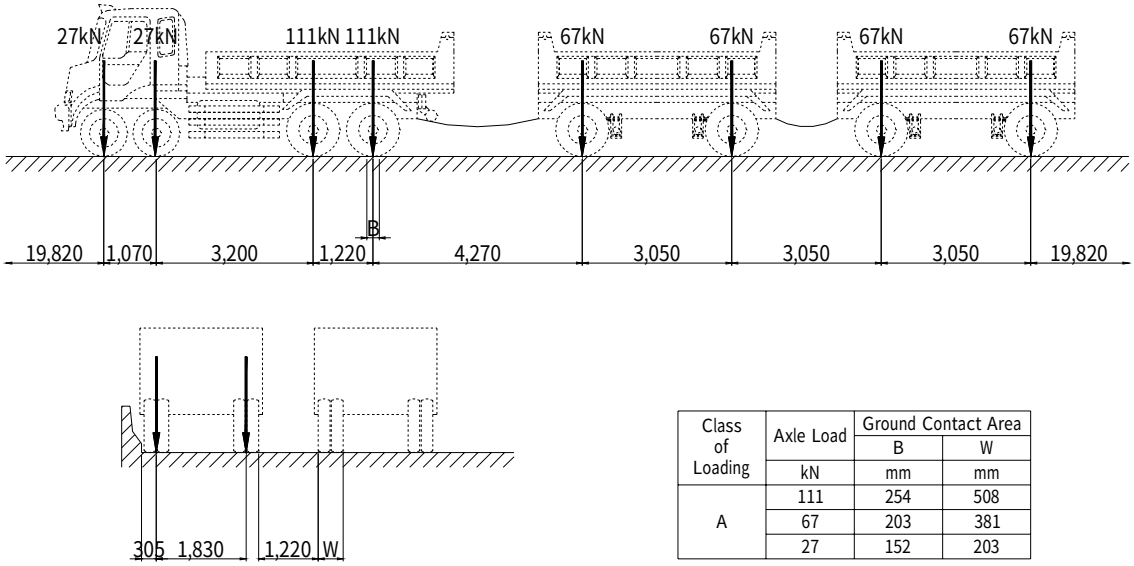


W = 0.03 × 22.5 = 0.675 kN/m^2

W = 0.06 × 22.5= 1.35 kN/m^2

4) Live Load

d. Class-A Loading



Class of Loading	Axle Load	Ground Contact Area	
		B	W
	kN	mm	mm
A	111	254	508
	67	203	381
	27	152	203

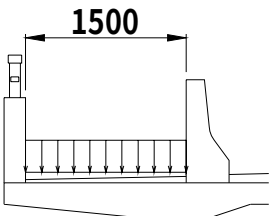
e. Impact Factor

i= 15.24/(L+38) L: Span Length (m)

= 15.24/(28.95+38)

= 0.228

f. Foot Way Loading



q = 2.87 kN/m^2

4. CALCULATION RESULT OF SECTIONAL FORCE

(1) Bending Moment : Mmax ,Mmin

(G-1 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1608.48	0
Surefacing	-46.4	1166.13	-46.4
Total of Dead Load	-46.4	4674.08	-46.4
LIive Load(max)	248.73	3299.15	248.73
LIive Load(min)	-349.15	-116.83	-349.15
Dead+Live (max)	202.33	7973.23	202.33
Dead+Live (min)	-395.55	4557.25	-395.55
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	221.1	0	-221.1
Surefacing	212.03	-41.83	-212.03
Total of Dead Load	694.49	-32.64	-694.49
LIive Load(max)	54.56	34.95	-54.56
LIive Load(min)	387.07	-18.32	-387.07
Dead+Live (max)	749.05	2.32	-749.05
Dead+Live (min)	1081.56	-50.95	-1081.56

(G-2 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	38.83	1307.89	38.83
Total of Dead Load	38.83	4858.91	38.83
LIive Load(max)	154.07	2592.31	154.07
LIive Load(min)	-171.35	0	-171.35
Dead+Live (max)	192.9	7451.22	192.9
Dead+Live (min)	-132.53	4858.91	-132.53
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	126.98	46.78	-126.98
Total of Dead Load	608.84	62.5	-608.84
LIive Load(max)	117.26	8.77	-117.26
LIive Load(min)	355.21	0	-355.21
Dead+Live (max)	726.1	71.26	-726.1
Dead+Live (min)	964.05	62.5	-964.05

(G-3 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	29.38	1247.74	29.38
Total of Dead Load	29.38	4798.76	29.38
LIive Load(max)	124.88	2310.75	124.88
LIive Load(min)	-170.54	0	-170.54
Dead+Live (max)	154.26	7109.5	154.26
Dead+Live (min)	-141.16	4798.76	-141.16
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	135.47	31.76	-135.47
Total of Dead Load	617.32	47.48	-617.32
LIive Load(max)	97.7	-25.95	-97.7
LIive Load(min)	347.6	0	-347.6
Dead+Live (max)	715.02	21.53	-715.02
Dead+Live (min)	964.93	47.48	-964.93

(G-4 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1712.21	0
Surefacing	-21.8	1123.23	-21.8
Total of Dead Load	-21.8	4734.92	-21.8
LIive Load(max)	331.36	2706.08	331.36
LIive Load(min)	-209.05	-289.72	-209.05
Dead+Live (max)	309.55	7441	309.55
Dead+Live (min)	-230.85	4445.2	-230.85
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	235.36	0	-235.36
Surefacing	197.37	-36.71	-197.37
Total of Dead Load	694.09	-27.51	-694.09
LIive Load(max)	20.27	72.32	-20.27
LIive Load(min)	242.34	-44.09	-242.34
Dead+Live (max)	714.36	44.81	-714.36
Dead+Live (min)	936.43	-71.6	-936.43

(2) Shear Force max,min

(G-1 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	221.1	0	-221.1
Surefacing	212.03	-41.83	-212.03
Total of Dead Load	694.49	-32.64	-694.49
LIive Load(max)	525.16	209.42	11.8
LIive Load(min)	-11.8	-221.93	-525.16
Dead+Live (max)	1219.66	176.78	-682.69
Dead+Live (min)	682.69	-254.57	-1219.66
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1608.48	0
Surefacing	-46.4	1166.13	-46.4
Total of Dead Load	-46.4	4674.08	-46.4
LIive Load(max)	-207.97	2514.72	113.5
LIive Load(min)	113.5	1335.07	-207.97
Dead+Live (max)	-254.37	7188.8	67.09
Dead+Live (min)	67.09	6009.15	-254.37

(G-2 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	126.98	46.78	-126.98
Total of Dead Load	608.84	62.5	-608.84
LIive Load(max)	474.38	170.51	14.11
LIive Load(min)	-14.11	-258.3	-474.38
Dead+Live (max)	1083.21	233.01	-594.73
Dead+Live (min)	594.73	-195.81	-1083.21
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	38.83	1307.89	38.83
Total of Dead Load	38.83	4858.91	38.83
LIive Load(max)	-88.35	2127.74	26.53
LIive Load(min)	26.53	981.19	-88.35
Dead+Live (max)	-49.52	6986.65	65.36
Dead+Live (min)	65.36	5840.1	-49.52

(G-3 Gider)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	135.47	31.76	-135.47
Total of Dead Load	617.32	47.48	-617.32
LIive Load(max)	465.6	142.52	3.76
LIive Load(min)	-3.76	-258.79	-465.6
Dead+Live (max)	1082.92	190	-613.57
Dead+Live (min)	613.57	-211.31	-1082.92
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	29.38	1247.74	29.38
Total of Dead Load	29.38	4798.76	29.38
LIive Load(max)	-95.02	1840.58	8.36
LIive Load(min)	8.36	945.75	-95.02
Dead+Live (max)	-65.64	6639.33	37.74
Dead+Live (min)	37.74	5744.51	-65.64

(G-4 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	235.36	0	-235.36
Surefacing	197.37	-36.71	-197.37
Total of Dead Load	694.09	-27.51	-694.09
LIive Load(max)	320.8	164.86	29.59
LIive Load(min)	-29.59	-126.75	-320.8
Dead+Live (max)	1014.89	137.35	-664.5
Dead+Live (min)	664.5	-154.26	-1014.89
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1712.21	0
Surefacing	-21.8	1123.23	-21.8
Total of Dead Load	-21.8	4734.92	-21.8
LIive Load(max)	-61.84	2093.37	214.31
LIive Load(min)	214.31	612.97	-61.84
Dead+Live (max)	-83.64	6828.29	192.51
Dead+Live (min)	192.51	5347.89	-83.64

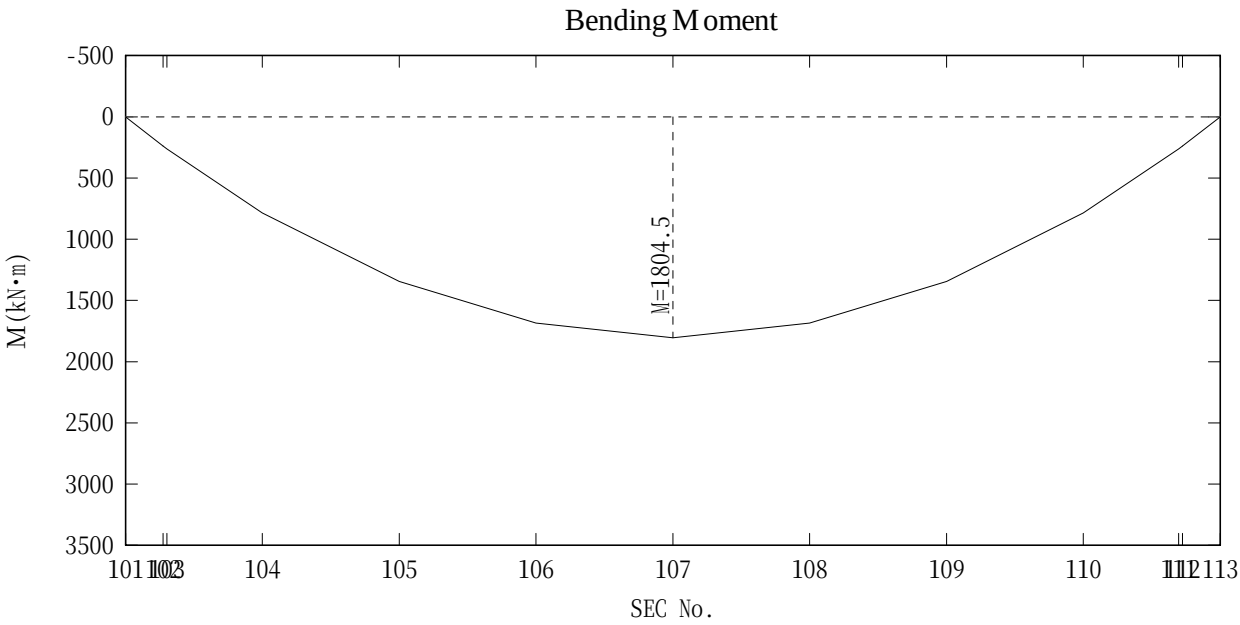
Selection of the Design Girder

Design girder selects G1 girder as a result of comparison of sectional force.

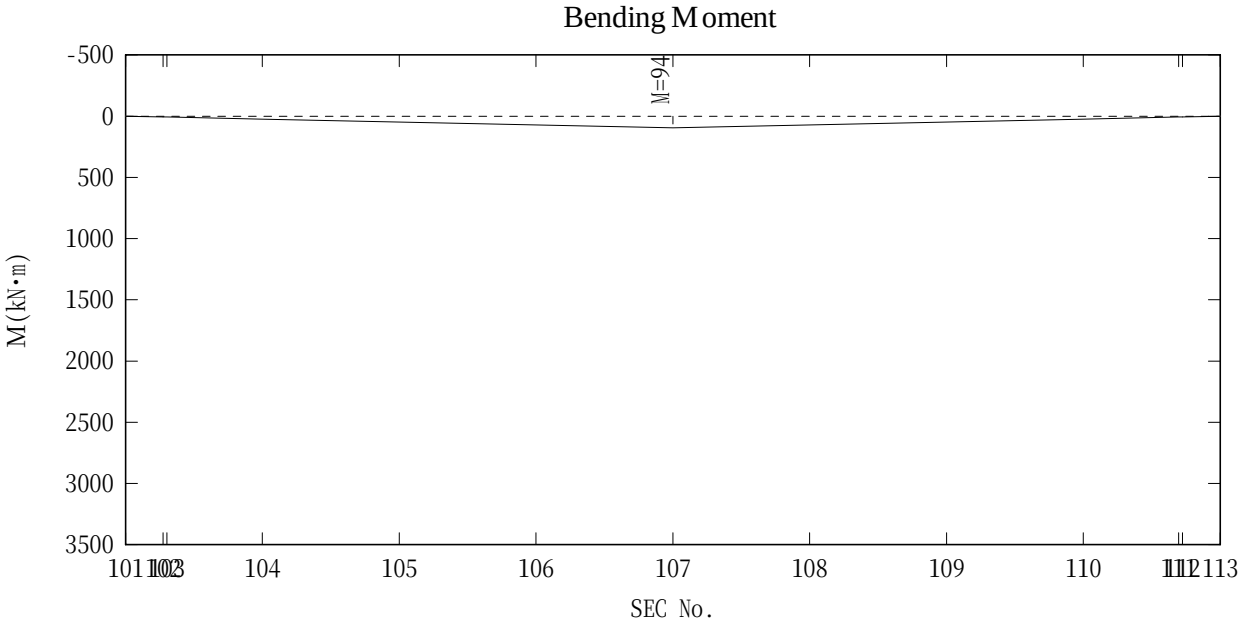
Comparison of bebding moment.

Number of Girder	**G1**	G2	G3	G4
Position	**1005**	2005	3005	4005
Distance from A1 bearing	**14.55**	14.55	14.55	14.55
Bebding Moment (max)	**7973.233**	7451.216	7109.504	7440.999

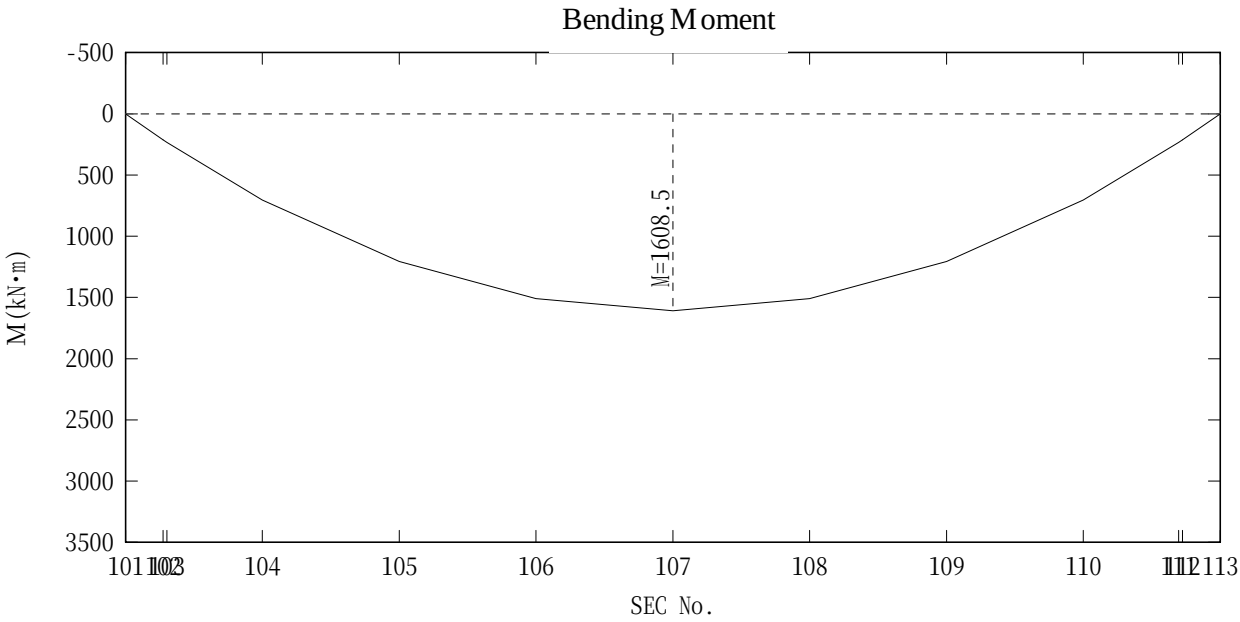
Bending Moment Diagram (Girder self-weight)



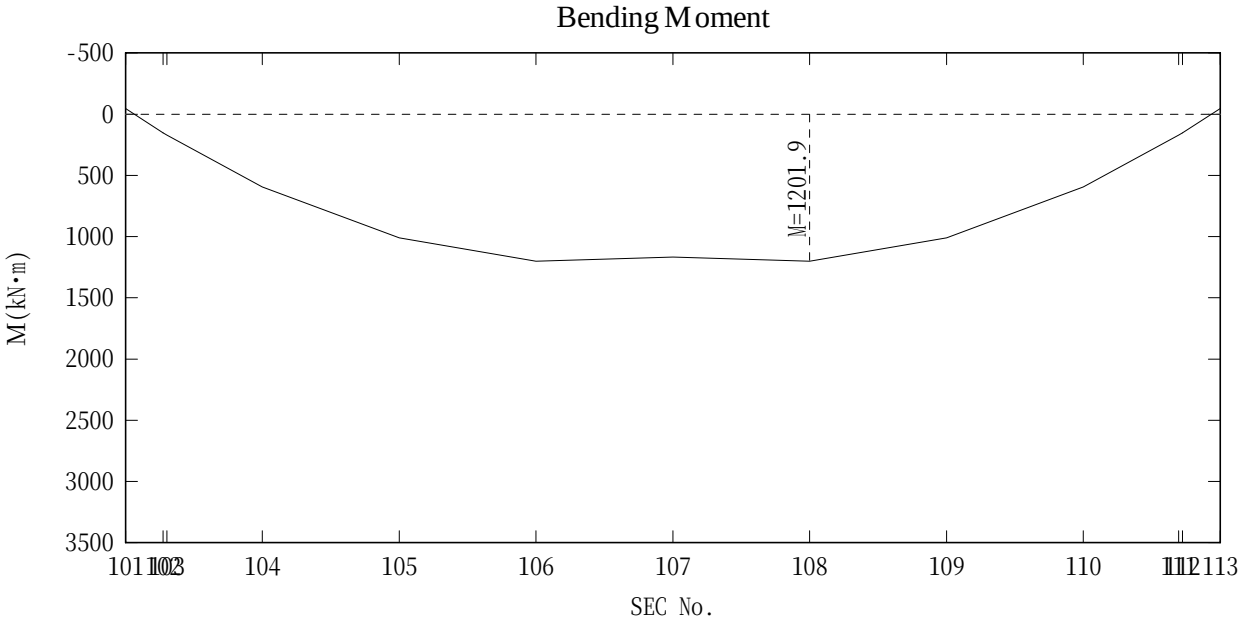
Bending Moment Diagram (Crossbeam self-weight)



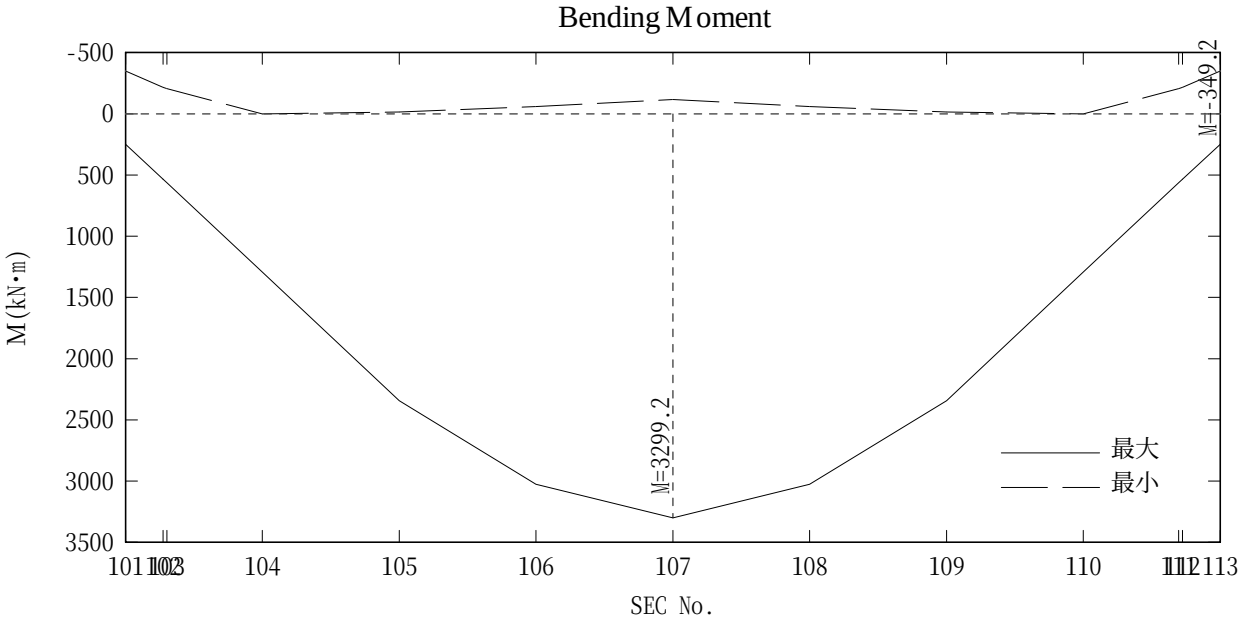
Bending Moment Diagram (Deck Slab self-weight)



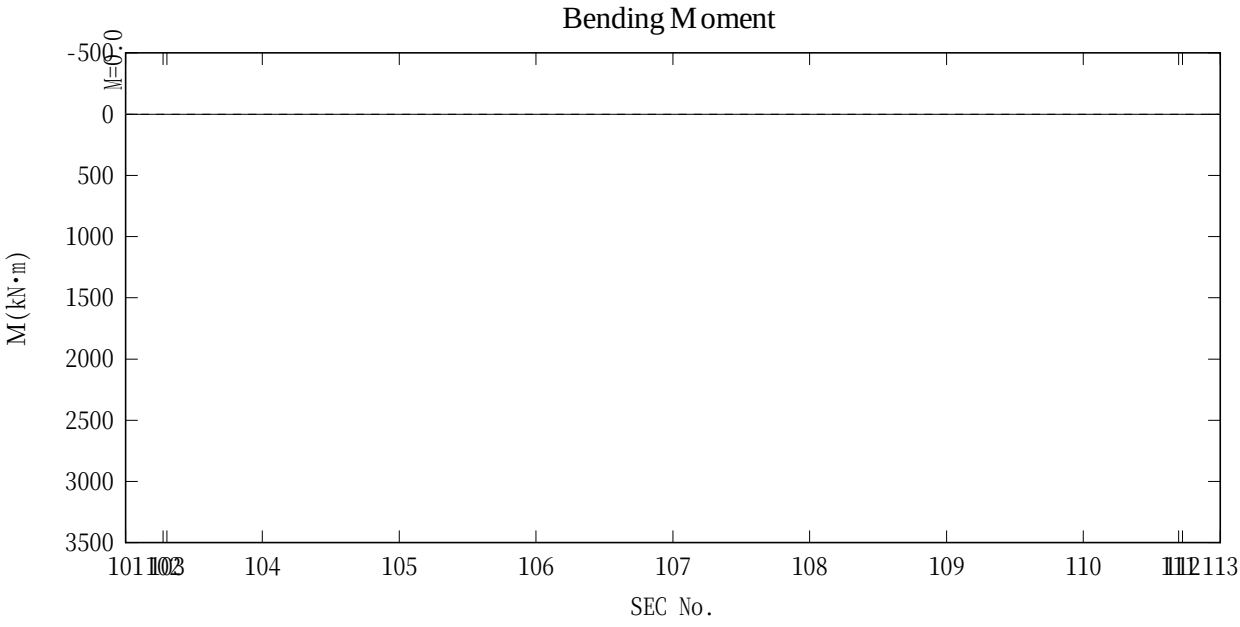
Bending Moment Diagram (Surfacing)



