

**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 D:
Structural Calculation (West Side Approach Viaduct)**

MARCH 2008

**JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.**

SD

JR

08-014

APPENDIX D
Table of Contents

Design Calculation of Superstructure	West Viaduct Superst. - 1
1. Design Criteria	- 2
1.1 Design Criteria	- 2
1.2 Bridge Profile	- 3
1.3 Materials Properties	- 4
1.4 Load Combination	- 5
2. Design Calculation of Superstructure	- 6
2.1 General Arrangement of Superstructure	- 6
2.2 Analysis Model	- 10
2.3 Loadings	- 12
2.4 Construction Sequence.....	- 16
2.5 Calculation Result of Sectional Force.....	- 17
2.6 Calculation of Pre-Stress	- 33
2.7 Service Load Design	- 39
2.8 Load Factor Design	- 49
2.9 Design of Cross Section.....	- 86
2.10 Design of Cross Beam	- 91
 Design Calculation of Substructure	 West Viaduct Subst. – 1
1. Design Condition	- 1
1.1 Design Criteria	- 1
1.2 Bridge Profile	- 2
1.3 Materials Property	- 3
2. Design of P5 Pier	- 5
2.1 General Arrangement	- 5
2.2 Bar Arrangement	- 7
2.3 Summary of Sectional Force at Bottom of Wall from Static Analysis Model	- 8
2.4 Sectional Force for Seismic Design	- 9
2.5 Design of Spread Footing	- 10
2.6 Design of Wall	- 35
3. Design of P6 Pier	- 40
3.1 General Arrangement	- 40
3.2 Bar Arrangement	- 42
3.3 Summary of Sectional Force at Bottom of Wall from Static Analysis Model	- 43
3.4 Sectional Force for Seismic Design	- 44
3.5 Design of Spread Footing	- 45
3.6 Design of Wall	- 70
4. Design of P7 Pier	- 75
4.1 General Arrangement	- 75
4.2 Bar Arrangement	- 77
4.3 Summary of Sectional Force at Bottom of Wall from Static Analysis Model	- 78
4.4 Sectional Force for Seismic Design	- 79
4.5 Design of Spread Footing	- 80
4.6 Design of Wall	- 105

5. Design of A1 Abutment	- 110
5.1 General Arrangement	- 110
5.2 Loading Data	- 112
5.3 Calculation of acting force at footing bottom	- 116
5.4 Stability Checking	- 132
5.5 Design of Parapet Wall	- 133
5.6 Calculation of Approach Slab Support	- 135
5.7 Design of Abutment Wall	- 136
5.8 Design of Front Footing	- 149
5.9 Design of Rear Footing	- 156
5.10 Design of Wing Wall	- 161

Seismic Analysis West Viaduct Seismic - 1

1. Seismic Analysis.....	-1
1.1 Summary of Analysis.....	- 1
1.2 Result of Eigenvalue Analysis	- 3
1.3 Calculation Result of Dynamic Analysis	- 10

Design Calculation of Superstructure

1. DESIGN CRITERIA

1.1 Design Criteria

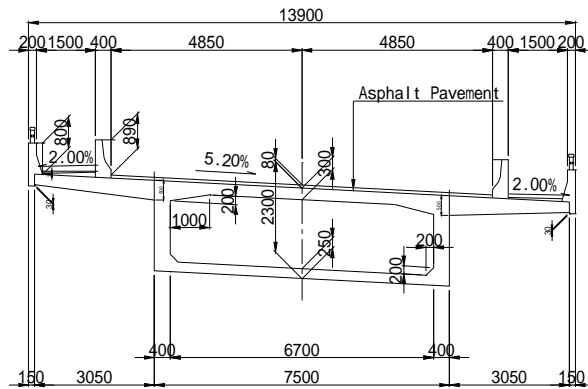
Design Criteria of West Side Approach Viaduct shown as following.

Superstructure	: 4Spans Continuous Rigid Connection PC-Box Girder
Bridge Length	: 168.000m
Girder Length	: 167.750m
Span Length	: 41.450 m + 2@42.000 m + 41.400 m
Bridge Width	: 13.900m
Effective Width	: Carriage Way 9.70m : Foot Way 2 x 1.50m
Live Load	: Class-A, Class-AA
Curvature	: R=150m
Gradient	: i i=2.000% ▲ ~ 5.564% ▲
Super Elevation	: i = 2.000% ▲ ~ 5.200% ▲
Skew Angle	: P4 ~ P7 $\theta = 90$ deg : A2 $\theta = 65$ deg
Support Condition	: P4 Movable Support : A2 Movable Support
Asphalt Pavement	: Carriage Way 80mm ~ : Foot Way 30mm ~

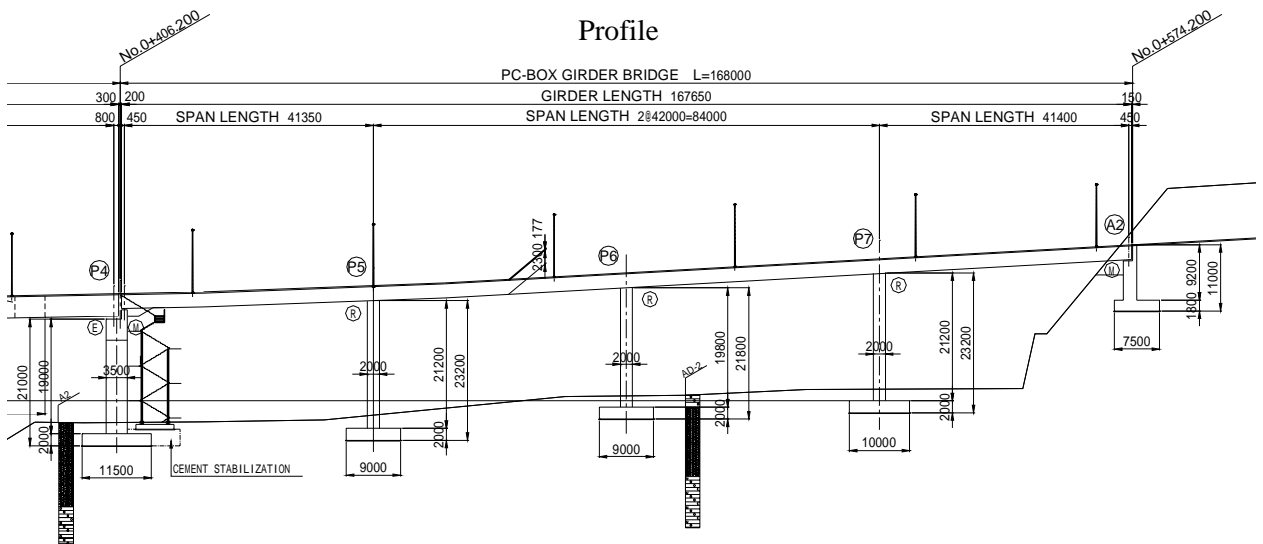
1.2 Bridge Profile

Typical Cross Section

P4 ~ A2



Profile



Plan

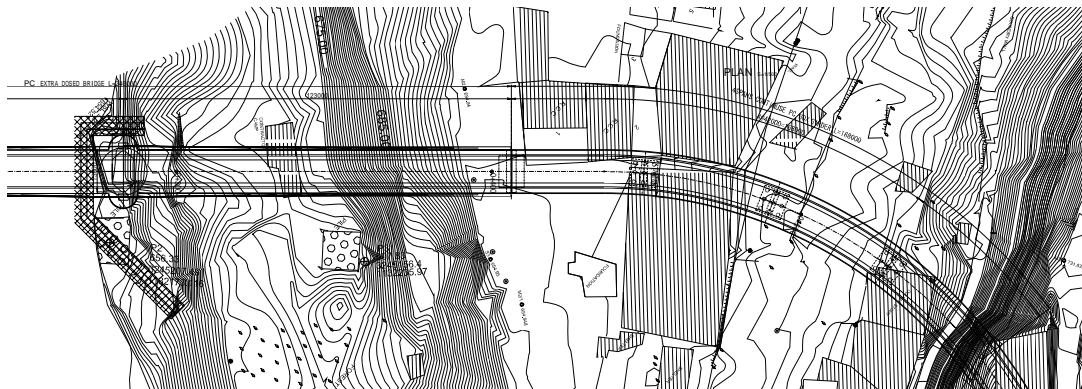


Fig.1.2.1 General View of Viaduct

1.3 Materials Properties

1.3.1 Concrete

	(N/mm ²)		
	PC-Box girder	Cross beam	Deck slab
	PC	PC	PC
Class	D1	D1	D1
28Days Cylinder Strength	35	35	35
Modulus of Elasticity	2.95×10^4	2.95×10^4	2.95×10^4
Allowable Compression Stress	14.00	14.00	14.00
Allowable Tensile Stress	-2.96	-2.96	-2.96
Temperature coefficient	10×10^{-6}	10×10^{-6}	10×10^{-6}
Allowable Shear Stress	0.47	0.47	0.47

Table 1.3.1 Material Properties of Concrete

1.3.2 PC Cable

	Unit	Longitudinal 12S15.2	Transverse 3S15.2	Cross Beam 12S15.2
Ultimate Strength	N/mm ²	1860	1860	1860
Minimum Breaking Strength	kN	3128.4	782.1	3128.4
Minimum Yield Strength	kN	2815.6	703.9	2815.6
Friction coefficient per 1 meter	1/m	0.0020	0.0020	0.0020
Friction coefficient per 1 radian	1/Rad	0.250	0.250	0.250
Set Losses	mm	9	9	9
Relaxation	%	1.5	1.5	1.5
Modulus of Elasticity	$\times 10^5$ N/mm ²	2.0	2.0	2.0
Sectional area	mm ²	1664.4	416.1	1664.4
Diameter of sheath	mm	75	65	75

Table 1.3.2 Material Property of PC Cable

1.3.3 Reinforcement

	(N/mm ²)
Yield strength	420
Modulus of Elasticity ($\times 10^5$)	2.0
Allowable Tensile Stress	168

Table 1.3.3 Material Property of Reinforcement

1.4 Load Combination

Table 5.1.1 Loading case table for Service Load Design

Group	γ												%
		D	(L+I)n	(L+I)p	CF	E	B	SF	W	WL	LF	R+S+T	
I	1.0	1	1	0	1	β_E	1	1	0	0	0	0	100
II	1.0	1	0	0	0	1	1	1	1	0	0	0	125
III	1.0	1	1	0	1	β_E	1	1	0.3	1	1	0	125
IV	1.0	1	1	0	1	β_E	1	1	0	0	0	1	125
V	1.0	1	0	0	0	1	1	1	1	0	0	1	140
VI	1.0	1	1	0	1	β_E	1	1	0.3	1	1	1	140

2 Check in close load coefficient method

Table 5.1.2 Loading case table for Load Factor Design

Group	γ												
		D	(L+I)n	(L+I)p	CF	E	B	SF	W	WL	LF	R+S+T	
I	1.3	β_D	1.67	0	1.0	β_E	1	1	0	0	0	0	-
II	1.3	β_D	0	0	0	β_E	1	1	1	0	0	0	-
III	1.3	β_D	1	0	1	β_E	1	1	0.3	1	1	0	-
IV	1.3	β_D	1	0	1	β_E	1	1	0	0	0	1	-
V	1.25	β_D	0	0	0	β_E	1	1	1	0	0	1	-
VI	1.25	β_D	1	0	1	β_E	1	1	0.3	1	1	1	-

D: dead load L: live load I: live load impact

E: earth pressure B: buoyancy

W: wind load on structure WL: wind load on live load

LF: longitudinal force CF: centrifugal force

R: rib shortening S: shrinkage T: temperature

EQ: earthquake SF: stream flow pressure

* %: percentage to be applied for the basic unit stress

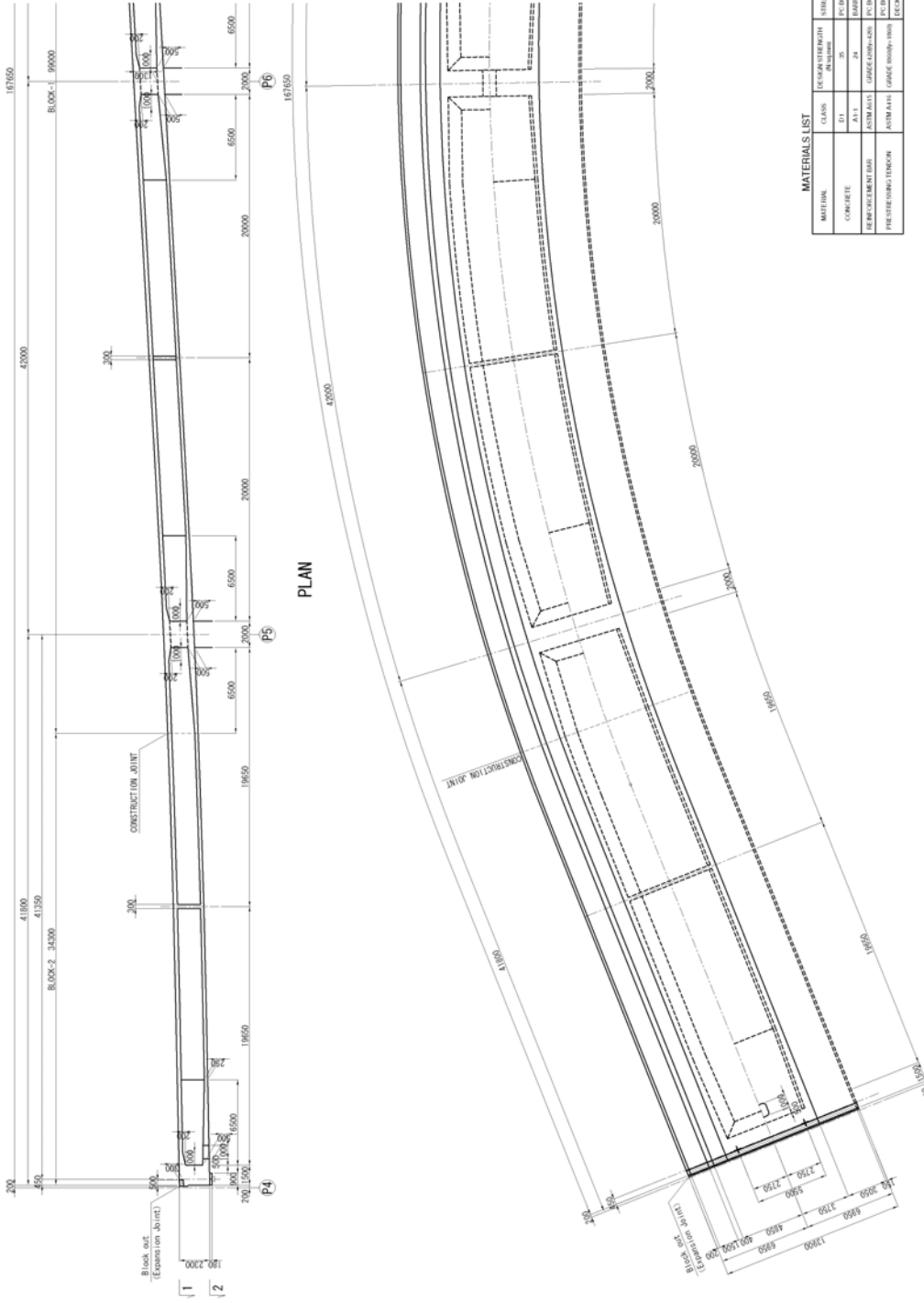
* (load factor) for all cases, is 1.0.

2. DESIGN CALCULATION OF SUPERSTRUCTURE

2.1 General Arrangement of Superstructure

General arrangement of superstructure which is shown as following next page.

GENERAL ARRANGEMENT OF SUPERSTRUCTURE (1)
SCALE 1:300
SIDE ELEVATION



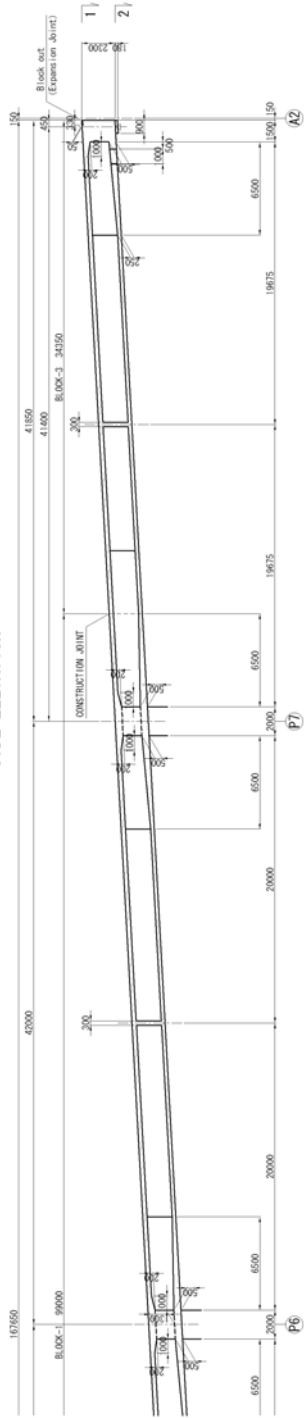
MATERIAL	CLASS	TECHNICAL SPECIFICATION	STRUCTURAL MEMBERS
CONCRETE	E11		PI BOX GIRDER
REINFORCEMENT BAR	A11.1		BARBERS
PRESTRESSING TENDON	ASTM A415	GRADE 270MPa-1860	PI BOX GIRDERS/SLAB
	ASTM A415	GRADE 800MPa-1860	DECK SLAB/DECK

NIPPON KOBAI CO. LTD.		DRAWING TITLE		DATE OF DWG	
NAME	DESIGNER	WEST SIDE APPROACH VIADUCT GENERAL ARRANGEMENT OF SUPERSTRUCTURE (1)		1 Oct. 2007	
DATE	SCALE			3:00	
24 Feb. 2007	1:300			DWG No.	
				PAC I BRN-5	
Japan International Cooperation Agency					
GOVERNMENT OF PAKISTAN PRIME MINISTER'S OFFICE (PUBLIC) EASTERN REGIONAL CONSTRUCTION REHABILITATION AUTHORITY (ERRA) ISLAMABAD					
THE URGENT DEVELOPMENT STUDY ON REHABILITATION AND RECONSTRUCTION IN MUZAFFARABAD CITY IN THE ISLAMIC REPUBLIC OF PAKISTAN (URGENT REHABILITATION PROJECT: WEST BANK BYPASS DESIGN)					

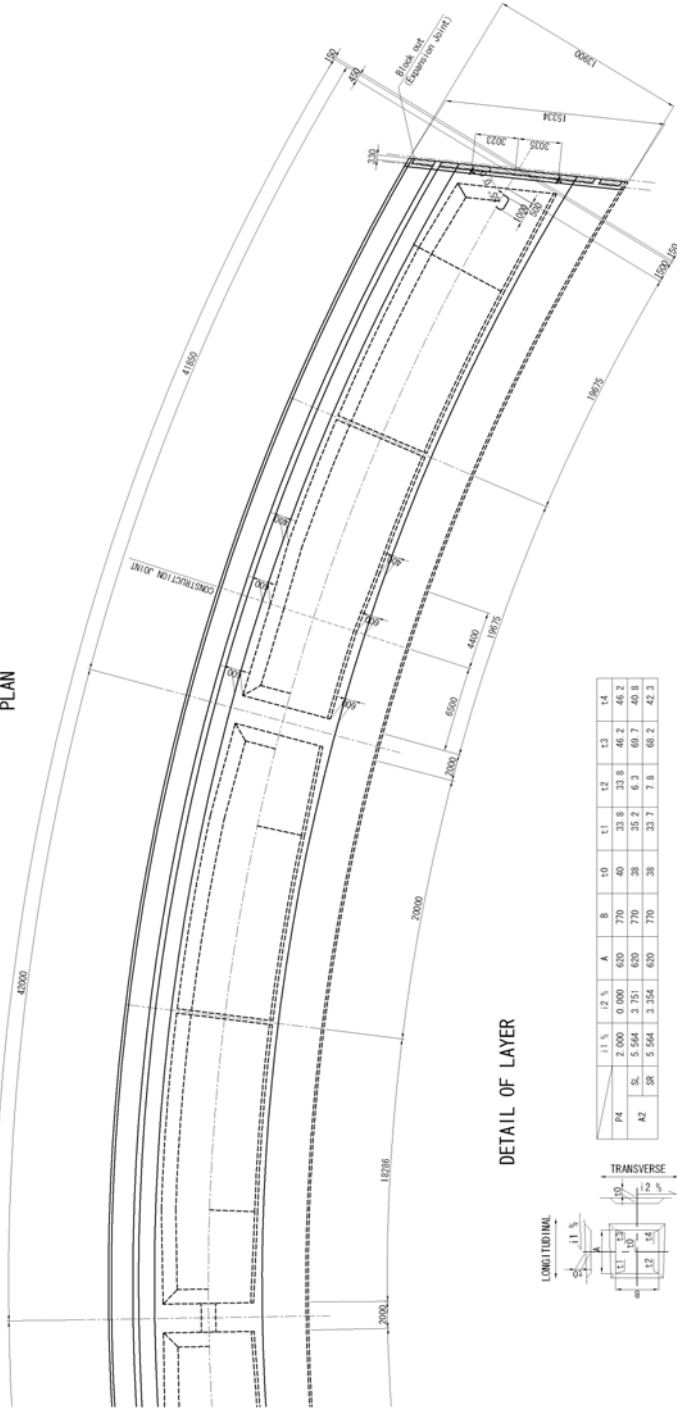
GENERAL ARRANGEMENT OF SUPERSTRUCTURE (2)

SIDE ELEVATION

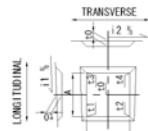
SCALE 1:300



PLAN



DETAIL OF LAYER



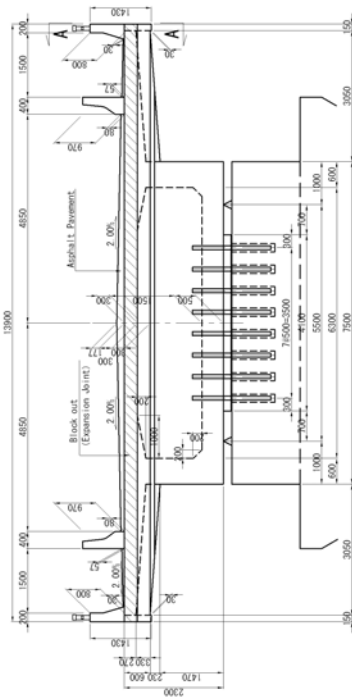
	11 %	12 %	A	B	10	11	12	13	14
P4	2.000	0.000	620	770	40	33.8	33.8	46.2	46.2
A2	5.584	3.751	620	770	38	35.2	6.3	69.7	40.3
	5.584	3.751	620	770	38	33.7	7.8	68.2	42.3

NIPPON KOBAI CO. LTD.		DRAWING TITLE		DATE OF DWG	
PRESIDENT	CHECKED BY	WEST SIDE APPROACH VIADUCT		1 Oct. 2007	
GENERAL MANAGER	DESIGNED BY	GENERAL ARRANGEMENT		SCALE	
DATE	DATE	OF SUPERSTRUCTURE (2)		1:300	
24 May 2007	26 May 2007	PAC1 BRW-6		PAC1 BRW-6	
JICA Japan International Cooperation Agency		GOVERNMENT OF PAKISTAN			
PRIME MINISTERS SECRETARIAT (PUBLIC)		EARTHQUAKE RECONSTRUCTION & REHABILITATION AUTHORITY (ERHA) ISLAMABAD			
REHABILITATION AUTHORITY (ERHA) ISLAMABAD		THE URGENT DEVELOPMENT STUDY ON REHABILITATION AND RECONSTRUCTION IN MUZZAFARABAD CITY IN THE ISLAMIC REPUBLIC OF PAKISTAN (URGENT REHABILITATION PROJECT WEST BANK BYPASS DESIGN)			

GENERAL ARRANGEMENT OF SUPERSTRUCTURE (3)

CROSS SECTION SCALE 1:100

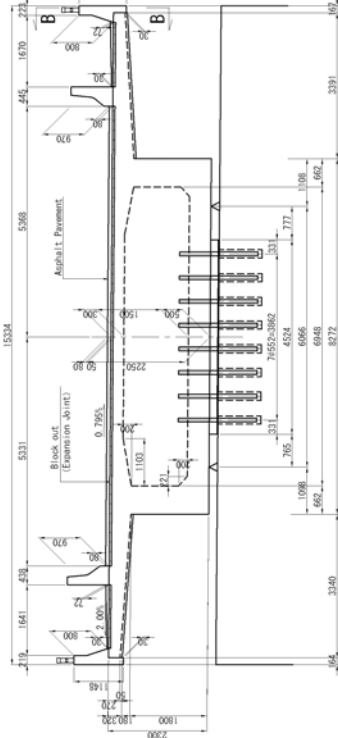
3 - 3



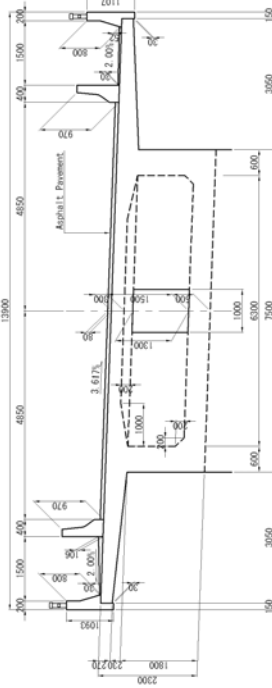
6 - 6



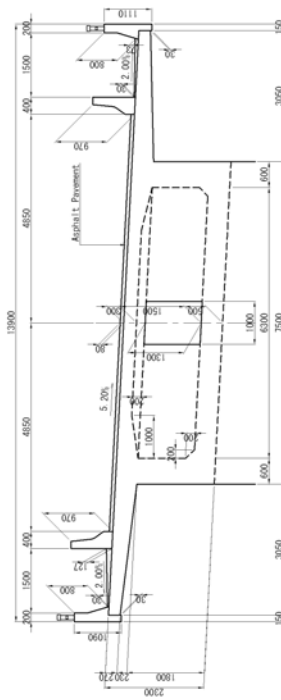
8 - 8



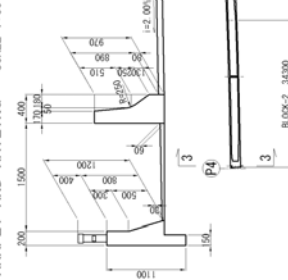
4 - 4



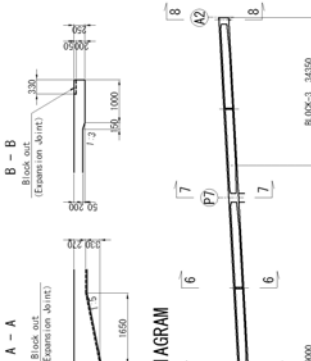
5 - 5 (7 - 7)



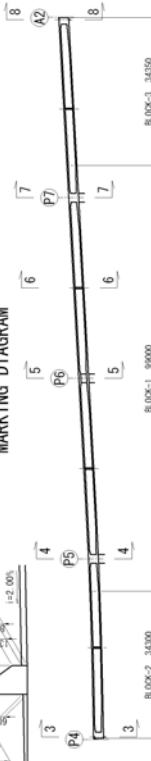
DETAIL OF PARAPET AND RAILING SCALE 1:60



DETAILS SCALE 1:100



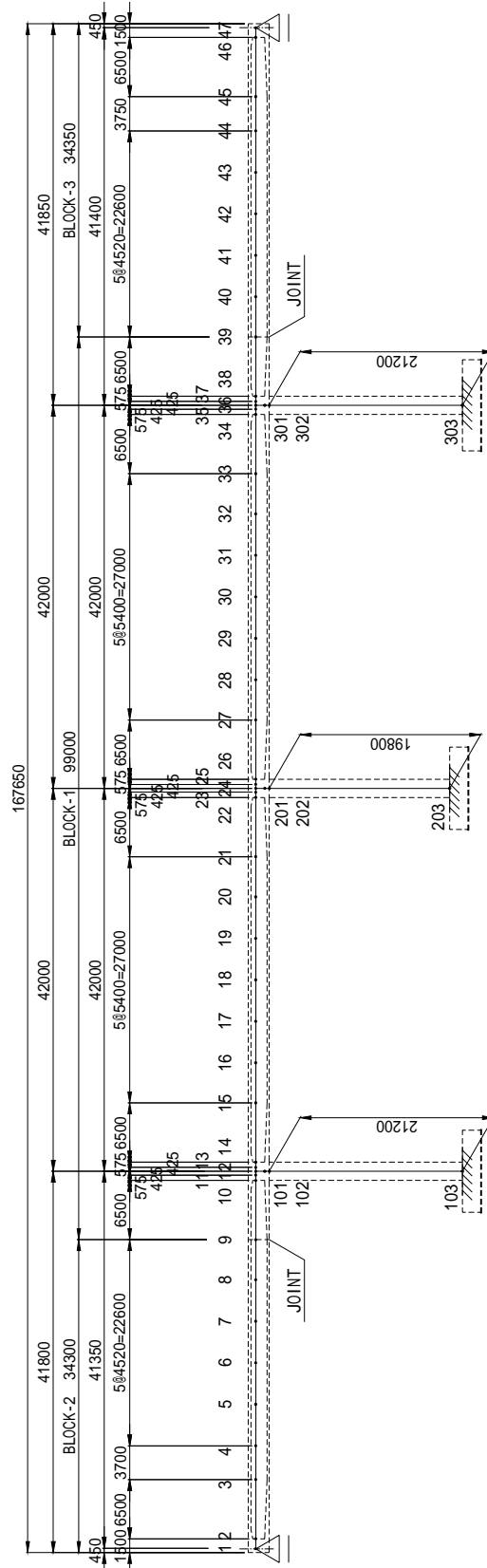
MARKING DIAGRAM



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 KOGYO CO. LTD. HEAD OFFICE: 1-1-1, MARUYAMA 2-CHOME, CHUO-KU, TOKYO 100, JAPAN BRANCH OFFICE: 201, BANGALORE ROAD, 4TH FLOOR, KARACHI-7, PAKISTAN		DRAWING TITLE WEST SIDE APPROACH STRUCTURE GENERAL ARRANGEMENT OF SUPERSTRUCTURE (3)		DATE OF DWG 1 Oct. 2007 SCALE 500/100 500/100 PAC1 BRW-7	
--	--	---	--	---	--	--	--	---	--	---	--

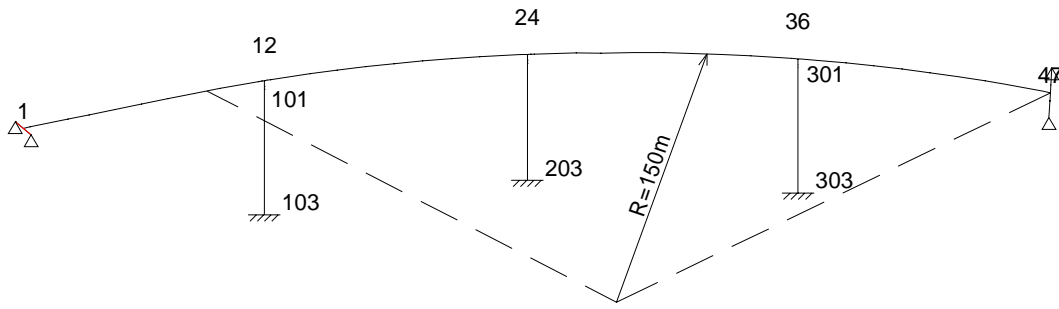
2.2 Analysis Model

Analysis model of superstructure which consideration as plane frame model shown as below.

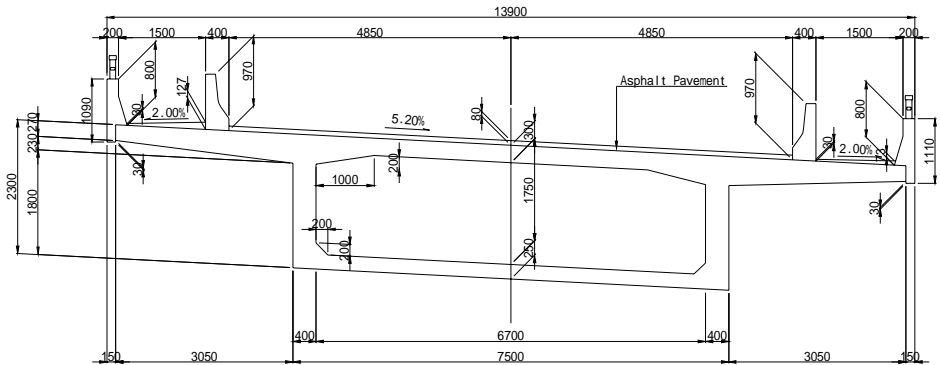


West Viaduct Superst.-10

3D-Analysis Model for Torsional Moment



Standard Section



Support Section

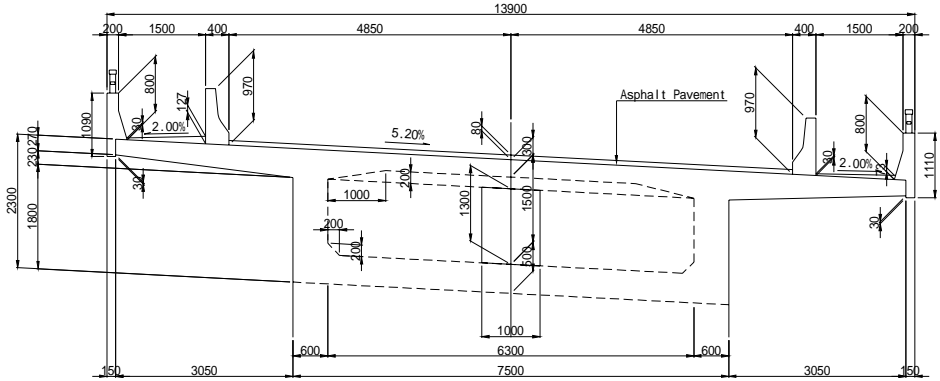


Figure 2.2.1 Plane Frame Analysis Model

2.3 Loadings

2.3.1 Dead Load

(1) Unit Weight

Unit weight for calculate dead load that should be taken as following value.

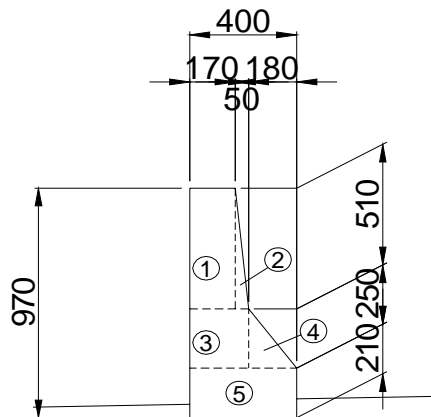
Reinforced Concrete	24.5N/m ³
Plain Concrete	23.0N/m ³
Structural Steel	77.0N/m ³
Asphalt Pavement	22.5N/m ³

(2) Self-weight of Girder

The self-weight of girder calculate according to section area, the software for design calculation that calculate girder self-weight automatically used input data.

(3) Surfacing

a. Parapet of Carriage Way



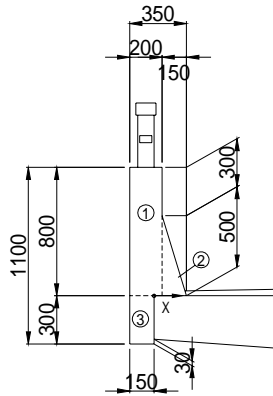
	A	X	AX
	$0.170 \times 0.510 \times 1.0 = 0.087$	0.085	0.007
	$0.050 \times 0.510 \times 0.5 = 0.013$	0.187	0.002
	$0.220 \times 0.250 \times 1.0 = 0.055$	0.110	0.006
	$0.180 \times 0.250 \times 0.5 = 0.023$	0.280	0.006
	$0.400 \times 0.210 \times 1.0 = 0.084$	0.200	0.017
Total	0.261		0.038

$$X = \frac{AX}{A} = 0.146 \text{ m}$$

$$P = 0.261 \times 24.5 = 6.395 \text{ kN/m}$$

b. Parapet of Foot Way

Concrete barrier



	A	X	AX
	$0.200 \times 0.800 \times 1.0 = 0.160$	-0.050	-0.00800
	$0.150 \times 0.500 \times 0.5 = 0.038$	0.100	0.00380
	$0.150 \times 0.300 \times 1.0 = 0.045$	-0.075	-0.00338
Total	0.243		-0.00758

$$X = AX / A = -0.031 \text{ m}$$

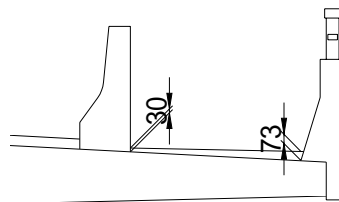
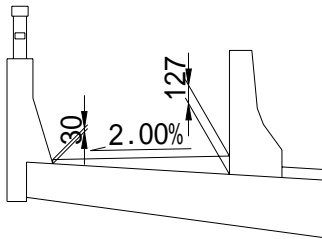
$$P = 0.243 \times 24.5 = 5.954 \text{ kN/m}$$

Steel Railing

$$W = 0.300 \text{ kN/m}$$

c. Asphalt Pavement

Foot Way (t=30mm~127mm)



$$W = 0.03 \times 22.5 = 0.675 \text{ kN/m}^2$$

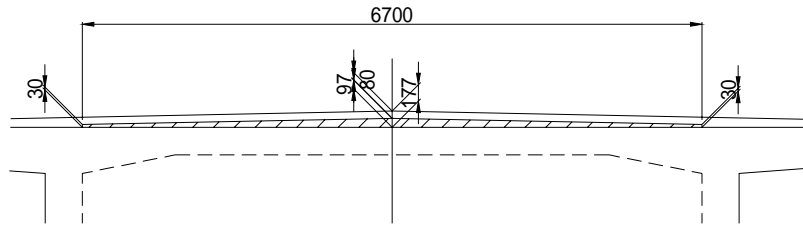
$$W = 0.127 \times 22.5 = 2.858 \text{ kN/m}^2$$

$$W = 0.073 \times 22.5 = 1.643 \text{ kN/m}^2$$

Carriage Way (t=80mm)

$$W = 0.08 \times 22.5 = 1.8 \text{ kN/m}^2$$

d. Leveling Concrete

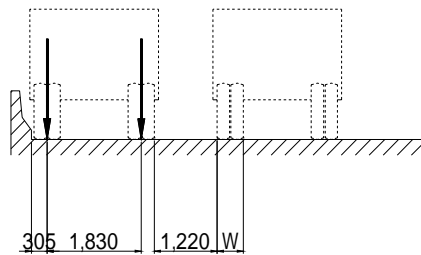
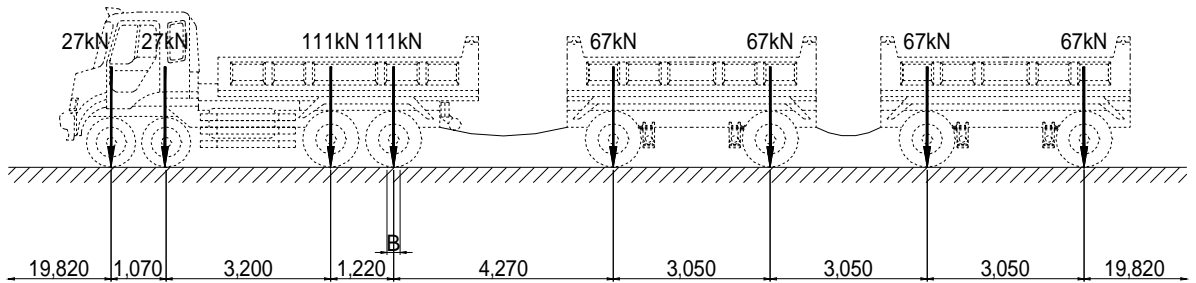


$$W = 0.03 \times 23.0 = 0.69 \text{ kN/m}^2$$

$$W = 0.097 \times 23.0 = 2.231 \text{ kN/m}^2$$

2.3.2 Live Load

a. Class-A Loading



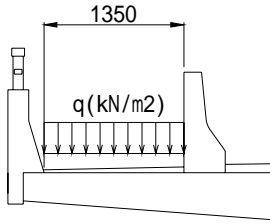
Class of Loading	Axle Load kN	Ground Contact Area	
		B mm	W mm
A	111	254	508
	67	203	381
	27	152	203

b. Impact Factor

$$i = 15.24 / (L + 38) \quad L: \text{Span Length (m)}$$

	Span(m)	Impact
P4 ~ P5	41.450	0.192
P5 ~ P7	42.000	0.191
P7 ~ A2	41.400	0.192

c. Foot Way Loading



$$q = (1435 + 43800 / L) \times (16.7 - W) / 15.2$$

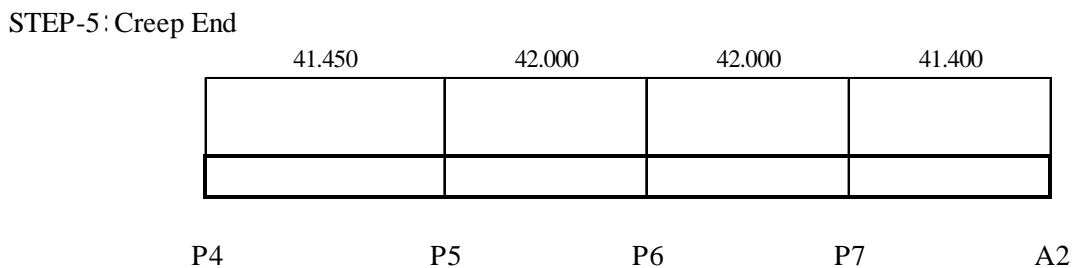
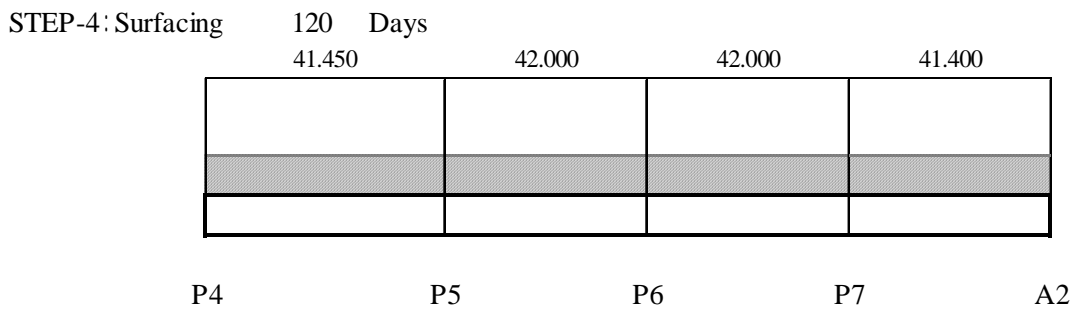
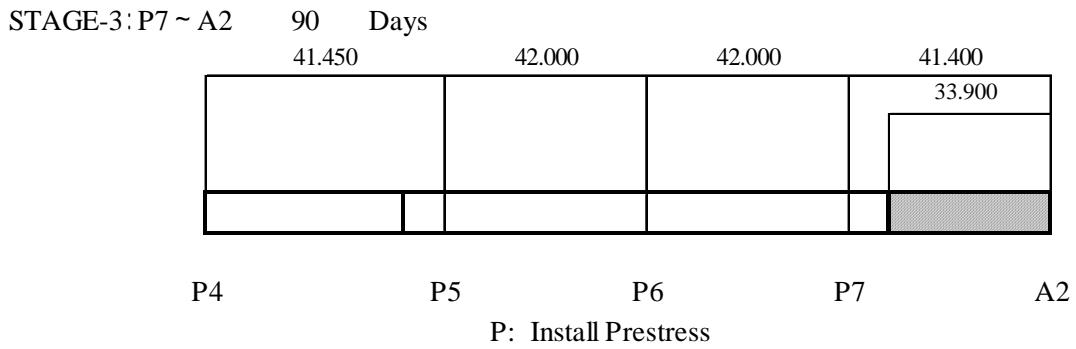
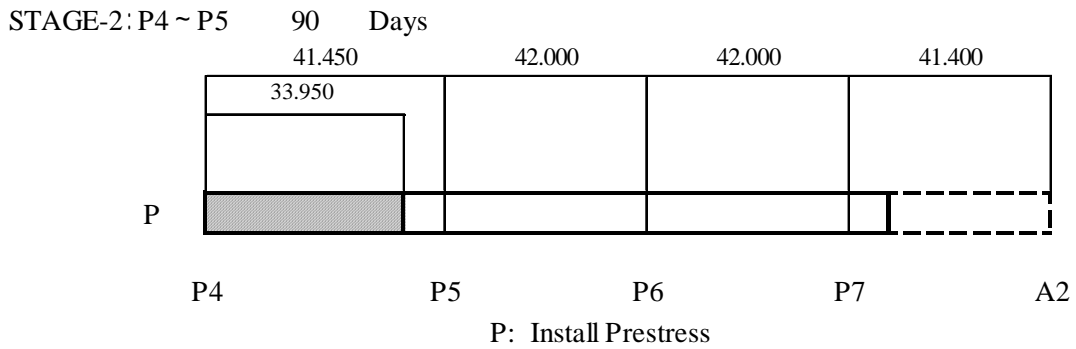
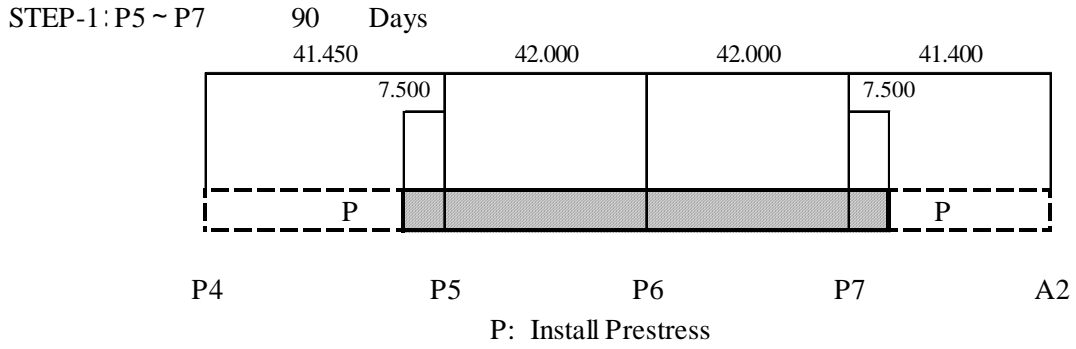
q: Foot way loading (Pa)