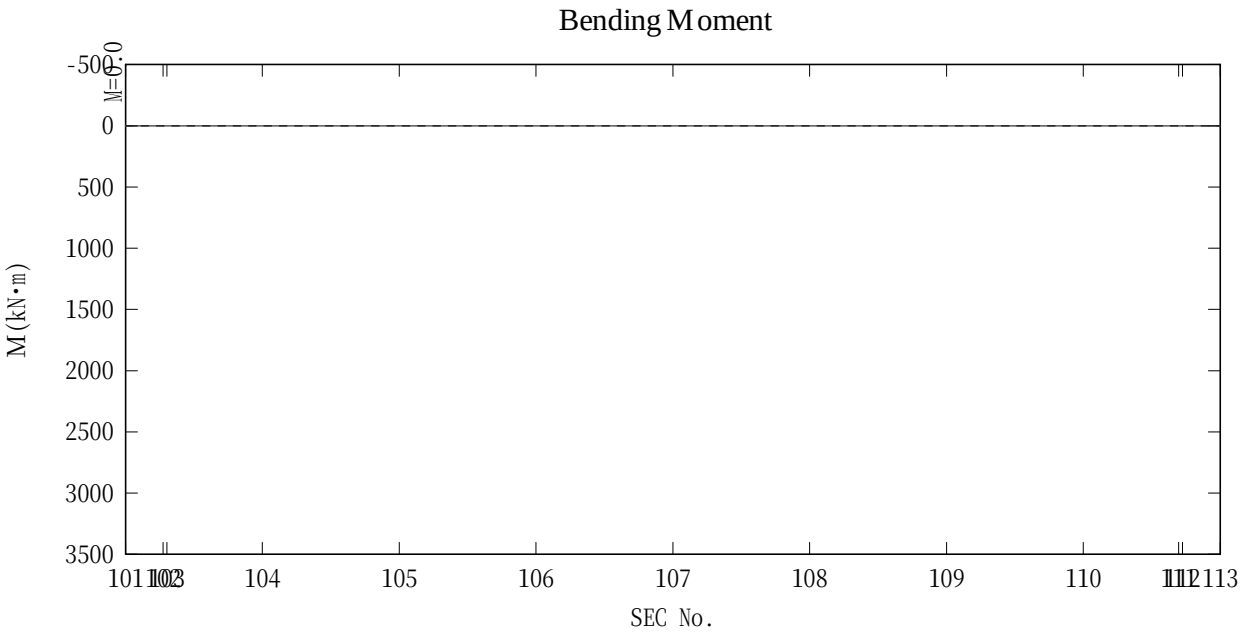
Bending Moment Diagram (Live Load)



Bending Moment Diagram (Creep)



Bending Moment Diagram (Shrinkage)



5. CALCULATION RESULT OF GIRDER STRESS

Combined Bending Stress

	SEC-105 (N/mm2)			SEC-106 (N/mm2)		
	upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress						
After Transfer (1)		-3.05	18.17		-5.50	21.32
Slab under Construction (2)		-2.58	15.40		-4.59	17.81
Design Load (3)		-2.36	14.09		-4.21	16.31
Secondary Force (4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder (5)		3.99	-4.08		5.03	-5.17
Selfweight of Cross Bea (6)		0.14	-0.13		0.21	-0.20
Selfweight of Slab (7)		3.53	-3.38		4.38	-4.16
Surfacing Load (8)	0.88	0.74	-2.02	1.04	0.87	-2.38
Live Load(max) (9)	2.03	1.71	-4.69	2.61	2.19	-5.99
Live Load(min) (10)	-0.01	-0.01	0.03	-0.05	-0.04	0.12
Difference Drying Shrink (11)	-0.09	0.30	-0.11	-0.09	0.30	-0.11
Creep Effect (12)	0.73	-2.27	0.84	0.84	-2.55	0.95
Temperature Difference (13)	0.29	-1.01	0.37	0.29	-1.01	0.36
Thermal Change(+) (14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-) (15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max) (16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min) (17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage (18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress						
After Transfer						
(1)+(5)	0.94	14.09			-0.47	16.15
Slab under Construction						
(2)+(5)+(6)+(7)	5.08	7.81			5.02	8.28
dead load +(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(1	1.52	4.07	5.21	1.79	4.03	5.24
D+L						
B:A+(9)	3.55	5.78	0.52	4.39	6.22	-0.75
C:A+(10)	1.50	4.06	5.24	1.74	3.99	5.36
Temperature Consideration						
H:B+(14)	3.55	5.78	0.52	4.39	6.22	-0.75
I:B+(15)	3.55	5.78	0.52	4.39	6.22	-0.75
J:C+(14)	1.50	4.06	5.24	1.74	3.99	5.36
K:C+(15)	1.50	4.06	5.24	1.74	3.99	5.36
L:H+(13)	3.84	4.76	0.89	4.68	5.21	-0.39
M:I+(13)	3.84	4.76	0.89	4.68	5.21	-0.39
N:J+(13)	1.79	3.04	5.61	2.02	2.98	5.72
O:K+(13)	1.79	3.04	5.61	2.02	2.98	5.72
Settlement Consideration						
MAX[B+(16) B+(17),C+(16),C+(17	3.55	5.78	0.52	4.39	6.22	-0.75
MIN[B+(16),B+(17),C+(16),C+(17)	1.50	4.06	5.24	1.74	3.99	5.36

		SEC-107 (N/mm2)				SEC-108 (N/mm2)	
		upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress							
After Transfer	(1)		-5.59	21.66		-5.50	21.32
Slab under Construction	(2)		-4.68	18.13		-4.59	17.81
Design Load	(3)		-4.30	16.67		-4.21	16.31
Secondary Force	(4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder	(5)		5.38	-5.54		5.03	-5.17
Selfweight of Cross Bea	(6)		0.28	-0.26		0.21	-0.20
Selfweight of Slab	(7)		4.67	-4.44		4.38	-4.16
Surfacing Load	(8)	1.01	0.85	-2.31	1.04	0.87	-2.38
Live Load(max)	(9)	2.84	2.39	-6.53	2.61	2.19	-5.99
Live Load(min)	(10)	-0.10	-0.09	0.23	-0.05	-0.04	0.12
Difference Drying Shrink	(11)	-0.09	0.30	-0.11	-0.09	0.30	-0.11
Creep Effect	(12)	0.94	-2.82	1.05	0.84	-2.55	0.95
Temperature Difference	(13)	0.29	-1.01	0.36	0.29	-1.01	0.36
Thermal Change(+)	(14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-)	(15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max)	(16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min)	(17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage	(18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress							
After Transfer							
(1)+(5)		-0.20	16.12	-0.47	16.15		
Slab under Construction							
(2)+(5)+(6)+(7)		5.66	7.89	5.02	8.28		
dead load	+(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(1		1.86	4.36	5.06	1.79	4.03	5.24
D+L							
B:A+(9)		4.70	6.75	-1.47	4.39	6.22	-0.75
C:A+(10)		1.76	4.27	5.30	1.74	3.99	5.36
Temperature Consideration							
H:B+(14)		4.70	6.75	-1.47	4.39	6.22	-0.75
I:B+(15)		4.70	6.75	-1.47	4.39	6.22	-0.75
J:C+(14)		1.76	4.27	5.30	1.74	3.99	5.36
K:C+(15)		1.76	4.27	5.30	1.74	3.99	5.36
L:H+(13)		4.99	5.74	-1.11	4.68	5.21	-0.39
M:I+(13)		4.99	5.74	-1.11	4.68	5.21	-0.39
N:J+(13)		2.05	3.27	5.65	2.02	2.98	5.72
O:K+(13)		2.05	3.27	5.65	2.02	2.98	5.72
Settlement Consideration							
MAX[B+(16) B+(17),C+(16),C+(17		4.70	6.75	-1.47	4.39	6.22	-0.75
MIN[B+(16),B+(17),C+(16),C+(17)		1.76	4.27	5.30	1.74	3.99	5.36

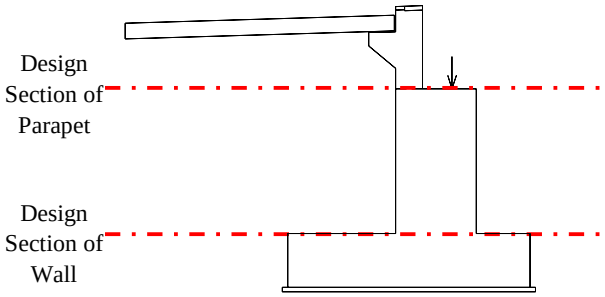
		SEC-109	(N/mm2)		SEC-110	(N/mm2)
	upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress						
After Transfer (1)		-3.05	18.17		1.28	13.54
Slab under Construction (2)		-2.58	15.40		1.11	11.74
Design Load (3)		-2.36	14.09		1.01	10.72
Secondary Force (4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder (5)	3.99	-4.08	2.31	-2.34		
Selfweight of Cross Bea (6)	0.14	-0.13	0.07	-0.07		
Selfweight of Slab (7)	3.53	-3.38	2.08	-2.02		
Surfacing Load (8)	0.88	0.74	-2.02	0.52	0.44	-1.21
Live Load(max) (9)	2.03	1.71	-4.69	1.13	0.95	-2.63
Live Load(min) (10)	-0.01	-0.01	0.03	0.00	0.00	0.00
Difference Drying Shrink (11)	-0.09	0.30	-0.11	-0.09	0.30	-0.11
Creep Effect (12)	0.73	-2.27	0.84	0.59	-1.93	0.72
Temperature Difference (13)	0.29	-1.01	0.37	0.29	-1.01	0.38
Thermal Change(+) (14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-) (15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max) (16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min) (17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage (18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress						
After Transfer						
(1)+(5)	0.94	14.09	3.59	11.20		
Slab under Construction						
(2)+(5)+(6)+(7)	5.08	7.81	5.57	7.32		
dead load +(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(1	1.52	4.07	5.21	1.02	4.29	5.68
D+L						
B:A+(9)	3.55	5.78	0.52	2.16	5.23	3.05
C:A+(10)	1.50	4.06	5.24	1.02	4.29	5.68
Temperature Consideration						
H:B+(14)	3.55	5.78	0.52	2.16	5.23	3.05
I:B+(15)	3.55	5.78	0.52	2.16	5.23	3.05
J:C+(14)	1.50	4.06	5.24	1.02	4.29	5.68
K:C+(15)	1.50	4.06	5.24	1.02	4.29	5.68
L:H+(13)	3.84	4.76	0.89	2.44	4.22	3.43
M:I+(13)	3.84	4.76	0.89	2.44	4.22	3.43
N:J+(13)	1.79	3.04	5.61	1.31	3.27	6.06
O:K+(13)	1.79	3.04	5.61	1.31	3.27	6.06
Settlement Consideration						
MAX[B+(16) B+(17),C+(16),C+(17	3.55	5.78	0.52	2.16	5.23	3.05
MIN[B+(16),B+(17),C+(16),C+(17)	1.50	4.06	5.24	1.02	4.29	5.68

6. Result of Substructure
6.1 A1 Abutment

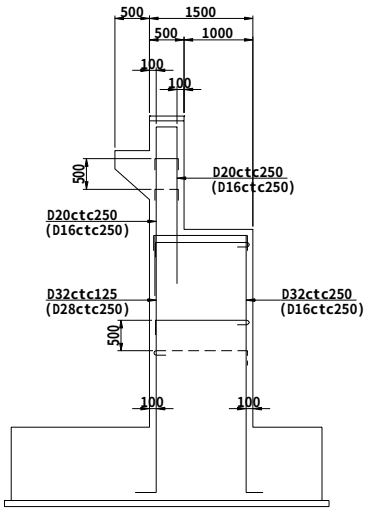
Summary of Design Calculation Result (1/3)

Stability	Force at the Center of Footing	Group-I	V=23297kN, H=4093kN, M=8874kNm
		Group-VII	V=20818kN, H=9144kN, M=34153kNm
	Safety Factor for Horizontal Force	Group-I	Safety Factor=3.415 > 1.5 (Allowable Factor)
		Group-VII	Safety Factor=1.412 > 1.2 (Allowable Factor)
	Ground Reaction	Group-I	qmax=397kN/m^2 < qa=600kN/m^2
		Group-VII	qmax=707kN/m^2 < qa=900kN/m^2

1. Wall and Parapet



Bar Arrangement of Parapet & Wall

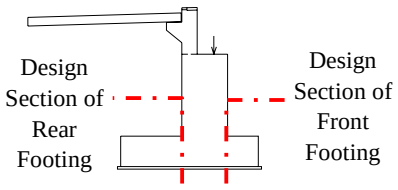


Size of Section			Thickness of Parapet	t=0.500m			
			Thickness of Wall	t=1.500m			
Bar Arrangement			Parapet	D20ctc250-1.0, d=400mm			
			Wall	D32ctc125-1.0, d=1400mm			
Parapet	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M=	68.8 kNm,	N=	0 kN	
		Stress	σc=	3.7 <	σca=	9.6 N/mm^2	
			σs=	149.0 <	σsa=	168 N/mm^2	
Wall	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M=	1021 kNm,	N=	446 kN	
		Stress	σc=	3.9 <	σca=	9.6 N/mm^2	
			σs=	80.5 <	σsa=	168 N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M=	1707 kNm,	N=	390 kN	
		Stress	σc=	6.4 <	σca=	12.8 N/mm^2	
			σs=	169.0 <	σsa=	223 N/mm^2	
	Load Factor Design	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		SectionalForce	Mu=	1451 kNm,	Nu=	934 kN	
		Strength	Flexural Strength		φMn=	3517 kNm	> Mu
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu=	2791 kNm,	Nu=	635 kN	
		Strength	Flexural Strength		φMn=	3517 kNm	> Mu

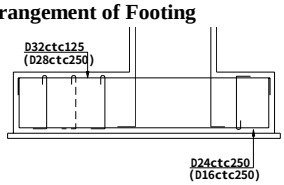
Small Bridge A1 Abutment

Summary of Design Calculation Result (2/3)

2. Spread Footing



Bar Arrangement of Footing

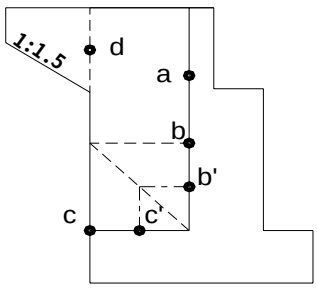


Size of Section			Longitudinal Direction	L_L=6.500m		T=1.500m	
			Transverse Direction	L_T=12.200m		T=1.500m	
Service Load Design	Front Footing	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M= 92 kNm, ①				
		Stress	σc= 1.0	<	σca= 9.6	N/mm^2	
			σs= 106.7	<	σsa= 168	N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M= 160 kNm, ①				
		Stress	σc= 3.3	<	σca= 12.8	N/mm^2	
			σs= 214.0	<	σsa= 223	N/mm^2	
	Rear Footing	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M= 473 kNm, ①				
		Stress	σc= 1.8	<	σca= 9.6	N/mm^2	
			σs= 59.7	<	σsa= 168	N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M= 1504 kNm, ①				
		Stress	σc= 5.6	<	σca= 12.8	N/mm^2	
			σs= 189.8	<	σsa= 223	N/mm^2	
Load Factor Design	Front Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		Sectional Force	Mu= 436 kNm, ①				
			Su= 293.8 kN ②				
		Strength	Flexural Strength	φMn=	998 kNm		> Mu
			Shear Strenth	φVn=	1133 kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu= 865 kNm, ①				
			Su= 598.9 kN ②				
		Strength	Flexural Strength	φMn=	998 kNm		> Mu
			Shear Strenth	φVn=	1133 kN		> Su
	Rear Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		Sectional Force	Mu= 602 kNm, ①				
			Su= 226.6 kN ②				
		Strength	Flexural Strength	φMn=	2446 kNm		> Mu
			Shear Strenth	φVn=	kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu= 2093 kNm, ①				
			Su= 932.8 kN ②				
		Strength	Flexural Strength	φMn=	2446 kNm		> Mu
			Shear Strenth	φVn=	1193 kN		> Su

Small Bridge-1 A1 Abutment

Summary of Design Calculation Result (3/3)

3. Wing



Bar Arranegement

Section	Reinforcement-bar Arranngement	
	Inside (mm^2)	Outside (mm2)
a	D28-@125	D24-@250
b	D28-@125	D24-@250
c	D32-@125	D28-@250
d	D28-@250	D24-@250

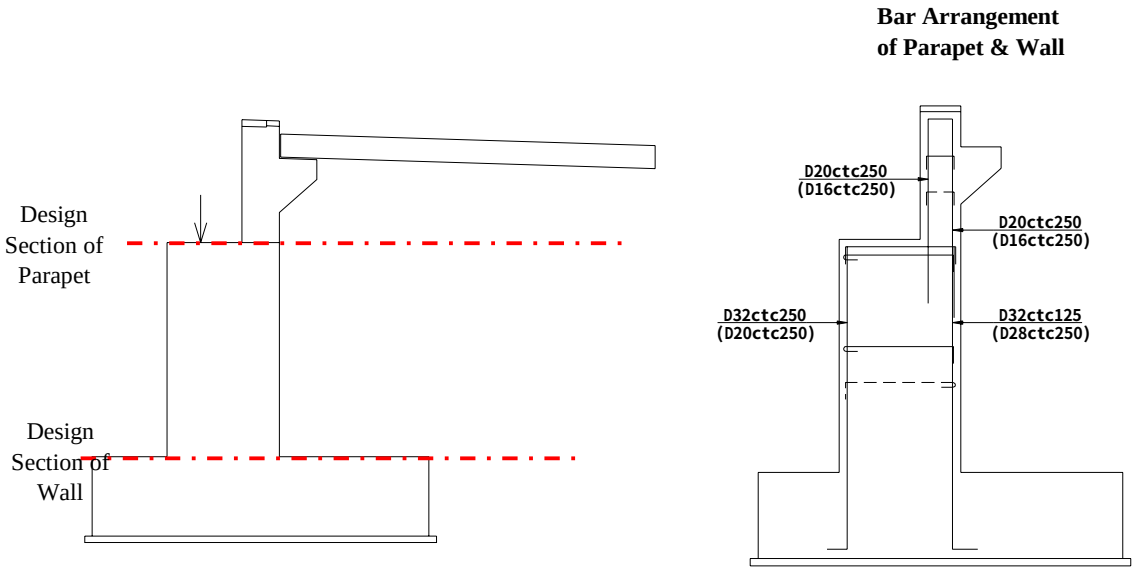
Size of Section			Thickness of Wing	t=0.700m				
Service Load Design	Section-"a"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	128.2	kNm,			
		Stress	σc=	4.8	<	σca=	9.6	N/mm²
			σs=	150.0	<	σsa=	168	N/mm²
	Section-"b"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	287.8	kNm,			
		Stress	σc=	4.6	<	σca=	9.6	N/mm²
			σs=	143.4	<	σsa=	168	N/mm²
	Section-"c"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	80.1	kNm,			
		Stress	σc=	2.3	<	σca=	9.6	N/mm²
			σs=	125.3	<	σsa=	168	N/mm²
	Section-"d"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	57.3	kNm,			
		Stress	σc=	1.9	<	σca=	9.6	N/mm²
			σs=	127.9	<	σsa=	168	N/mm²
Load Factor Design	Section-"a"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	423.0	kNm,			
		Strength	Flexural Strength			φMn=	968	kNm > Mu
	Section-"b"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	414.5	kNm,			
		Strength	Flexural Strength			φMn=	970	kNm > Mu
	Section-"c"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	487.4	kNm,			
		Strength	Flexural Strength			φMn=	1236	kNm > Mu
	Section-"d"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	95.8	kNm,			
		Strength	Flexural Strength			φMn=	524	kNm > Mu

6.2 A2 Abutment

Summary of Design Calculation Result (1/3)

Stability	Force at the Center of Footing	Group-I	V=21404kN, H=3424kN, M=3244kNm
		Group-VII	V=18986kN, H=8587kN, M=29269kNm
	Safety Factor for Horizontal Force	Group-I	Safety Factor=3.751 > 1.5 (Allowable Factor)
		Group-VII	Safety Factor=1.327 > 1.2 (Allowable Factor)
	Subgrade Reaction	Group-I	qmax=283kN/m^2 < qa=700kN/m^2
		Group-VII	qmax=530kN/m^2 < qa=1050kN/m^2

1. Wall and Parapet

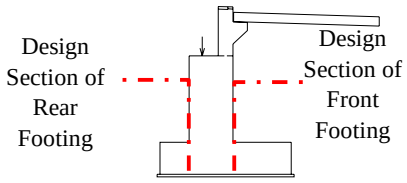


Size of Section			Thickness of Parapet		t=0.500m			
			Thickness of Wall		t=1.500m			
Bar Arrangement			Parapet		D20ctc250-1.0, d=500mm			
			Wall		D32ctc125-1.0, d=1400mm			
Parapet	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	69	kNm,	N=	0	kN
		Stress	σc=	3.7	<	σca=	9.6	N/mm^2
			σs=	128.0	<	σsa=	168	N/mm^2
Wall	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	748	kNm,	N=	611	kN
		Stress	σc=	2.3	<	σca=	9.6	N/mm^2
			σs=	50.9	<	σsa=	168	N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)					
		Sectional Force	M=	1660	kNm,	N=	735	kN
		Stress	σc=	4.9	<	σca=	12.8	N/mm^2
			σs=	166.2	<	σsa=	223	N/mm^2
	Load Factor Design	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)					
		Sectional Force	Mu=	1073	kNm,	Nu=	886	kN
		Strength	Flexural Strength			φMn=	2476	kNm > Mu
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)					
		Sectional Force	Mu=	2159	kNm,	Nu=	661	kN
		Strength	Flexural Strength			φMn=	2476	kNm > Mu

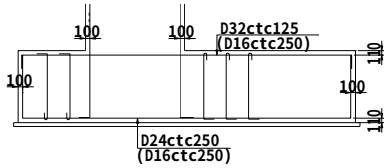
Small Bridge-1 A2 Abutment

Summary of Design Calculation Result (2/3)

2. Spread Footing



Bar Arrangement of Footing

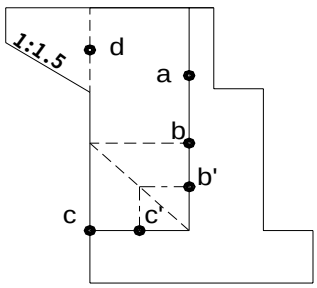


Size of Section			Longitudinal Direction	L_L=7.000m	T=1.500m		
			Transverse Direction	L_T=12.200m	T=1.500m		
Service Load Design	Front Footing	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M= 252 kNm, ①				
		Stress	σc= 1.7	<	σca= 9.6	N/mm^2	
			σs= 106.7	<	σsa= 168	N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M= 484 kNm, ①				
		Stress	σc= 3.2	<	σca= 12.8	N/mm^2	
			σs= 205.0	<	σsa= 223	N/mm^2	
	Rear Footing	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M= 285 kNm, ①				
		Stress	σc= 1.1	<	σca= 9.6	N/mm^2	
			σs= 35.9	<	σsa= 168	N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M= 1543 kNm, ①				
		Stress	σc= 5.8	<	σca= 12.8	N/mm^2	
			σs= 194.7	<	σsa= 223	N/mm^2	
Load Factor Design	Front Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		Sectional Force	Mu= 359 kNm, ①				
			Su= 240.9 kN ②				
		Strength	Flexural Strength	φMn=	890 kNm		> Mu
			Shear Strenth	φVn=	542 kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu= 622 kNm, ①				
			Su= 425.9 kN ②				
		Strength	Flexural Strength	φMn=	890 kNm		> Mu
			Shear Strenth	φVn=	1132 kN		> Su
	Rear Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		Sectional Force	Mu= 425 kNm, ①				
			Su= 126.4 kN ②				
		Strength	Flexural Strength	φMn=	2668 kNm		> Mu
			Shear Strenth	φVn=	659 kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu= 2018 kNm, ①				
			Su= 727.6 kN ②				
		Strength	Flexural Strength	φMn=	2994 kNm		> Mu
			Shear Strenth	φVn=	1133 kN		> Su

Small Bridge-1 A1 Abutment

Summary of Design Calculation Result (3/3)

3. Wing



Bar Arranegement

Section	Reinforcement-bar Arranngement	
	Inside (mm^2)	Outside (mm2)
a	D28-@125	D24-@250
b	D28-@125	D24-@250
c	D32-@125	D28-@250
d	D28-@250	D24-@250

Size of Section			Thickness of Wing	t=0.700m				
Service Load Design	Section-"a"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	248.8	kNm,			
		Stress	σc=	4.8	<	σca=	9.6	N/mm²
			σs=	150.0	<	σsa=	168	N/mm²
	Section-"b"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	287.8	kNm,			
		Stress	σc=	4.6	<	σca=	9.6	N/mm²
			σs=	143.4	<	σsa=	168	N/mm²
	Section-"c"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	80.1	kNm,			
		Stress	σc=	2.3	<	σca=	9.6	N/mm²
			σs=	125.3	<	σsa=	168	N/mm²
	Section-"d"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	57.3	kNm,			
		Stress	σc=	1.9	<	σca=	9.6	N/mm²
			σs=	127.9	<	σsa=	168	N/mm²
Load Factor Design	Section-"a"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	220.9	kNm,			
		Strength	Flexural Strength			φMn=	418	kNm > Mu
	Section-"b"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	414.5	kNm,			
		Strength	Flexural Strength			φMn=	642	kNm > Mu
	Section-"c"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	487.4	kNm,			
		Strength	Flexural Strength			φMn=	809	kNm > Mu
	Section-"d"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	95.8	kNm,			
		Strength	Flexural Strength			φMn=	169	kNm > Mu