L: Loaded Length(m)

W: Sidewalk Width(m)

	Span(m)	W(m)	q(kN/m ²)
P4 ~ P5	41.450	1.350	2.52
P5 ~ P7	42.000	1.350	2.5
P7 ~ A2	41.400	1.350	2.52

2.4 Construction Sequence



2.5 Calculation Result of Sectional Force

2.5.1 List of Sectional Force per Each Section

Member No.	Joint No.	Self-Weight (D)				Surfacing (D)				Secondary Force by Pre-stress (D)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
1-i	1	-26	3213	0	32	0	954	0	-113	0	581	0	0
1-j	2	3498	2916	0	32	1054	880	0	-113	668	581	0	0
2-i	2	3498	2916	0	32	1054	880	0	-101	668	581	0	0
2-j	3	17387	1418	0	32	5411	463	0	-101	4446	581	0	0
3-i	3	17387	1418	0	32	5411	463	0	-85	4446	581	0	0
3-j	4	21214	679	0	32	6680	233	0	-85	6568	581	0	0
4-i	4	21214	679	0	32	6680	233	0	-72	6568	581	0	0
4-j	5	22205	-243	0	32	7100	-48	0	-72	9212	581	0	0
5-i	5	22205	-243	0	32	7100	-48	0	-57	9212	581	0	0
5-j	6	19004	-1164	0	32	6254	-324	0	-57	11857	581	0	0
6-i	6	19004	-1249	0	32	6254	-324	0	-43	11857	581	0	0
6-j	7	11224	-2171	0	32	4164	-594	0	-43	14501	581	0	0
7-i	7	11224	-2171	0	32	4164	-594	0	-28	14501	581	0	0
7-j	8	-748	-3092	0	32	855	-859	0	-28	17146	581	0	0
8-i	8	-748	-3092	0	166	855	-859	0	28	17146	581	0	0
8-j	9	-16370	-4021	0	166	-3481	-1111	0	28	19703	581	0	0
9-i	9	-16370	-4021	0	-120	-3481	-1111	0	16	19703	581	0	0
9-j	10	-47420	-5575	0	-120	-11896	-1479	0	16	23481	581	0	0
10-i	10	-47420	-5575	0	-1095	-11896	-1479	0	-149	23481	581	0	0
10-j	11	-50668	-5723	0	-1095	-12756	-1511	0	-149	23815	581	0	0
11-i	11	-50668	-5723	0	-1125	-12756	-1511	0	-138	23815	581	0	0
11-j	12	-53123	-5833	0	-1125	-13403	-1535	0	-138	24062	581	0	0
12-i	12	-40188	4838	-838	478	-9639	1223	-243	-145	16198	-218	108	0
12-j	13	-38155	4728	-838	478	-9125	1199	-243	-145	16105	-218	108	0
13-i	13	-38155	4728	-838	433	-9125	1199	-243	-150	16105	-218	108	0
13-j	14	-35479	4579	-838	433	-8445	1166	-243	-150	15980	-218	108	0
14-i	14	-35479	4579	-838	-388	-8445	1166	-243	-303	15980	-218	108	0
14-j	15	-10777	3082	-838	-388	-2059	798	-243	-303	14566	-218	108	0
15-i	15	-10777	3082	-838	-712	-2059	798	-243	-315	14566	-218	108	0
15-j	16	821	2190	-838	-712	907	549	-243	-315	13609	-218	108	0
16-i	16	821	2190	-838	-645	907	549	-243	-240	13609	-218	108	0
16-j	17	8691	1269	-838	-645	2821	292	-243	-240	12620	-218	108	0
17-i	17	8691	1269	-838	-341	2821	292	-243	-115	12620	-218	108	0
17-j	18	12367	347	-838	-341	3564	35	-243	-115	11630	-218	108	0
18-i	18	12367	263	-838	25	3564	35	-243	20	11630	-218	108	0
18-j	19	11465	-659	-838	25	3135	-223	-243	20	10641	-218	108	0
19-i	19	11465	-659	-838	390	3135	-223	-243	155	10641	-218	108	0
19-j	20	6371	-1581	-838	390	1535	-480	-243	155	9651	-218	108	0
20-i	20	6371	-1581	-838	574	1535	-480	-243	250	9651	-218	108	0
20-j	21	-2544	-2472	-838	574	-1127	-729	-243	250	8694	-218	108	0
21-i	21	-2544	-2472	-838	457	-1127	-729	-243	280	8694	-218	108	0
21-j	22	-23282	-3970	-838	457	-7063	-1097	-243	280	7280	-218	108	0
22-i	22	-23282	-3970	-838	-102	-7063	-1097	-243	200	7280	-218	108	0
22-j	23	-25607	-4118	-838	-102	-7704	-1130	-243	200	7155	-218	108	0
23-i	23	-25607	-4118	-838	-220	-7704	-1130	-243	191	7155	-218	108	0
23-j	24	-27381	-4228	-838	-220	-8189	-1154	-243	191	7063	-218	108	0
24-i	24	-27347	4201	-819	183	-8290	1159	-233	-198	6843	255	107	0
24-j	25	-25585	4092	-819	183	-7803	1135	-233	-198	6951	255	107	0
25-i	25	-25585	4092	-819	135	-7803	1135	-233	-204	6951	255	107	0
25-j	26	-23275	3943	-819	135	-7160	1102	-233	-204	7098	255	107	0
26-i	26	-23275	3943	-819	-476	-7160	1102	-233	-312	7098	255	107	0
26-j	27	-2708	2445	-819	-476	-1191	734	-233	-312	8752	255	107	0
27-i	27	-2708	2445	-819	-851	-1191	734	-233	-292	8752	255	107	0
27-j	28	6091	1554	-819	-851	1492	485	-233	-292	9872	255	107	0
28-i	28	6091	1554	-819	-1332	1492	485	-233	-390	9872	255	107	0
28-j	29	11065	633	-819	-1332	3115	228	-233	-390	11030	255	107	0

Member No.	Joint No.	Self-Weight (D)				Surfacing (D)				Secondary Force by Pre-stress (D)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
29-i	29	11065	633	-819	-313	3115	228	-233	-142	11030	255	107	0
29-j	30	11846	-289	-819	-313	3566	-30	-233	-142	12188	255	107	0
30-i	30	11846	-374	-819	97	3566	-30	-233	37	12188	255	107	0
30-j	31	8050	-1295	-819	97	2845	-287	-233	37	13346	255	107	0
31-i	31	8050	-1295	-819	422	2845	-287	-233	163	13346	255	107	0
31-j	32	61	-2217	-819	422	953	-545	-233	163	14504	255	107	0
32-i	32	61	-2217	-819	525	953	-545	-233	240	14504	255	107	0
32-j	33	-11654	-3108	-819	525	-1991	-794	-233	240	15624	255	107	0
33-i	33	-11654	-3108	-819	255	-1991	-794	-233	237	15624	255	107	0
33-j	34	-36527	-4606	-819	255	-8345	-1161	-233	237	17278	255	107	0
34-i	34	-36527	-4606	-819	-577	-8345	-1161	-233	100	17278	255	107	0
34-j	35	-39218	-4754	-819	-577	-9022	-1194	-233	100	17425	255	107	0
35-i	35	-39218	-4754	-819	-516	-9022	-1194	-233	130	17425	255	107	0
35-j	36	-41262	-4864	-819	-516	-9535	-1218	-233	130	17533	255	107	0
36-i	36	-53355	5824	0	2911	-13064	1483	0	480	24936	-605	0	0
36-j	37	-50903	5714	0	2911	-12439	1459	0	480	24679	-605	0	0
37-i	37	-50903	5714	0	2813	-12439	1459	0	466	24679	-605	0	0
37-j	38	-47660	5566	0	2813	-11609	1426	0	466	24331	-605	0	0
38-i	38	-47660	5566	0	1920	-11609	1426	0	297	24331	-605	0	0
38-j	39	-16666	4012	0	1920	-3534	1058	0	297	20397	-605	0	0
39-i	39	-16666	4012	0	1598	-3534	1058	0	281	20397	-605	0	0
39-j	40	-1083	3083	0	1598	575	809	0	281	17734	-605	0	0
40-i	40	-1083	3083	0	1762	575	809	0	374	17734	-605	0	0
40-j	41	10850	2162	0	1762	3672	552	0	374	14980	-605	0	0
41-i	41	10850	2162	0	2246	3672	552	0	535	14980	-605	0	0
41-j	42	18589	1240	0	2246	5598	294	0	535	12226	-605	0	0
42-i	42	18589	1156	0	2938	5598	294	0	741	12226	-605	0	0
42-j	43	21752	234	0	2938	6352	37	0	741	9472	-605	0	0
43-i	43	21752	234	0	3664	6352	37	0	955	9472	-605	0	0
43-j	44	20720	-687	0	3664	5934	-221	0	955	6718	-605	0	0
44-i	44	20720	-687	0	4242	5934	-221	0	1130	6718	-605	0	0
44-j	45	17143	-1386	0	4242	4836	-416	0	1130	4630	-605	0	0
45-i	45	17143	-1386	0	4822	4836	-416	0	1309	4630	-605	0	0
45-j	46	3461	-2884	0	4822	939	-784	0	1309	696	-605	0	0
46-i	46	3461	-2884	0	4863	939	-784	0	1362	696	-605	0	0
46-j	47	-26	-3181	0	4863	0	-849	0	1362	0	-605	0	0
101-i	12	-12936	838	11122	-29	-3764	243	2758	-3	7864	-108	-799	0
101-j	101	-12107	838	11122	-29	-3524	243	2758	-3	7757	-108	-799	0
102-i	101	-12107	838	11122	-29	-3524	243	2758	-3	7757	-108	-799	0
102-j	102	-11688	838	11257	-29	-3402	243	2758	-3	7703	-108	-799	0
103-i	102	-11688	838	11257	-29	-3402	243	2758	-3	7703	-108	-799	0
103-j	103	6080	838	16970	-29	1753	243	2758	-3	5407	-108	-799	0
201-i	24	-34	-19	8880	-65	101	-10	2313	-11	220	1	472	0
201-j	201	-53	-19	8880	-65	91	-10	2313	-11	221	1	472	0
202-i	201	-53	-19	8880	-65	91	-10	2313	-11	221	1	472	0
202-j	202	-62	-19	9015	-65	86	-10	2313	-11	221	1	472	0
203-i	202	-62	-19	9015	-65	86	-10	2313	-11	221	1	472	0
203-j	203	-437	-19	14351	-65	-117	-10	2313	-11	245	1	472	0
301-i	36	12093	-819	11140	-91	3529	-233	2701	-18	-7403	107	-860	0
301-j	301	11283	-819	11140	-91	3298	-233	2701	-18	-7297	107	-860	0
302-i	301	11283	-819	11140	-91	3298	-233	2701	-18	-7297	107	-860	0
302-j	302	10873	-819	11274	-91	3182	-233	2701	-18	-7244	107	-860	0
303-i	302	10873	-819	11274	-91	3182	-233	2701	-18	-7244	107	-860	0
303-j	303	-6493	-819	16988	-91	-1756	-233	2701	-18	-4973	107	-860	0

Member No.	Joint No.	Creep Effect (D)				Live Load Mmax (L)				Live Load Mmin (L)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
1-i	1	0	-58	0	0	0	0	0	0	0	0	0	0
1-j	2	-67	-58	0	0	1178	1021	0	0	-72	-62	0	0
2-i	2	-67	-58	0	0	1178	1021	0	0	-72	-62	0	0
2-j	3	-445	-58	0	0	6130	710	0	0	-477	-62	0	0
3-i	3	-445	-58	0	0	6130	710	0	0	-477	-62	0	0
3-j	4	-658	-58	0	0	7599	327	0	0	-705	-62	0	0
4-i	4	-658	-58	0	0	7599	327	0	0	-705	-62	0	0
4-j	5	-923	-58	0	0	8199	-133	0	0	-988	-62	0	0
5-i	5	-923	-58	0	0	8199	-133	0	0	-988	-62	0	0
5-j	6	-1187	-58	0	0	7752	-314	0	0	-1272	-62	0	0
6-i	6	-1187	-58	0	0	7752	-314	0	0	-1272	-62	0	0
6-j	7	-1452	-58	0	0	6428	-502	0	0	-1556	-62	0	0
7-i	7	-1452	-58	0	0	6428	-502	0	0	-1556	-62	0	0
7-j	8	-1717	-58	0	0	4109	-671	0	0	-1840	-62	0	0
8-i	8	-1717	-58	0	0	4109	-671	0	0	-1840	-62	0	0
8-j	9	-1973	-58	0	0	1859	-389	0	0	-3796	-816	0	0
9-i	9	-1973	-58	0	0	1859	-389	0	0	-3796	-816	0	0
9-j	10	-2352	-58	0	0	385	-258	0	0	-9978	-1063	0	0
10-i	10	-2352	-58	0	0	385	-258	0	0	-9978	-1063	0	0
10-j	11	-2385	-58	0	0	358	-152	0	0	-10591	-1070	0	0
11-i	11	-2385	-58	0	0	358	-152	0	0	-10591	-1070	0	0
11-j	12	-2410	-58	0	0	342	8	0	0	-11047	-1074	0	0
12-i	12	-2117	21	-1	0	1485	-99	-133	0	-10364	1058	6	0
12-j	13	-2108	21	-1	0	1443	-97	-133	0	-9919	1028	5	0
13-i	13	-2108	21	-1	0	1443	-97	-133	0	-9919	1028	5	0
13-j	14	-2096	21	-1	0	1388	-94	-133	0	-9337	993	3	0
14-i	14	-2096	21	-1	0	1388	-94	-133	0	-9337	993	3	0
14-j	15	-1959	21	-1	0	2448	390	40	0	-3860	567	-77	0
15-i	15	-1959	21	-1	0	2448	390	40	0	-3860	567	-77	0
15-j	16	-1866	21	-1	0	4153	421	135	0	-2357	114	-271	0
16-i	16	-1866	21	-1	0	4153	421	135	0	-2357	114	-271	0
16-j	17	-1770	21	-1	0	5494	300	190	0	-2026	59	-317	0
17-i	17	-1770	21	-1	0	5494	300	190	0	-2026	59	-317	0
17-j	18	-1674	21	-1	0	5797	-164	165	0	-1762	57	-321	0
18-i	18	-1674	21	-1	0	5797	-164	165	0	-1762	57	-321	0
18-j	19	-1578	21	-1	0	5296	-344	180	0	-1506	55	-322	0
19-i	19	-1578	21	-1	0	5296	-344	180	0	-1506	55	-322	0
19-j	20	-1482	21	-1	0	3982	-404	-96	0	-1557	-106	-43	0
20-i	20	-1482	21	-1	0	3982	-404	-96	0	-1557	-106	-43	0
20-j	21	-1389	21	-1	0	2407	-494	-117	0	-3128	-629	127	0
21-i	21	-1389	21	-1	0	2407	-494	-117	0	-3128	-629	127	0
21-j	22	-1252	21	-1	0	1872	140	-266	0	-8299	-918	134	0
22-i	22	-1252	21	-1	0	1872	140	-266	0	-8299	-918	134	0
22-j	23	-1240	21	-1	0	1954	143	-266	0	-8829	-925	134	0
23-i	23	-1240	21	-1	0	1954	143	-266	0	-8829	-925	134	0
23-j	24	-1231	21	-1	0	2015	144	-266	0	-9224	-933	134	0
24-i	24	-1282	-19	4	0	2004	-143	-265	0	-9224	933	134	0
24-j	25	-1290	-19	4	0	1944	-142	-265	0	-8829	925	134	0
25-i	25	-1290	-19	4	0	1944	-142	-265	0	-8829	925	134	0
25-j	26	-1300	-19	4	0	1863	-139	-265	0	-8299	918	134	0
26-i	26	-1300	-19	4	0	1863	-139	-265	0	-8299	918	134	0
26-j	27	-1424	-19	4	0	2403	495	-116	0	-3128	629	126	0
27-i	27	-1424	-19	4	0	2403	495	-116	0	-3128	629	126	0
27-j	28	-1507	-19	4	0	3981	405	-95	0	-1557	106	-43	0
28-i	28	-1507	-19	4	0	3981	405	-95	0	-1557	106	-43	0
28-j	29	-1593	-19	4	0	5297	344	180	0	-1504	-54	-321	0
29-i	29	-1593	-19	4	0	5297	344	180	0	-1504	-54	-321	0
29-j	30	-1679	-19	4	0	5798	164	164	0	-1757	-56	-319	0

Member No.	Joint No.	Creep Effect (D)				Live Load Mmax (L)				Live Load Mmin (L)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
30-i	30	-1679	-19	4	0	5798	164	164	0	-1757	-56	-319	0
30-j	31	-1766	-19	4	0	5494	-300	189	0	-2018	-60	-312	0
31-i	31	-1766	-19	4	0	5494	-300	189	0	-2018	-60	-312	0
31-j	32	-1852	-19	4	0	4153	-421	135	0	-2346	-115	-267	0
32-i	32	-1852	-19	4	0	4153	-421	135	0	-2346	-115	-267	0
32-j	33	-1935	-19	4	0	2450	-390	40	0	-3848	-566	-76	0
33-i	33	-1935	-19	4	0	2450	-390	40	0	-3848	-566	-76	0
33-j	34	-2058	-19	4	0	1389	94	-133	0	-9317	-992	5	0
34-i	34	-2058	-19	4	0	1389	94	-133	0	-9317	-992	5	0
34-j	35	-2069	-19	4	0	1444	98	-134	0	-9897	-1028	6	0
35-i	35	-2069	-19	4	0	1444	98	-134	0	-9897	-1028	6	0
35-j	36	-2077	-19	4	0	1486	99	-134	0	-10340	-1057	8	0
36-i	36	-2261	55	0	0	343	-8	0	0	-11004	1070	0	0
36-j	37	-2238	55	0	0	358	152	0	0	-10550	1066	0	0
37-i	37	-2238	55	0	0	358	152	0	0	-10550	1066	0	0
37-j	38	-2206	55	0	0	386	258	0	0	-9938	1060	0	0
38-i	38	-2206	55	0	0	386	258	0	0	-9938	1060	0	0
38-j	39	-1850	55	0	0	1860	389	0	0	-3771	811	0	0
39-i	39	-1850	55	0	0	1860	389	0	0	-3771	811	0	0
39-j	40	-1608	55	0	0	4109	668	0	0	-1839	63	0	0
40-i	40	-1608	55	0	0	4109	668	0	0	-1839	63	0	0
40-j	41	-1358	55	0	0	6412	499	0	0	-1554	63	0	0
41-i	41	-1358	55	0	0	6412	499	0	0	-1554	63	0	0
41-j	42	-1109	55	0	0	7710	309	0	0	-1268	63	0	0
42-i	42	-1109	55	0	0	7710	309	0	0	-1268	63	0	0
42-j	43	-859	55	0	0	8141	128	0	0	-982	63	0	0
43-i	43	-859	55	0	0	8141	128	0	0	-982	63	0	0
43-j	44	-609	55	0	0	7503	-332	0	0	-697	63	0	0
44-i	44	-609	55	0	0	7503	-332	0	0	-697	63	0	0
44-j	45	-420	55	0	0	6107	-707	0	0	-480	63	0	0
45-i	45	-420	55	0	0	6107	-707	0	0	-480	63	0	0
45-j	46	-63	55	0	0	1175	-1018	0	0	-72	63	0	0
46-i	46	-63	55	0	0	1175	-1018	0	0	-72	63	0	0
46-j	47	0	55	0	0	0	0	0	0	0	0	0	0
101-i	12	-293	1	79	0	3589	-230	857	0	-5193	343	954	0
101-j	101	-292	1	79	0	3361	-230	857	0	-4853	343	954	0
102-i	101	-292	1	79	0	3361	-230	857	0	-4853	343	954	0
102-j	102	-292	1	79	0	3246	-230	857	0	-4682	343	954	0
103-i	102	-292	1	79	0	3246	-230	857	0	-4682	343	954	0
103-j	103	-272	1	79	0	2613	343	957	0	-1725	-227	681	0
201-i	24	51	-5	-40	0	5500	-415	745	0	-5492	414	746	0
201-j	201	46	-5	-40	0	5089	-415	745	0	-5082	414	746	0
202-i	201	46	-5	-40	0	5089	-415	745	0	-5082	414	746	0
202-j	202	44	-5	-40	0	4882	-415	750	0	-4875	414	746	0
203-i	202	44	-5	-40	0	4882	-415	750	0	-4875	414	746	0
203-j	203	-53	-5	-40	0	3354	413	692	0	-3360	-414	691	0
301-i	36	184	4	74	0	5174	-342	950	0	-3587	230	857	0
301-j	301	188	4	74	0	4836	-342	950	0	-3360	230	857	0
302-i	301	188	4	74	0	4836	-342	950	0	-3360	230	857	0
302-j	302	190	4	74	0	4665	-342	950	0	-3245	230	857	0
303-i	302	190	4	74	0	4665	-342	950	0	-3245	230	857	0
303-j	303	274	4	74	0	1724	227	682	0	-2608	-342	957	0