Design Calculation of No.2 Bridge

Structural Calculation of Small bridge No.2

Contents

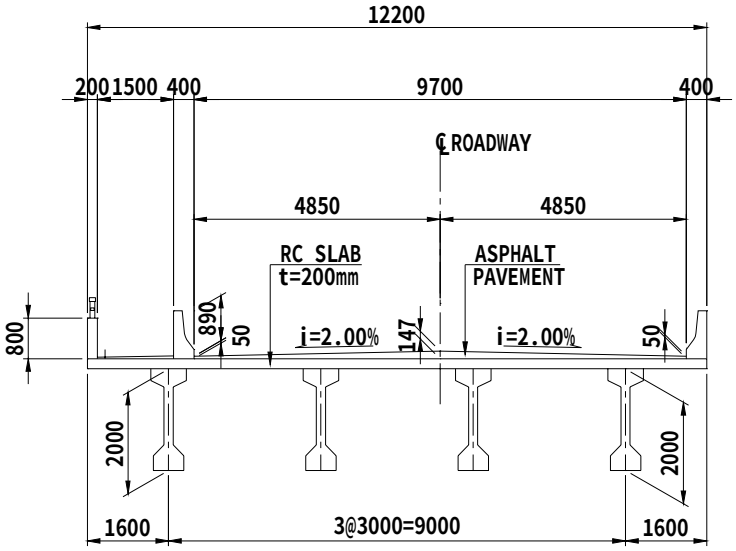
1. DESIGN CRITERIA

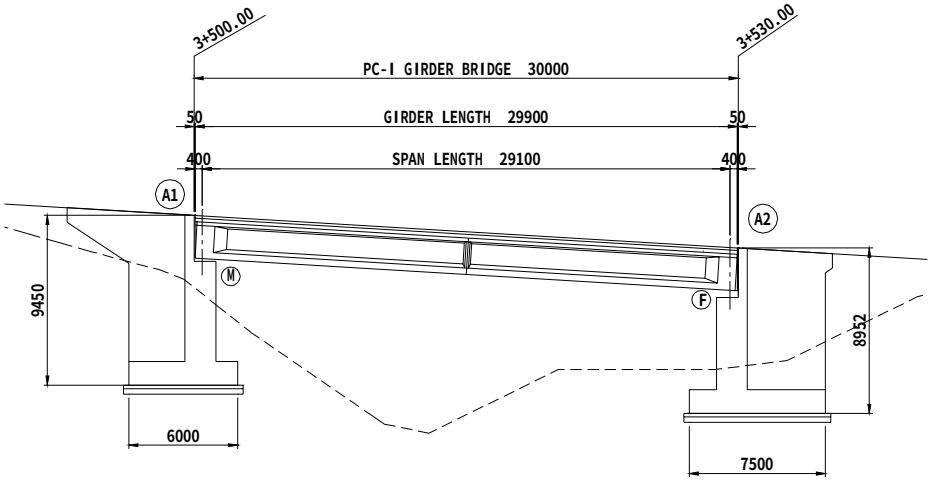
1.1 Design Criteria

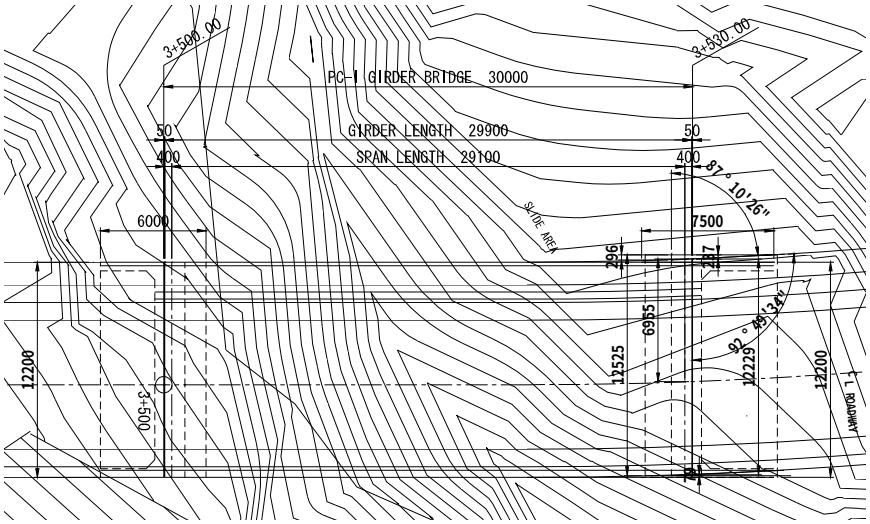
Design Criteria of three small bridge(No.2) are shown as follows.

Superstructure	: Single Span PC-I Girder
Bridge Length	: 30.000m
Girder Length	: 29.900m
Span Length	: 29.100
Bridge Width	: 12.200m
Effective Width	: Carriage Way 9.70m
	: Foot Way 1.50m
Live Load	: Class-A, Class-AA
Curvature	: R=∞
Gradient	: i=3.500% ↙~ 2.000% ↙
Super Elevation	: i = 2.000% ↙ ↘ 3.620%
Skew Angle	: θ = 90 deg
Support Condition	: A1 Movable support
	: A2 Fixed Support
Asphalt Pavement	: Carriage Way 80mm～
	Foot Way 30mm～

2.GENERAL ARRANGEMENT







3. LOADINGS

1) Selfweight of Girder

Wd0 = Ag×γg

Pd0 = Vd0×γg

Wd0 ; Selfweight of Girder(kN/m)

Ag ; Gross Sectiinal Area of Girder (m2)

γg ; Unit Weight of Girder Concrete (kN/m3) = 24.5

Pd0 ; Weight of Diaphragm (kN)

Vd0 ; Volume of Diaphragm(m3)

	Sectional Area of Ag(m2)	Intensity Wd0(kN/m)		Sectional Area of Ag(m2)	Intensity Wd0(kN/m)
(Outer Gider)			(Iside Girder)		
support	1.22425	29.99413	support	1.22425	29.99413
intermediate	0.6793	16.64285	intermediate	0.6793	16.64285

	volume Vd0(m3)	Intensity Pd0(kN)
Diaphragm	0.21798	5.34051

2) Weight of Cross Beam

Pd1 = Vd1×γc

Pd1 ; Load Intensity (kN)

Vd1 ; Volume of Cross Baem (m3)

γc ; Unit Weight of Cross Beam Concrete (kN/m3) = 24.5

Number of Coss Beam	G- 1 Vd1(m3)	Pd1(kN)	G- 2 Vd1(m3)	Pd1(kN)	G- 3 Vd1(m3)	Pd1(kN)	G- 4 Vd1(m3)	Pd1(kN)
C1	1.910208	46.8001	3.820416	93.6002	3.820416	93.6002	1.910208	46.8001
C5	0.532613	13.04901	1.065225	26.09801	1.065225	26.09801	0.532613	13.04901
C9	1.910208	46.8001	3.820416	93.6002	3.820416	93.6002	1.910208	46.8001

3) Deck Slab

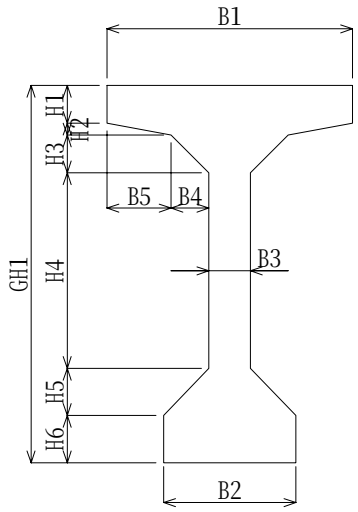
Wd2 = At×γs

Wd2 ; Load Intensity of Deck Slab (kN/m)

At ; Thickness of Deck Slab (m)

γs ; Unit Weight of Deck Slab Concrete (kN/m3) = 24.5

Wd2 = 0.20 ×24.5 =4.9 (kN/m2)



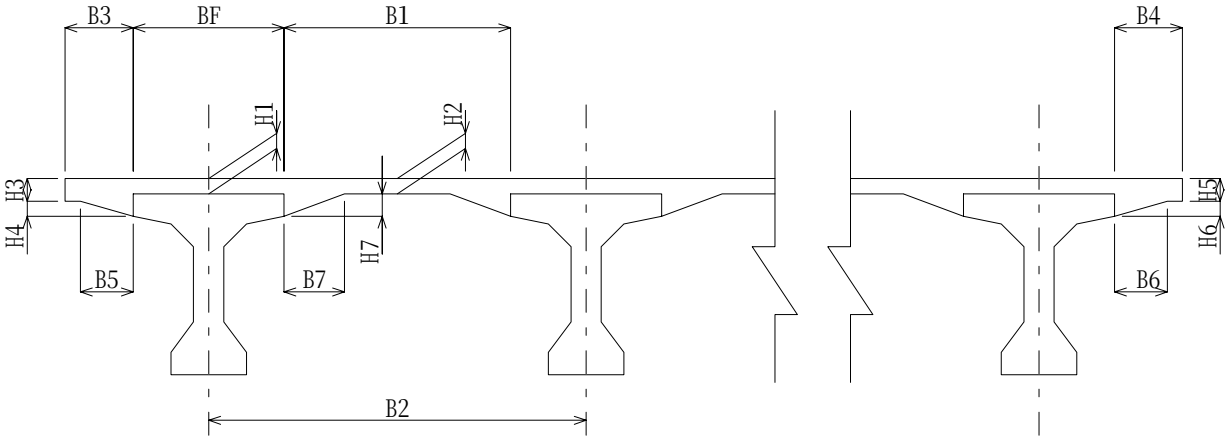
B1 = 0.700(m)
B2 = 0.600(m)
H1 = 0.230(m)
H6 = 0.290(m)

Girder Dimension (G1)

	B3 (m)	B4 (m)	B5 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	GH1 (m)
C1	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000
C2	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C3	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C4	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C5	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C6	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C7	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C8	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C9	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000

Girder Dimension (G2)

	B3 (m)	B4 (m)	B5 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	GH1 (m)
C1	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000
C2	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C3	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C4	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C5	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C6	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C7	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C8	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C9	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000



BF = 0.700(m)

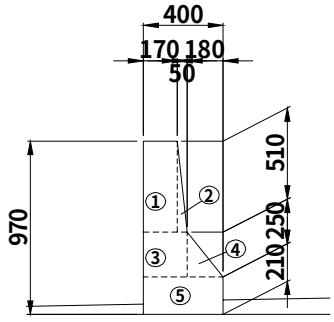
Deck Slab Dimension

	H1 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	H6 (m)	H7 (m)	B3 (m)	B4 (m)	B5 (m)	B6 (m)	B7 (m)
C1	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C2	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C3	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C4	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C5	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C6	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C7	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C8	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C9	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001

	G- 1		G- 2		G- 3	
	B1 (m)	B2 (m)	B1 (m)	B2 (m)	B1 (m)	B2 (m)
C1	2.300	3.000	2.300	3.000	2.300	3.000
C2	2.300	3.000	2.300	3.000	2.300	3.000
C3	2.300	3.000	2.300	3.000	2.300	3.000
C4	2.300	3.000	2.300	3.000	2.300	3.000
C5	2.300	3.000	2.300	3.000	2.300	3.000
C6	2.300	3.000	2.300	3.000	2.300	3.000
C7	2.300	3.000	2.300	3.000	2.300	3.000
C8	2.300	3.000	2.300	3.000	2.300	3.000
C9	2.300	3.000	2.300	3.000	2.300	3.000

3) Surfacing

a. Parapet of Carriage Way



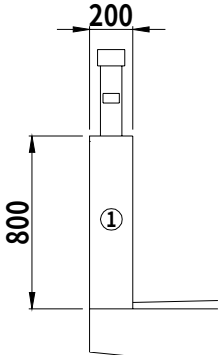
	A	X	AX
①	0.170×0.510×1.0=0.087	0.085	0.007
②	0.050×0.510×0.5=0.013	0.187	0.002
③	0.220×0.250×1.0=0.055	0.110	0.006
④	0.180×0.250×0.5=0.023	0.280	0.006
⑤	0.400×0.210×1.0=0.084	0.200	0.017
計	0.261		0.038

X = ∑AX/∑A = 0.146 m

P = 0.261 × 24.5 = 6.393 kN/m

b. Parapet of Foot Way

Concrete barrier



	A	X	AX
①	0.200×0.800×1.0=0.160	0.100	0.01600
Total	0.160		0.01600

X = ∑AX/∑A = 0.1 m

P = 0.160 × 24.5 = 3.92 kN/m

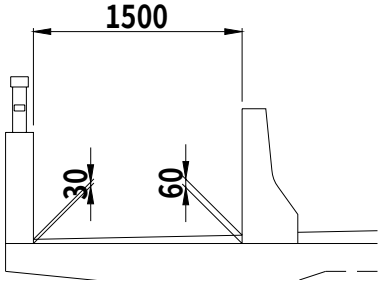
M = 0.100 × 3.920 = 0.392 kN・m/m

Steel Railing

W= 0.300kN/m

c. Asphalt Pavement

Foot Way (t=30mm~60mm)

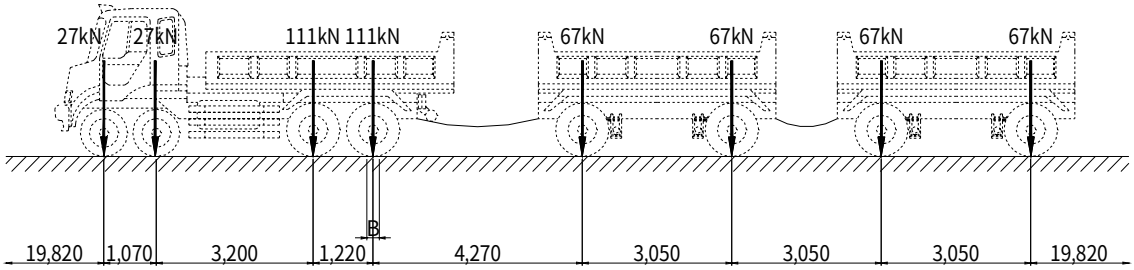


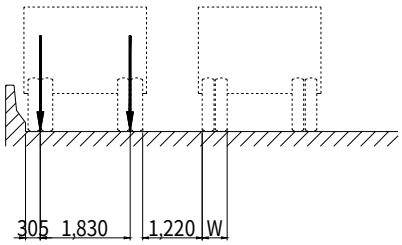
W = 0.03 × 22.5 = 0.675 kN/m^2

W = 0.06 × 22.5= 1.35 kN/m^2

4) Live Load

d. Class-A Loading





Class of Loading	Axle Load	Ground Contact Area	
		B	W
	kN	mm	mm
A	111	254	508
	67	203	381
	27	152	203

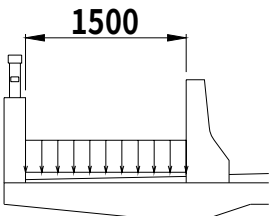
e. Impact Factor

i= 15.24/(L+38) L: Span Length (m)

= 15.24/(28.95+38)

= 0.228

f. Foot Way Loading



q = 2.87 kN/m^2

4. CALCULATION RESULT OF SECTIONAL FORCE

(1) Bending Moment : Mmax ,Mmin

(G-1 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1608.48	0
Surefacing	-46.4	1166.13	-46.4
Total of Dead Load	-46.4	4674.08	-46.4
LIive Load(max)	248.73	3299.15	248.73
LIive Load(min)	-349.15	-116.83	-349.15
Dead+Live (max)	202.33	7973.23	202.33
Dead+Live (min)	-395.55	4557.25	-395.55
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	221.1	0	-221.1
Surefacing	212.03	-41.83	-212.03
Total of Dead Load	694.49	-32.64	-694.49
LIive Load(max)	54.56	34.95	-54.56
LIive Load(min)	387.07	-18.32	-387.07
Dead+Live (max)	749.05	2.32	-749.05
Dead+Live (min)	1081.56	-50.95	-1081.56

(G-2 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	38.83	1307.89	38.83
Total of Dead Load	38.83	4858.91	38.83
LIive Load(max)	154.07	2592.31	154.07
LIive Load(min)	-171.35	0	-171.35
Dead+Live (max)	192.9	7451.22	192.9
Dead+Live (min)	-132.53	4858.91	-132.53
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	126.98	46.78	-126.98
Total of Dead Load	608.84	62.5	-608.84
LIive Load(max)	117.26	8.77	-117.26
LIive Load(min)	355.21	0	-355.21
Dead+Live (max)	726.1	71.26	-726.1
Dead+Live (min)	964.05	62.5	-964.05

(G-3 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN･m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	29.38	1247.74	29.38
Total of Dead Load	29.38	4798.76	29.38
LIive Load(max)	124.88	2310.75	124.88
LIive Load(min)	-170.54	0	-170.54
Dead+Live (max)	154.26	7109.5	154.26
Dead+Live (min)	-141.16	4798.76	-141.16
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	135.47	31.76	-135.47
Total of Dead Load	617.32	47.48	-617.32
LIive Load(max)	97.7	-25.95	-97.7
LIive Load(min)	347.6	0	-347.6
Dead+Live (max)	715.02	21.53	-715.02
Dead+Live (min)	964.93	47.48	-964.93

(G-4 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN･m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1712.21	0
Surefacing	-21.8	1123.23	-21.8
Total of Dead Load	-21.8	4734.92	-21.8
LIive Load(max)	331.36	2706.08	331.36
LIive Load(min)	-209.05	-289.72	-209.05
Dead+Live (max)	309.55	7441	309.55
Dead+Live (min)	-230.85	4445.2	-230.85
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	235.36	0	-235.36
Surefacing	197.37	-36.71	-197.37
Total of Dead Load	694.09	-27.51	-694.09
LIive Load(max)	20.27	72.32	-20.27
LIive Load(min)	242.34	-44.09	-242.34
Dead+Live (max)	714.36	44.81	-714.36
Dead+Live (min)	936.43	-71.6	-936.43

(2) Shear Force max,min

(G-1 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	221.1	0	-221.1
Surefacing	212.03	-41.83	-212.03
Total of Dead Load	694.49	-32.64	-694.49
LIive Load(max)	525.16	209.42	11.8
LIive Load(min)	-11.8	-221.93	-525.16
Dead+Live (max)	1219.66	176.78	-682.69
Dead+Live (min)	682.69	-254.57	-1219.66
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1608.48	0
Surefacing	-46.4	1166.13	-46.4
Total of Dead Load	-46.4	4674.08	-46.4
LIive Load(max)	-207.97	2514.72	113.5
LIive Load(min)	113.5	1335.07	-207.97
Dead+Live (max)	-254.37	7188.8	67.09
Dead+Live (min)	67.09	6009.15	-254.37

(G-2 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	126.98	46.78	-126.98
Total of Dead Load	608.84	62.5	-608.84
LIive Load(max)	474.38	170.51	14.11
LIive Load(min)	-14.11	-258.3	-474.38
Dead+Live (max)	1083.21	233.01	-594.73
Dead+Live (min)	594.73	-195.81	-1083.21
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	38.83	1307.89	38.83
Total of Dead Load	38.83	4858.91	38.83
LIive Load(max)	-88.35	2127.74	26.53
LIive Load(min)	26.53	981.19	-88.35
Dead+Live (max)	-49.52	6986.65	65.36
Dead+Live (min)	65.36	5840.1	-49.52

(G-3 Gider)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	135.47	31.76	-135.47
Total of Dead Load	617.32	47.48	-617.32
LIive Load(max)	465.6	142.52	3.76
LIive Load(min)	-3.76	-258.79	-465.6
Dead+Live (max)	1082.92	190	-613.57
Dead+Live (min)	613.57	-211.31	-1082.92
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	29.38	1247.74	29.38
Total of Dead Load	29.38	4798.76	29.38
LIive Load(max)	-95.02	1840.58	8.36
LIive Load(min)	8.36	945.75	-95.02
Dead+Live (max)	-65.64	6639.33	37.74
Dead+Live (min)	37.74	5744.51	-65.64

(G-4 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	235.36	0	-235.36
Surefacing	197.37	-36.71	-197.37
Total of Dead Load	694.09	-27.51	-694.09
LIive Load(max)	320.8	164.86	29.59
LIive Load(min)	-29.59	-126.75	-320.8
Dead+Live (max)	1014.89	137.35	-664.5
Dead+Live (min)	664.5	-154.26	-1014.89
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1712.21	0
Surefacing	-21.8	1123.23	-21.8
Total of Dead Load	-21.8	4734.92	-21.8
LIive Load(max)	-61.84	2093.37	214.31
LIive Load(min)	214.31	612.97	-61.84
Dead+Live (max)	-83.64	6828.29	192.51
Dead+Live (min)	192.51	5347.89	-83.64

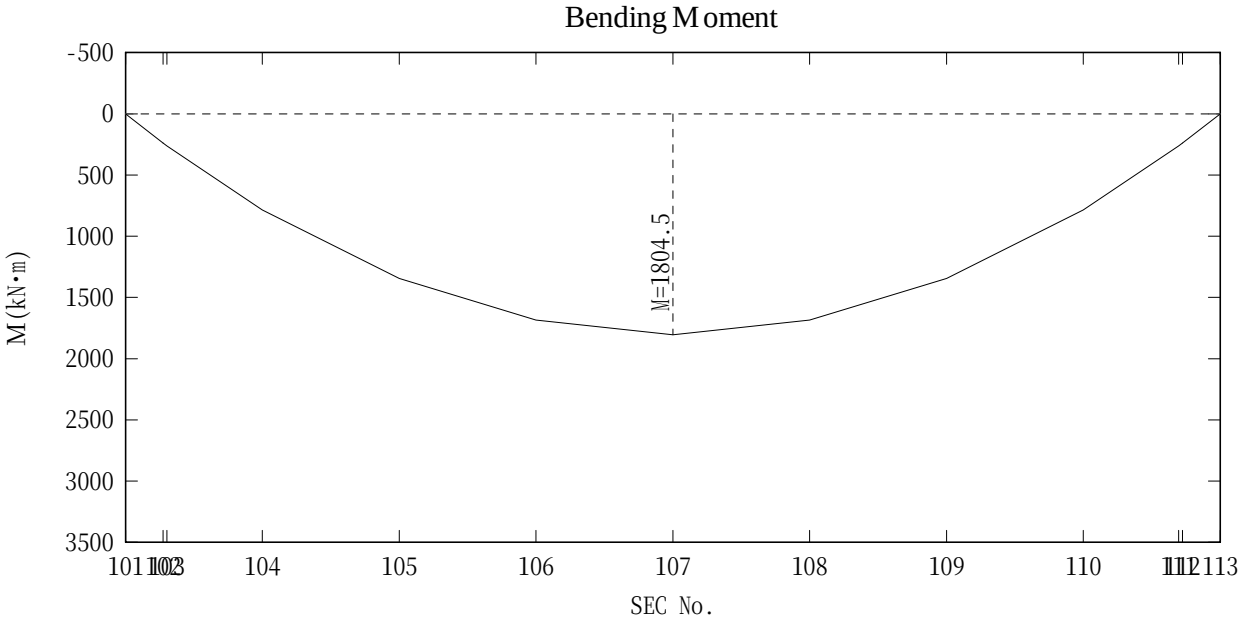
Selection of the Design Girder

Design girder selects G1 girder as a result of comparison of sectional force.

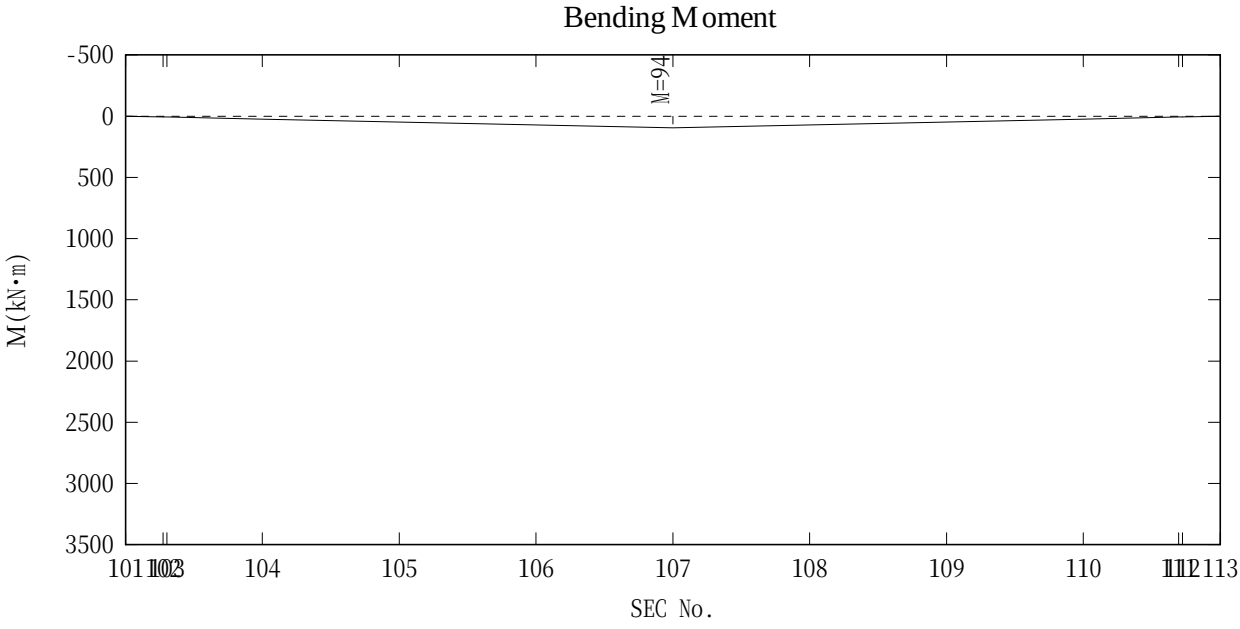
Comparison of bebding moment.