Member No.	Joint No.	Live Load Smax (L)				Live Load Smin (L)				Live Load Nmax (L)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
1-i	1	0	1080	0	0	0	-62	0	0	0	0	0	0
1-j	2	1174	1021	0	0	-67	-63	0	0	0	0	0	0
2-i	2	1174	1021	0	0	-67	-63	0	0	0	0	0	0
2-j	3	5609	733	0	0	2796	-192	0	0	0	0	0	0
3-i	3	5609	733	0	0	2796	-192	0	0	0	0	0	0
3-j	4	6693	592	0	0	4182	-289	0	0	0	0	0	0
4-i	4	6693	592	0	0	4182	-289	0	0	0	0	0	0
4-j	5	6883	434	0	0	5242	-464	0	0	0	0	0	0
5-i	5	6883	434	0	0	5242	-464	0	0	0	0	0	0
5-j	6	6084	298	0	0	5150	-652	0	0	0	0	0	0
6-i	6	6084	298	0	0	5150	-652	0	0	0	0	0	0
6-j	7	4655	187	0	0	3829	-827	0	0	0	0	0	0
7-i	7	4655	187	0	0	3829	-827	0	0	0	0	0	0
7-j	8	3015	102	0	0	1655	-981	0	0	0	0	0	0
8-i	8	3015	102	0	0	1655	-981	0	0	0	0	0	0
8-j	9	1694	50	0	0	-2273	-1128	0	0	0	0	0	0
9-i	9	1694	50	0	0	-2273	-1128	0	0	0	0	0	0
9-j	10	385	10	0	0	-7357	-1325	0	0	0	0	0	0
10-i	10	385	10	0	0	-7357	-1325	0	0	0	0	0	0
10-j	11	358	9	0	0	-7824	-1342	0	0	0	0	0	0
11-i	11	358	9	0	0	-7824	-1342	0	0	0	0	0	0
11-j	12	342	8	0	0	-8171	-1354	0	0	0	0	0	0
12-i	12	-8118	1302	10	0	1483	-99	-133	0	-6188	809	268	0
12-j	13	-7778	1289	10	0	1441	-99	-133	0	-5845	806	268	0
13-i	13	-7778	1289	10	0	1441	-99	-133	0	-5845	806	268	0
13-j	14	-7329	1270	12	0	1385	-99	-133	0	-5383	802	268	0
14-i	14	-7329	1270	12	0	1385	-99	-133	0	-5383	802	268	0
14-j	15	-1278	1048	-2	0	2132	-148	-25	0	-314	758	268	0
15-i	15	-1278	1048	-2	0	2132	-148	-25	0	-314	758	268	0
15-j	16	1032	897	-19	0	2892	-238	-10	0	2896	664	268	0
16-i	16	1032	897	-19	0	2892	-238	-10	0	2896	664	268	0
16-j	17	2780	726	-40	0	3887	-362	76	0	5240	305	268	0
17-i	17	2780	726	-40	0	3887	-362	76	0	5240	305	268	0
17-j	18	3687	548	-52	0	4058	-527	98	0	5311	-150	268	0
18-i	18	3687	548	-52	0	4058	-527	98	0	5311	-150	268	0
18-j	19	3647	379	-63	0	3345	-697	107	0	4277	-340	268	0
19-i	19	3647	379	-63	0	3345	-697	107	0	4277	-340	268	0
19-j	20	2784	265	-157	0	1826	-859	112	0	2101	-689	268	0
20-i	20	2784	265	-157	0	1826	-859	112	0	2101	-689	268	0
20-j	21	2149	170	-140	0	-285	-1006	107	0	-997	-719	268	0
21-i	21	2149	170	-140	0	-285	-1006	107	0	-997	-719	268	0
21-j	22	1872	144	-266	0	-6110	-1229	107	0	-5813	-763	268	0
22-i	22	1872	144	-266	0	-6110	-1229	107	0	-5813	-763	268	0
22-j	23	1954	144	-266	0	-6550	-1248	105	0	-6253	-767	268	0
23-i	23	1954	144	-266	0	-6550	-1248	105	0	-6253	-767	268	0
23-j	24	2015	144	-266	0	-5381	-1263	103	0	-6580	-770	268	0
24-i	24	-5381	1263	102	0	2004	-143	-265	0	-6579	770	268	0
24-j	25	-6550	1248	104	0	1943	-143	-265	0	-6253	767	268	0
25-i	25	-6550	1248	104	0	1943	-143	-265	0	-6253	767	268	0
25-j	26	-6110	1229	106	0	1862	-144	-265	0	-5813	763	268	0
26-i	26	-6110	1229	106	0	1862	-144	-265	0	-5813	763	268	0
26-j	27	-285	1006	107	0	2145	-169	-139	0	-997	719	268	0
27-i	27	-285	1006	107	0	2145	-169	-139	0	-997	719	268	0
27-j	28	1826	859	111	0	2783	-265	-156	0	2101	689	268	0
28-i	28	1826	859	111	0	2783	-265	-156	0	2101	689	268	0
28-j	29	3346	697	107	0	3649	-378	-62	0	4277	340	268	0
29-i	29	3346	697	107	0	3649	-378	-62	0	4277	340	268	0
29-j	30	4058	527	97	0	3690	-547	-51	0	5310	149	268	0

Member No.	Joint No.	Live Load Smax (L)				Live Load Smin (L)				Live Load Nmax (L)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
30-i	30	4058	527	97	0	3690	-547	-51	0	5310	149	268	0
30-j	31	3888	362	75	0	2788	-726	-39	0	5240	-305	268	0
31-i	31	3888	362	75	0	2788	-726	-39	0	5240	-305	268	0
31-j	32	2893	238	-11	0	1046	-896	-18	0	2895	-664	268	0
32-i	32	2893	238	-11	0	1046	-896	-18	0	2895	-664	268	0
32-j	33	2134	148	-25	0	-1255	-1047	1	0	-314	-758	268	0
33-i	33	2134	148	-25	0	-1255	-1047	1	0	-314	-758	268	0
33-j	34	1386	100	-133	0	-7294	-1269	14	0	-5384	-802	268	0
34-i	34	1386	100	-133	0	-7294	-1269	14	0	-5384	-802	268	0
34-j	35	1443	99	-133	0	-7742	-1287	13	0	-5846	-806	268	0
35-i	35	1443	99	-133	0	-7742	-1287	13	0	-5846	-806	268	0
35-j	36	1485	99	-133	0	-8081	-1301	12	0	-6189	-809	268	0
36-i	36	-8146	1351	0	0	343	-8	0	0	0	0	0	0
36-j	37	-7799	1339	0	0	358	-9	0	0	0	0	0	0
37-i	37	-7799	1339	0	0	358	-9	0	0	0	0	0	0
37-j	38	-7332	1322	0	0	385	-10	0	0	0	0	0	0
38-i	38	-7332	1322	0	0	385	-10	0	0	0	0	0	0
38-j	39	-2260	1126	0	0	1694	-50	0	0	0	0	0	0
39-i	39	-2260	1126	0	0	1694	-50	0	0	0	0	0	0
39-j	40	1656	978	0	0	3013	-103	0	0	0	0	0	0
40-i	40	1656	978	0	0	3013	-103	0	0	0	0	0	0
40-j	41	3816	823	0	0	4648	-188	0	0	0	0	0	0
41-i	41	3816	823	0	0	4648	-188	0	0	0	0	0	0
41-j	42	5113	647	0	0	6065	-300	0	0	0	0	0	0
42-i	42	5113	647	0	0	6065	-300	0	0	0	0	0	0
42-j	43	5169	458	0	0	6843	-437	0	0	0	0	0	0
43-i	43	5169	458	0	0	6843	-437	0	0	0	0	0	0
43-j	44	4104	284	0	0	6621	-596	0	0	0	0	0	0
44-i	44	4104	284	0	0	6621	-596	0	0	0	0	0	0
44-j	45	2783	193	0	0	5587	-730	0	0	0	0	0	0
45-i	45	2783	193	0	0	5587	-730	0	0	0	0	0	0
45-j	46	-68	63	0	0	1170	-1018	0	0	0	0	0	0
46-i	46	-68	63	0	0	1170	-1018	0	0	0	0	0	0
46-j	47	0	63	0	0	0	-1077	0	0	0	0	0	0
101-i	12	-5180	343	960	0	3535	-231	745	0	-191	-6	1801	0
101-j	101	-4841	343	960	0	3307	-231	745	0	-197	-6	1801	0
102-i	101	-4841	343	960	0	3307	-231	745	0	-197	-6	1801	0
102-j	102	-4669	343	960	0	3191	-231	745	0	-200	-6	1801	0
103-i	102	-4669	343	960	0	3191	-231	745	0	-200	-6	1801	0
103-j	103	2612	343	960	0	-1710	-231	745	0	-325	-6	1801	0
201-i	24	-5480	415	724	0	5487	-415	724	0	-6	2	1630	0
201-j	201	-5070	415	724	0	5077	-415	724	0	-5	2	1630	0
202-i	201	-5070	415	724	0	5077	-415	724	0	-5	2	1630	0
202-j	202	-4862	415	724	0	4869	-415	724	0	-4	2	1630	0
203-i	202	-4862	415	724	0	4869	-415	724	0	-4	2	1630	0
203-j	203	3348	415	724	0	-3355	-415	724	0	31	2	1630	0
301-i	36	-3534	231	745	0	5162	-342	956	0	167	7	1797	0
301-j	301	-3305	231	745	0	4824	-342	956	0	175	7	1797	0
302-i	301	-3305	231	745	0	4824	-342	956	0	175	7	1797	0
302-j	302	-3190	231	745	0	4652	-342	956	0	178	7	1797	0
303-i	302	-3190	231	745	0	4652	-342	956	0	178	7	1797	0
303-j	303	1710	231	745	0	-2608	-342	956	0	334	7	1797	0

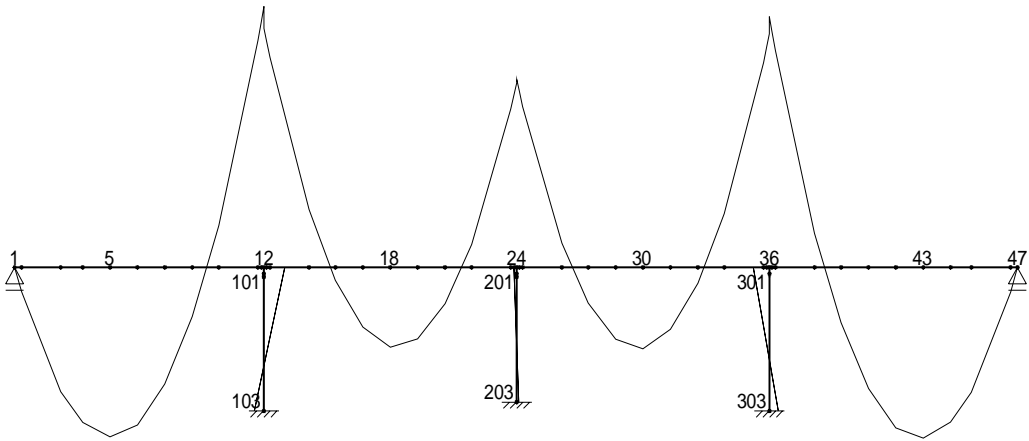
Member No.	Joint No.	Live Load Nmin (L)				Live Load Tmax (L)				Live Load Tmin (L)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
1-i	1	0	0	0	0	0	1080	0	3534	0	-62	0	-3536
1-j	2	0	0	0	0	1174	1021	0	3534	-67	-63	0	-3536
2-i	2	0	0	0	0	1174	1021	0	3006	-67	-63	0	-2996
2-j	3	0	0	0	0	5609	733	0	3006	2796	-192	0	-2996
3-i	3	0	0	0	0	5609	733	0	2533	2796	-192	0	-2519
3-j	4	0	0	0	0	6693	592	0	2533	4182	-289	0	-2519
4-i	4	0	0	0	0	6693	592	0	2147	4182	-289	0	-2135
4-j	5	0	0	0	0	6883	434	0	2147	5242	-464	0	-2135
5-i	5	0	0	0	0	6883	434	0	1846	5242	-464	0	-1847
5-j	6	0	0	0	0	6084	298	0	1846	5150	-652	0	-1847
6-i	6	0	0	0	0	6084	298	0	1638	5150	-652	0	-1640
6-j	7	0	0	0	0	4655	187	0	1638	3829	-827	0	-1640
7-i	7	0	0	0	0	4655	187	0	1854	3829	-827	0	-1844
7-j	8	0	0	0	0	3015	102	0	1854	1655	-981	0	-1844
8-i	8	0	0	0	0	3015	102	0	2213	1655	-981	0	-2084
8-j	9	0	0	0	0	1694	50	0	2213	-2273	-1128	0	-2084
9-i	9	0	0	0	0	1694	50	0	2664	-2273	-1128	0	-2512
9-j	10	0	0	0	0	385	10	0	2664	-7357	-1325	0	-2512
10-i	10	0	0	0	0	385	10	0	3013	-7357	-1325	0	-3173
10-j	11	0	0	0	0	358	9	0	3013	-7824	-1342	0	-3173
11-i	11	0	0	0	0	358	9	0	3066	-7824	-1342	0	-3223
11-j	12	0	0	0	0	342	8	0	3066	-8171	-1354	0	-3223
12-i	12	-2615	52	-399	0	-8118	1302	10	3418	1483	-99	-133	-3501
12-j	13	-2593	52	-399	0	-7778	1289	10	3418	1441	-99	-133	-3501
13-i	13	-2593	52	-399	0	-7778	1289	10	3355	1441	-99	-133	-3454
13-j	14	-2563	52	-399	0	-7329	1270	12	3355	1385	-99	-133	-3454
14-i	14	-2563	52	-399	0	-7329	1270	12	2695	1385	-99	-133	-3096
14-j	15	-2228	52	-399	0	-1278	1048	-2	2695	2132	-148	-25	-3096
15-i	15	-2228	52	-399	0	-1278	1048	-2	2236	2132	-148	-25	-2636
15-j	16	-2001	52	-399	0	1032	897	-19	2236	2892	-238	-10	-2636
16-i	16	-2001	52	-399	0	1032	897	-19	2010	2892	-238	-10	-2253
16-j	17	-1766	52	-399	0	2780	726	-40	2010	3887	-362	76	-2253
17-i	17	-1766	52	-399	0	2780	726	-40	1920	3887	-362	76	-1912
17-j	18	-1531	52	-399	0	3687	548	-52	1920	4058	-527	98	-1912
18-i	18	-1531	52	-399	0	3687	548	-52	2180	4058	-527	98	-1780
18-j	19	-1296	52	-399	0	3647	379	-63	2180	3345	-697	107	-1780
19-i	19	-1296	52	-399	0	3647	379	-63	2593	3345	-697	107	-1919
19-j	20	-1061	52	-399	0	2784	265	-157	2593	1826	-859	112	-1919
20-i	20	-1061	52	-399	0	2784	265	-157	3008	1826	-859	112	-2191
20-j	21	-834	52	-399	0	2149	170	-140	3008	-285	-1006	107	-2191
21-i	21	-834	52	-399	0	2149	170	-140	3437	-285	-1006	107	-2658
21-j	22	-498	52	-399	0	1872	144	-266	3437	-6110	-1229	107	-2658
22-i	22	-498	52	-399	0	1872	144	-266	3711	-6110	-1229	107	-3310
22-j	23	-468	52	-399	0	1954	144	-266	3711	-6550	-1248	105	-3310
23-i	23	-468	52	-399	0	1954	144	-266	3736	-6550	-1248	105	-3384
23-j	24	-446	52	-399	0	2015	144	-266	3736	-5381	-1263	103	-3384
24-i	24	-457	-51	-398	0	-5381	1263	102	3609	2004	-143	-265	-3608
24-j	25	-479	-51	-398	0	-6550	1248	104	3609	1943	-143	-265	-3608
25-i	25	-479	-51	-398	0	-6550	1248	104	3555	1943	-143	-265	-3553
25-j	26	-508	-51	-398	0	-6110	1229	106	3555	1862	-144	-265	-3553
26-i	26	-508	-51	-398	0	-6110	1229	106	2996	1862	-144	-265	-3109
26-j	27	-838	-51	-398	0	-285	1006	107	2996	2145	-169	-139	-3109
27-i	27	-838	-51	-398	0	-285	1006	107	2628	2145	-169	-139	-2673
27-j	28	-1062	-51	-398	0	1826	859	111	2628	2783	-265	-156	-2673
28-i	28	-1062	-51	-398	0	1826	859	111	1983	2783	-265	-156	-2516
28-j	29	-1294	-51	-398	0	3346	697	107	1983	3649	-378	-62	-2516
29-i	29	-1294	-51	-398	0	3346	697	107	2135	3649	-378	-62	-1962
29-j	30	-1525	-51	-398	0	4058	527	97	2135	3690	-547	-51	-1962

Membar No.	Joint No.	Live Load Nmin (L)				Live Load Tmax (L)				Live Load Tmin (L)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
30-i	30	-1525	-51	-398	0	4058	527	97	2318	3690	-547	-51	-1725
30-j	31	-1756	-51	-398	0	3888	362	75	2318	2788	-726	-39	-1725
31-i	31	-1756	-51	-398	0	3888	362	75	2710	2788	-726	-39	-1838
31-j	32	-1988	-51	-398	0	2893	238	-11	2710	1046	-896	-18	-1838
32-i	32	-1988	-51	-398	0	2893	238	-11	3074	1046	-896	-18	-2099
32-j	33	-2211	-51	-398	0	2134	148	-25	3074	-1255	-1047	1	-2099
33-i	33	-2211	-51	-398	0	2134	148	-25	3419	-1255	-1047	1	-2544
33-j	34	-2542	-51	-398	0	1386	100	-133	3419	-7294	-1269	14	-2544
34-i	34	-2542	-51	-398	0	1386	100	-133	3618	-7294	-1269	14	-3243
34-j	35	-2571	-51	-398	0	1443	99	-133	3618	-7742	-1287	13	-3243
35-i	35	-2571	-51	-398	0	1443	99	-133	3668	-7742	-1287	13	-3286
35-j	36	-2593	-51	-398	0	1485	99	-133	3668	-8081	-1301	12	-3286
36-i	36	0	0	0	0	-8146	1351	0	3642	343	-8	0	-2785
36-j	37	0	0	0	0	-7799	1339	0	3642	358	-9	0	-2785
37-i	37	0	0	0	0	-7799	1339	0	3591	358	-9	0	-2739
37-j	38	0	0	0	0	-7332	1322	0	3591	385	-10	0	-2739
38-i	38	0	0	0	0	-7332	1322	0	3066	385	-10	0	-2307
38-j	39	0	0	0	0	-2260	1126	0	3066	1694	-50	0	-2307
39-i	39	0	0	0	0	-2260	1126	0	2770	1694	-50	0	-1889
39-j	40	0	0	0	0	1656	978	0	2770	3013	-103	0	-1889
40-i	40	0	0	0	0	1656	978	0	2664	3013	-103	0	-1536
40-j	41	0	0	0	0	3816	823	0	2664	4648	-188	0	-1536
41-i	41	0	0	0	0	3816	823	0	2703	4648	-188	0	-1450
41-j	42	0	0	0	0	5113	647	0	2703	6065	-300	0	-1450
42-i	42	0	0	0	0	5113	647	0	3216	6065	-300	0	-1472
42-j	43	0	0	0	0	5169	458	0	3216	6843	-437	0	-1472
43-i	43	0	0	0	0	5169	458	0	3803	6843	-437	0	-1551
43-j	44	0	0	0	0	4104	284	0	3803	6621	-596	0	-1551
44-i	44	0	0	0	0	4104	284	0	4312	6621	-596	0	-1668
44-j	45	0	0	0	0	2783	193	0	4312	5587	-730	0	-1668
45-i	45	0	0	0	0	2783	193	0	4783	5587	-730	0	-1933
45-j	46	0	0	0	0	-68	63	0	4783	1170	-1018	0	-1933
46-i	46	0	0	0	0	-68	63	0	5062	1170	-1018	0	-2569
46-j	47	0	0	0	0	0	63	0	5062	0	-1077	0	-2569
101-i	12	-1326	114	-84	0	-5180	343	960	207	3535	-231	745	-210
101-j	101	-1214	114	-84	0	-4841	343	960	207	3307	-231	745	-210
102-i	101	-1214	114	-84	0	-4841	343	960	207	3307	-231	745	-210
102-j	102	-1157	114	-84	0	-4669	343	960	207	3191	-231	745	-210
103-i	102	-1157	114	-84	0	-4669	343	960	207	3191	-231	745	-210
103-j	103	1258	114	-84	0	2612	343	960	207	-1710	-231	745	-210
201-i	24	8	-1	-223	0	-5480	415	724	209	5487	-415	724	-231
201-j	201	8	-1	-223	0	-5070	415	724	209	5077	-415	724	-231
202-i	201	8	-1	-223	0	-5070	415	724	209	5077	-415	724	-231
202-j	202	7	-1	-223	0	-4862	415	724	209	4869	-415	724	-231
203-i	202	7	-1	-223	0	-4862	415	724	209	4869	-415	724	-231
203-j	203	-7	-1	-223	0	3348	415	724	209	-3355	-415	724	-231
301-i	36	1328	-114	-84	0	-3534	231	745	234	5162	-342	956	-272
301-j	301	1215	-114	-84	0	-3305	231	745	234	4824	-342	956	-272
302-i	301	1215	-114	-84	0	-3305	231	745	234	4824	-342	956	-272
302-j	302	1158	-114	-84	0	-3190	231	745	234	4652	-342	956	-272
303-i	302	1158	-114	-84	0	-3190	231	745	234	4652	-342	956	-272
303-j	303	-1260	-114	-84	0	1710	231	745	234	-2608	-342	956	-272