Number of Girder	**G1**	G2	G3	G4
Position	**1005**	2005	3005	4005
Distance from A1 bearing	**14.55**	14.55	14.55	14.55
Bebding Moment (max)	**7973.233**	7451.216	7109.504	7440.999

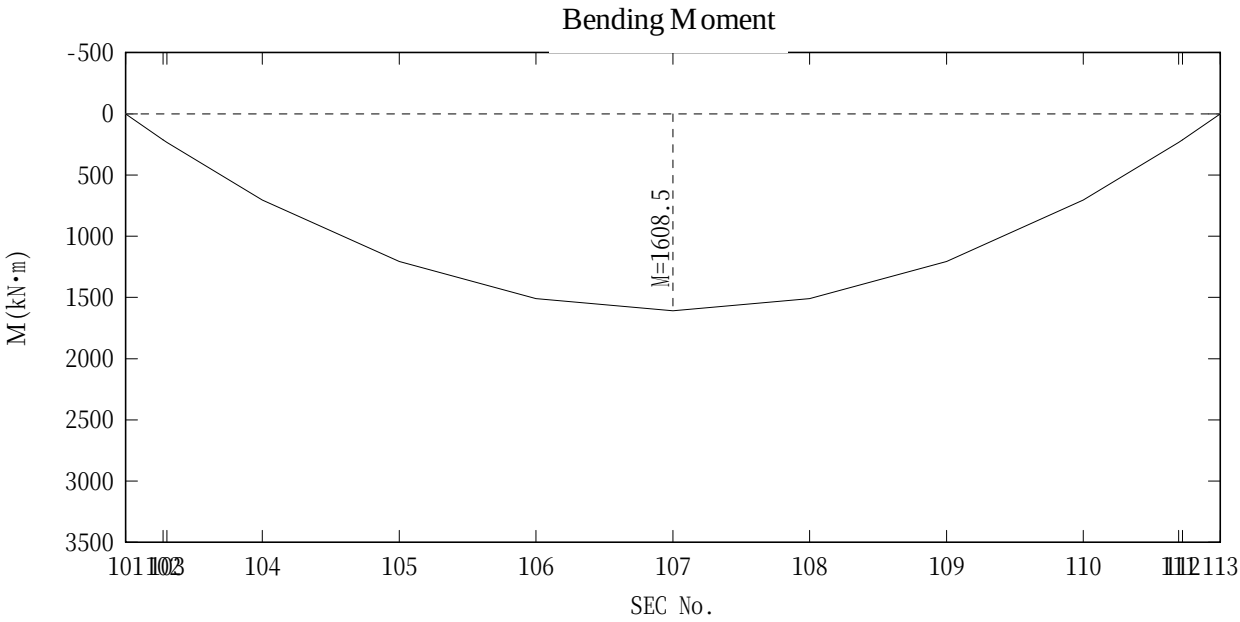
Bending Moment Diagram (Girder self-weight)



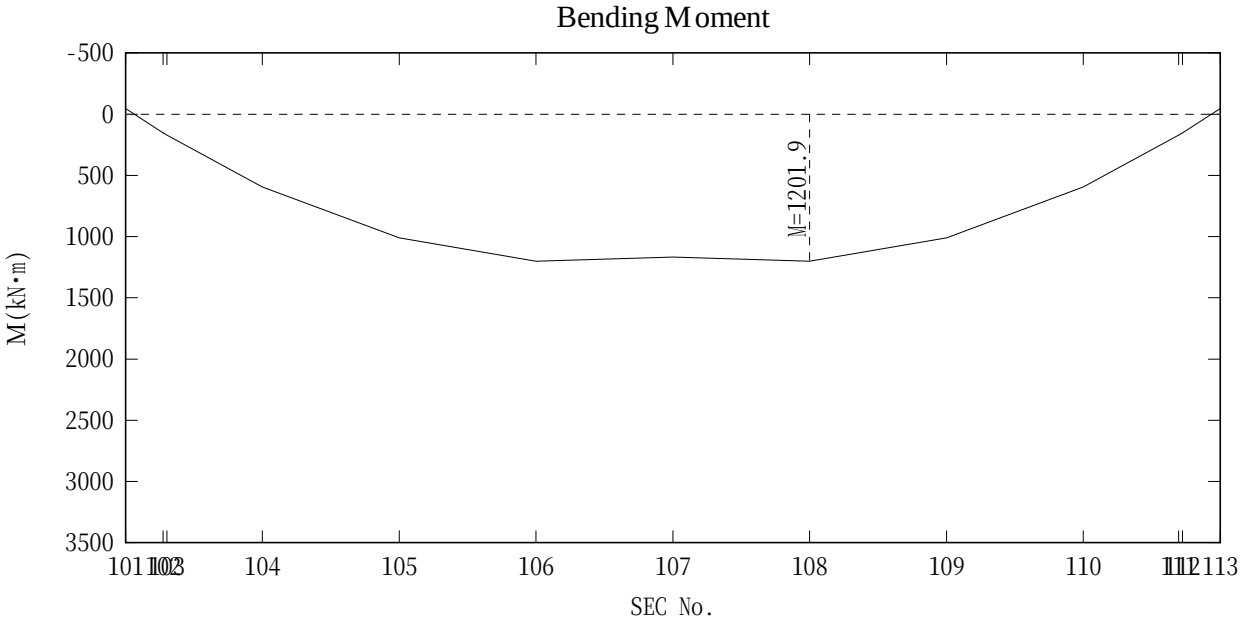
Bending Moment Diagram (Crossbeam self-weight)



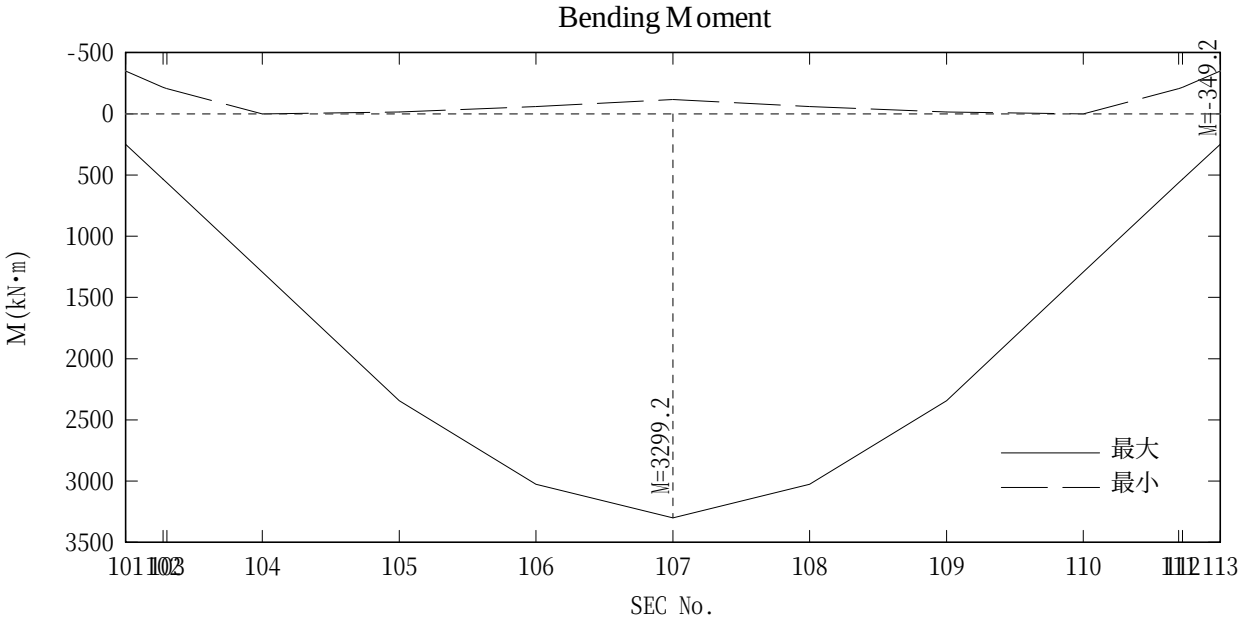
Bending Moment Diagram (Deck Slab self-weight)



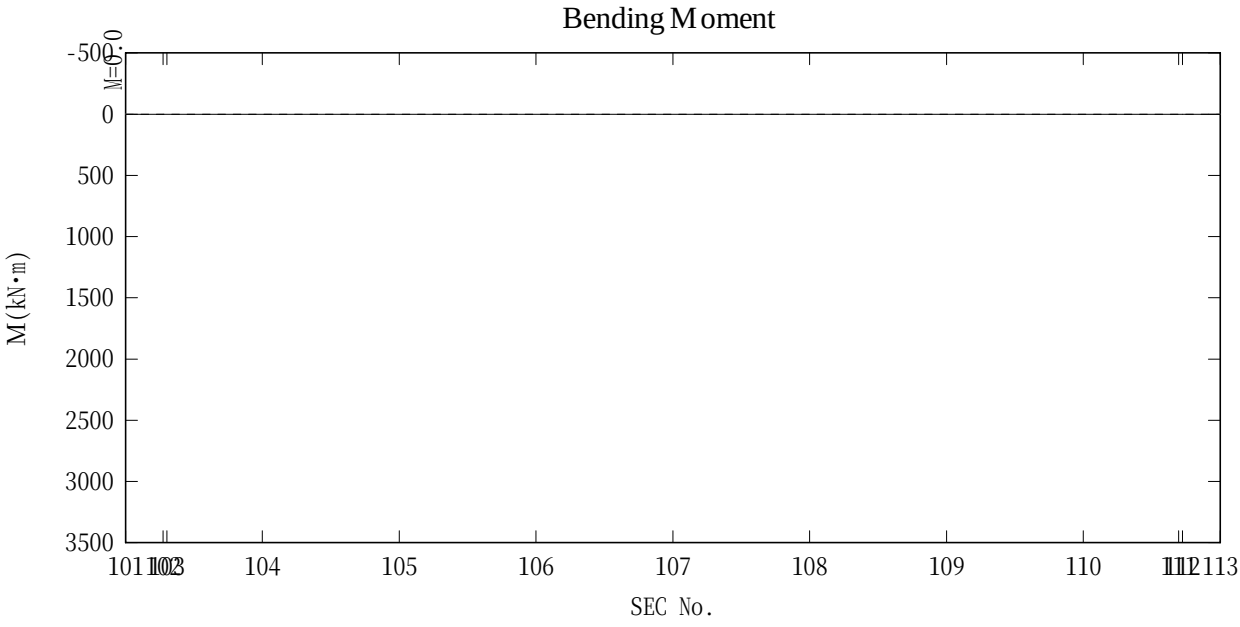
Bending Moment Diagram (Surfacing)



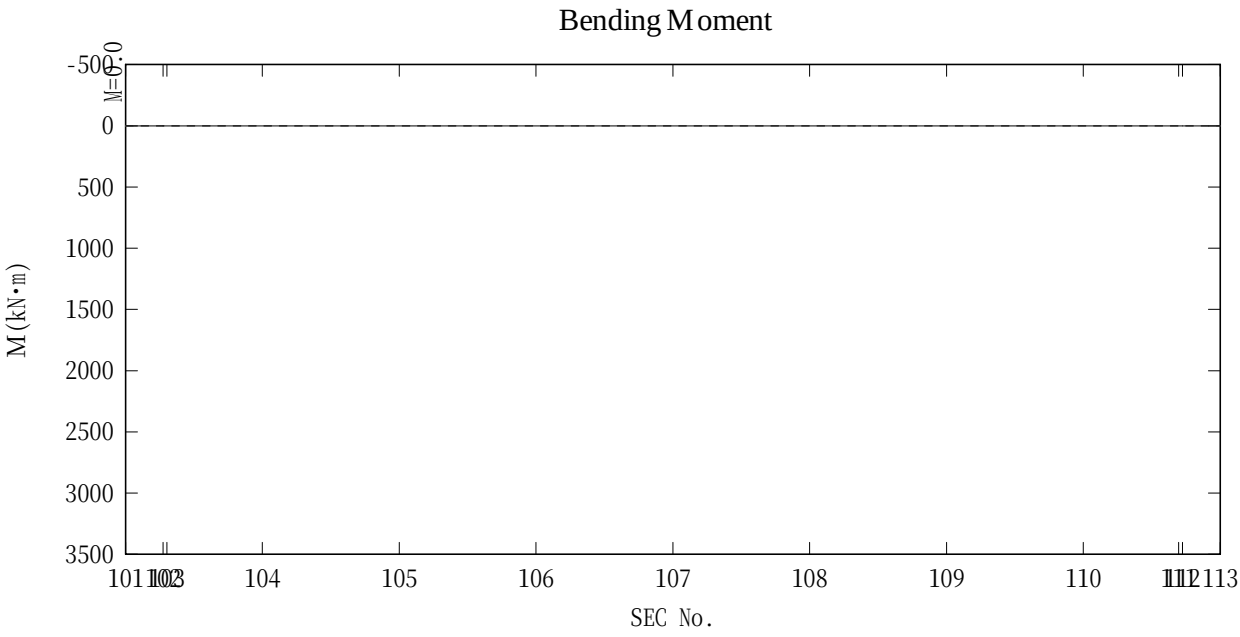
Bending Moment Diagram (Live Load)



Bending Moment Diagram (Creep)



Bending Moment Diagram (Shrinkage)



5. CALCULATION RESULT OF GIRDER STRESS

Combined Bending Stress

	SEC-105 (N/mm2)			SEC-106 (N/mm2)		
	upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress						
After Transfer (1)		-3.05	18.17		-5.50	21.32
Slab under Construction (2)		-2.58	15.40		-4.59	17.81
Design Load (3)		-2.36	14.09		-4.21	16.31
Secondary Force (4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder (5)		3.99	-4.08		5.03	-5.17
Selfweight of Cross Bea (6)		0.14	-0.13		0.21	-0.20
Selfweight of Slab (7)		3.53	-3.38		4.38	-4.16
Surfacing Load (8)	0.88	0.74	-2.02	1.04	0.87	-2.38
Live Load(max) (9)	2.03	1.71	-4.69	2.61	2.19	-5.99
Live Load(min) (10)	-0.01	-0.01	0.03	-0.05	-0.04	0.12
Difference Drying Shrink (11)	-0.09	0.30	-0.11	-0.09	0.30	-0.11
Creep Effect (12)	0.73	-2.27	0.84	0.84	-2.55	0.95
Temperature Difference (13)	0.29	-1.01	0.37	0.29	-1.01	0.36
Thermal Change(+) (14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-) (15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max) (16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min) (17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage (18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress						
After Transfer						
(1)+(5)	0.94	14.09			-0.47	16.15
Slab under Construction						
(2)+(5)+(6)+(7)	5.08	7.81			5.02	8.28
dead load +(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(1	1.52	4.07	5.21	1.79	4.03	5.24
D+L						
B:A+(9)	3.55	5.78	0.52	4.39	6.22	-0.75
C:A+(10)	1.50	4.06	5.24	1.74	3.99	5.36
Temperature Consideration						
H:B+(14)	3.55	5.78	0.52	4.39	6.22	-0.75
I:B+(15)	3.55	5.78	0.52	4.39	6.22	-0.75
J:C+(14)	1.50	4.06	5.24	1.74	3.99	5.36
K:C+(15)	1.50	4.06	5.24	1.74	3.99	5.36
L:H+(13)	3.84	4.76	0.89	4.68	5.21	-0.39
M:I+(13)	3.84	4.76	0.89	4.68	5.21	-0.39
N:J+(13)	1.79	3.04	5.61	2.02	2.98	5.72
O:K+(13)	1.79	3.04	5.61	2.02	2.98	5.72
Settlement Consideration						
MAX[B+(16) B+(17),C+(16),C+(17	3.55	5.78	0.52	4.39	6.22	-0.75
MIN[B+(16),B+(17),C+(16),C+(17)	1.50	4.06	5.24	1.74	3.99	5.36

		SEC-107 (N/mm2)				SEC-108 (N/mm2)	
		upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress							
After Transfer	(1)		-5.59	21.66		-5.50	21.32
Slab under Construction	(2)		-4.68	18.13		-4.59	17.81
Design Load	(3)		-4.30	16.67		-4.21	16.31
Secondary Force	(4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder	(5)		5.38	-5.54		5.03	-5.17
Selfweight of Cross Bea	(6)		0.28	-0.26		0.21	-0.20
Selfweight of Slab	(7)		4.67	-4.44		4.38	-4.16
Surfacing Load	(8)	1.01	0.85	-2.31	1.04	0.87	-2.38
Live Load(max)	(9)	2.84	2.39	-6.53	2.61	2.19	-5.99
Live Load(min)	(10)	-0.10	-0.09	0.23	-0.05	-0.04	0.12
Difference Drying Shrink	(11)	-0.09	0.30	-0.11	-0.09	0.30	-0.11
Creep Effect	(12)	0.94	-2.82	1.05	0.84	-2.55	0.95
Temperature Difference	(13)	0.29	-1.01	0.36	0.29	-1.01	0.36
Thermal Change(+)	(14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-)	(15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max)	(16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min)	(17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage	(18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress							
After Transfer							
(1)+(5)		-0.20	16.12	-0.47	16.15		
Slab under Construction							
(2)+(5)+(6)+(7)		5.66	7.89	5.02	8.28		
dead load	+(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(1		1.86	4.36	5.06	1.79	4.03	5.24
D+L							
B:A+(9)		4.70	6.75	-1.47	4.39	6.22	-0.75
C:A+(10)		1.76	4.27	5.30	1.74	3.99	5.36
Temperature Consideration							
H:B+(14)		4.70	6.75	-1.47	4.39	6.22	-0.75
I:B+(15)		4.70	6.75	-1.47	4.39	6.22	-0.75
J:C+(14)		1.76	4.27	5.30	1.74	3.99	5.36
K:C+(15)		1.76	4.27	5.30	1.74	3.99	5.36
L:H+(13)		4.99	5.74	-1.11	4.68	5.21	-0.39
M:I+(13)		4.99	5.74	-1.11	4.68	5.21	-0.39
N:J+(13)		2.05	3.27	5.65	2.02	2.98	5.72
O:K+(13)		2.05	3.27	5.65	2.02	2.98	5.72
Settlement Consideration							
MAX[B+(16) B+(17),C+(16),C+(17		4.70	6.75	-1.47	4.39	6.22	-0.75
MIN[B+(16),B+(17),C+(16),C+(17)		1.76	4.27	5.30	1.74	3.99	5.36

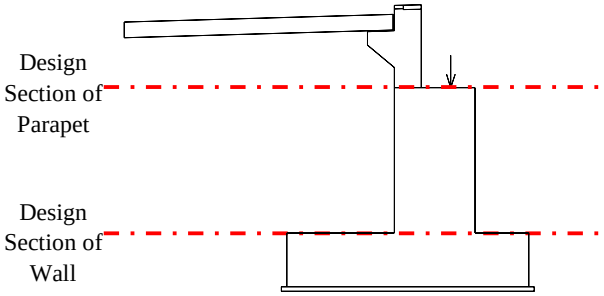
		SEC-109	(N/mm2)		SEC-110	(N/mm2)
	upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress						
After Transfer (1)		-3.05	18.17		1.28	13.54
Slab under Construction (2)		-2.58	15.40		1.11	11.74
Design Load (3)		-2.36	14.09		1.01	10.72
Secondary Force (4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder (5)	3.99	-4.08	2.31	-2.34		
Selfweight of Cross Bea (6)	0.14	-0.13	0.07	-0.07		
Selfweight of Slab (7)	3.53	-3.38	2.08	-2.02		
Surfacing Load (8)	0.88	0.74	-2.02	0.52	0.44	-1.21
Live Load(max) (9)	2.03	1.71	-4.69	1.13	0.95	-2.63
Live Load(min) (10)	-0.01	-0.01	0.03	0.00	0.00	0.00
Difference Drying Shrink (11)	-0.09	0.30	-0.11	-0.09	0.30	-0.11
Creep Effect (12)	0.73	-2.27	0.84	0.59	-1.93	0.72
Temperature Difference (13)	0.29	-1.01	0.37	0.29	-1.01	0.38
Thermal Change(+) (14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-) (15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max) (16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min) (17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage (18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress						
After Transfer						
(1)+(5)	0.94	14.09	3.59	11.20		
Slab under Construction						
(2)+(5)+(6)+(7)	5.08	7.81	5.57	7.32		
dead load +(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(1	1.52	4.07	5.21	1.02	4.29	5.68
D+L						
B:A+(9)	3.55	5.78	0.52	2.16	5.23	3.05
C:A+(10)	1.50	4.06	5.24	1.02	4.29	5.68
Temperature Consideration						
H:B+(14)	3.55	5.78	0.52	2.16	5.23	3.05
I:B+(15)	3.55	5.78	0.52	2.16	5.23	3.05
J:C+(14)	1.50	4.06	5.24	1.02	4.29	5.68
K:C+(15)	1.50	4.06	5.24	1.02	4.29	5.68
L:H+(13)	3.84	4.76	0.89	2.44	4.22	3.43
M:I+(13)	3.84	4.76	0.89	2.44	4.22	3.43
N:J+(13)	1.79	3.04	5.61	1.31	3.27	6.06
O:K+(13)	1.79	3.04	5.61	1.31	3.27	6.06
Settlement Consideration						
MAX[B+(16) B+(17),C+(16),C+(17	3.55	5.78	0.52	2.16	5.23	3.05
MIN[B+(16),B+(17),C+(16),C+(17)	1.50	4.06	5.24	1.02	4.29	5.68

6. Result of Substructure
6.1 A1 Abutment

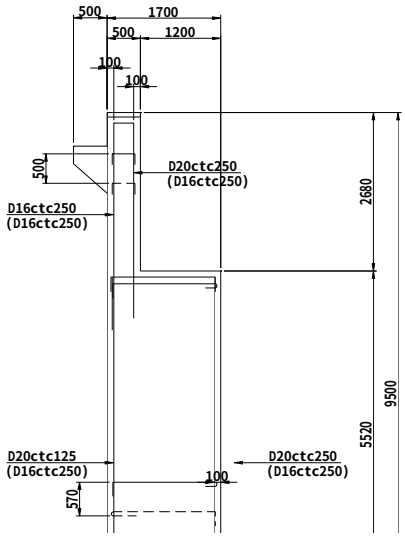
Summary of Design Calculation Result (1/3)

Stability	Force at the Center of Footing	Group-I	V=18349kN, H=3264kN, M=4173kNm
		Group-VII	V=16077kN, H=7197kN, M=20910kNm
	Safety Factor for Horizontal Force	Group-I	Safety Factor=3.415 > 1.5 (Allowable Factor)
		Group-VII	Safety Factor=1.412 > 1.2 (Allowable Factor)
	Ground Reaction	Group-I	qmax=397kN/m^2 < qa=600kN/m^2
		Group-VII	qmax=707kN/m^2 < qa=900kN/m^2

1. Wall and Parapet



Bar Arrangement of Parapet & Wall

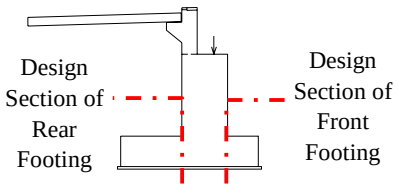


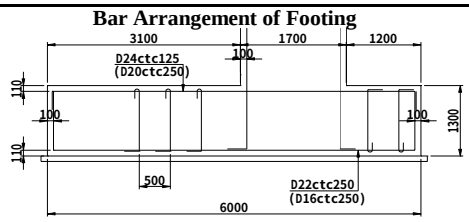
Size of Section			Thickness of Parapet	t=0.500m			
			Thickness of Wall	t=1.700m			
Bar Arrangement			Parapet	D20ctc250-1.0, d=400mm			
			Wall	D20ctc125-1.0, d=1600mm			
Parapet	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M=	70.2 kNm,	N=	0 kN	
		Stress	σc=	3.7 <	σca=	9.6 N/mm^2	
			σs=	152.0 <	σsa=	168 N/mm^2	
Wall	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M=	665 kNm,	N=	616 kN	
		Stress	σc=	1.6 <	σca=	9.6 N/mm^2	
			σs=	43.2 <	σsa=	168 N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M=	1176 kNm,	N=	514 kN	
		Stress	σc=	3.0 <	σca=	12.8 N/mm^2	
			σs=	132.0 <	σsa=	223 N/mm^2	
	Load Factor Design	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		SectionalForce	Mu=	957 kNm,	Nu=	668 kN	
		Strength	Flexural Strength		φMn=	2146 kNm	> Mu
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu=	1970 kNm,	Nu=	635 kN	
		Strength	Flexural Strength		φMn=	2146 kNm	> Mu

Small Bridge-2 A1 Abutment

Summary of Design Calculation Result (2/3)

2. Spread Footing

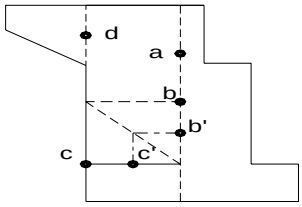




Size of Section			Longitudinal Direction	L_L=6.000m	T=1.500m	
			Transverse Direction	L_T=12.200m	T=1.500m	
Service Load Design	Front Footing	Load Case	Group-I : (D+SD+L+CF+E+B)			
		Sectional Force	M= 178.2 kNm, ①			
		Stress	σc= 1.0	<	σca= 9.6 N/mm^2	
			σs= 106.7	<	σsa= 168 N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)			
		Sectional Force	M= 305.2 kNm, ①			
		Stress	σc= 3.3	<	σca= 12.8 N/mm^2	
			σs= 214.0	<	σsa= 223 N/mm^2	
	Rear Footing	Load Case	Group-I : (D+SD+L+CF+E+B)			
		Sectional Force	M= 473.4 kNm, ①			
		Stress	σc= 1.8	<	σca= 9.6 N/mm^2	
			σs= 59.7	<	σsa= 168 N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)			
		Sectional Force	M= 1503.6 kNm, ①			
		Stress	σc= 5.6	<	σca= 12.8 N/mm^2	
			σs= 189.8	<	σsa= 223 N/mm^2	
Load Factor Design	Front Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)			
		Sectional Force	Mu= 261.4 kNm, ①			
			Su= 201.8 kN ②			
		Strength	Flexural Strength	φMn= 654 kNm		> Mu
			Shear Strenth	φVn= 979 kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)			
		Sectional Force	Mu= 487.0 kNm, ①			
			Su= 385.6 kN ②			
		Strength	Flexural Strength	φMn= 654 kNm		> Mu
			Shear Strenth	φVn= 1133 kN		> Su
	Rear Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E	979		
		Sectional Force	Mu= 365.3 kNm, ①			
			Su= 149.8 kN ②			
		Strength	Flexural Strength	φMn= 1684 kNm		> Mu
			Shear Strenth	φVn= 979 kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)			
		Sectional Force	Mu= 1397.3 kNm, ①			
			Su= 695.6 kN ②			
		Strength	Flexural Strength	φMn= 1684 kNm		> Mu
			Shear Strenth	φVn= 979 kN		> Su

Summary of Design Calculation Result (3/3)

3. Wing



Bar Arranegement

Section	Reinforcement-bar Arranngement	
	Inside (mm^2)	Outside (mm^2)
a	D20@125	D16@250
b	D20@125	D16@250
c	D22@125	D20@250
d	D20@250	D16@250

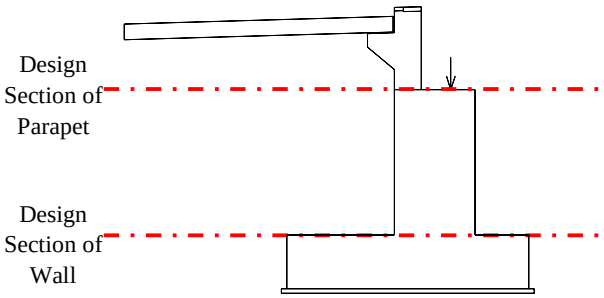
Size of Section			Thickness of Wing t=0.600m					
Service Load Design	Section-"a"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	136.6	kNm,			
		Stress	σc=	3.3	<	σca=	9.6	N/mm²
			σs=	120.5	<	σsa=	168	N/mm²
	Section-"b"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	156.9	kNm,			
		Stress	σc=	3.8	<	σca=	9.6	N/mm²
			σs=	138.0	<	σsa=	168	N/mm²
	Section-"c"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	185.2	kNm,			
		Stress	σc=	4.35	<	σca=	9.6	N/mm²
			σs=	136.7	<	σsa=	168	N/mm²
	Section-"d"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	53.5	kNm,			
		Stress	σc=	1.47	<	σca=	9.6	N/mm²
			σs=	91.1	<	σsa=	168	N/mm²
Load Factor Design	Section-"a"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	225.1	kNm,			
		Strength	Flexural Strength			φMn=	385	kNm > Mu
	Section-"b"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	269.7	kNm,			
		Strength	Flexural Strength			φMn=	385	kNm > Mu
	Section-"c"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	320.3	kNm,			
		Strength	Flexural Strength			φMn=	412	kNm > Mu
	Section-"d"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	37.2	kNm,			
		Strength	Flexural Strength			φMn=	267	kNm > Mu

6.2 A2 Abutment

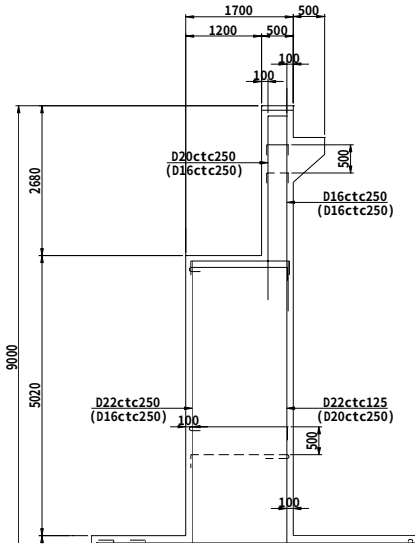
Summary of Design Calculation Result (1/3)

Stability	Force at the Center of Footing	Group-I	V=181924kN, H=2392kN, M=597kNm
		Group-VII	V=17854kN, H=6995kN, M=20545kNm
	Safety Factor for Horizontal Force	Group-I	Safety Factor=4.748 > 1.5 (Allowable Factor)
		Group-VII	Safety Factor=1.532 > 1.2 (Allowable Factor)
	Ground Reaction	Group-I	qmax=207kN/m^2 < qa=600kN/m^2
		Group-VII	qmax=365kN/m^2 < qa=900kN/m^2

1. Wall and Parapet



Bar Arrangement of Parapet & Wall

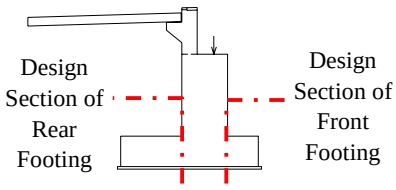


Size of Section			Thickness of Parapet	t=0.500m		
			Thickness of Wall	t=1.700m		
Bar Arrangement			Parapet	D20ctc250-1.0, d=400mm		
			Wall	D20ctc125-1.0, d=1600mm		
Parapet	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)			
		Sectional Force	M= 68.8 kNm,	N= 0 kN		
		Stress	σc= 3.4 <	σca= 9.6 N/mm^2		
			σs= 149.5 <	σsa= 168 N/mm^2		
Wall	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)			
		Sectional Force	M= 496 kNm,	N= 597 kN		
		Stress	σc= 1.8 <	σca= 9.6 N/mm^2		
			σs= 31.1 <	σsa= 168 N/mm^2		
		Load Case	Group-VII : (D+SD+E+B+EQ)			
		Sectional Force	M= 1176 kNm,	N= 514 kN		
		Stress	σc= 5.8 <	σca= 12.8 N/mm^2		
			σs= 188.0 <	σsa= 223 N/mm^2		
	Load Factor Design	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)			
		SectionalForce	Mu= 719 kNm,	Nu= 793 kN		
		Strength	Flexural Strength	φMn= 1716 kNm	> Mu	
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)			
		Sectional Force	Mu= 1514 kNm,	Nu= 568 kN		
		Strength	Flexural Strength	φMn= 1716 kNm	> Mu	

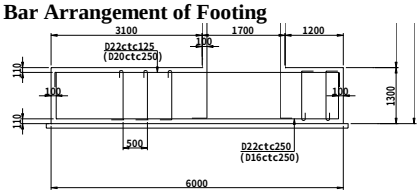
Small Bridge-2 A1 Abutment

Summary of Design Calculation Result (2/3)

2. Spread Footing



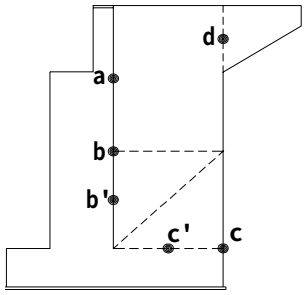
Bar Arrangement of Footing



Size of Section			Longitudinal Direction	L_L=6.000m		T=1.500m	
			Transverse Direction	L_T=12.200m		T=1.500m	
Service Load Design	Front Footing	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M= 188.6 kNm, ①				
		Stress	σc= 1.6	<	σca= 9.6	N/mm^2	
			σs= 108.8	<	σsa= 168	N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M= 327.2 kNm, ①				
		Stress	σc= 2.8	<	σca= 12.8	N/mm^2	
			σs= 188.9	<	σsa= 223	N/mm^2	
	Rear Footing	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M= 59.4 kNm, ①				
		Stress	σc= 0.3	<	σca= 9.6	N/mm^2	
			σs= 11.3	<	σsa= 168	N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M= 1047.5 kNm, ①				
		Stress	σc= 5.7	<	σca= 12.8	N/mm^2	
			σs= 198.6	<	σsa= 223	N/mm^2	
Load Factor Design	Front Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		Sectional Force	Mu= 257.5 kNm, ①				
			Su= 194.7 kN ②				
		Strength	Flexural Strength	φMn=	654 kNm		> Mu
			Shear Strenth	φVn=	979 kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu= 397.4 kNm, ①				
			Su= 303.8 kN ②				
		Strength	Flexural Strength	φMn=	654 kNm		> Mu
			Shear Strenth	φVn=	979 kN		> Su
	Rear Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		Sectional Force	Mu= 119.5 kNm, ①				
			Su= 20.8 kN ②				
		Strength	Flexural Strength	φMn=	1529 kNm		> Mu
			Shear Strenth	φVn=	979 kN		> Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu= 1347.2 kNm, ①				
			Su= 438.8 kN ②				
		Strength	Flexural Strength	φMn=	1529 kNm		> Mu
			Shear Strenth	φVn=	979 kN		> Su

Summary of Design Calculation Result (3/3)

3. Wing



Bar Arranegement

Section	Reinforcement-bar Arranngement	
	Inside (mm^2)	Outside (mm^2)
a	D20@125	D16@250
b	D20@125	D16@250
c	D22@125	D20@250
d	D20@250	D16@250

Size of Section			Thickness of Wing t=0.700m					
Service Load Design	Section-"a"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	107.3	kNm,			
		Stress	σc=	2.3	<	σca=	9.6	N/mm²
			σs=	86.2	<	σsa=	168	N/mm²
	Section-"b"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	186.0	kNm,			
		Stress	σc=	4.0	<	σca=	9.6	N/mm²
			σs=	150.0	<	σsa=	168	N/mm²
	Section-"c"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	253.6	kNm,			
		Stress	σc=	5.2	<	σca=	9.6	N/mm²
			σs=	158.8	<	σsa=	168	N/mm²
	Section-"d"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	0.4	kNm,			
		Stress	σc=	0.0	<	σca=	9.6	N/mm²
			σs=	0.6	<	σsa=	168	N/mm²
Load Factor Design	Section-"a"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	171.0	kNm,			
		Strength	Flexural Strength			φMn=	386 kNm	> Mu
	Section-"b"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	310.7	kNm,			
		Strength	Flexural Strength			φMn=	386 kNm	> Mu
	Section-"c"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	430.0	kNm,			
		Strength	Flexural Strength			φMn=	413 kNm	> Mu
	Section-"d"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	0.5	kNm,			
		Strength	Flexural Strength			φMn=	264 kNm	> Mu

Design Calculation of No.3 Bridge

Structural Calculation of Small bridge No.3

Contents

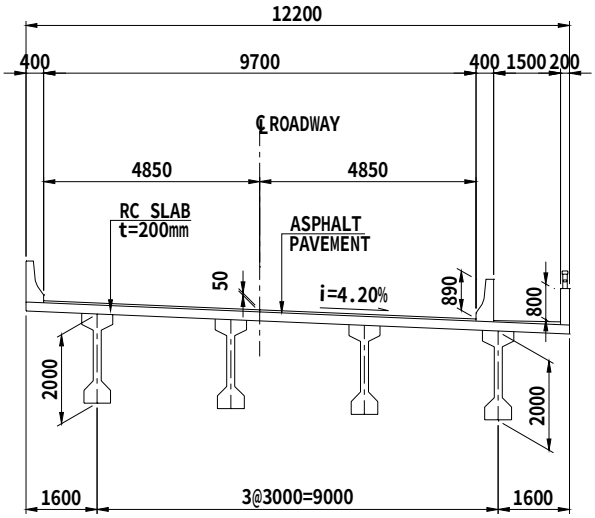
1. DESIGN CRITERIA

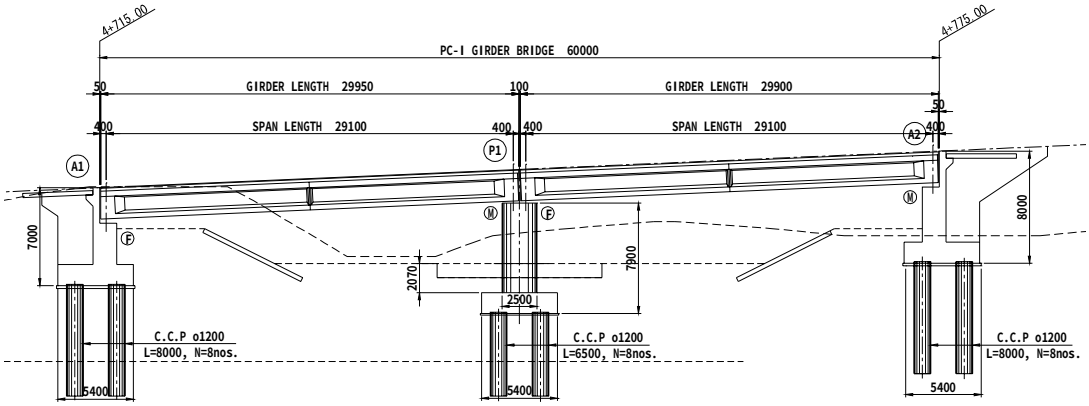
1.1 Design Criteria

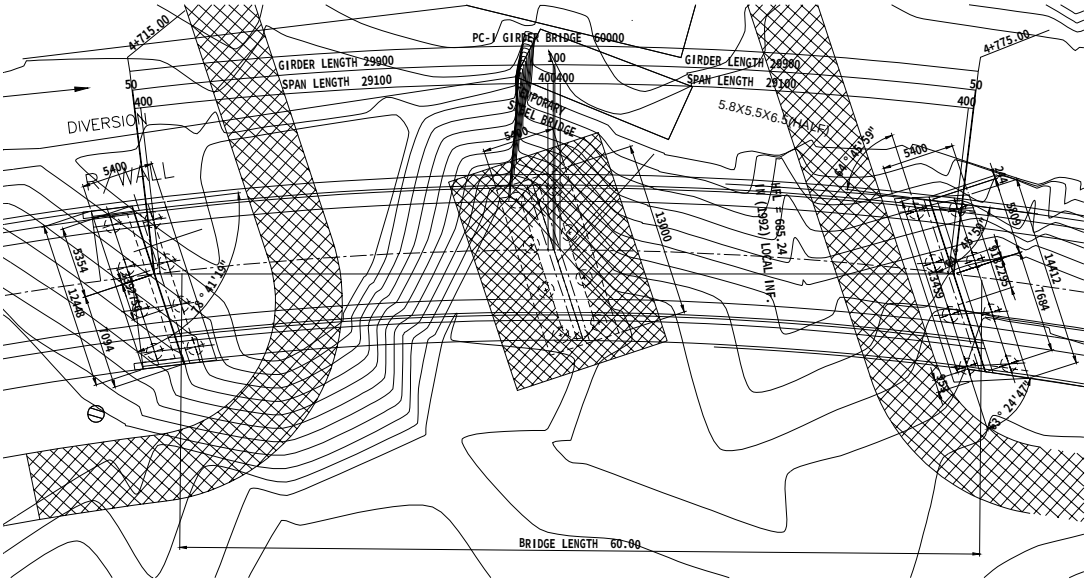
Design Criteria of three small bridge(No.1) are shown as follows.

Superstructure	: Single Span PC-I Girder
Bridge Length	: 30.000m × 2
Girder Length	: 29.900m × 2
Span Length	: 29.100m × 2
Bridge Width	: 12.200m
Effective Width	: Carriage Way 9.70m
	: Foot Way 1.50m
Live Load	: Class-A, Class-AA
Curvature	: R=∞
Gradient	: i=3.450%
Super Elevation	: i = 4.200%
Skew Angle	: A1:θ = 78-41-19
	: P1:θ = 78-00-00
	:A2:θ = 64-45-59
Support Condition	: A1 Fixed Support
	: P1(L):Movable support
	: P1(R):Fixed Support
	: A2 Movable support
Asphalt Pavement	: Carriage Way 80mm～
	Foot Way 30mm～

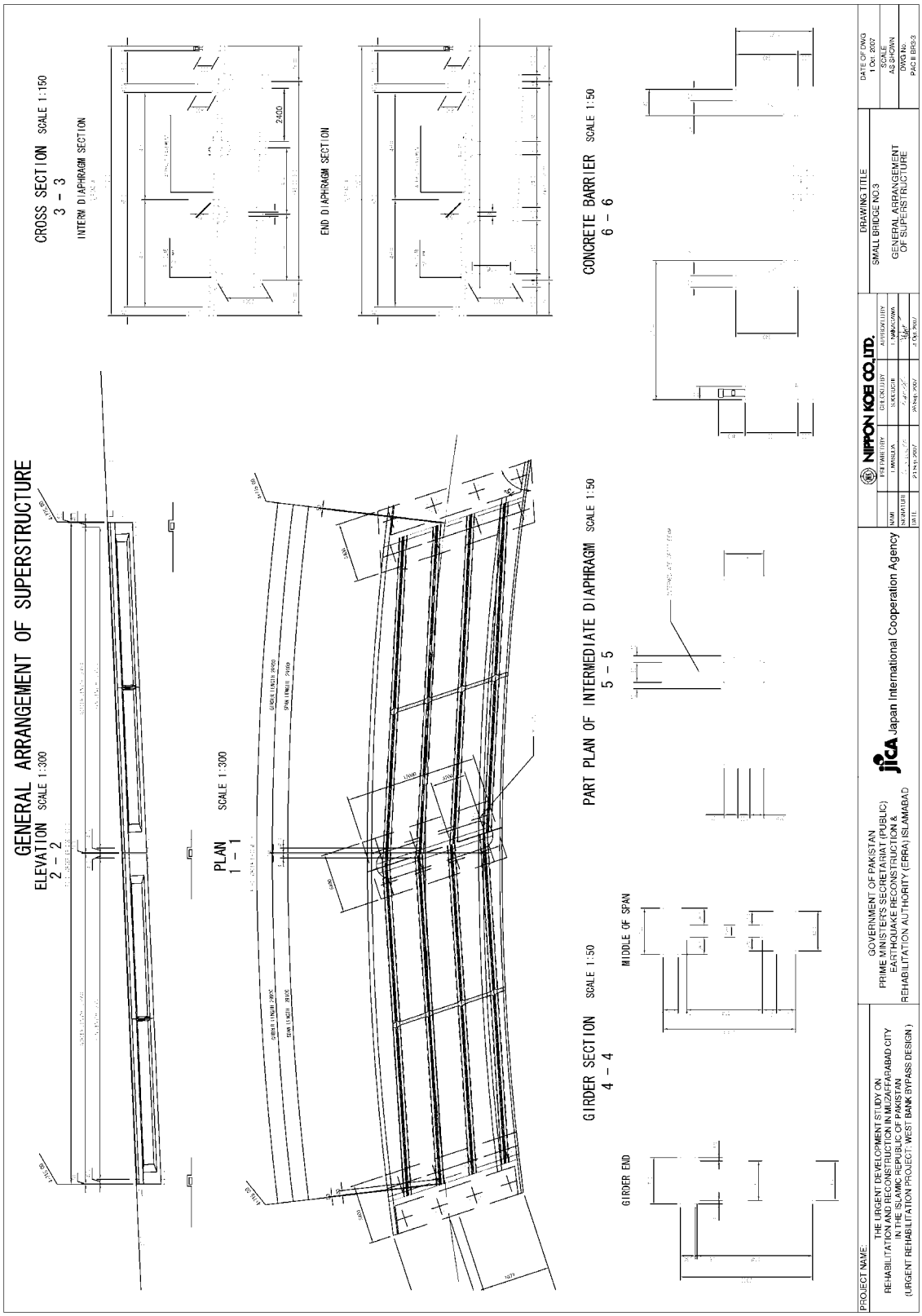
1.2 General Arrangement of Bridge







2. GENERAL ARRANGEMENT



3. LOADINGS

1) Selfweight of Girder

Wd0 = Ag×γg

Pd0 = Vd0×γg

Wd0 ; Selfweight of Girder(kN/m)

Ag ; Gross Sectiinal Area of Girder (m2)

γg ; Unit Weight of Girder Concrete (kN/m3) = 24.5

Pd0 ; Weight of Diaphragm (kN)

Vd0 ; Volume of Diaphragm(m3)

	Sectional Area of Ag(m2)	Intensity Wd0(kN/m)		Sectional Area of Ag(m2)	Intensity Wd0(kN/m)
(Outer Gider)			(Iside Girder)		
support	1.22425	29.99413	support	1.22425	29.99413
intermediate	0.6793	16.64285	intermediate	0.6793	16.64285

	volume Vd0(m3)	Intensity Pd0(kN)
Diaphragm	0.21798	5.34051

2) Weight of Cross Beam

Pd1 = Vd1×γc

Pd1 ; Load Intensity (kN)

Vd1 ; Volume of Cross Baem (m3)

γc ; Unit Weight of Cross Beam Concrete (kN/m3) = 24.5

Number of Coss Beam	G- 1 Vd1(m3)	Pd1(kN)	G- 2 Vd1(m3)	Pd1(kN)	G- 3 Vd1(m3)	Pd1(kN)	G- 4 Vd1(m3)	Pd1(kN)
C1	1.910208	46.8001	3.820416	93.6002	3.820416	93.6002	1.910208	46.8001
C5	0.532613	13.04901	1.065225	26.09801	1.065225	26.09801	0.532613	13.04901
C9	1.910208	46.8001	3.820416	93.6002	3.820416	93.6002	1.910208	46.8001

3) Deck Slab

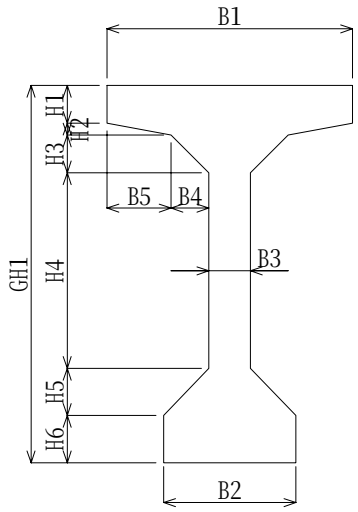
Wd2 = At×γs

Wd2 ; Load Intensity of Deck Slab (kN/m)

At ; Thickness of Deck Slab (m)

γs ; Unit Weight of Deck Slab Concrete (kN/m3) = 24.5

Wd2 = 0.20 ×24.5 =4.9 (kN/m2)



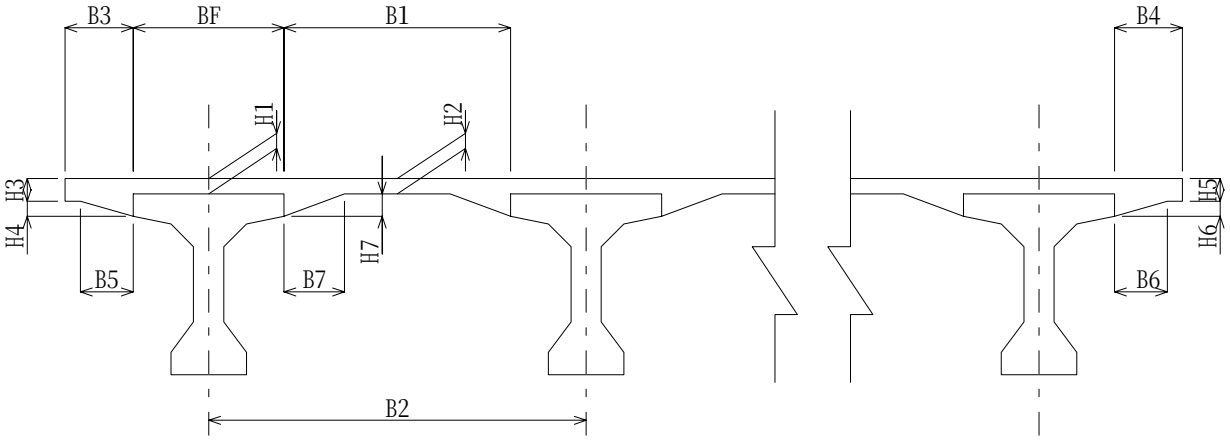
B1 = 0.700(m)
B2 = 0.600(m)
H1 = 0.230(m)
H6 = 0.290(m)