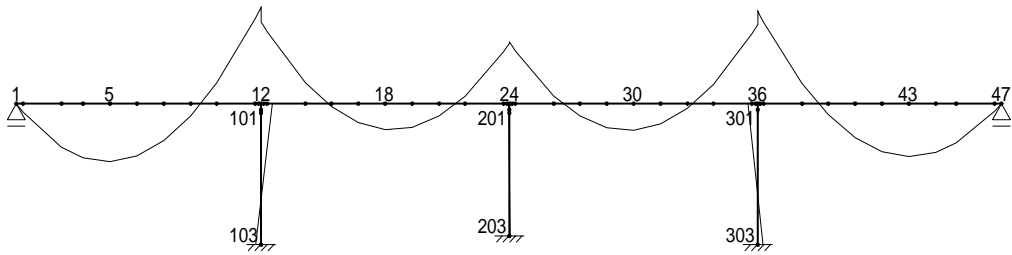
Member No.	Joint No.	Shrinkage (T)				Thermal Rise (T)				Temperature Difference (T)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
1-i	1	0	-109	0	0	0	54	0	0	-6188	183	-7659	0
1-j	2	-125	-109	0	0	62	54	0	0	-5977	183	-7659	0
2-i	2	-125	-109	0	0	62	54	0	0	-5977	414	-7659	0
2-j	3	-835	-109	0	0	415	54	0	0	-3285	414	-7541	0
3-i	3	-835	-109	0	0	415	54	0	0	-3285	183	-7541	0
3-j	4	-1233	-109	0	0	613	54	0	0	-2615	183	-7541	0
4-i	4	-1233	-109	0	0	613	54	0	0	-2615	183	-7541	0
4-j	5	-1729	-109	0	0	860	54	0	0	-1781	183	-7541	0
5-i	5	-1729	-109	0	0	860	54	0	0	-1781	183	-7541	0
5-j	6	-2226	-109	0	0	1107	54	0	0	-947	183	-7541	0
6-i	6	-2226	-109	0	0	1107	54	0	0	-947	183	-7541	0
6-j	7	-2722	-109	0	0	1354	54	0	0	-112	183	-7541	0
7-i	7	-2722	-109	0	0	1354	54	0	0	-112	183	-7541	0
7-j	8	-3218	-109	0	0	1601	54	0	0	722	183	-7541	0
8-i	8	-3218	-109	0	0	1601	54	0	0	722	123	-7541	0
8-j	9	-3698	-109	0	0	1840	54	0	0	1263	123	-7659	0
9-i	9	-3698	-109	0	0	1840	54	0	0	1263	-7	-7659	0
9-j	10	-4407	-109	0	0	2193	54	0	0	1221	-7	-7659	0
10-i	10	-4407	-109	0	0	2193	54	0	0	1221	183	-7659	0
10-j	11	-4470	-109	0	0	2224	54	0	0	1327	183	-7659	0
11-i	11	-4470	-109	0	0	2224	54	0	0	1327	183	-7659	0
11-j	12	-4517	-109	0	0	2248	54	0	0	1404	183	-7659	0
12-i	12	14405	-533	-1991	0	-3066	112	533	0	-1113	-5	-7450	0
12-j	13	14178	-533	-1991	0	-3019	112	533	0	-1115	-5	-7450	0
13-i	13	14178	-533	-1991	0	-3019	112	533	0	-1115	-5	-7450	0
13-j	14	13872	-533	-1991	0	-2954	112	533	0	-1117	-5	-7450	0
14-i	14	13872	-533	-1991	0	-2954	112	533	0	-1117	226	-7450	0
14-j	15	10410	-533	-1991	0	-2226	112	533	0	351	226	-7332	0
15-i	15	10410	-533	-1991	0	-2226	112	533	0	351	-5	-7332	0
15-j	16	8067	-533	-1991	0	-1733	112	533	0	329	-5	-7332	0
16-i	16	8067	-533	-1991	0	-1733	112	533	0	329	-5	-7332	0
16-j	17	5643	-533	-1991	0	-1223	112	533	0	307	-5	-7332	0
17-i	17	5643	-533	-1991	0	-1223	112	533	0	307	-5	-7332	0
17-j	18	3220	-533	-1991	0	-714	112	533	0	284	-5	-7332	0
18-i	18	3220	-533	-1991	0	-714	112	533	0	284	-5	-7332	0
18-j	19	796	-533	-1991	0	-204	112	533	0	262	-5	-7332	0
19-i	19	796	-533	-1991	0	-204	112	533	0	262	-5	-7332	0
19-j	20	-1627	-533	-1991	0	306	112	533	0	239	-5	-7332	0
20-i	20	-1627	-533	-1991	0	306	112	533	0	239	-5	-7332	0
20-j	21	-3971	-533	-1991	0	799	112	533	0	217	-5	-7332	0
21-i	21	-3971	-533	-1991	0	799	112	533	0	217	-236	-7332	0
21-j	22	-7433	-533	-1991	0	1527	112	533	0	-1315	-236	-7450	0
22-i	22	-7433	-533	-1991	0	1527	112	533	0	-1315	-5	-7450	0
22-j	23	-7739	-533	-1991	0	1591	112	533	0	-1318	-5	-7450	0
23-i	23	-7739	-533	-1991	0	1591	112	533	0	-1318	-5	-7450	0
23-j	24	-7965	-533	-1991	0	1639	112	533	0	-1320	-5	-7450	0
24-i	24	-8006	536	-1988	0	1638	-112	533	0	-1321	5	-7450	0
24-j	25	-7778	536	-1988	0	1591	-112	533	0	-1319	5	-7450	0
25-i	25	-7778	536	-1988	0	1591	-112	533	0	-1319	5	-7450	0
25-j	26	-7470	536	-1988	0	1526	-112	533	0	-1316	5	-7450	0
26-i	26	-7470	536	-1988	0	1526	-112	533	0	-1316	236	-7450	0
26-j	27	-3989	536	-1988	0	798	-112	533	0	217	236	-7332	0
27-i	27	-3989	536	-1988	0	798	-112	533	0	217	5	-7332	0
27-j	28	-1633	536	-1988	0	306	-112	533	0	239	5	-7332	0
28-i	28	-1633	536	-1988	0	306	-112	533	0	239	5	-7332	0
28-j	29	804	536	-1988	0	-204	-112	533	0	262	5	-7332	0
29-i	29	804	536	-1988	0	-204	-112	533	0	262	5	-7332	0
29-j	30	3241	536	-1988	0	-713	-112	533	0	285	5	-7332	0

Member No.	Joint No.	Shrinkage (T)				Thermal Rise (T)				Temperature Difference (T)			
		M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)	M (kN.m)	S (kN)	N (kN)	T (kN.m)
30-i	30	3241	536	-1988	0	-713	-112	533	0	285	5	-7332	0
30-j	31	5678	536	-1988	0	-1223	-112	533	0	308	5	-7332	0
31-i	31	5678	536	-1988	0	-1223	-112	533	0	308	5	-7332	0
31-j	32	8115	536	-1988	0	-1732	-112	533	0	330	5	-7332	0
32-i	32	8115	536	-1988	0	-1732	-112	533	0	330	5	-7332	0
32-j	33	10472	536	-1988	0	-2225	-112	533	0	352	5	-7332	0
33-i	33	10472	536	-1988	0	-2225	-112	533	0	352	-226	-7332	0
33-j	34	13953	536	-1988	0	-2953	-112	533	0	-1115	-226	-7450	0
34-i	34	13953	536	-1988	0	-2953	-112	533	0	-1115	5	-7450	0
34-j	35	14261	536	-1988	0	-3017	-112	533	0	-1112	5	-7450	0
35-i	35	14261	536	-1988	0	-3017	-112	533	0	-1112	5	-7450	0
35-j	36	14489	536	-1988	0	-3065	-112	533	0	-1110	5	-7450	0
36-i	36	-4361	106	0	0	2250	-55	0	0	1409	-184	-7659	0
36-j	37	-4316	106	0	0	2227	-55	0	0	1330	-184	-7659	0
37-i	37	-4316	106	0	0	2227	-55	0	0	1330	-184	-7659	0
37-j	38	-4255	106	0	0	2196	-55	0	0	1224	-184	-7659	0
38-i	38	-4255	106	0	0	2196	-55	0	0	1224	6	-7659	0
38-j	39	-3567	106	0	0	1841	-55	0	0	1260	6	-7659	0
39-i	39	-3567	106	0	0	1841	-55	0	0	1260	-124	-7659	0
39-j	40	-3101	106	0	0	1600	-55	0	0	715	-124	-7541	0
40-i	40	-3101	106	0	0	1600	-55	0	0	715	-184	-7541	0
40-j	41	-2620	106	0	0	1352	-55	0	0	-124	-184	-7541	0
41-i	41	-2620	106	0	0	1352	-55	0	0	-124	-184	-7541	0
41-j	42	-2138	106	0	0	1103	-55	0	0	-963	-184	-7541	0
42-i	42	-2138	106	0	0	1103	-55	0	0	-963	-184	-7541	0
42-j	43	-1657	106	0	0	855	-55	0	0	-1802	-184	-7541	0
43-i	43	-1657	106	0	0	855	-55	0	0	-1802	-184	-7541	0
43-j	44	-1175	106	0	0	606	-55	0	0	-2641	-184	-7541	0
44-i	44	-1175	106	0	0	606	-55	0	0	-2641	-184	-7541	0
44-j	45	-810	106	0	0	418	-55	0	0	-3277	-184	-7541	0
45-i	45	-810	106	0	0	418	-55	0	0	-3277	-415	-7541	0
45-j	46	-122	106	0	0	63	-55	0	0	-5976	-415	-7659	0
46-i	46	-122	106	0	0	63	-55	0	0	-5976	-184	-7659	0
46-j	47	0	106	0	0	0	-55	0	0	-6188	-184	-7659	0
101-i	12	-18921	1991	-424	0	5314	-533	58	0	2517	-209	-188	0
101-j	101	-16952	1991	-424	0	4787	-533	58	0	2311	-209	-188	0
102-i	101	-16952	1991	-424	0	4787	-533	58	0	2311	-209	-188	0
102-j	102	-15956	1991	-424	0	4521	-533	58	0	2206	-209	-188	0
103-i	102	-15956	1991	-424	0	4521	-533	58	0	2206	-209	-188	0
103-j	103	26263	1991	-424	0	-6770	-533	58	0	-2217	-209	-188	0
201-i	24	41	-4	1068	0	1	0	-224	0	1	0	10	0
201-j	201	37	-4	1068	0	1	0	-224	0	1	0	10	0
202-i	201	37	-4	1068	0	1	0	-224	0	1	0	10	0
202-j	202	35	-4	1068	0	1	0	-224	0	1	0	10	0
203-i	202	35	-4	1068	0	1	0	-224	0	1	0	10	0
203-j	203	-35	-4	1068	0	-1	0	-224	0	-1	0	10	0
301-i	36	18850	-1988	-430	0	-5315	533	57	0	-2519	209	-189	0
301-j	301	16884	-1988	-430	0	-4788	533	57	0	-2312	209	-189	0
302-i	301	16884	-1988	-430	0	-4788	533	57	0	-2312	209	-189	0
302-j	302	15890	-1988	-430	0	-4522	533	57	0	-2208	209	-189	0
303-i	302	15890	-1988	-430	0	-4522	533	57	0	-2208	209	-189	0
303-j	303	-26254	-1988	-430	0	6770	533	57	0	2218	209	-189	0

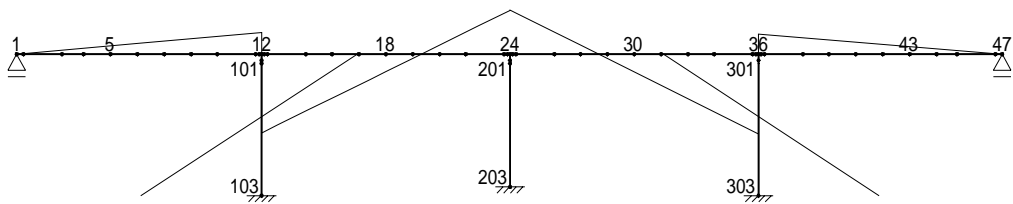
Self Weigh



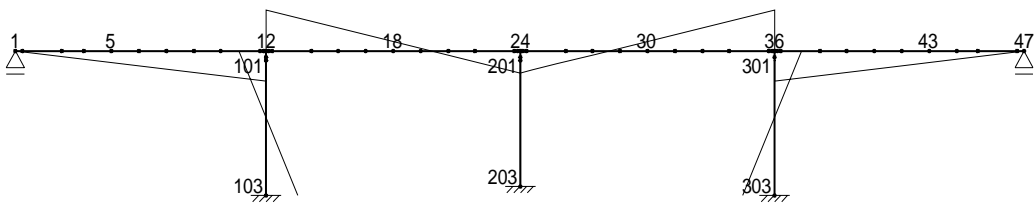
Surfacing



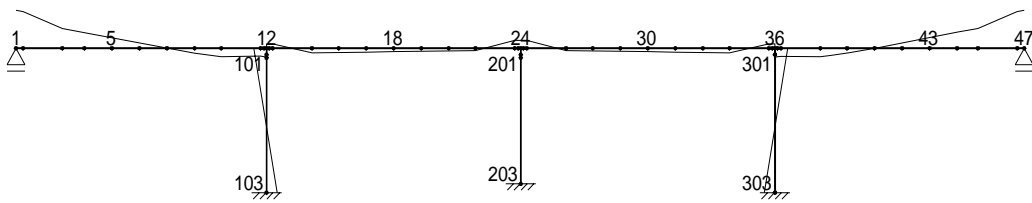
Shrinkage



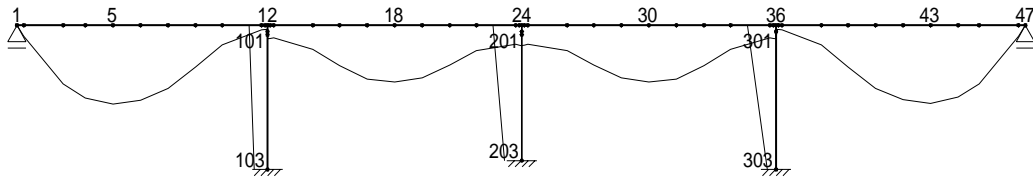
Temperature Rise



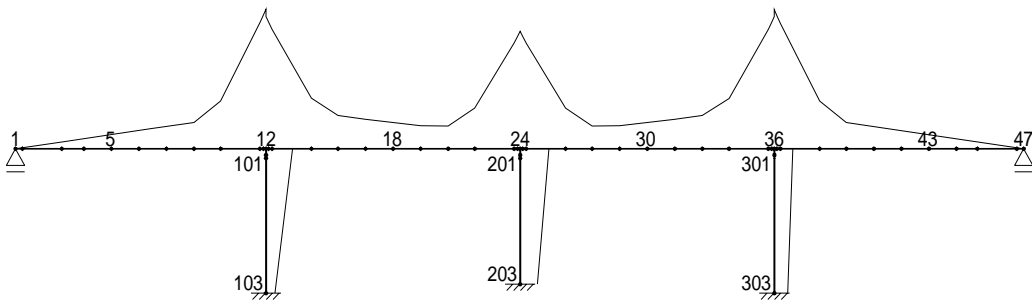
Temperature Difference



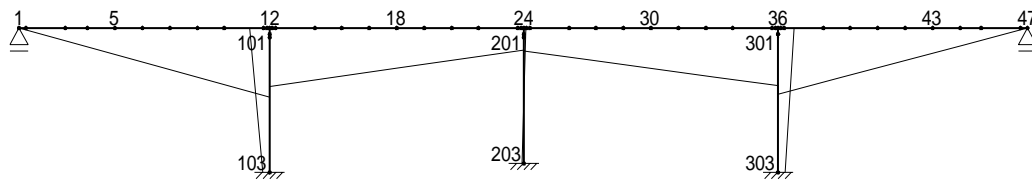
Live Load Moment Max



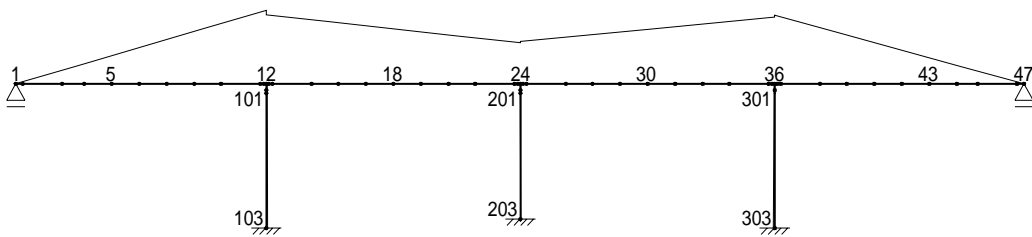
Live Load Moment Min



2ndary Force by Pre-stress



Creep Effect by Pre-stress



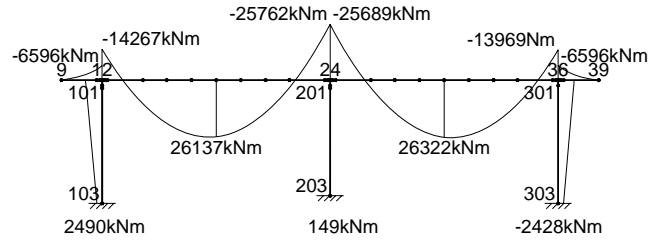
2.5.2 Summary of Section Force Calculation

(1) Section Force Diagram

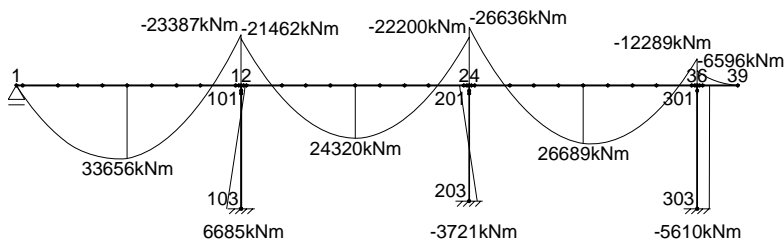
a. Bending Moment

Dead Load (D+SH+CR+PS)

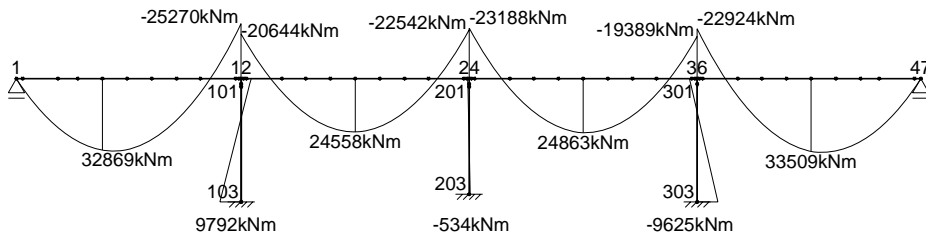
STEP-1



STEP-2



STEP-3



STEP-4

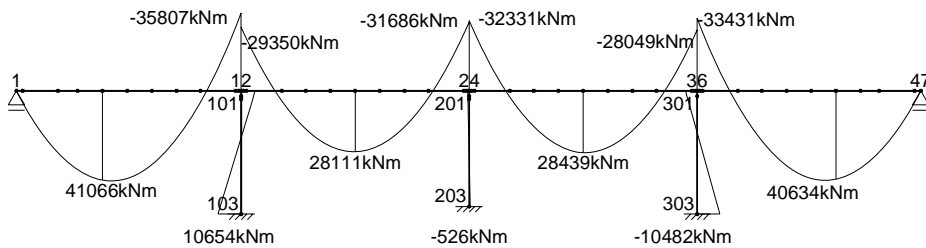


Figure 2.4.2.1 Bending Moment Diagram (1)

Service Load (GROUP-I : D+L+SH+CR+PS)

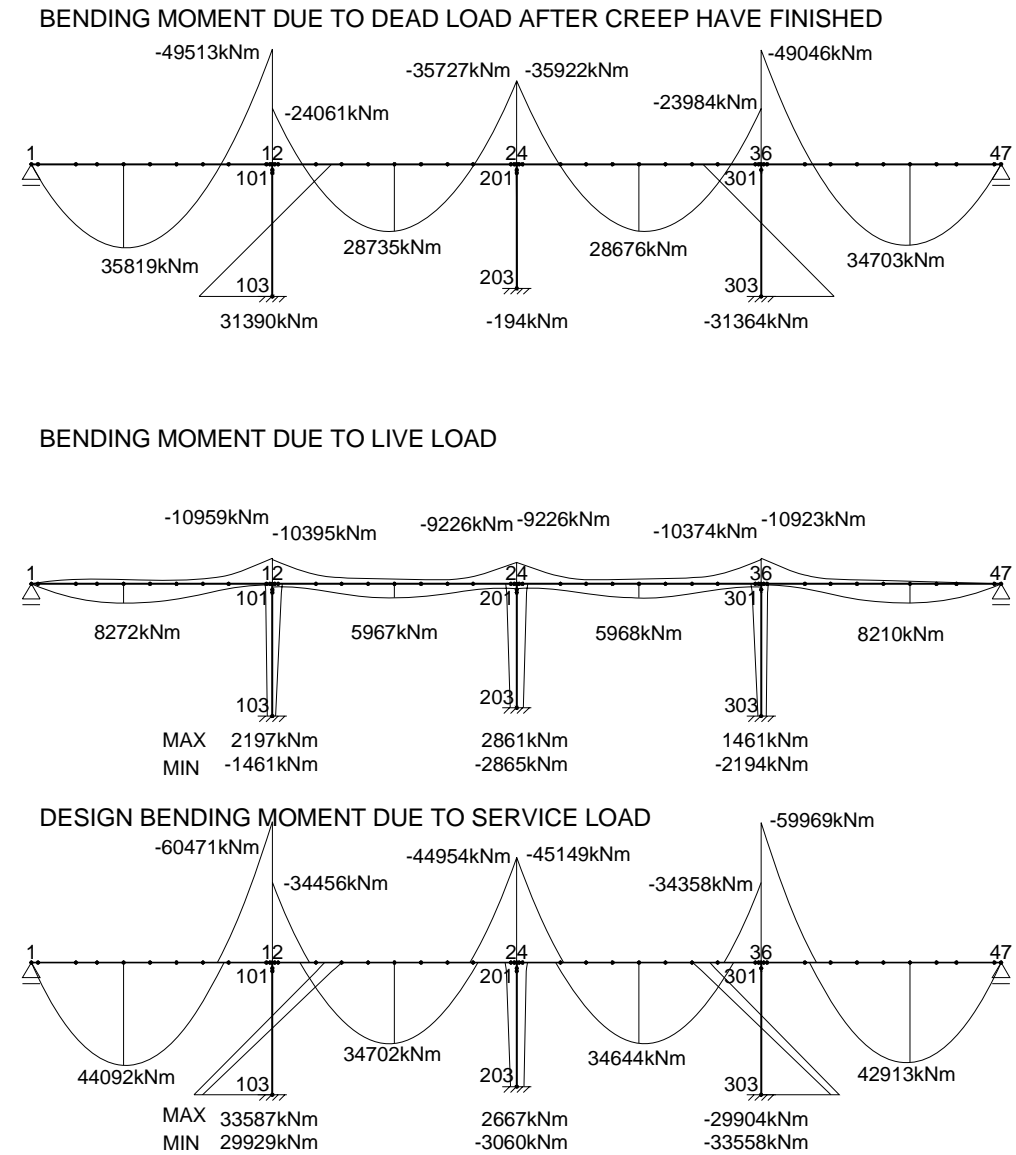
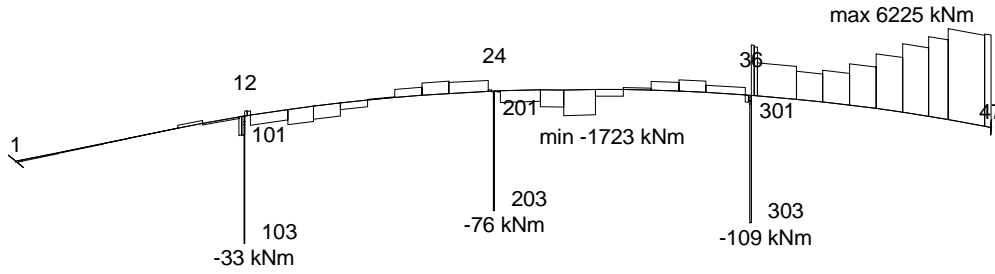