Girder Dimension (G1)

	B3 (m)	B4 (m)	B5 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	GH1 (m)
C1	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000
C2	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C3	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C4	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C5	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C6	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C7	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C8	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C9	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000

Girder Dimension (G2)

	B3 (m)	B4 (m)	B5 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	GH1 (m)
C1	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000
C2	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C3	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C4	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C5	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C6	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C7	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C8	0.180	0.000	0.260	0.130	0.000	1.140	0.210	2.000
C9	0.600	0.000	0.050	0.025	0.000	1.455	0.000	2.000



BF = 0.700(m)

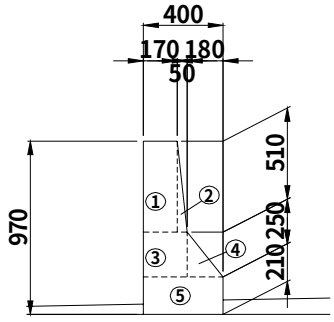
Deck Slab Dimension

	H1 (m)	H2 (m)	H3 (m)	H4 (m)	H5 (m)	H6 (m)	H7 (m)	B3 (m)	B4 (m)	B5 (m)	B6 (m)	B7 (m)
C1	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C2	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C3	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C4	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C5	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C6	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C7	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C8	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001
C9	0.200	0.200	0.200	0.230	0.200	0.230	0.230	1.250	1.450	0.001	0.001	0.001

	G- 1		G- 2		G- 3	
	B1 (m)	B2 (m)	B1 (m)	B2 (m)	B1 (m)	B2 (m)
C1	2.300	3.000	2.300	3.000	2.300	3.000
C2	2.300	3.000	2.300	3.000	2.300	3.000
C3	2.300	3.000	2.300	3.000	2.300	3.000
C4	2.300	3.000	2.300	3.000	2.300	3.000
C5	2.300	3.000	2.300	3.000	2.300	3.000
C6	2.300	3.000	2.300	3.000	2.300	3.000
C7	2.300	3.000	2.300	3.000	2.300	3.000
C8	2.300	3.000	2.300	3.000	2.300	3.000
C9	2.300	3.000	2.300	3.000	2.300	3.000

3) Surfacing

a. Parapet of Carriage Way



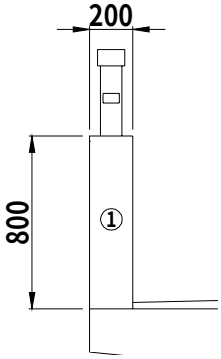
	A	X	AX
①	0.170×0.510×1.0=0.087	0.085	0.007
②	0.050×0.510×0.5=0.013	0.187	0.002
③	0.220×0.250×1.0=0.055	0.110	0.006
④	0.180×0.250×0.5=0.023	0.280	0.006
⑤	0.400×0.210×1.0=0.084	0.200	0.017
計	0.261		0.038

X = ∑AX/∑A = 0.146 m

P = 0.261 × 24.5 = 6.393 kN/m

b. Parapet of Foot Way

Concrete barrier



	A	X	AX
①	0.200×0.800×1.0=0.160	0.100	0.01600
Total	0.160		0.01600

X = ∑AX/∑A = 0.1 m

P = 0.160 × 24.5 = 3.92 kN/m

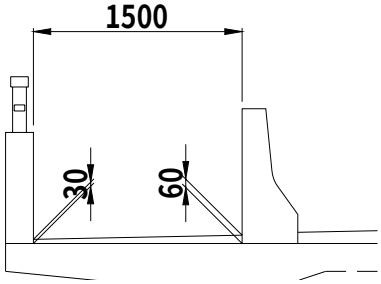
M = 0.100 × 3.920 = 0.392 kN・m/m

Steel Railing

W= 0.300kN/m

c. Asphalt Pavement

Foot Way (t=30mm~60mm)

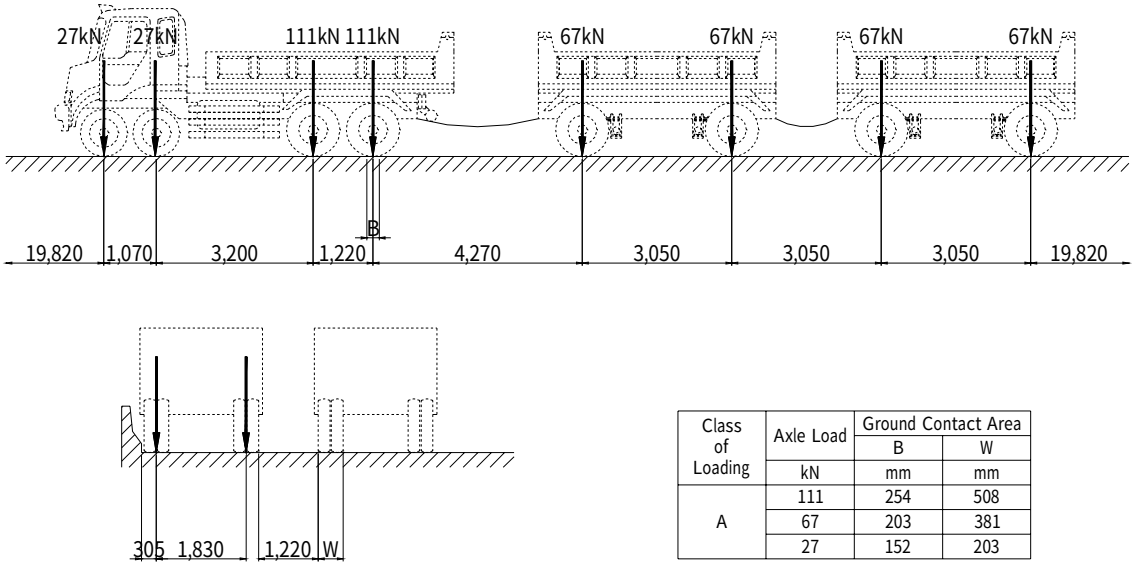


W = 0.03 × 22.5 = 0.675 kN/m^2

W = 0.06 × 22.5= 1.35 kN/m^2

4) Live Load

d. Class-A Loading



Class of Loading	Axle Load	Ground Contact Area	
		B	W
	kN	mm	mm
A	111	254	508
	67	203	381
	27	152	203

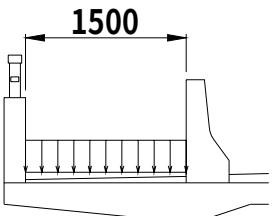
e. Impact Factor

i= 15.24/(L+38) L: Span Length (m)

= 15.24/(28.95+38)

= 0.228

f. Foot Way Loading



q = 2.87 kN/m^2

4. CALCULATION RESULT OF SECTIONAL FORCE

Summary of Sectipnal Force

(1) Bending Moment : Mmax ,Mmin

(G-1 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1608.48	0
Surefacing	-46.4	1166.13	-46.4
Total of Dead Load	-46.4	4674.08	-46.4
LIive Load(max)	248.73	3299.15	248.73
LIive Load(min)	-349.15	-116.83	-349.15
Dead+Live (max)	202.33	7973.23	202.33
Dead+Live (min)	-395.55	4557.25	-395.55
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	221.1	0	-221.1
Surefacing	212.03	-41.83	-212.03
Total of Dead Load	694.49	-32.64	-694.49
LIive Load(max)	54.56	34.95	-54.56
LIive Load(min)	387.07	-18.32	-387.07
Dead+Live (max)	749.05	2.32	-749.05
Dead+Live (min)	1081.56	-50.95	-1081.56

(G-2 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	38.83	1307.89	38.83
Total of Dead Load	38.83	4858.91	38.83
LIive Load(max)	154.07	2592.31	154.07
LIive Load(min)	-171.35	0	-171.35
Dead+Live (max)	192.9	7451.22	192.9
Dead+Live (min)	-132.53	4858.91	-132.53
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	126.98	46.78	-126.98
Total of Dead Load	608.84	62.5	-608.84
LIive Load(max)	117.26	8.77	-117.26
LIive Load(min)	355.21	0	-355.21
Dead+Live (max)	726.1	71.26	-726.1
Dead+Live (min)	964.05	62.5	-964.05

(G-3 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	29.38	1247.74	29.38
Total of Dead Load	29.38	4798.76	29.38
LIive Load(max)	124.88	2310.75	124.88
LIive Load(min)	-170.54	0	-170.54
Dead+Live (max)	154.26	7109.5	154.26
Dead+Live (min)	-141.16	4798.76	-141.16
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	135.47	31.76	-135.47
Total of Dead Load	617.32	47.48	-617.32
LIive Load(max)	97.7	-25.95	-97.7
LIive Load(min)	347.6	0	-347.6
Dead+Live (max)	715.02	21.53	-715.02
Dead+Live (min)	964.93	47.48	-964.93

(G-4 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1712.21	0
Surefacing	-21.8	1123.23	-21.8
Total of Dead Load	-21.8	4734.92	-21.8
LIive Load(max)	331.36	2706.08	331.36
LIive Load(min)	-209.05	-289.72	-209.05
Dead+Live (max)	309.55	7441	309.55
Dead+Live (min)	-230.85	4445.2	-230.85
Shear Force (kN)	C1	C5	C9
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	235.36	0	-235.36
Surefacing	197.37	-36.71	-197.37
Total of Dead Load	694.09	-27.51	-694.09
LIive Load(max)	20.27	72.32	-20.27
LIive Load(min)	242.34	-44.09	-242.34
Dead+Live (max)	714.36	44.81	-714.36
Dead+Live (min)	936.43	-71.6	-936.43

(2) Shear Force max,min

(G-1 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	221.1	0	-221.1
Surefacing	212.03	-41.83	-212.03
Total of Dead Load	694.49	-32.64	-694.49
LIive Load(max)	525.16	209.42	11.8
LIive Load(min)	-11.8	-221.93	-525.16
Dead+Live (max)	1219.66	176.78	-682.69
Dead+Live (min)	682.69	-254.57	-1219.66
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1608.48	0
Surefacing	-46.4	1166.13	-46.4
Total of Dead Load	-46.4	4674.08	-46.4
LIive Load(max)	-207.97	2514.72	113.5
LIive Load(min)	113.5	1335.07	-207.97
Dead+Live (max)	-254.37	7188.8	67.09
Dead+Live (min)	67.09	6009.15	-254.37

(G-2 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	126.98	46.78	-126.98
Total of Dead Load	608.84	62.5	-608.84
LIive Load(max)	474.38	170.51	14.11
LIive Load(min)	-14.11	-258.3	-474.38
Dead+Live (max)	1083.21	233.01	-594.73
Dead+Live (min)	594.73	-195.81	-1083.21
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	38.83	1307.89	38.83
Total of Dead Load	38.83	4858.91	38.83
LIive Load(max)	-88.35	2127.74	26.53
LIive Load(min)	26.53	981.19	-88.35
Dead+Live (max)	-49.52	6986.65	65.36
Dead+Live (min)	65.36	5840.1	-49.52

(G-3 Gider)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	13.05	13.05	-13.05
Deck Slab	213.97	0	-213.97
Surefacing	135.47	31.76	-135.47
Total of Dead Load	617.32	47.48	-617.32
LIive Load(max)	465.6	142.52	3.76
LIive Load(min)	-3.76	-258.79	-465.6
Dead+Live (max)	1082.92	190	-613.57
Dead+Live (min)	613.57	-211.31	-1082.92
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	189.86	0
Deck Slab	0	1556.61	0
Surefacing	29.38	1247.74	29.38
Total of Dead Load	29.38	4798.76	29.38
LIive Load(max)	-95.02	1840.58	8.36
LIive Load(min)	8.36	945.75	-95.02
Dead+Live (max)	-65.64	6639.33	37.74
Dead+Live (min)	37.74	5744.51	-65.64

(G-4 Girder)

Point	C1	C5	C9
Distance	0	14.55	29.1
Position	A1 Bearing	Mmax	A2 Bearing
Shear Force (kN)			
Self Weight of Girder	254.84	2.67	-254.84
Cross Beam	6.52	6.52	-6.52
Deck Slab	235.36	0	-235.36
Surefacing	197.37	-36.71	-197.37
Total of Dead Load	694.09	-27.51	-694.09
LIive Load(max)	320.8	164.86	29.59
LIive Load(min)	-29.59	-126.75	-320.8
Dead+Live (max)	1014.89	137.35	-664.5
Dead+Live (min)	664.5	-154.26	-1014.89
Bending Moment (kN·m)			
Self Weight of Girder	0	1804.55	0
Cross Beam	0	94.93	0
Deck Slab	0	1712.21	0
Surefacing	-21.8	1123.23	-21.8
Total of Dead Load	-21.8	4734.92	-21.8
LIive Load(max)	-61.84	2093.37	214.31
LIive Load(min)	214.31	612.97	-61.84
Dead+Live (max)	-83.64	6828.29	192.51
Dead+Live (min)	192.51	5347.89	-83.64

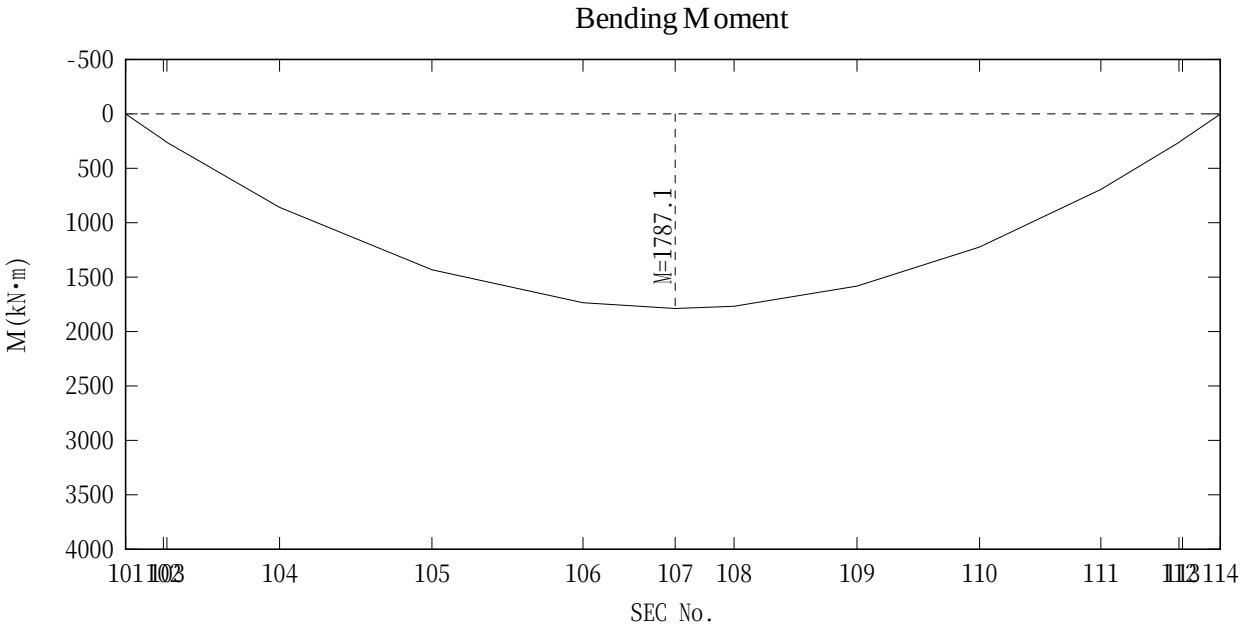
Selection of the Design Girder

Design girder selects G1 girder as a result of comparison of sectional force.

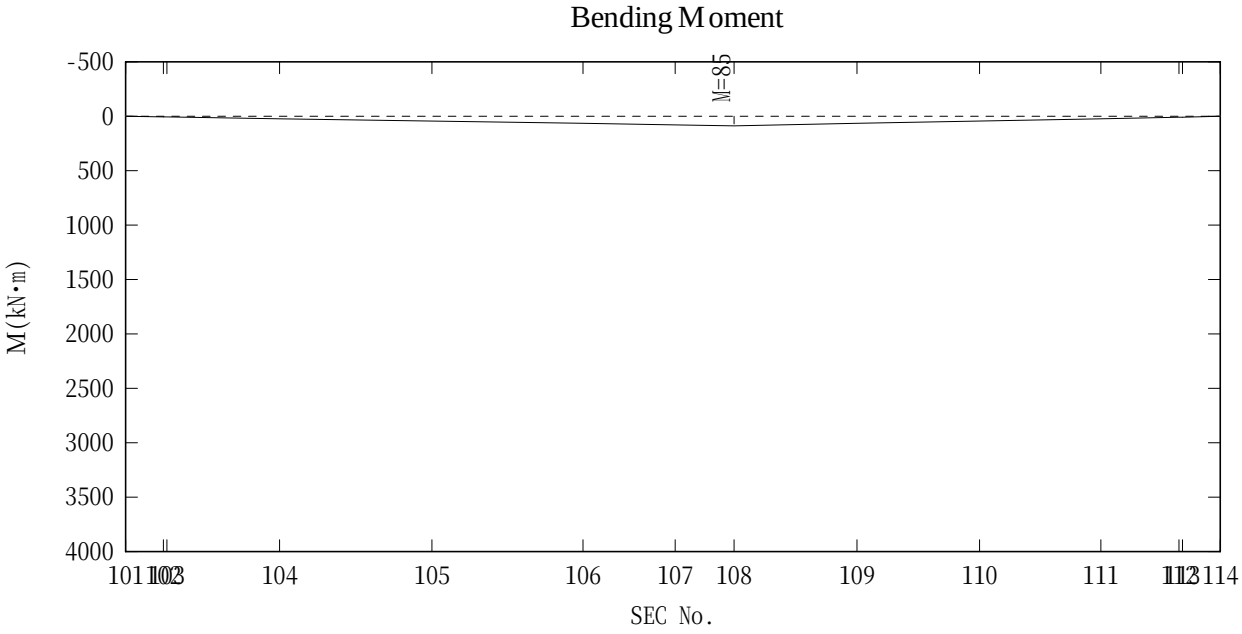
Comparison of bebding moment.

Number of Girder	**G1**	G2	G3	G4
Position	**1005**	2005	3005	4005
Distance from A1 bearing	**14.55**	14.55	14.55	14.55
Bebding Moment (max)	**7973.233**	7451.216	7109.504	7440.999

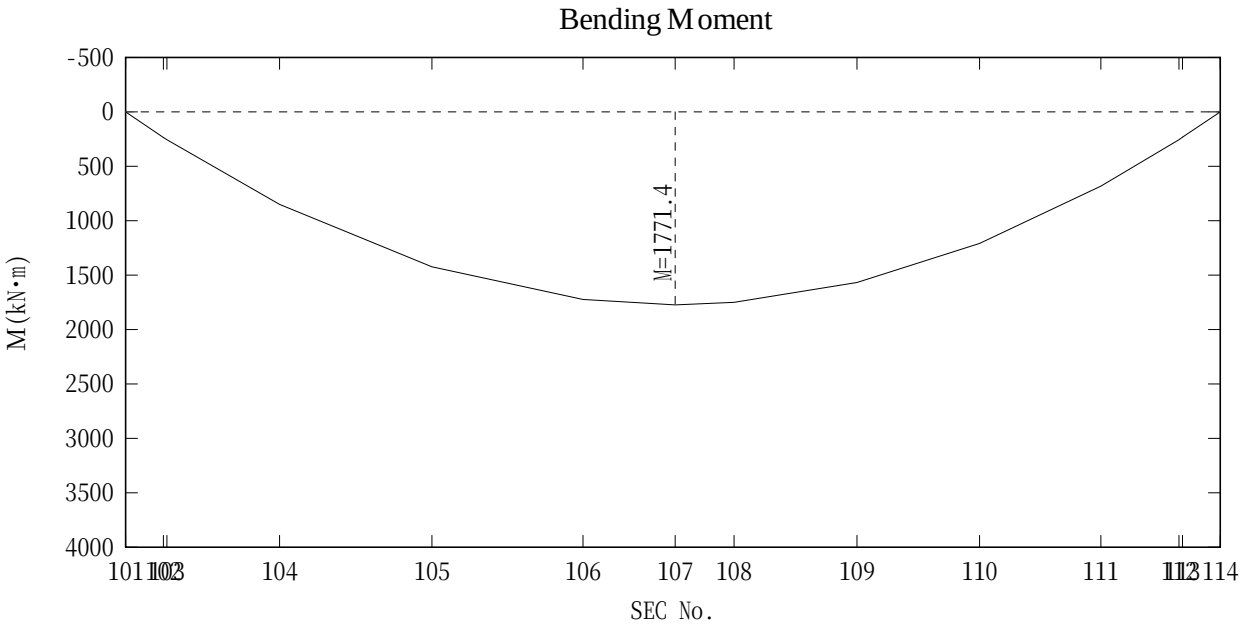
Bending Moment Diagram (Girder self-weight)



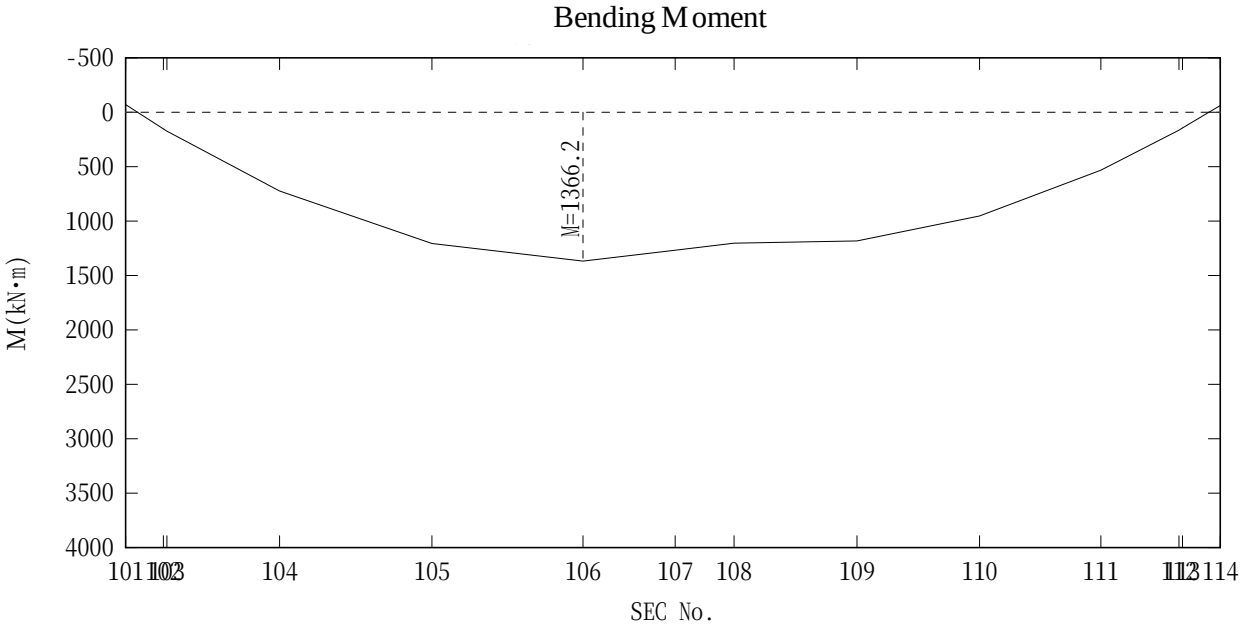
Bending Moment Diagram (Crossbeam self-weight)



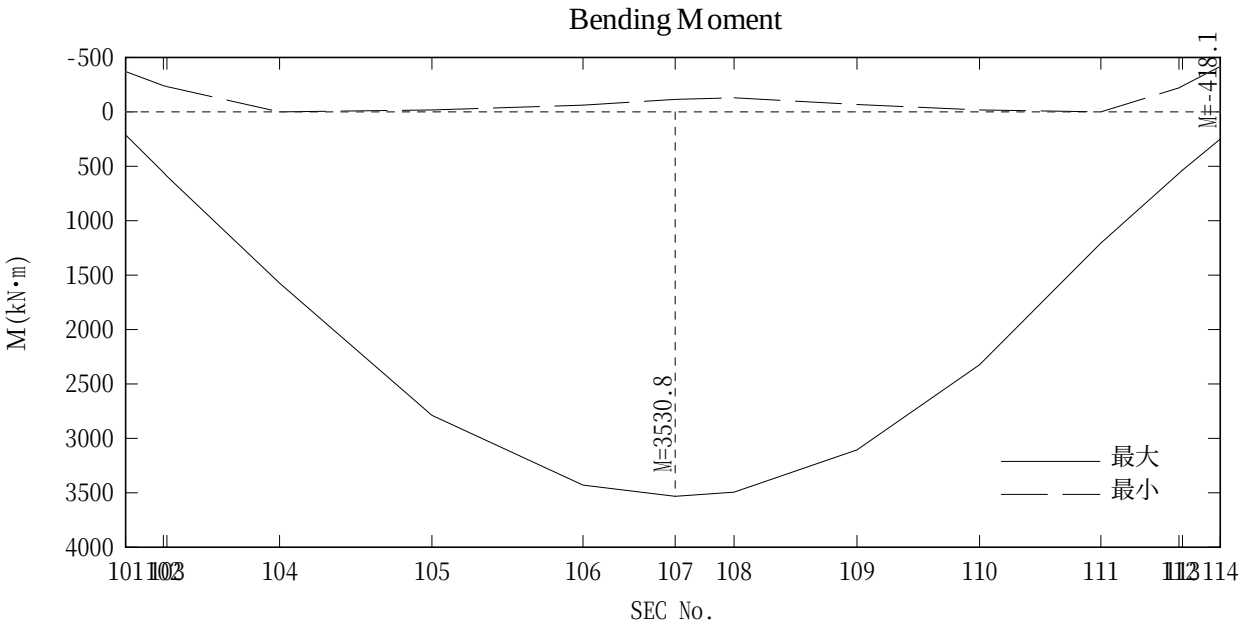
Bending Moment Diagram (Deck Slab self-weight)