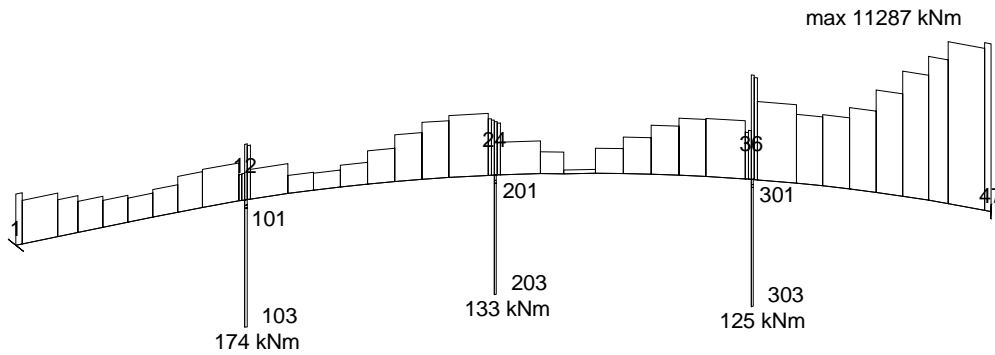
Figure 2.4.2.2 Bending Moment Diagram (2)

b. Torsional Moment

TORSIONAL MOMENT DUE TO DEAD LOAD AFTER CREEP HAVE FINISHED



DESIGN TORSIONAL MOMENT DUE TO SERVICE LOAD



DESIGN TORSIONAL MOMENT DUE TO SERVICE LOAD

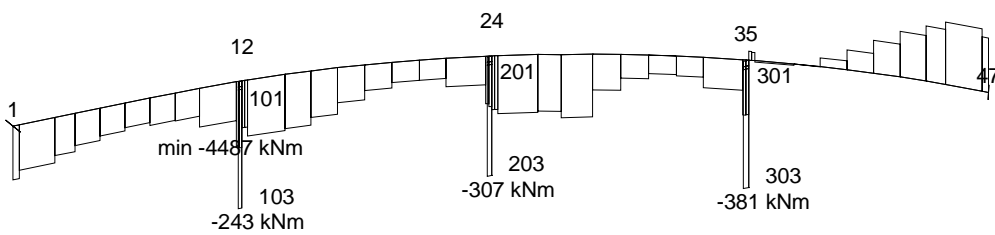


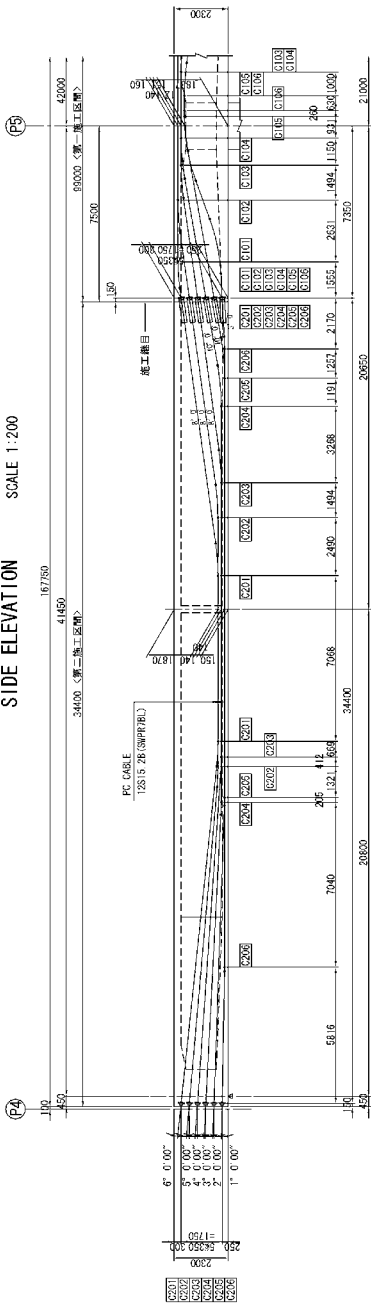
Figure 2.4.2.3 Torsional Moment Diagram

2.6 Calculation of Pre-Stress

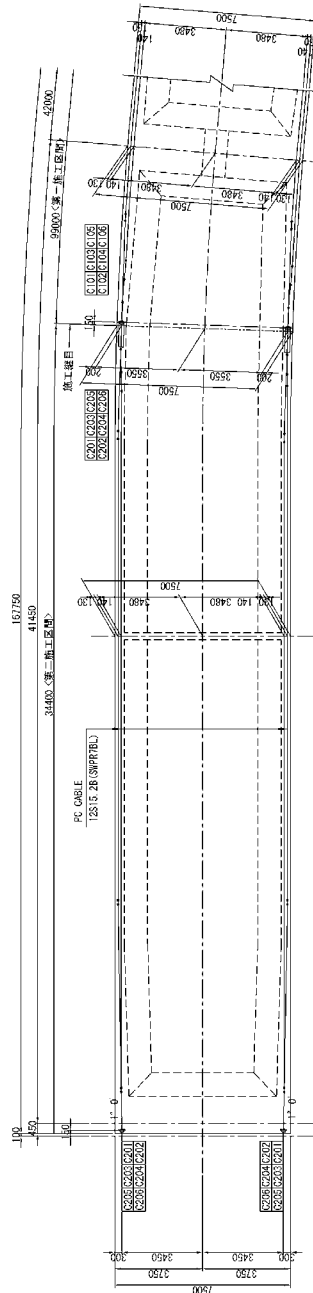
2.6.1 PC Cable Arrangement

PC CABLE ARRANGEMENT OF GIRDER (4)

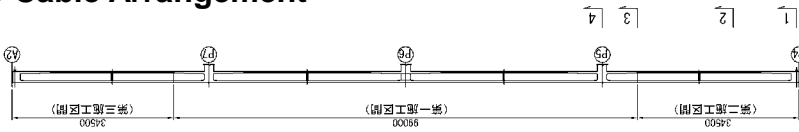
SIDE ELEVATION SCALE 1:200



PLAN SCALE 1:200



MARKING DIAGRAM SCALE 1:1000



CROSS SECTION

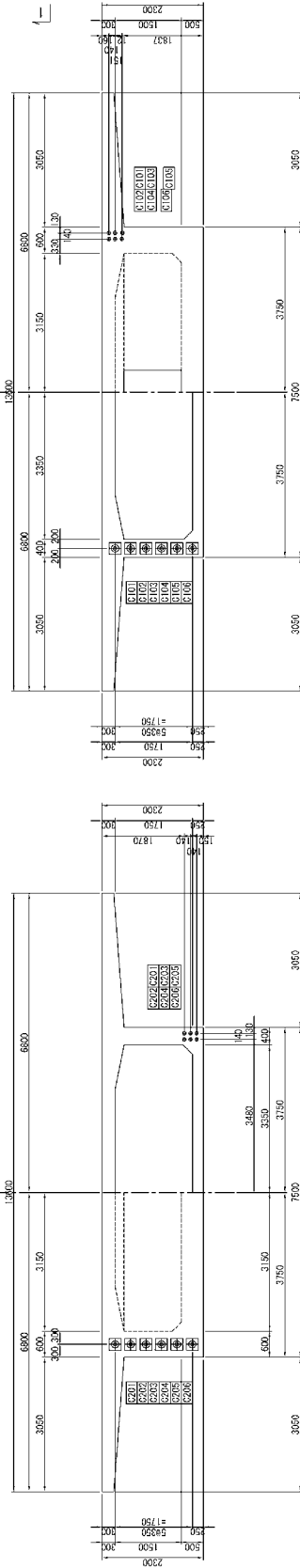
1 - 1

2 - 2

SCALE 1:100

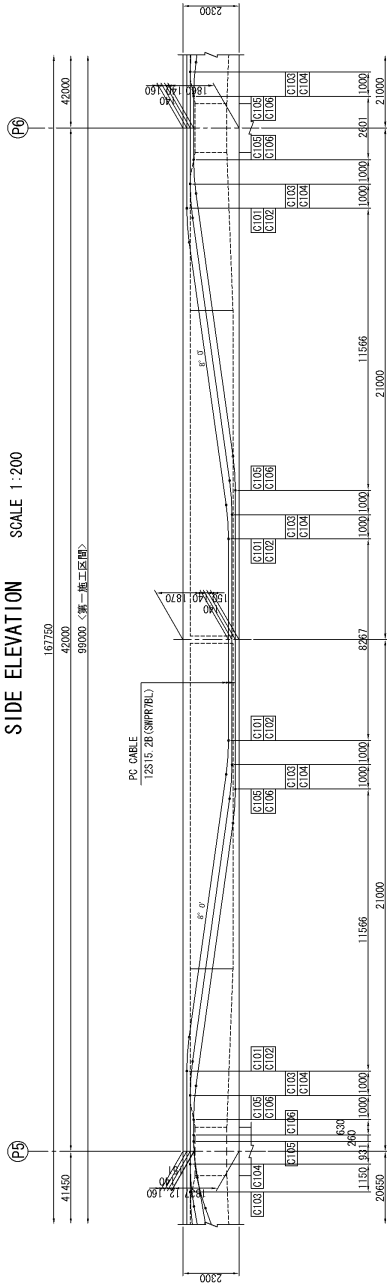
3 - 3

4 - 4

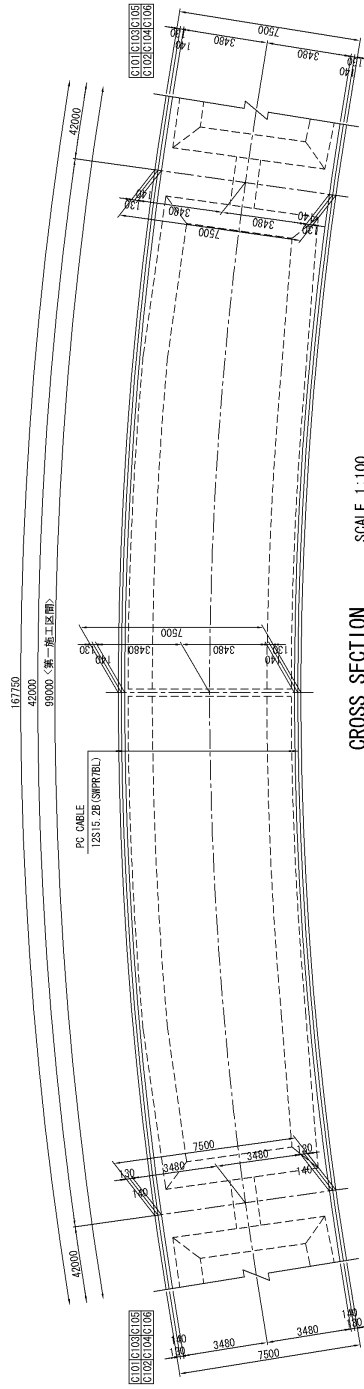


PC CABLE ARRANGEMENT OF GIRDER (5)

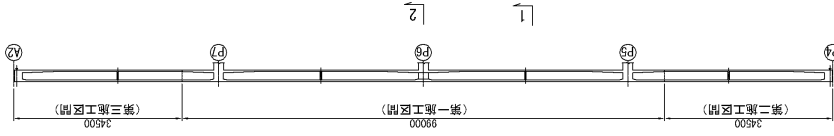
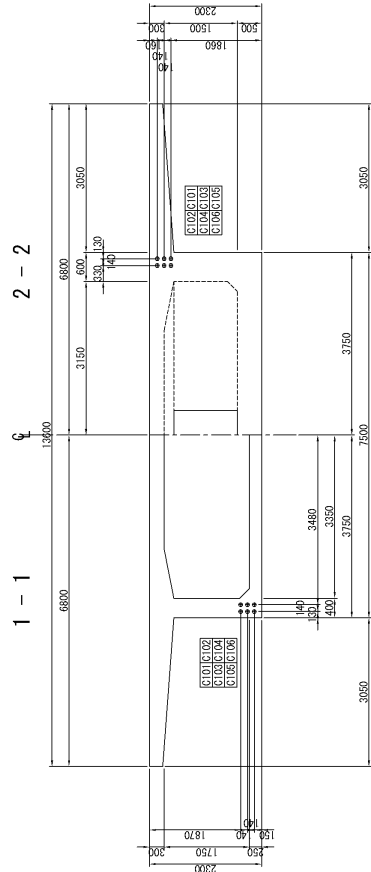
SIDE ELEVATION SCALE 1:200



PLAN SCALE 1:200



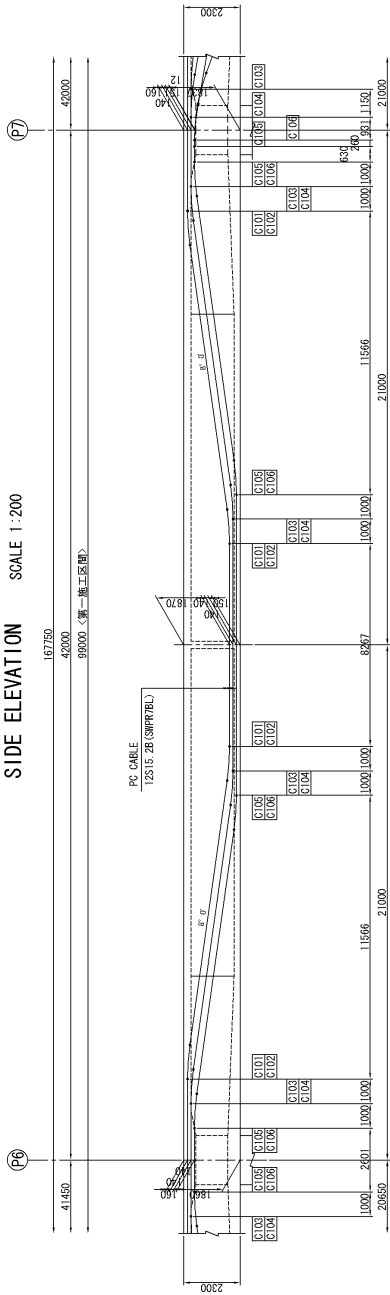
CROSS SECTION SCALE 1:100



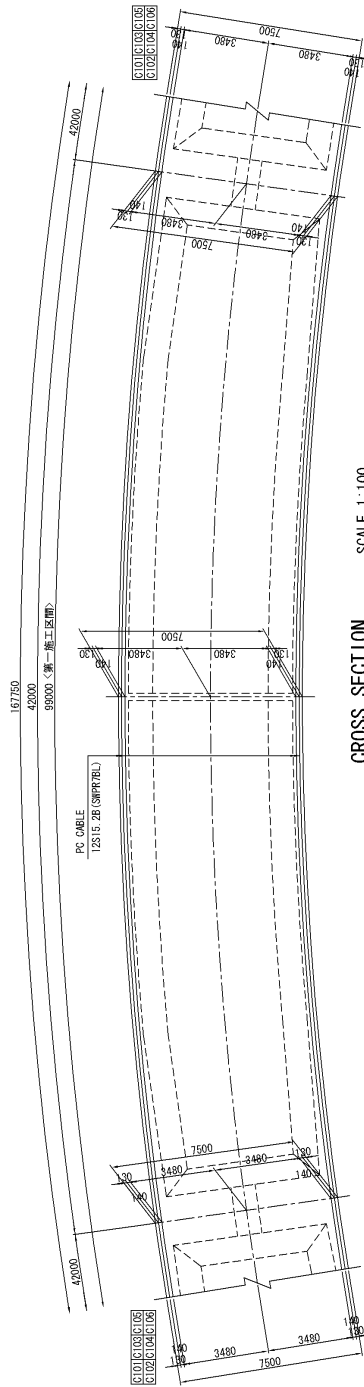
MARKING DIAGRAM SCALE 1:1000

PC CABLE ARRANGEMENT OF GIRDER (D)

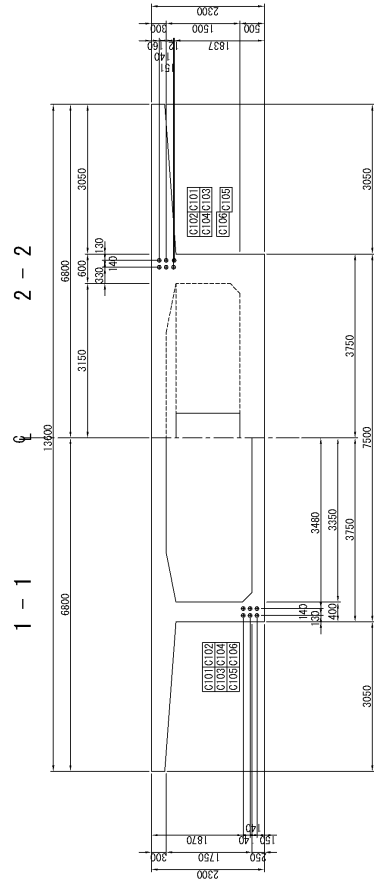
SIDE ELEVATION SCALE 1:200



PLAN SCALE 1:200

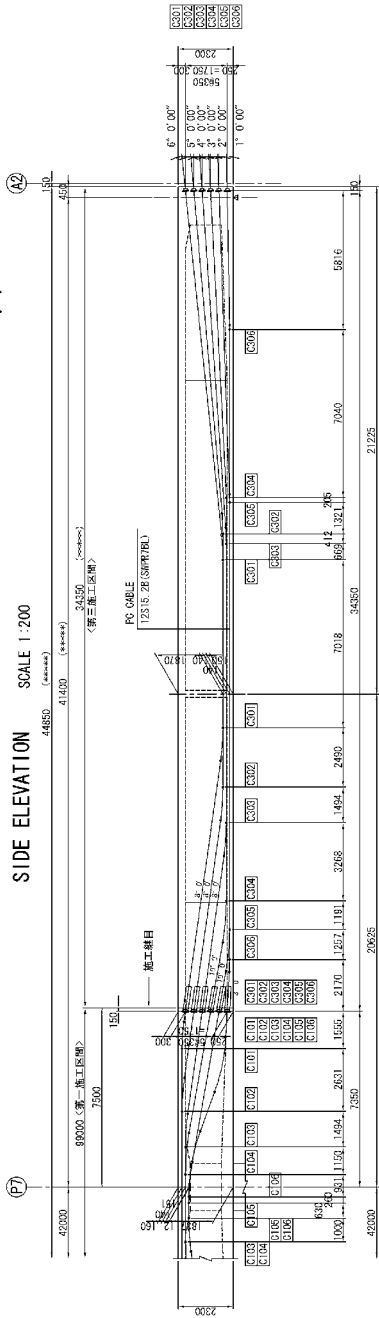


CROSS SECTION SCALE 1:100

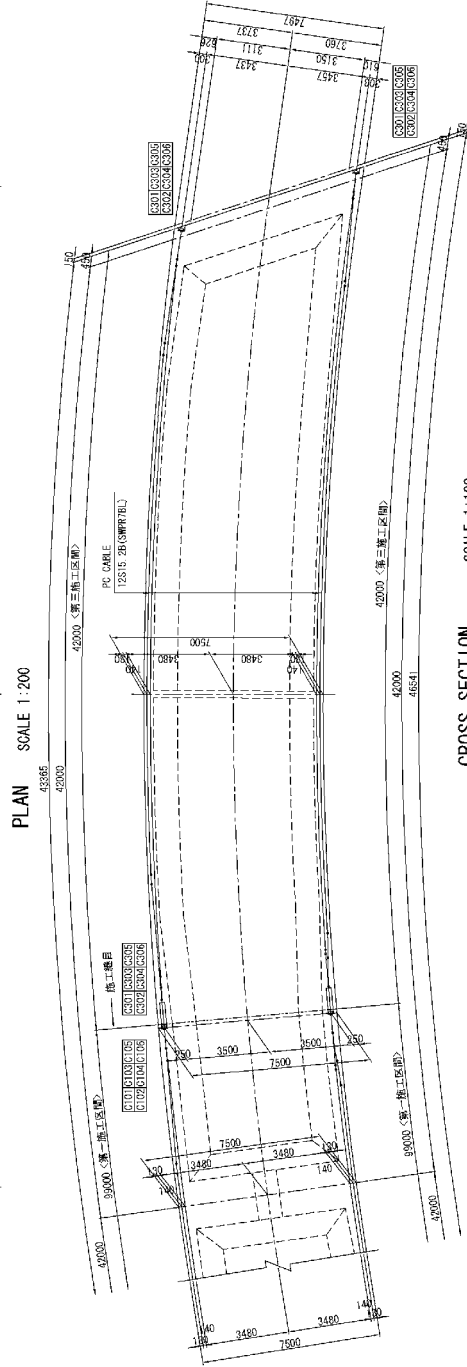


PC CABLE ARRANGEMENT OF GIRDER (7)

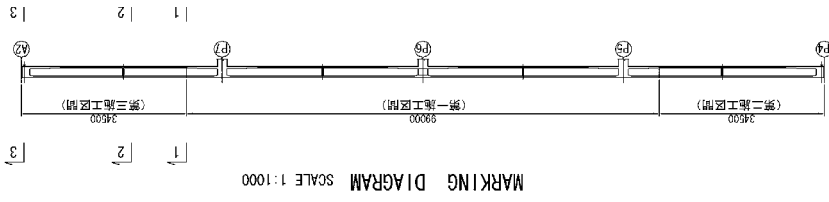
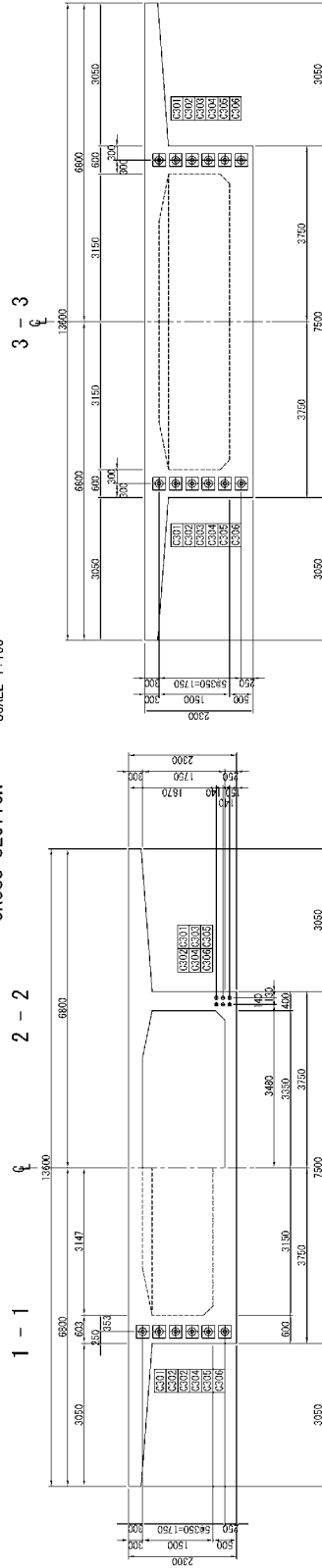
SIDE ELEVATION SCALE 1:200