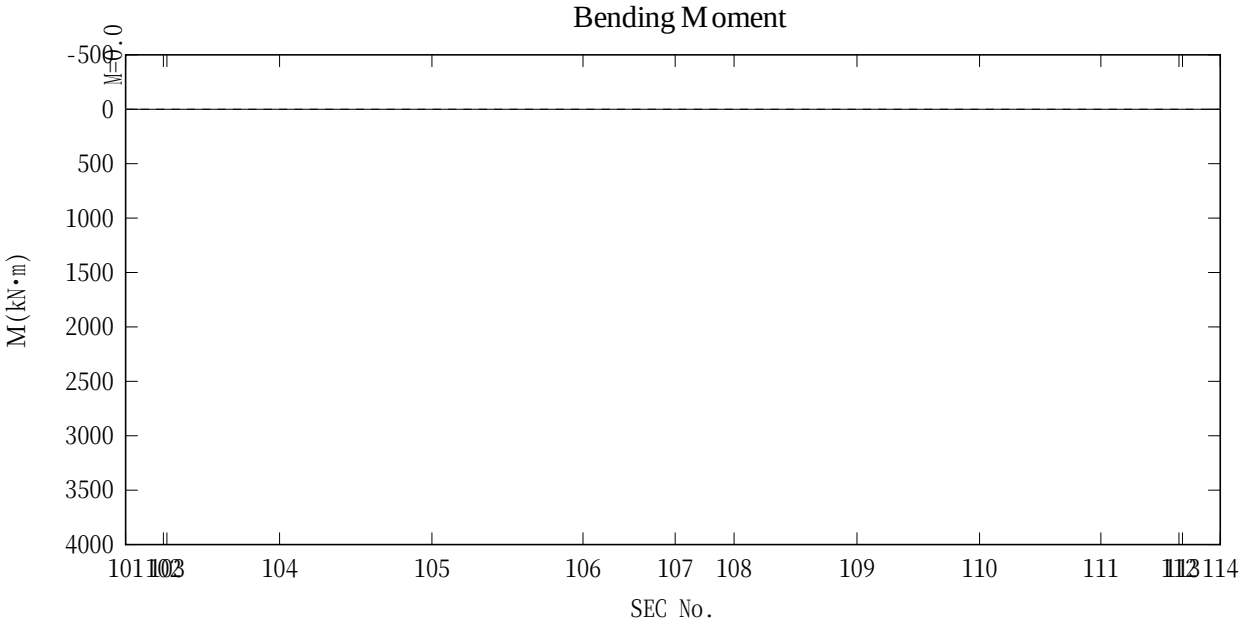
Bending Moment Diagram (Surfacing)



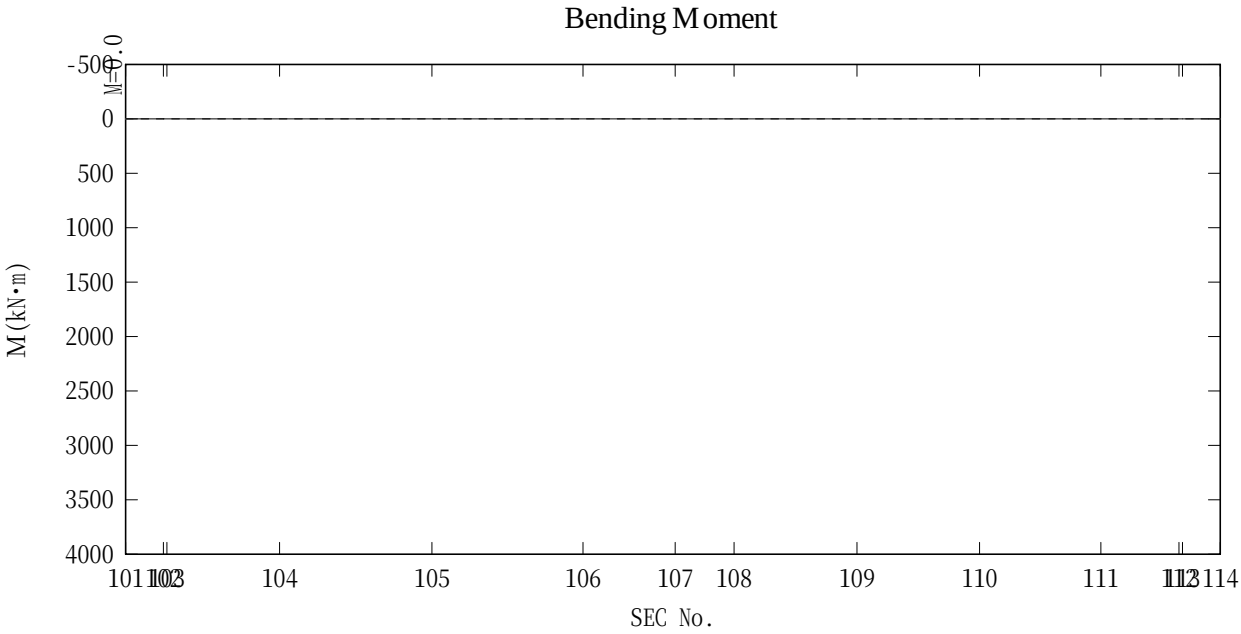
Bending Moment Diagram (Live Load)



Bending Moment Diagram (Creep)



Bending Moment Diagram (Shrinkage)



5. CALCULATION RESULT OF GIRDER STRESS

Combined Bending Stress

		SEC-105 (N/mm2)			SEC-106 (N/mm2)		
		upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress							
After Transfer	(1)		-3.68	18.92		-5.53	21.45
Slab under Construction	(2)		-3.11	15.98		-4.63	17.93
Design Load	(3)		-2.86	14.69		-4.27	16.55
Secondary Force	(4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder	(5)		4.25	-4.35		5.17	-5.32
Selfweight of Cross Beam	(6)		0.13	-0.12		0.19	-0.18
Selfweight of Slab	(7)		4.16	-3.97		5.01	-4.76
Surfacing Load	(8)	0.97	0.80	-2.38	1.08	0.89	-2.67
Live Load(max)	(9)	2.25	1.86	-5.50	2.72	2.24	-6.70
Live Load(min)	(10)	-0.02	-0.01	0.04	-0.05	-0.04	0.13
Difference Drying Shrinkage	(11)	-0.08	0.31	-0.12	-0.08	0.31	-0.12
Creep Effect	(12)	0.77	-2.61	0.97	0.89	-3.01	1.12
Temperature Difference	(13)	0.26	-1.04	0.37	0.26	-1.04	0.37
Thermal Change(+)	(14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-)	(15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max)	(16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min)	(17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage	(18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress							
After Transfer							
(1)+(5)		0.57	14.57	-0.36	16.14		
Slab under Construction							
(2)+(5)+(6)+(7)		5.43	7.53	5.74	7.68		
dead load	+(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(12)		1.66	4.18	4.72	1.89	4.29	4.63
D+L							
B:A+(9)		3.91	6.04	-0.78	4.61	6.53	-2.07
C:A+(10)		1.65	4.16	4.76	1.84	4.25	4.76
Temperature Consideration							
H:B+(14)		3.91	6.04	-0.78	4.61	6.53	-2.07
I:B+(15)		3.91	6.04	-0.78	4.61	6.53	-2.07
J:C+(14)		1.65	4.16	4.76	1.84	4.25	4.76
K:C+(15)		1.65	4.16	4.76	1.84	4.25	4.76
L:H+(13)		4.17	5.00	-0.41	4.86	5.49	-1.70
M:I+(13)		4.17	5.00	-0.41	4.86	5.49	-1.70
N:J+(13)		1.90	3.12	5.14	2.10	3.21	5.13
O:K+(13)		1.90	3.12	5.14	2.10	3.21	5.13
Settlement Consideration							
MAX[B+(16) B+(17),C+(16),C+(17)]		3.91	6.04	-0.78	4.61	6.53	-2.07
MIN[B+(16),B+(17),C+(16),C+(17)]		1.65	4.16	4.76	1.84	4.25	4.76

Combined Bending Stress

		SEC-107 (N/mm2)			SEC-108 (N/mm2)		
		upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress							
After Transfer	(1)	-5.59	21.67	-5.55	21.53		
Slab under Construction	(2)	-4.68	18.13	-4.64	18.01		
Design Load	(3)	-4.32	16.73	-4.28	16.60		
Secondary Force	(4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder	(5)	5.33	-5.48	5.27	-5.42		
Selfweight of Cross Beam	(6)	0.23	-0.21	0.25	-0.24		
Selfweight of Slab	(7)	5.15	-4.89	5.08	-4.83		
Surfacing Load	(8)	1.00	0.83	-2.48	0.95	0.79	-2.35
Live Load(max)	(9)	2.80	2.31	-6.90	2.77	2.29	-6.83
Live Load(min)	(10)	-0.09	-0.08	0.23	-0.10	-0.09	0.26
Difference Drying Shrinkage	(11)	-0.08	0.31	-0.12	-0.08	0.31	-0.12
Creep Effect	(12)	0.93	-3.14	1.17	0.92	-3.11	1.16
Temperature Difference	(13)	0.26	-1.04	0.37	0.26	-1.04	0.37
Thermal Change(+)	(14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-)	(15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max)	(16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min)	(17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage	(18)	0.00	0.00	0.00	0.00	0.00	
Combine Stress							
After Transfer							
(1)+(5)		-0.26	16.18	-0.28	16.10		
Slab under Construction							
(2)+(5)+(6)+(7)		6.03	7.54	5.96	7.52		
dead load	+(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(12)		1.86	4.39	4.73	1.80	4.31	4.81
D+L							
B:A+(9)		4.66	6.70	-2.17	4.56	6.60	-2.02
C:A+(10)		1.77	4.31	4.95	1.69	4.22	5.07
Temperature Consideration							
H:B+(14)		4.66	6.70	-2.17	4.56	6.60	-2.02
I:B+(15)		4.66	6.70	-2.17	4.56	6.60	-2.02
J:C+(14)		1.77	4.31	4.95	1.69	4.22	5.07
K:C+(15)		1.77	4.31	4.95	1.69	4.22	5.07
L:H+(13)		4.91	5.66	-1.81	4.82	5.55	-1.65
M:I+(13)		4.91	5.66	-1.81	4.82	5.55	-1.65
N:J+(13)		2.02	3.27	5.32	1.95	3.18	5.43
O:K+(13)		2.02	3.27	5.32	1.95	3.18	5.43
Settlement Consideration							
MAX[B+(16) B+(17),C+(16),C+(17)]		4.66	6.70	-2.17	4.56	6.60	-2.02
MIN[B+(16),B+(17),C+(16),C+(17)]		1.77	4.31	4.95	1.69	4.22	5.07

Combined Bending Stress

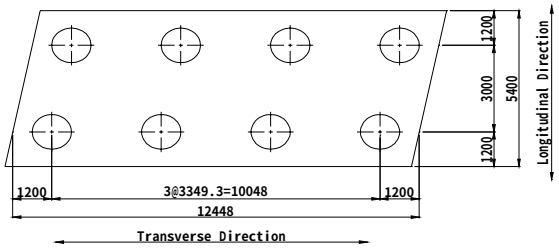
		SEC-109 (N/mm2)			SEC-110 (N/mm2)		
		upper edge of slab	upper edge of slab	upper edge of girder	upper edge of slab	upper edge of slab	upper edge of girder
Grder Pre-stress							
After Transfer	(1)	-5.21	20.74	-1.58	16.64		
Slab under Construction	(2)	-4.35	17.32	-1.35	14.24		
Design Load	(3)	-3.99	15.88	-1.24	13.09		
Secondary Force	(4)	0.00	0.00	0.00	0.00	0.00	0.00
Selfweight of Girder	(5)	4.72	-4.85	3.61	-3.68		
Selfweight of Cross Beam	(6)	0.19	-0.18	0.13	-0.12		
Selfweight of Slab	(7)	4.55	-4.33	3.55	-3.42		
Surfacing Load	(8)	0.94	0.78	-2.31	0.78	0.65	-1.90
Live Load(max)	(9)	2.49	2.06	-6.09	1.91	1.58	-4.63
Live Load(min)	(10)	-0.05	-0.05	0.13	-0.02	-0.01	0.04
Difference Drying Shrinkage	(11)	-0.08	0.31	-0.12	-0.08	0.31	-0.11
Creep Effect	(12)	0.79	-2.69	1.00	0.75	-2.53	0.94
Temperature Difference	(13)	0.26	-1.04	0.37	0.26	-1.04	0.38
Thermal Change(+)	(14)	0.00	0.00	0.00	0.00	0.00	0.00
Thermal Change(-)	(15)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (max)	(16)	0.00	0.00	0.00	0.00	0.00	0.00
Settlement (min)	(17)	0.00	0.00	0.00	0.00	0.00	0.00
Drying Shrinkage	(18)	0.00	0.00	0.00	0.00	0.00	0.00
Combine Stress							
After Transfer							
(1)+(5)		-0.50	15.89	2.03	12.96		
Slab under Construction							
(2)+(5)+(6)+(7)		5.10	7.97	5.93	7.03		
dead load	+(18)						
A:(3)+(4)+(5)+(6)+(7)+(8)+(11)+(12)		1.66	3.87	5.10	1.46	4.47	4.80
D+L							
B:A+(9)		4.14	5.93	-0.99	3.36	6.05	0.17
C:A+(10)		1.60	3.82	5.23	1.44	4.46	4.84
Temperature Consideration							
H:B+(14)		4.14	5.93	-0.99	3.36	6.05	0.17
I:B+(15)		4.14	5.93	-0.99	3.36	6.05	0.17
J:C+(14)		1.60	3.82	5.23	1.44	4.46	4.84
K:C+(15)		1.60	3.82	5.23	1.44	4.46	4.84
L:H+(13)		4.40	4.89	-0.62	3.63	5.01	0.54
M:I+(13)		4.40	4.89	-0.62	3.63	5.01	0.54
N:J+(13)		1.86	2.78	5.60	1.70	3.42	5.22
O:K+(13)		1.86	2.78	5.60	1.70	3.42	5.22
Settlement Consideration							
MAX[B+(16) B+(17),C+(16),C+(17)]		4.14	5.93	-0.99	3.36	6.05	0.17
MIN[B+(16),B+(17),C+(16),C+(17)]		1.60	3.82	5.23	1.44	4.46	4.84

6. Result of Substructure
6.1 A1 Abutment

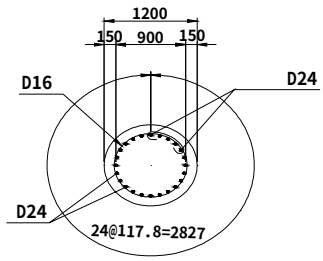
Summary of Design Calculation Result (1/4)

1. Cast in-situ Pile

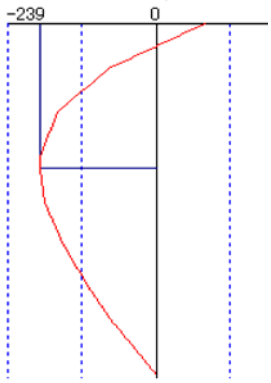
Pile Arrangement



Bar Arrangement



Bending Moment (Seismic Design)

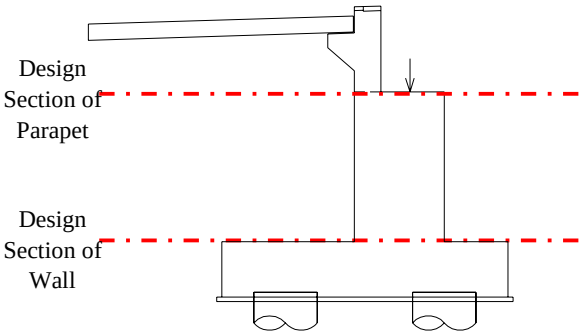


Pile Arrangement			Diameter of Pile	D= 1200 mm
			Length of Pile	L= 8.000 m
			Nos. of Pile	N= 8 Nos
Bar Arrangement			24-D24 (@147)	
Stability	Force at the Center of Pile Cap	Longitudinal Direction	Group-I	V=12846.3kN, H=1550kN, M=2169kNm
			Group-VII	V=11942kN, H=4827kN, M=13384kNm
	Reaction at Pile Head	Longitudinal Direction	Group-I	Rmax=1385kN < Ra=2183kN, Rmin=1377kN > Pa=0kN
			Group-VII	Rmax=2379kN < Ra=3317kN, Rmin=606kN > Pa=-1284kN
	Displacement at Pile Head	Longitudinal Direction	Group-I	δx=1.8mm < 15mm
			Group-VII	δx=4.3mm < 15mm
Service Load Design		Load Case	Group-I : (D+SD+L+CF+E+B)	
		Sectional Force	M= 233 kNm,	N= 1377 kN
		Stress	σc= 2.2 <	σca= 9.6 N/mm^2
			σs= -24.9 <	σsa= 168 N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)	
		Sectional Force	M= 864 kNm,	N= 607 kN
		Stress	σc= 8.1 <	σca= 12.8 N/mm^2
			σs= 178.3 <	σsa= 223 N/mm^2
Load Factor Design		Load Case	Group-I : 1.3(D+SD+1.67L+CF+E+B)	
		Sectional Force	Mu= 333 kNm,	Nu= 1806 kN
			Su= 276 kN	
		Strength	Flexural Strength	φMn= 1879 kNm > Mu
			Shear Strenth	φVn= 1744 kN > Su
		Load Case	Group-VII : 1.3(D+SD+E+B+EQ)	
		Sectional Force	Mu= 1062 kNm,	Nu= 673 kN
			Su= 749 kN	
		Strength	Flexural Strength	φMn= 1493 kNm > Mu
			Shear Strenth	φVn= 1744 kN > Su

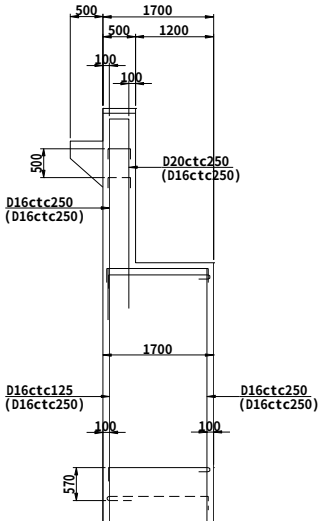
Small Bridge-2 A1 Abutment

Summary of Design Calculation Result (2/4)

2. Wall and Parapet



Bar Arrangement of Parapet & Wall

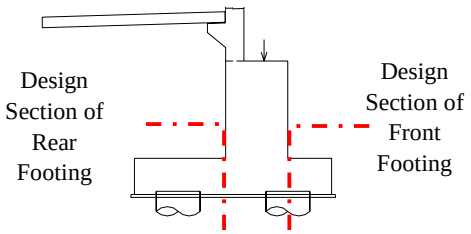


Size of Section			Thickness of Parapet	t=0.500m				
			Thickness of Wall	t=1.700m				
Bar Arrangement			Parapet	D20ctc250-1.0, d=400mm				
			Wall	D16ctc125-1.0, d=1600mm				
Parapet	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	70.3	kNm,			
		Stress	σc=	3.4	<	σca=	9.6	N/mm^2
			σs=	151.2	<	σsa=	168	N/mm^2
Wall	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	193	kNm,	N=	507	kN
		Stress	σc=	0.7	<	σca=	9.6	N/mm^2
			σs=	1.2	<	σsa=	168	N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)					
		Sectional Force	M=	578	kNm,	N=	406	kN
		Stress	σc=	2.8	<	σca=	12.8	N/mm^2
			σs=	123.4	<	σsa=	223	N/mm^2
	Load Factor Design	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)					
		Sectional Force	Mu=	288	kNm,	Nu=	699	kN
		Strength	Flexural Strength			φMn=	928	kNm > Mu
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)					
		Sectional Force	Mu=	730	kNm,	Nu=	479	kN
		Strength	Flexural Strength			φMn=	928	kNm > Mu

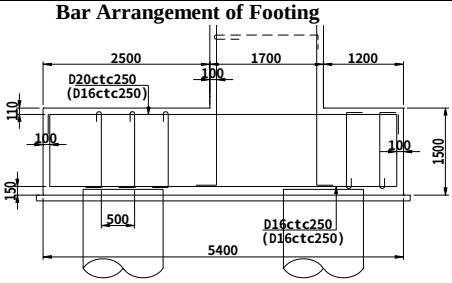
Small Bridge-2 A1 Abutment

Summary of Design Calculation Result (3/4)

3. Pile Cap



Bar Arrangement of Footing

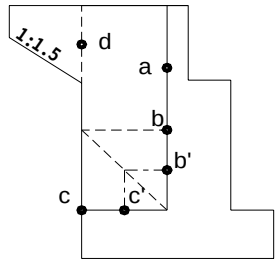


Service Load Design	Front Footing	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	51.4	kNm,	①		
		Stress	σc=	0.5	<	σca=	9.6	N/mm^2
			σs=	48.6	<	σsa=	168	N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)					
		Sectional Force	M=	62.0	kNm,	①		
		Stress	σc=	0.5	<	σca=	12.8	N/mm^2
			σs=	58.6	<	σsa=	223	N/mm^2
	Rear Footing	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	37.6	kNm,	①		
		Stress	σc=	0.3	<	σca=	9.6	N/mm^2
			σs=	35.5	<	σsa=	168	N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)					
		Sectional Force	M=	254.5	kNm,	①		
		Stress	σc=	1.9	<	σca=	12.8	N/mm^2
			σs=	167.9	<	σsa=	223	N/mm^2
Load Factor Design	Front Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)					
		Sectional Force	Mu=	70.3	kNm,			
		Strength	Flexural Strength			φMn=	460	kNm > Mu
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)					
		Sectional Force	Mu=	70.3	kNm,			
		Strength	Flexural Strength			φMn=	460	kNm > Mu
	Rear Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E				979	
		Sectional Force	Mu=	34.3	kNm,	①		
			Su=	316.3	kN	②		
		Strength	Flexural Strength			φMn=	727	kNm > Mu
			Shear Strenth			φVn=	1260	kN > Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)					
		Sectional Force	Mu=	344.5	kNm,	①		
			Su=	245.3	kN	②		
		Strength	Flexural Strength			φMn=	727	kNm > Mu
			Shear Strenth			φVn=	1260	kN > Su

Small Bridge-3 A1 Abutment

Summary of Design Calculation Result (4/4)

4. Wing



Bar Arranegement

Section	Reinforcement-bar Arranngement	
	Inside (mm^2)	Outside (mm^2)
a	D16@250	D16@250
b	D16@125	D16@250
c	D16@125	D16@250
d	D16@250	D16@250

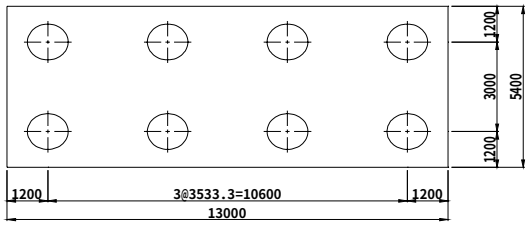
Size of Section			Thickness of Wing t=0.700m					
Service Load Design	Section-"a"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	44.5	kNm,			
		Stress	σc=	2.8	<	σca=	9.6	N/mm²
			σs=	150.8	<	σsa=	168	N/mm²
	Section-"b"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	58.8	kNm,			
		Stress	σc=	2.8	<	σca=	9.6	N/mm²
			σs=	102.5	<	σsa=	168	N/mm²
	Section-"c"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	73.4	kNm,			
		Stress	σc=	3.5	<	σca=	9.6	N/mm²
			σs=	127.9	<	σsa=	168	N/mm²
	Section-"d"	Load Case	Group-I : (D+L+E)					
		Sectional Force	M=	2.7	kNm,			
		Stress	σc=	0.2	<	σca=	9.6	N/mm²
			σs=	9.3	<	σsa=	168	N/mm²
Load Factor Design	Section-"a"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	64.5	kNm,			
		Strength	Flexural Strength			φMn=	174	kNm > Mu
	Section-"b"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	94.4	kNm,			
		Strength	Flexural Strength			φMn=	325	kNm > Mu
	Section-"c"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	120.2	kNm,			
		Strength	Flexural Strength			φMn=	325	kNm > Mu
	Section-"d"	Load Case	Group-VII : 1.3(D+E+EQ)					
		Sectional Force	Mu=	3.6	kNm,			
		Strength	Flexural Strength			φMn=	174	kNm > Mu

6.2 P1 Pier

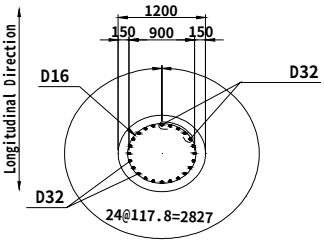
Summary of Design Calculation Result (1/3)

1. Cast in-situ Pile

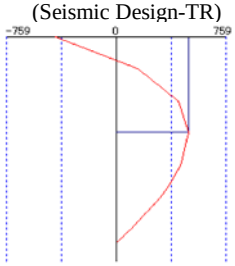
Pile Arrangement



Bar Arrangement



Bending Moment (Seismic Design-TR)

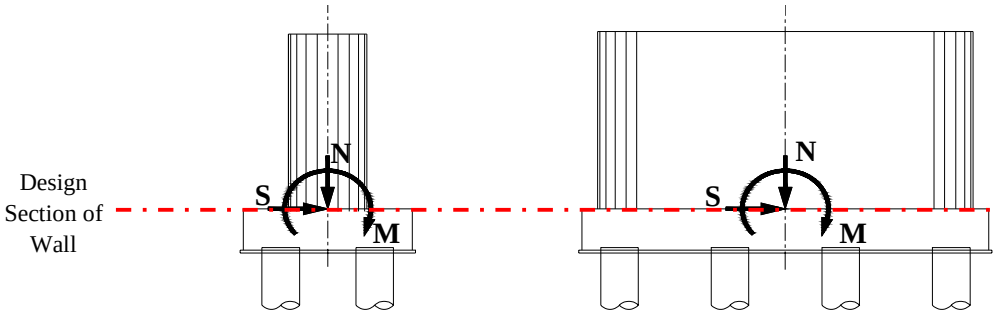


Design Seismic Coefficient			Longitudinal	Kh=0.29	T=0.615(sec)			
			Transverse	Kh=0.40	T=0.384(sec)			
Pile Arrangement			Diameter of Pile	D=	1200	mm		
			Length of Pile	L=	6.500	m		
			Nos. of Pile	N=	8	Nos		
Bar Arrangement			24-D32 (@147)					
Stability	Force at the Center of Pile Cap	Longitudinal Direction	Group-I	V=16894kN, H=0kN, M=0kNm				
			Group-VII	V=14644kN, H=3771kN, M=24230kNm				
		Transverse Direction	Group-VII	V=14644kN, H=5199kN, M=33396kNm				
	Reaction at Pile Head	Longitudinal Direction	Group-I	Rmax=2112kN < Ra=2557kN, Rmin=2112kN > Pa=0kN				
			Group-VII	Rmax=3261kN < Ra=3856kN, Rmin=400kN > Pa=-842kN				
		Transverse Direction	Group-VII	Rmax=3490kN < Ra=3856kN, Rmin=-130kN > Pa=-842kN				
	Displacement at Pile Head	Longitudinal Direction	Group-I	δx=0mm < 15mm				
			Group-VII	δx=7.7mm < 15mm				
		Transverse Direction	Group-VII	δx=5.3mm < 15mm				
Service Load Design	Longitudinal Direction	Load Case	Group-I	(D+SD+L+B)				
		Sectional Force	M=	0 kNm,	N=	2112 kN		
		Stress	σc=	1.5	<	σca=	9.6 N/mm^2	(24 x 0.4)
			σs=	-22.4	<	σsa=	168 N/mm^2	
		Load Case	Group-VII	(D+SD+B+EQ)				
		Sectional Force	M=	1240 kNm,	N=	99 kN		
		Stress	σc=	9.4	<	σca=	12.8 N/mm^2	(9.6 x 1.33)
			σs=	220.2	<	σsa=	223 N/mm^2	(168 x 1.33)
	Transverse Direction	Load Case	Group-VII	(D+SD+B+EQ)				
		Sectional Force	M=	755 kNm,	N=	-130 kN		
		Stress	σc=	5.7	<	σca=	12.8 N/mm^2	(9.6 x 1.33)
			σs=	145.5	<	σsa=	223 N/mm^2	(168 x 1.33)
Load Factor Design	Longitudinal Direction	Load Case	Group-I	1.3(D+SD+1.67L+B)				
		Sectional Force	Mu=	0 kNm,	Nu=	2991 kN		
			Su=	0 kN				
		Strength	Flexural Strength		φMn=	2697 kNm	> Mu	
			Shear Strenth		φVn=	1744 kN	> Su	
		Load Case	Group - VII	1.3(D+SD+B+EQ)				
		Sectional Force	Mu=	1820 kNm,	Nu=	449 kN		
			Su=	612 kN				
		Strength	Flexural Strength		φMn=	2697 kNm	> Mu	
			Shear Strenth		φVn=	1744 kN	> Su	
	Transverse Direction	Load Case	Group - VII	1.3(D+SD+B+EQ)				
		Sectional Force	Mu=	853 kNm,	Nu=	74 kN		
			Su=	845 kN				
		Strength	Flexural Strength		φMn=	2697 kNm	> Mu	
			Shear Strenth		φVn=	1744 kN	> Su	

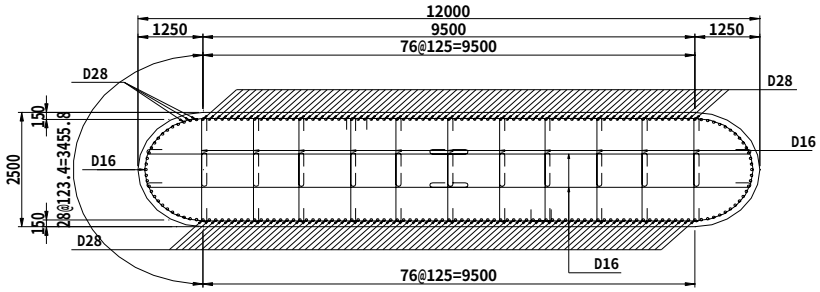
Small Bridge-3 P1 Pier

Summary of Design Calculation Result (2/3)

2. Wall



Bar Arrangement of Wall

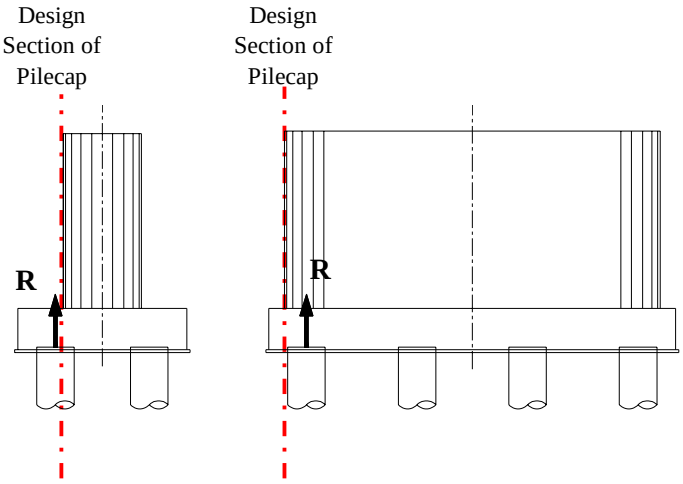


Size of Section			Longitudinal Direction	L_L=2.500m			
			Transverse Direction	L_T=12.000m			
Bar Arrangement			D28ctc125-1.0, Cover=150mm				
Service Load Design	Longitudinal Direction	Load Case	Group-I	(D+SD+L+CF+E+B)			
		Sectional Force	M=	0 kNm,	N=	12744 kN	
		Stress	σc=	0.4 <	σca=	9.6 N/mm^2	
			σs=	-6.2 <	σsa=	168 N/mm^2	
		Load Case	Group-VII	(D+SD+E+B+EQ)			
		Sectional Force	M=	19134 kNm,	N=	10494 kN	
		Stress	σc=	2.8 <	σca=	12.8 N/mm^2	
			σs=	71.5 <	σsa=	223 N/mm^2	
	Transverse Direction	Load Case	Group-VII	(D+SD+E+B+EQ)			
		Sectional Force	M=	26371 kNm,	N=	10494 kN	
		Stress	σc=	0.8 <	σca=	12.8 N/mm^2	
			σs=	2.1 <	σsa=	223 N/mm^2	
Load Factor Design	Longitudinal Direction	Load Case	Group - I	1.3(D+SD+1.67L+CF+E+B)			
		Sectional Force	Mu=	0 kNm,	Nu=	18532 kN	
			Su=	0 kN			
		Strength	Flexural Strength	φMn=	66698 kNm	> Mu	
			Shear Strenth	φVn=	21971 kN	> Su	
		Load Case	Group - VII	1.3(D+SD+E+B+EQ)			
		Sectional Force	Mu=	24822 kNm,	Nu=	13642 kN	
			Su=	3924 kN			
		Strength	Flexural Strength	φMn=	66698 kNm	> Mu	
			Shear Strenth	φVn=	21971 kN	> Su	
	Transverse Direction	Load Case	Group - VII	1.3(D+SD+E+B+EQ)			
		Sectional Force	Mu=	34274 kNm,	Nu=	13642 kN	
			Su=	5417 kN			
		Strength	Flexural Strength	φMn=	218638 kNm	> Mu	
			Shear Strenth	φVn=	20325 kN	> Su	

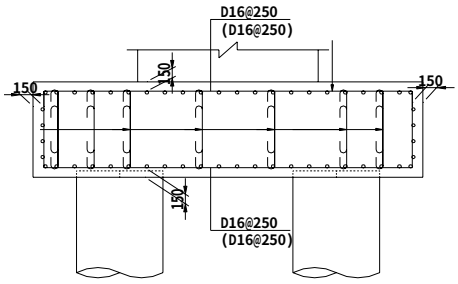
Small Bridge-3 P1 Pier

Summary of Design Calculation Result (3/3)

3. Pile Cap



Bar Arrangement of Footing



Size of Section			Longitudinal Direction	L_L=5.400m	T=1.800m		
			Transverse Direction	L_T=13.000m	T=1.800m		
Bar Arrangement			Longitudinal Direction	D16ctc250			
			Transverse Direction	D16ctc250			
Service Load Design	Longitudinal Direction	Load Case	Group-I	(D+SD+L+CF+E+B)			
		Sectional Force	M=	85 kNm,	①		
		Stress	σc=	0.8	<	σca=	9.6 N/mm^2
			σs=	82.0	<	σsa=	168 N/mm^2
		Load Case	Group-VII	(D+SD+E+B+EQ)			
		Sectional Force	M=	185 kNm,	①		
		Stress	σc=	1.7	<	σca=	12.8 N/mm^2
			σs=	180.0	<	σsa=	223 N/mm^2
	Transverse Direction	Load Case	Group-VII	(D+SD+E+B+EQ)			
		Sectional Force	M=	29 kNm,	①		
		Stress	σc=	0.3	<	σca=	12.8 N/mm^2
			σs=	27.6	<	σsa=	223 N/mm^2
Load Factor Design	Longitudinal Direction	Load Case	Group - I	1.3(D+SD+1.67L+CF+E+B)			
		Sectional Force	Mu=	129 kNm,	①		
			Su=	68 kN	②		
		Strength	Flexural Strength		φMn=	400 kNm	> Mu
			Shear Strenth		φVn=	1097 kN	> Su
		Load Case	Group - VII	1.3(D+SD+1.67L+CF+E+B)			
		Sectional Force	Mu=	219 kNm,	①		
			Su=	68 kN	②		
		Strength	Flexural Strength		φMn=	400 kNm	> Mu
			Shear Strenth		φVn=	1097 kN	> Su
	Transverse Direction	Load Case	Group - VII	1.3(D+SD+1.67L+CF+E+B)			
		Sectional Force	Mu=	38 kNm,	①		
		Strength	Flexural Strength		φMn=	393 kNm	> Mu

Design Seismic Coefficient

The design seismic coefficient for P1 Pier is given by the following formula

$$Kh = \frac{Cs}{R}$$

$$Cs = \frac{1.2*A*S}{T^{2/3}}$$

in which,

Kh : Design Seismic Coefficient

Cs : Elastic Seismic Response Coefficient

R : Response Modifications Factor

Wall-type pier	R=2	← P1 Pier
Reinforced concrete pile bents		
a. Vertical piles only	R=3	
b. One or more batter piles	R=2	
Single columns	R=3	
Multiple column bent	R=5	

A : Acceleration Coefficient

A= 0.35

S : dimensionless coefficient for the soil profile characteristics of the site

Soil Profile Type		
Ⅰ	S=1.0	← P1 Pier
Ⅱ	S=1.2	
Ⅲ	S=1.5	
Ⅳ	S=2.0	

T : Period of the bridge(sec)

(1) Longitudinal Direction

R=2, A=0.35, S=1.0, T=0.615sec

$$Cs = \frac{1.2*A*S}{T^{2/3}} = \frac{1.2*0.35*1.0}{(615)^{2/3}} = 0.581$$

$$Kh = \frac{Cs}{R} = \frac{0.581}{2} = 0.290 \rightarrow \underline{0.29}$$

(2) Transverse Direction

R=2, A=0.35, S=1.0, T=0.384sec

$$Cs = \frac{1.2*A*S}{T^{2/3}} = \frac{1.2*0.35*1.0}{(0.384)^{2/3}} = 0.795$$

$$Kh = \frac{Cs}{R} = \frac{0.795}{2} = 0.397 \rightarrow \underline{0.40}$$

(3) Calculation Result of Design Seismic Coefficient for P1 Pier

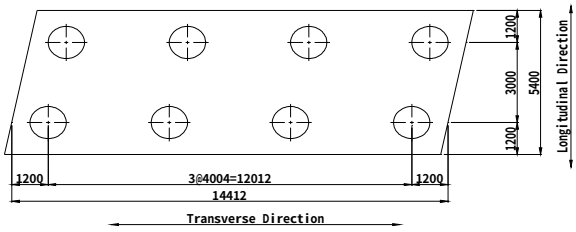
	Design Seismic Coefficient
Longitudinal Direction	Kh = 0.29
Transverse Direction	Kh = 0.40

6.3 A2 Abutment

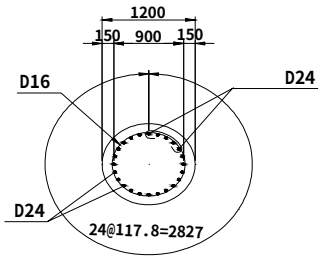
Summary of Design Calculation Result (1/4)

1. Cast in-situ Pile

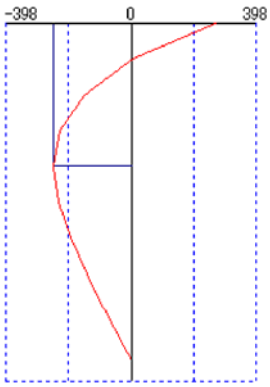
Pile Arrangement



Bar Arrangement



Bending Moment (Seismic Design)

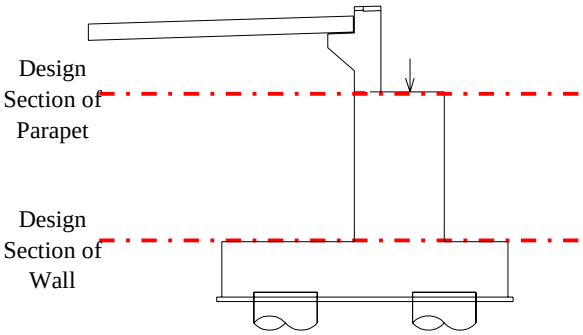


Pile Arrangement			Diameter of Pile	D= 1200 mm	
			Length of Pile	L= 9.500 m	
			Nos. of Pile	N= 8 Nos	
Bar Arrangement			24-D24 (@147)		
Stability	Force at the Center of Pile Cap	Longitudinal Direction	Group-I	V=16506kN, H=2587kN, M=1142kNm	
			Group-VII	V=14409kN, H=5970kN, M=13444kNm	
	Reaction at Pile Head	Longitudinal Direction	Group-I	Rmax=2336kN < Ra=2377kN, Rmin=1791kN > Pa=0kN	
			Group-VII	Rmax=2775kN < Ra=3615kN, Rmin=828kN > Pa=-1521kN	
	Displacement at Pile Head	Longitudinal Direction	Group-I	δx=2.6mm < 15mm	
			Group-VII	δx=5mm < 15mm	
Service Load Design		Load Case	Group-I : (D+SD+L+CF+E+B)		
		Sectional Force	M= 392 kNm,	N= 1647 kN	
		Stress	σc= 3.3 <	σca= 9.6 N/mm^2	
			σs= -42.0 <	σsa= 168 N/mm^2	
		Load Case	Group-VII : (D+SD+E+B+EQ)		
		Sectional Force	M= 914 kNm,	N= 828 kN	
		Stress	σc= 8.5 <	σca= 12.8 N/mm^2	
			σs= 172.0 <	σsa= 223 N/mm^2	
Load Factor Design		Load Case	Group-I : 1.3(D+SD+1.67L+CF+E+B)		
		Sectional Force	Mu= 557 kNm,	Nu= 2255 kN	
			Su= 452 kN		
		Strength	Flexural Strength	φMn= 1493 kNm	> Mu
			Shear Strenth	φVn= 1744 kN	> Su
		Load Case	Group-VII : 1.3(D+SD+E+B+EQ)		
		Sectional Force	Mu= 1117 kNm,	Nu= 932 kN	
			Su= 927 kN		
		Strength	Flexural Strength	φMn= 1583 kNm	> Mu
			Shear Strenth	φVn= 1744 kN	> Su

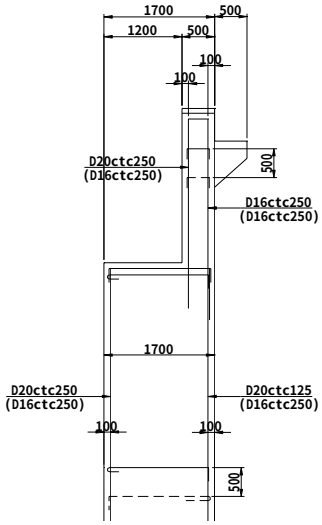
Small Bridge-2 A2 Abutment

Summary of Design Calculation Result (2/4)

2. Wall and Parapet



Bar Arrangement of Parapet & Wall

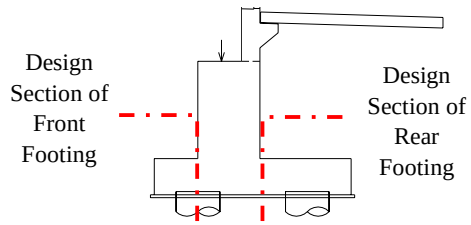


Size of Section			Thickness of Parapet	t=0.500m			
			Thickness of Wall	t=1.700m			
Bar Arrangement			Parapet	D20ctc250-1.0, d=400mm			
			Wall	D20ctc125-1.0, d=1600mm			
Parapet	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M=	70.2	kNm,		
		Stress	σc=	3.4	< σca=	9.6	N/mm^2
			σs=	152.6	< σsa=	168	N/mm^2
Wall	Service Load Design	Load Case	Group-I : (D+SD+L+CF+E+B)				
		Sectional Force	M=	352	kNm, N=	524	kN
		Stress	σc=	1.3	< σca=	9.6	N/mm^2
			σs=	17.1	< σsa=	168	N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)				
		Sectional Force	M=	578	kNm, N=	406	kN
		Stress	σc=	2.8	< σca=	12.8	N/mm^2
			σs=	103.0	< σsa=	223	N/mm^2
	Load Factor Design	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)				
		Sectional Force	Mu=	517	kNm,	702	kN
		Strength	Flexural Strength		φMn=	1811	kNm > Mu
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)				
		Sectional Force	Mu=	806	kNm, Nu=	498	kN
		Strength	Flexural Strength		φMn=	1753	kNm > Mu

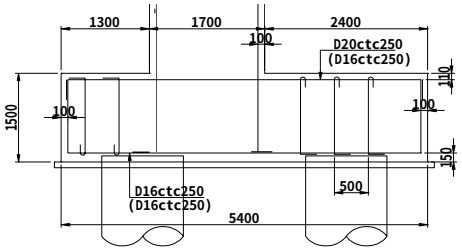
Small Bridge-2 A2 Abutment

Summary of Design Calculation Result (3/4)

3. Pile Cap



Bar Arrangement of Footing

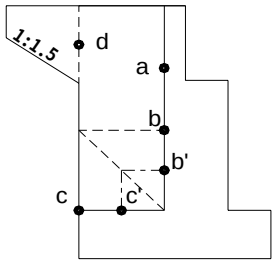


Service Load Design	Front Footing	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	28.7	kNm,	①		
		Stress	σc=	0.3	<	σca=	9.6	N/mm^2
			σs=	27.6	<	σsa=	168	N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)					
		Sectional Force	M=	30.5	kNm,	①		
		Stress	σc=	0.3	<	σca=	12.8	N/mm^2
			σs=	31.6	<	σsa=	223	N/mm^2
	Rear Footing	Load Case	Group-I : (D+SD+L+CF+E+B)					
		Sectional Force	M=	81.6	kNm,	①		
		Stress	σc=	0.6	<	σca=	9.6	N/mm^2
			σs=	53.8	<	σsa=	168	N/mm^2
		Load Case	Group-VII : (D+SD+E+B+EQ)					
		Sectional Force	M=	310.2	kNm,	①		
		Stress	σc=	2.1	<	σca=	12.8	N/mm^2
			σs=	186.6	<	σsa=	223	N/mm^2
Load Factor Design	Front Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E+B)					
		Sectional Force	Mu=	43.2	kNm,			
		Strength	Flexural Strength			φMn=	400	kNm > Mu
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)					
		Sectional Force	Mu=	41.9	kNm,			
		Strength	Flexural Strength			φMn=	400	kNm > Mu
	Rear Footing	Load Case	Group - I 1.3(D+SD+1.67L+CF+E				979	
		Sectional Force	Mu=	137.1	kNm,	①		
			Su=	381.9	kN	②		
		Strength	Flexural Strength			φMn=	633	kNm > Mu
			Shear Strenth			φVn=	1098	kN > Su
		Load Case	Group - VII 1.3(D+SD+E+B+EQ)					
		Sectional Force	Mu=	417.9	kNm,	①		
			Su=	311.5	kN	②		
		Strength	Flexural Strength			φMn=	633	kNm > Mu
			Shear Strenth			φVn=	1098	kN > Su

Small Bridge-3 A2 Abutment

Summary of Design Calculation Result (4/4)

4. Wing



Bar Arranegement

Section	Reinforcement-bar Arranngement	
	Inside (mm^2)	Outside (mm^2)
a	D22@125	D20@250
b	D22@250	D20@250
c	D16@125	D16@250
d	D22@250	D20@250

Size of Section			Thickness of Wing t=0.700m				
Service Load Design	Section-"a"	Load Case	Group-I : (D+L+E)				
		Sectional Force	M= 180.9 kNm,				
		Stress	σc= 4.7	<	σca=	9.6 N/mm^2	
			σs= 132.1	<	σsa=	168 N/mm^2	
	Section-"b"	Load Case	Group-I : (D+L+E)				
		Sectional Force	M= 91.4 kNm,				
		Stress	σc= 3.1	<	σca=	9.6 N/mm^2	
			σs= 129.4	<	σsa=	168 N/mm^2	
	Section-"c"	Load Case	Group-I : (D+L+E)				
		Sectional Force	M= 110.9 kNm,				
		Stress	σc= 3.7	<	σca=	9.6 N/mm^2	
			σs= 153.2	<	σsa=	168 N/mm^2	
	Section-"d"	Load Case	Group-I : (D+L+E)				
		Sectional Force	M= 50.3 kNm,				
		Stress	σc= 1.7	<	σca=	9.6 N/mm^2	
			σs= 71.2	<	σsa=	168 N/mm^2	
Load Factor Design	Section-"a"	Load Case	Group-VII : 1.3(D+E+EQ)				
		Sectional Force	Mu= 279.5 kNm,				
		Strength	Flexural Strength		φMn=	412 kNm	> Mu
	Section-"b"	Load Case	Group-VII : 1.3(D+E+EQ)				
		Sectional Force	Mu= 152.9 kNm,				
		Strength	Flexural Strength		φMn=	318 kNm	> Mu
	Section-"c"	Load Case	Group-VII : 1.3(D+E+EQ)				
		Sectional Force	Mu= 187.4 kNm,				
		Strength	Flexural Strength		φMn=	325 kNm	> Mu
	Section-"d"	Load Case	Group-VII : 1.3(D+E+EQ)				
		Sectional Force	Mu= 75.4 kNm,				
		Strength	Flexural Strength		φMn=	318 kNm	> Mu