PLAN SCALE 1:200



CROSS SECTION SCALE 1:100



MARKING DIAGRAM SCALE 1:1000

2.6.2 Calculation Result of Pre-stress

1) Effective Pre-stress of P5~P7

Member No.	Joint No.	σ_{pt} (N/mm ²)	$\Delta\sigma_{22}$ (N/mm ²)	$\Delta\sigma_{\Phi}$ (N/mm ²)	σ_{pr} (N/mm ²)	σ_{pe} (N/mm ²)	η_e	$\sigma_{ce'}$ (N/mm ²)	σ_{ce} (N/mm ²)
9-j	10	1079.5	0.0	77.9	9.3	992.4	0.880	3.81	-0.62
14-i	14	1095.5	0.0	88.4	9.5	997.7	0.868	3.89	-0.70
14-j	15	1094.5	0.0	86.7	9.5	998.2	0.864	2.33	2.56
15-i	15	1089.6	0.0	82.3	9.5	997.8	0.864	2.33	2.56
15-j	16	1075.0	0.0	77.6	9.4	988.0	0.868	0.69	5.54
16-i	16	1075.0	0.0	77.6	9.4	988.0	0.868	0.69	5.54
16-j	17	1016.0	0.0	77.2	8.9	929.9	0.858	-0.71	7.80
17-i	17	1016.0	0.0	77.2	8.9	929.9	0.858	-0.71	7.80
17-j	18	999.2	0.0	76.9	8.7	913.5	0.861	-0.71	7.68
18-i	18	999.2	0.0	76.9	8.7	913.5	0.861	-0.71	7.68
18-j	19	971.8	0.0	81.1	8.5	882.1	0.850	-0.68	7.41
19-i	19	971.8	0.0	81.1	8.5	882.1	0.850	-0.68	7.41
19-j	20	930.4	0.0	82.0	8.2	840.2	0.848	0.39	5.09
20-i	20	930.4	0.0	82.0	8.2	840.2	0.848	0.39	5.09
20-j	21	914.0	0.0	81.6	8.0	824.3	0.846	1.73	2.48
21-i	21	918.7	0.0	86.0	8.0	824.7	0.847	1.73	2.48
21-j	22	881.1	0.0	74.2	7.6	799.3	0.866	2.93	-0.33
26-i	26	880.5	0.0	74.1	7.6	798.9	0.867	2.93	-0.33
26-j	27	915.8	0.0	86.0	8.0	821.8	0.846	1.73	2.46
27-i	27	911.1	0.0	81.6	8.0	821.4	0.846	1.73	2.46
27-j	28	927.6	0.0	82.0	8.1	837.5	0.848	0.39	5.07
28-i	28	927.6	0.0	82.0	8.1	837.5	0.848	0.39	5.07
28-j	29	969.2	0.0	81.0	8.5	879.7	0.851	-0.68	7.38
29-i	29	969.2	0.0	81.0	8.5	879.7	0.851	-0.68	7.38
29-j	30	997.5	0.0	76.7	8.7	912.0	0.862	-0.71	7.67
30-i	30	997.5	0.0	76.7	8.7	912.0	0.862	-0.71	7.67
30-j	31	1014.8	0.0	76.9	8.9	929.1	0.860	-0.71	7.79
31-i	31	1014.8	0.0	76.9	8.9	929.1	0.860	-0.71	7.79
31-j	32	1072.9	0.0	77.5	9.4	986.0	0.868	0.54	5.82
32-i	32	1072.9	0.0	77.5	9.4	986.0	0.868	0.54	5.82
32-j	33	1088.4	0.0	82.0	9.5	996.8	0.864	2.24	2.72
33-i	33	1093.2	0.0	86.4	9.5	997.3	0.864	2.24	2.72
33-j	34	1093.5	0.0	88.7	9.5	995.4	0.866	3.88	-0.70
38-i	38	1076.8	0.0	78.5	9.3	989.1	0.877	3.79	-0.62

2) Effective Pre-stress of P4~P5

Member No.	Joint No.	σ_{pt} (N/mm ²)	$\Delta\sigma_{22}$ (N/mm ²)	$\Delta\sigma_{\Phi}$ (N/mm ²)	σ_{pr} (N/mm ²)	σ_{pe} (N/mm ²)	η_e	$\sigma_{ce'}$ (N/mm ²)	σ_{ce} (N/mm ²)
1-i	1	1089.6	0.0	95.8	9.8	984.0	0.864	1.36	2.53
1-j	2	1095.9	0.0	95.5	9.8	990.5	0.865	1.19	2.78
2-i	2	1092.4	0.0	92.4	9.8	990.1	0.865	1.19	2.78
2-j	3	1126.7	0.0	91.1	10.1	1025.5	0.871	0.15	6.82
3-i	3	1122.5	0.0	87.2	10.1	1025.1	0.871	0.15	6.82
3-j	4	1146.2	0.0	85.5	10.3	1050.5	0.879	-0.44	8.12
4-i	4	1146.2	0.0	85.5	10.3	1050.5	0.879	-0.44	8.12
4-j	5	1180.5	0.0	85.5	10.5	1084.5	0.884	-0.84	9.11
5-i	5	1180.5	0.0	85.5	10.5	1084.5	0.884	-0.84	9.11
5-j	6	1170.1	0.0	86.8	10.4	1072.8	0.882	-0.83	9.02
6-i	6	1170.1	0.0	86.8	10.4	1072.8	0.882	-0.83	9.02
6-j	7	1134.1	0.0	91.7	10.2	1032.2	0.871	-0.66	8.42
7-i	7	1134.1	0.0	91.7	10.2	1032.2	0.871	-0.66	8.42
7-j	8	1094.3	0.0	95.5	9.9	989.0	0.859	0.06	6.74
8-i	8	1095.9	0.0	96.9	9.9	989.1	0.859	0.06	6.75
8-j	9	1055.4	0.0	94.1	9.5	951.7	0.856	1.22	3.71
9-i	9	1076.2	0.0	90.5	9.5	976.2	0.878	1.26	3.80

3) Effective Pre-stress of P7~A2

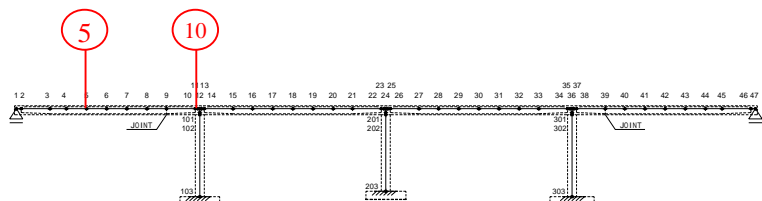
Member No.	Joint No.	σ_{pt} (N/mm ²)	$\Delta\sigma_{22}$ (N/mm ²)	$\Delta\sigma_{\Phi}$ (N/mm ²)	σ_{pr} (N/mm ²)	σ_{pe} (N/mm ²)	η_e	$\sigma_{ce'}$ (N/mm ²)	σ_{ce} (N/mm ²)
38-j	39	1086.5	0.0	90.5	10.0	986.0	0.886	1.28	3.84
39-i	39	1064.2	0.0	100.1	10.0	954.0	0.857	1.22	3.72
39-j	40	1105.9	0.0	102.8	10.4	992.7	0.861	0.06	6.77
40-i	40	1104.5	0.0	101.5	10.4	992.6	0.861	0.06	6.77
40-j	41	1144.1	0.0	97.5	10.7	1035.8	0.873	-0.67	8.45
41-i	41	1144.1	0.0	97.5	10.7	1035.8	0.873	-0.67	8.45
41-j	42	1179.1	0.0	92.5	11.0	1075.7	0.884	-0.83	9.04
42-i	42	1179.1	0.0	92.5	11.0	1075.7	0.884	-0.83	9.04
42-j	43	1187.5	0.0	91.4	11.1	1085.0	0.884	-0.84	9.12
43-i	43	1187.5	0.0	91.4	11.1	1085.0	0.884	-0.84	9.12
43-j	44	1151.7	0.0	91.4	10.8	1049.5	0.879	-0.38	8.00
44-i	44	1151.7	0.0	91.4	10.8	1049.5	0.879	-0.38	8.00
44-j	45	1129.0	0.0	93.5	10.6	1024.9	0.872	0.18	6.77
45-i	45	1132.7	0.0	96.8	10.6	1025.2	0.872	0.18	6.78
45-j	46	1097.8	0.0	98.1	10.3	989.4	0.865	1.21	2.74
46-i	46	1100.9	0.0	100.8	10.3	989.7	0.865	1.21	2.74
46-j	47	1094.6	0.0	101.1	10.3	983.2	0.864	1.38	2.50

2.7 Service Load Design

2.7.1 Checking Bending Stress

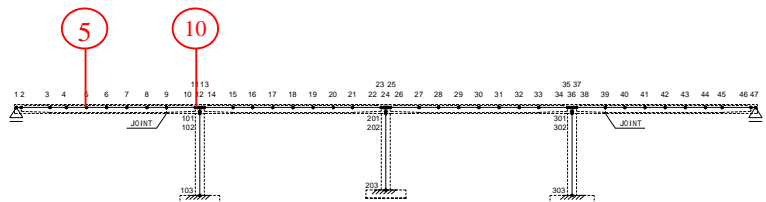
		5-i Joint No. 5				9-j Joint No. 10			
		Sectional Force		σ_{cu}	σ_{cl}	Sectional Force		σ_{cu}	σ_{cl}
		M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)	M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)
Self Weight + Stay Cable	D	26151	0	3.57	-6.50	-37363	0	-4.87	6.14
Creep Effect of Self Weight	D	-3946	0	-0.54	0.97	-10057	0	-1.31	1.65
Surfacing	D	7418	0	1.01	-1.84	-11086	0	-1.44	1.82
Creep Effect of Surfacing	D	-318	0	-0.04	0.08	-810	0	-0.10	0.13
2ndary Force by Prestress	D	8689	0	1.19	-2.16	22148	0	2.89	-3.64
Creep Effect of 2ndary Force	D	298	0	0.04	-0.08	759	0	0.11	-0.13
Effective Prestress	D	-25864	21651	-0.84	9.11	15536	19707	3.93	-0.65
Losses of Prestress	D	-907	0	-0.12	0.22	-2311	0	-0.30	0.38
CLASS-A Live Load Mmax	L	8199	0	1.11	-1.97	385	0	0.05	-0.06
CLASS-A Live Load Mmin	L	-988	0	-0.13	0.24	-9978	0	-1.28	1.64
CLASS-A Live Load Nmax	L	0	0	0.00	0.00	0	0	0.00	0.00
CLASS-A Live Load Nmin	L	0	0	0.00	0.00	0	0	0.00	0.00
Shrinkage	S	-1729	0	-0.23	0.41	-4407	0	-0.56	0.72
Thermal Rise	T	860	0	0.12	-0.21	2193	0	0.28	-0.36
Temparature Difference	T	-1781	-7541	0.31	-0.50	1221	-7659	0.90	-0.93
Group-I (L-Mmax)				5.37	-2.17			-1.05	5.65
Group-I (L-Mmin)				4.13	0.04			-2.38	7.35
Group-I (L-Nmax)				4.26	-0.20			-1.10	5.71
Group-I (L-Nmin)				4.26	-0.20			-1.10	5.71
Allowable Stress for Group-I				-2.96< σ <14.00				-2.96< σ <14.00	
Group-IV (L-Mmax, T-Rise)				5.26	1.79			-1.33	1.79
Group-IV (L-Mmin, T-Rise)				4.01	1.79			-2.66	1.79
Group-IV (L-Nmax, T-Rise)				4.14	2.07			-1.38	2.07
Group-IV (L-Nmin, T-Rise)				4.14	2.07			-1.38	2.07
Group-IV (L-Mmax, T-Down)				5.02	-1.55			-1.89	6.73
Group-IV (L-Mmin, T-Down)				3.78	0.65			-3.22	8.43
Group-IV (L-Nmax, T-Down)				3.91	0.41			-1.94	6.80
Group-IV (L-Nmin, T-Down)				3.91	0.41			-1.94	6.80
Group-IV (L-Mmax, T-Rise, T-Diff.)				5.57	-2.46			-0.43	5.08
Group-IV (L-Mmin, T-Rise, T-Diff.)				4.32	-0.26			-1.76	6.78
Group-IV (L-Nmax, T-Rise, T-Diff.)				4.45	-0.50			-0.48	5.14
Group-IV (L-Nmin, T-Rise, T-Diff.)				4.45	-0.50			-0.48	5.14
Group-IV (L-Mmax, T-Down, T-Diff.)				5.33	-2.05			-0.99	5.80
Group-IV (L-Mmin, T-Down, T-Diff.)				4.09	0.15			-2.32	7.50
Group-IV (L-Nmax, T-Down, T-Diff.)				4.22	-0.08			-1.04	5.86
Group-IV (L-Nmin, T-Down, T-Diff.)				4.22	-0.08			-1.04	5.86
Allowable Stress for Group-IV				-3.70< σ <17.50				-3.70< σ <17.50	

*) Group-I : $\Sigma D + L$
 Group-I : $\Sigma D + L + S + T$



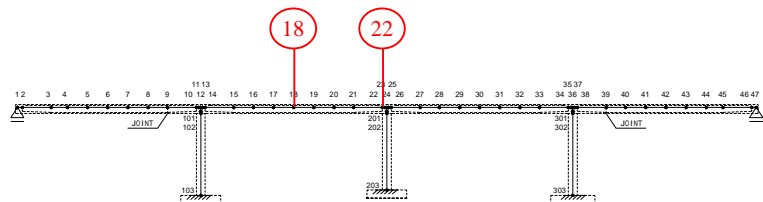
		5-i				9-j			
		Joint No. 5				Joint No. 10			
		Sectional Force		σ_{cu}	σ_{cl}	Sectional Force		σ_{cu}	σ_{cl}
		M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)	M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)
Self Weight + Stay Cable	D	26151	0	3.57	-6.50	-37363	0	-4.87	6.14
Creep Effect of Self Weight	D	-3946	0	-0.54	0.97	-10057	0	-1.31	1.65
Surfacing	D	7418	0	1.01	-1.84	-11086	0	-1.44	1.82
Creep Effect of Sufracing	D	-318	0	-0.04	0.08	-810	0	-0.10	0.13
2ndary Force by Prestress	D	8689	0	1.19	-2.16	22148	0	2.89	-3.64
Creep Effect of 2ndary Force	D	298	0	0.04	-0.08	759	0	0.11	-0.13
Effective Prestress	D	-25864	21651	-0.84	9.11	15536	19707	3.93	-0.65
Losses of Prestress	D	-907	0	-0.12	0.22	-2311	0	-0.30	0.38
CLASS-A Live Load Mmax	L	8199	0	1.11	-1.97	385	0	0.05	-0.06
CLASS-A Live Load Mmin	L	-988	0	-0.13	0.24	-9978	0	-1.28	1.64
CLASS-A Live Load Nmax	L	0	0	0.00	0.00	0	0	0.00	0.00
CLASS-A Live Load Nmin	L	0	0	0.00	0.00	0	0	0.00	0.00
Shrinkage	S	-1729	0	-0.23	0.41	-4407	0	-0.56	0.72
Thermal Rise	T	860	0	0.12	-0.21	2193	0	0.28	-0.36
Temparature Difference	T	-1781	-7541	0.31	-0.50	1221	-7659	0.90	-0.93
Group-I (L-Mmax)				5.37	-2.17			-1.05	5.65
Group-I (L-Mmin)				4.13	0.04			-2.38	7.35
Group-I (L-Nmax)				4.26	-0.20			-1.10	5.71
Group-I (L-Nmin)				4.26	-0.20			-1.10	5.71
Allowable Stress for Group-I				-2.96< σ <14.00				-2.96< σ <14.00	
Group-IV (L-Mmax, T-Rise)				5.26	1.79			-1.33	1.79
Group-IV (L-Mmin, T-Rise)				4.01	1.79			-2.66	1.79
Group-IV (L-Nmax, T-Rise)				4.14	2.07			-1.38	2.07
Group-IV (L-Nmin, T-Rise)				4.14	2.07			-1.38	2.07
Group-IV (L-Mmax, T-Down)				5.02	-1.55			-1.89	6.73
Group-IV (L-Mmin, T-Down)				3.78	0.65			-3.22	8.43
Group-IV (L-Nmax, T-Down)				3.91	0.41			-1.94	6.80
Group-IV (L-Nmin, T-Down)				3.91	0.41			-1.94	6.80
Group-IV (L-Mmax, T-Rise, T-Diff.)				5.57	-2.46			-0.43	5.08
Group-IV (L-Mmin, T-Rise, T-Diff.)				4.32	-0.26			-1.76	6.78
Group-IV (L-Nmax, T-Rise, T-Diff.)				4.45	-0.50			-0.48	5.14
Group-IV (L-Nmin, T-Rise, T-Diff.)				4.45	-0.50			-0.48	5.14
Group-IV (L-Mmax, T-Down, T-Diff.)				5.33	-2.05			-0.99	5.80
Group-IV (L-Mmin, T-Down, T-Diff.)				4.09	0.15			-2.32	7.50
Group-IV (L-Nmax, T-Down, T-Diff.)				4.22	-0.08			-1.04	5.86
Group-IV (L-Nmin, T-Down, T-Diff.)				4.22	-0.08			-1.04	5.86
Allowable Stress for Group-IV				-3.70< σ <17.50				-3.70< σ <17.50	

*) Group-I : $\Sigma D + L$
Group-I : $\Sigma D + L + S + T$



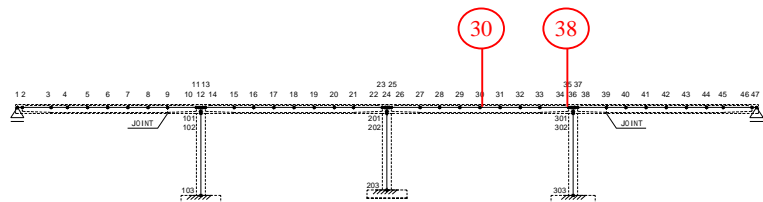
		18-i Joint No. 18				21-j Joint No. 22			
		Sectional Force		σ_{cu}	σ_{cl}	Sectional Force		σ_{cu}	σ_{cl}
		M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)	M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)
Self Weight + Stay Cable	D	12629	-324	1.68	-3.18	-25052	-324	-3.29	4.08
Creep Effect of Self Weight	D	-262	-514	-0.10	0.01	1770	-514	0.18	-0.34
Surfacing	D	3387	-146	0.44	-0.86	-6769	-146	-0.90	1.10
Creep Effect of Sufracing	D	177	-97	0.01	-0.05	-294	-97	-0.05	0.04
2ndary Force by Prestress	D	11861	189	1.64	-2.92	6622	189	0.88	-1.07
Creep Effect of 2ndary Force	D	-593	-87	-0.09	0.13	418	-87	0.04	-0.08
Effective Prestress	D	-21771	18224	-0.71	7.67	11489	15884	3.03	-0.35
Losses of Prestress	D	-1641	0	-0.22	0.40	-1225	0	-0.16	0.20
CLASS-A Live Load Mmax	L	5797	165	0.81	-1.37	1872	-266	0.22	-0.33
CLASS-A Live Load Mmin	L	-1762	-321	-0.28	0.38	-8299	134	-1.05	1.37
CLASS-A Live Load Nmax	L	5311	268	0.75	-1.24	-5813	268	-0.72	0.98
CLASS-A Live Load Nmin	L	-1531	-399	-0.26	0.32	-498	-399	-0.10	0.04
Shrinkage	S	3220	-1991	0.19	-1.03	-7433	-1991	-1.15	1.03
Thermal Rise	T	-714	533	-0.03	0.24	1527	533	0.25	-0.20
Temparature Difference	T	284	-7332	0.62	-0.97	-1315	-7450	0.59	-0.50
Group-I (L-Mmax)				3.46	-0.18			-0.04	3.25
Group-I (L-Mmin)				2.38	1.57			-1.31	4.96
Group-I (L-Nmax)				3.41	-0.05			-0.97	4.57
Group-I (L-Nmin)				2.40	1.51			-0.36	3.63
Allowable Stress for Group-I				-2.96< σ <14.00				-2.96< σ <14.00	
Group-IV (L-Mmax, T-Rise)				3.63	1.79			-0.94	1.79
Group-IV (L-Mmin, T-Rise)				2.54	1.79			-2.21	1.79
Group-IV (L-Nmax, T-Rise)				3.57	2.07			-1.88	2.07
Group-IV (L-Nmin, T-Rise)				2.56	2.07			-1.26	2.07
Group-IV (L-Mmax, T-Down)				3.69	-1.44			-1.44	4.48
Group-IV (L-Mmin, T-Down)				2.60	0.31			-2.70	6.19
Group-IV (L-Nmax, T-Down)				3.64	-1.31			-2.37	5.79
Group-IV (L-Nmin, T-Down)				2.63	0.25			-1.75	4.86
Group-IV (L-Mmax, T-Rise, T-Diff.)				4.24	-1.94			-0.35	3.59
Group-IV (L-Mmin, T-Rise, T-Diff.)				3.16	-0.18			-1.62	5.29
Group-IV (L-Nmax, T-Rise, T-Diff.)				4.19	-1.81			-1.28	4.90
Group-IV (L-Nmin, T-Rise, T-Diff.)				3.18	-0.25			-0.67	3.96
Group-IV (L-Mmax, T-Down, T-Diff.)				4.31	-2.41			-0.84	3.98
Group-IV (L-Mmin, T-Down, T-Diff.)				3.22	-0.66			-2.11	5.69
Group-IV (L-Nmax, T-Down, T-Diff.)				4.25	-2.28			-1.78	5.30
Group-IV (L-Nmin, T-Down, T-Diff.)				3.24	-0.72			-1.16	4.36
Allowable Stress for Group-IV				-3.70< σ <17.50				-3.70< σ <17.50	

*) Group-I : $\Sigma D + L$
Group-I : $\Sigma D + L + S + T$



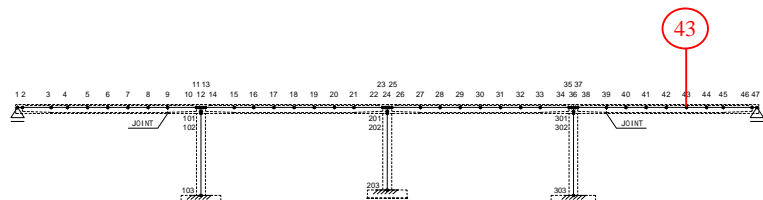
		30-i				38-i			
		Joint No. 30				Joint No. 38			
		Sectional Force		σ_{cu}	σ_{cl}	Sectional Force		σ_{cu}	σ_{cl}
		M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)	M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)
Self Weight + Stay Cable	D	12814	-282	1.65	-3.21	-35719	0	-4.53	5.84
Creep Effect of Self Weight	D	-968	-537	-0.19	0.18	-11941	0	-1.51	1.95
Surfacing	D	3467	-134	0.45	-0.88	-10591	0	-1.34	1.73
Creep Effect of Sufracing	D	99	-99	0.00	-0.04	-1018	0	-0.13	0.17
2ndary Force by Prestress	D	12272	156	1.64	-3.02	21626	0	2.74	-3.54
Creep Effect of 2ndary Force	D	-84	-49	-0.02	0.01	2705	0	0.35	-0.44
Effective Prestress	D	-22049	18216	-0.71	7.67	15252	19755	3.79	-0.62
Losses of Prestress	D	-1679	4	-0.22	0.41	-2206	0	-0.28	0.36
CLASS-A Live Load Mmax	L	5798	164	0.79	-1.37	386	0	0.05	-0.06
CLASS-A Live Load Mmin	L	-1757	-319	-0.27	0.38	-9938	0	-1.24	1.62
CLASS-A Live Load Nmax	L	5310	268	0.74	-1.24	0	0	0.00	0.00
CLASS-A Live Load Nmin	L	-1525	-398	-0.25	0.32	0	0	0.00	0.00
Shrinkage	S	3241	-1988	0.19	-1.02	-4255	0	-0.53	0.69
Thermal Rise	T	-713	533	-0.03	0.24	2196	0	0.27	-0.36
Temparature Difference	T	285	-7332	0.63	-0.95	1224	-7659	0.91	-0.92
Group-I (L-Mmax)				3.39	-0.25			-0.85	5.39
Group-I (L-Mmin)				2.33	1.50			-2.14	7.08
Group-I (L-Nmax)				3.34	-0.12			-0.90	5.46
Group-I (L-Nmin)				2.35	1.44			-0.90	5.46
Allowable Stress for Group-I				-2.96< σ <14.00				-2.96< σ <14.00	
Group-IV (L-Mmax, T-Rise)				3.55	1.79			-1.10	1.79
Group-IV (L-Mmin, T-Rise)				2.49	1.79			-2.39	1.79
Group-IV (L-Nmax, T-Rise)				3.50	2.07			-1.15	2.07
Group-IV (L-Nmin, T-Rise)				2.51	2.07			-1.15	2.07
Group-IV (L-Mmax, T-Down)				3.61	-1.51			-1.65	6.45
Group-IV (L-Mmin, T-Down)				2.55	0.24			-2.94	8.13
Group-IV (L-Nmax, T-Down)				3.56	-1.38			-1.70	6.51
Group-IV (L-Nmin, T-Down)				2.57	0.18			-1.70	6.51
Group-IV (L-Mmax, T-Rise, T-Diff.)				4.18	-1.99			-0.20	4.81
Group-IV (L-Mmin, T-Rise, T-Diff.)				3.12	-0.24			-1.49	6.49
Group-IV (L-Nmax, T-Rise, T-Diff.)				4.13	-1.86			-0.25	4.87
Group-IV (L-Nmin, T-Rise, T-Diff.)				3.15	-0.30			-0.25	4.87
Group-IV (L-Mmax, T-Down, T-Diff.)				4.24	-2.46			-0.75	5.52
Group-IV (L-Mmin, T-Down, T-Diff.)				3.18	-0.71			-2.04	7.21
Group-IV (L-Nmax, T-Down, T-Diff.)				4.19	-2.33			-0.79	5.59
Group-IV (L-Nmin, T-Down, T-Diff.)				3.21	-0.77			-0.79	5.59
Allowable Stress for Group-IV				-3.70< σ <17.50				-3.70< σ <17.50	

*) Group-I : $\Sigma D + L$
Group-I : $\Sigma D + L + S + T$



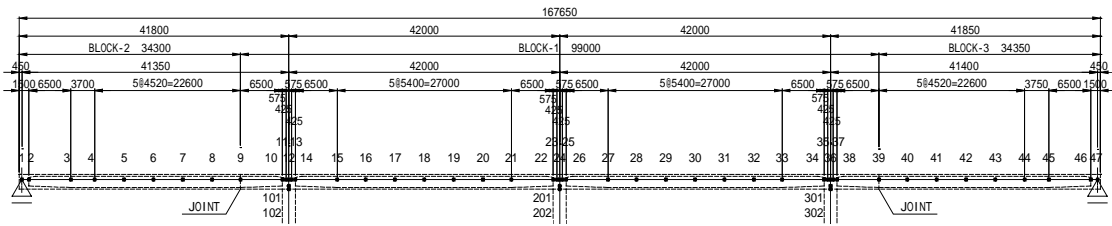
		43-i			
		Joint No. 43			
		Sectional Force		σ_{cu}	σ_{cl}
		M (kN.m)	N(kN)	(N/mm ²)	(N/mm ²)
Self Weight + Stay Cable	D	26400	0	3.49	-6.54
Creep Effect of Self Weight	D	-4649	0	-0.62	1.14
Surfacing	D	6748	0	0.90	-1.67
Creep Effect of Sufracing	D	-396	0	-0.05	0.10
2ndary Force by Prestress	D	8419	0	1.11	-2.09
Creep Effect of 2ndary Force	D	1053	0	0.14	-0.27
Effective Prestress	D	-26230	21670	-0.84	9.12
Losses of Prestress	D	-859	0	-0.11	0.21
CLASS-A Live Load Mmax	L	8141	0	1.08	-1.95
CLASS-A Live Load Mmin	L	-982	0	-0.13	0.24
CLASS-A Live Load Nmax	L	0	0	0.00	0.00
CLASS-A Live Load Nmin	L	0	0	0.00	0.00
Shrinkage	S	-1657	0	-0.22	0.39
Thermal Rise	T	855	0	0.11	-0.20
Temparature Difference	T	-1802	-7541	0.33	-0.48
Group-I (L-Mmax)				5.09	-1.95
Group-I (L-Mmin)				3.88	0.23
Group-I (L-Nmax)				4.01	-0.01
Group-I (L-Nmin)				4.01	-0.01
Allowable Stress for Group-I				-2.96 < σ < 14.00	
Group-IV (L-Mmax, T-Rise)				4.98	1.79
Group-IV (L-Mmin, T-Rise)				3.77	1.79
Group-IV (L-Nmax, T-Rise)				3.90	2.07
Group-IV (L-Nmin, T-Rise)				3.90	2.07
Group-IV (L-Mmax, T-Down)				4.75	-1.36
Group-IV (L-Mmin, T-Down)				3.55	0.82
Group-IV (L-Nmax, T-Down)				3.68	0.59
Group-IV (L-Nmin, T-Down)				3.68	0.59
Group-IV (L-Mmax, T-Rise, T-Diff.)				5.31	-2.24
Group-IV (L-Mmin, T-Rise, T-Diff.)				4.10	-0.06
Group-IV (L-Nmax, T-Rise, T-Diff.)				4.23	-0.30
Group-IV (L-Nmin, T-Rise, T-Diff.)				4.23	-0.30
Group-IV (L-Mmax, T-Down, T-Diff.)				5.08	-1.84
Group-IV (L-Mmin, T-Down, T-Diff.)				3.88	0.35
Group-IV (L-Nmax, T-Down, T-Diff.)				4.01	0.11
Group-IV (L-Nmin, T-Down, T-Diff.)				4.01	0.11
Allowable Stress for Group-IV				-3.70 < σ < 17.50	

*) Group-I : $\Sigma D + L$
Group-I : $\Sigma D + L + S + T$

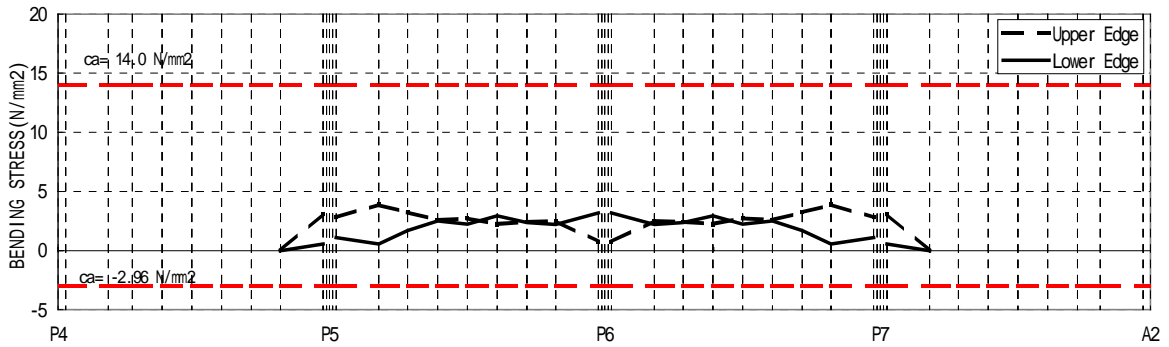


2.7.2 Bending Stress Diagram

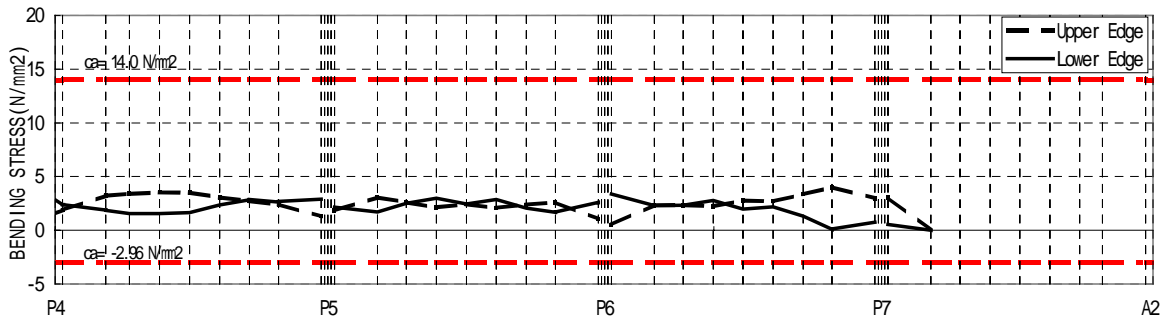
a. Fiber Stress Diagram For Dominant Combination



STEP-1 Bending Stress Diagram



STEP-2 Bending Stress Diagram



STEP-3 Bending Stress Diagram

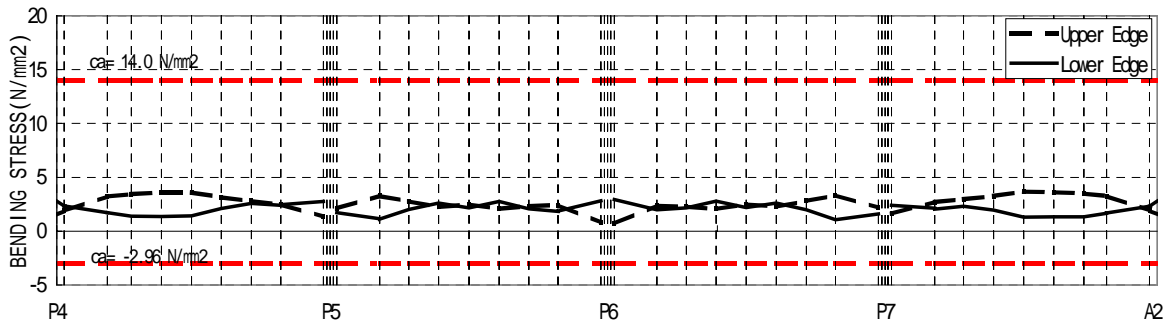
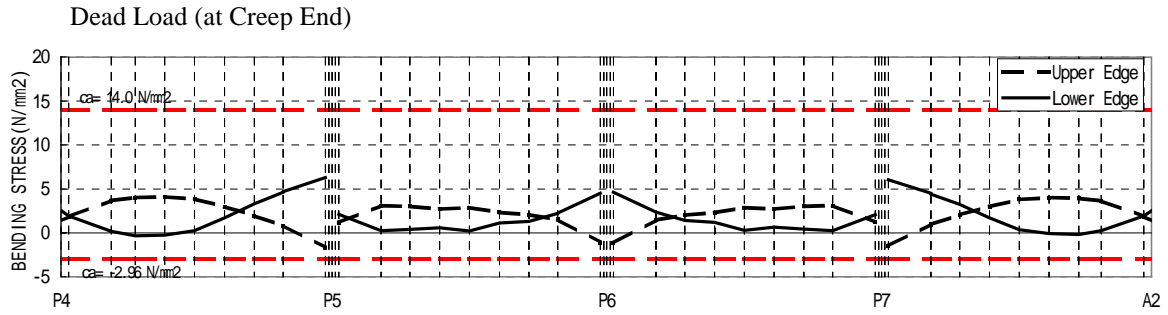


Figure 2.4.3.1 Bending Stress Diagram (1)



Service Load Design (Group-I)

Dead Load + Live Load Maximum (CLASS-A)

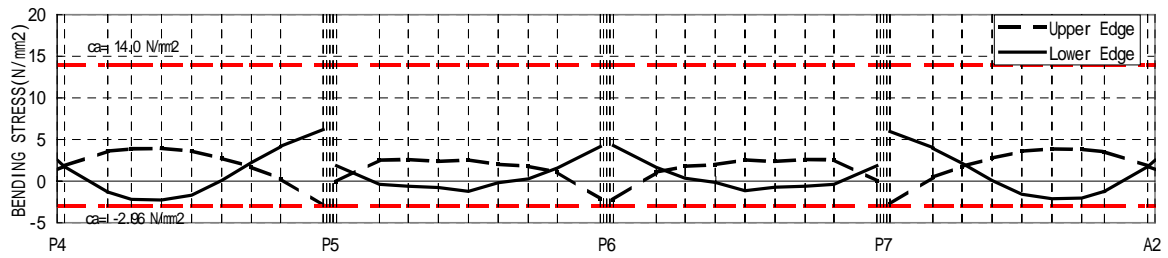


Figure 2.4.3.2 Bending Stress Diagram (2)

2.7.3 Calculation of Required Longitudinal Reinforcement

Member	Load Case	Upper Stress $\sigma_c(N/mm^2)$	Lower Stress $\sigma_c(N/mm^2)$	Neutral Axis (m)	Tensile Force T(kN)	Required Bar Area T/fsa(m,m^2)	Re-Bar Arrangement (mm^2)
No.2-j	Group-I	4.536	-1.069	0.439	1479.947	8809.2	9091.2
	Group-IV	4.697	-1.300	0.498	1909.154	9091.2	
No.3-i	Group-I	4.536	-1.072	0.440	1484.723	8837.6	9114.4
	Group-IV	4.697	-1.302	0.499	1914.024	9114.4	
No.3-j	Group-I	5.023	-1.779	0.602	2822.496	16800.6	17551.3
	Group-IV	5.303	-2.221	0.679	3685.778	17551.3	
No.4-i	Group-I	5.023	-1.779	0.602	2822.495	16800.6	17551.3
	Group-IV	5.303	-2.221	0.679	3685.777	17551.3	
No.4-j	Group-I	5.139	-1.759	0.587	2763.877	16451.6	19722.1
	Group-IV	5.566	-2.462	0.705	4141.637	19722.1	
No.5-i	Group-I	5.139	-1.759	0.587	2763.877	16451.6	19722.1
	Group-IV	5.566	-2.462	0.705	4141.637	19722.1	
No.5-j	Group-I	4.785	-1.212	0.465	1725.177	10268.9	17040.6
	Group-IV	5.359	-2.174	0.664	3578.533	17040.6	
No.6-i	Group-I	4.785	-1.212	0.465	1725.177	10268.9	17040.6
	Group-IV	5.359	-2.174	0.664	3578.533	17040.6	
No.6-j	Group-I	No tension	No tension	-	0.000	0.0	4019.7
	Group-IV	4.399	-0.725	0.325	844.132	4019.7	
No.7-i	Group-I	No tension	No tension	-	0.000	0.0	4019.7
	Group-IV	4.399	-0.725	0.325	844.133	4019.7	
No.7-j	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.8-i	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.8-j	Group-I	-0.082	5.970	0.031	17.224	102.5	1203.4
	Group-IV	-0.330	6.391	0.113	252.711	1203.4	
No.9-i	Group-I	-0.048	6.068	0.018	5.852	34.8	960.0
	Group-IV	-0.296	6.489	0.100	201.602	960.0	
No.9-j	Group-I	-2.937	8.072	0.614	10181.023	60601.3	60601.3
	Group-IV	-3.218	8.431	0.635	11344.771	54022.7	
No.14-i	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.14-j	Group-I	3.723	-0.815	0.413	1094.786	6516.6	20072.6
	Group-IV	4.585	-2.407	0.792	4215.236	20072.6	
No.15-i	Group-I	3.721	-0.817	0.414	1097.864	6534.9	20089.4
	Group-IV	4.584	-2.408	0.792	4218.768	20089.4	
No.15-j	Group-I	3.831	-1.024	0.485	1485.721	8843.6	20850.5
	Group-IV	4.624	-2.487	0.804	4378.600	20850.5	
No.16-i	Group-I	3.831	-1.024	0.485	1485.719	8843.6	20850.5
	Group-IV	4.624	-2.487	0.804	4378.598	20850.5	
No.16-j	Group-I	3.461	-0.717	0.395	940.509	5598.3	16806.4
	Group-IV	4.181	-2.047	0.756	3529.345	16806.4	
No.17-i	Group-I	3.461	-0.717	0.395	940.510	5598.3	16806.4
	Group-IV	4.181	-2.047	0.756	3529.345	16806.4	
No.17-j	Group-I	3.657	-1.205	0.570	1872.699	11147.0	20360.7
	Group-IV	4.305	-2.408	0.825	4275.743	20360.7	
No.18-i	Group-I	3.657	-1.205	0.570	1872.699	11147.0	20360.7
	Group-IV	4.305	-2.408	0.825	4275.743	20360.7	
No.18-j	Group-I	2.991	-0.220	0.158	129.985	773.7	9849.1
	Group-IV	3.566	-1.295	0.613	2068.318	9849.1	

Member	Load Case	Upper Stress $\sigma_c'(N/mm^2)$	Lower Stress $\sigma_c(N/mm^2)$	Neutral Axis (m)	Tensile Force T(kN)	Required Bar Area T/fsa(m,m ²)	Re-Bar Arrangement (mm ²)
No.19-i	Group-I	2.991	-0.220	0.158	129.985	773.7	9849.1
	Group-IV	3.566	-1.295	0.613	2068.319	9849.1	
No.19-j	Group-I	0.000	0.000	0.000	0.000	0.0	4688.7
	Group-IV	3.015	-0.711	0.439	984.635	4688.7	
No.20-i	Group-I	0.000	0.000	0.000	0.000	0.0	4688.7
	Group-IV	3.015	-0.711	0.439	984.637	4688.7	
No.20-j	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.21-i	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.21-j	Group-I	-2.455	5.987	0.669	8862.838	52755.0	52755.0
	Group-IV	-2.702	6.187	0.699	9947.042	47366.9	
No.26-i	Group-I	-2.500	6.050	0.673	9047.324	53853.1	53853.1
	Group-IV	-2.747	6.249	0.702	10131.668	48246.0	
No.26-j	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.27-i	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.27-j	Group-I	0.000	0.000	0.000	0.000	0.0	4557.9
	Group-IV	3.004	-0.696	0.433	957.160	4557.9	
No.28-i	Group-I	0.000	0.000	0.000	0.000	0.0	4557.9
	Group-IV	3.004	-0.696	0.433	957.158	4557.9	
No.28-j	Group-I	2.993	-0.228	0.163	139.082	827.9	9924.9
	Group-IV	3.568	-1.303	0.615	2084.239	9924.9	
No.29-i	Group-I	2.993	-0.228	0.163	139.082	827.9	9924.9
	Group-IV	3.568	-1.303	0.615	2084.239	9924.9	
No.29-j	Group-I	3.670	-1.227	0.576	1915.180	11399.9	20574.5
	Group-IV	4.317	-2.430	0.828	4320.649	20574.5	
No.30-i	Group-I	3.670	-1.227	0.576	1915.180	11399.9	20574.5
	Group-IV	4.317	-2.430	0.828	4320.649	20574.5	
No.30-j	Group-I	3.486	-0.758	0.411	1014.942	6041.3	17194.6
	Group-IV	4.205	-2.088	0.763	3610.874	17194.6	
No.31-i	Group-I	3.486	-0.758	0.411	1014.942	6041.3	17194.6
	Group-IV	4.205	-2.088	0.763	3610.874	17194.6	
No.31-j	Group-I	3.707	-0.800	0.408	1068.336	6359.1	18688.9
	Group-IV	4.500	-2.263	0.770	3924.674	18688.9	
No.32-i	Group-I	3.707	-0.800	0.408	1068.338	6359.2	18688.9
	Group-IV	4.500	-2.263	0.770	3924.677	18688.9	
No.32-j	Group-I	3.679	-0.734	0.383	945.228	5626.4	19286.4
	Group-IV	4.542	-2.326	0.779	4050.153	19286.4	
No.33-i	Group-I	3.680	-0.732	0.382	942.102	5607.8	19269.2
	Group-IV	4.543	-2.324	0.778	4046.541	19269.2	
No.33-j	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.38-i	Group-I	-2.788	7.871	0.602	9567.749	56950.9	56950.9
	Group-IV	-3.069	8.231	0.625	10731.307	51101.5	
No.38-j	Group-I	0.000	0.000	0.000	0.000	0.0	443.1
	Group-IV	-0.198	6.381	0.069	93.060	443.1	
No.39-i	Group-I	0.000	0.000	0.000	0.000	0.0	670.9
	Group-IV	-0.242	6.253	0.086	140.893	670.9	
No.39-j	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	

Member	Load Case	Upper Stress $\sigma_c'(N/mm^2)$	Lower Stress $\sigma_c(N/mm^2)$	Neutral Axis (m)	Tensile Force T(kN)	Required Bar Area T/fsa(m,m ²)	Re-Bar Arrangement (mm ²)
No.40-i	Group-I	No tension	No tension	-	0.000	0.0	0.0
	Group-IV	No tension	No tension	-	0.000	0.0	
No.40-j	Group-I	No tension	No tension	-	0.000	0.0	3358.6
	Group-IV	4.367	-0.647	0.297	705.300	3358.6	
No.41-i	Group-I	No tension	No tension	-	0.000	0.0	3358.6
	Group-IV	4.367	-0.647	0.297	705.300	3358.6	
No.41-j	Group-I	4.705	-1.051	0.420	1423.548	8473.5	15475.2
	Group-IV	5.275	-2.008	0.634	3249.800	15475.2	
No.42-i	Group-I	4.705	-1.051	0.420	1423.548	8473.5	15475.2
	Group-IV	5.275	-2.008	0.634	3249.800	15475.2	
No.42-j	Group-I	5.021	-1.545	0.541	2351.101	13994.6	17637.1
	Group-IV	5.444	-2.242	0.671	3703.799	17637.1	
No.43-i	Group-I	5.021	-1.545	0.541	2351.101	13994.6	17637.1
	Group-IV	5.444	-2.242	0.671	3703.799	17637.1	
No.43-j	Group-I	4.935	-1.628	0.571	2530.865	15064.7	16060.5
	Group-IV	5.211	-2.062	0.652	3372.711	16060.5	
No.44-i	Group-I	4.935	-1.628	0.571	2530.866	15064.7	16060.5
	Group-IV	5.211	-2.062	0.652	3372.712	16060.5	
No.44-j	Group-I	4.477	-0.968	0.409	1293.454	7699.1	8207.9
	Group-IV	4.640	-1.201	0.473	1723.649	8207.9	
No.45-i	Group-I	4.477	-0.966	0.408	1289.114	7673.3	8186.7
	Group-IV	4.640	-1.199	0.472	1719.213	8186.7	

2.8 Load Factor Design

2.8.1 Checking Flexural Strength

Group-I : D+L , Group-IV : D+L+T

Member No.	Combination Group	Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	$\phi M_n2 / M_u$	Neutral Axis (cm)	
		Nu(kN)	Mu(kN.m)	ϕM_n1 (kN.m)	ϕM_n2 (kN.m)			
1-i	Group-I	LMmax	0.0	-34.0	-34932.4	-75409.9	2218.07	18.1
		LMmin	0.0	-34.0	-34932.4	-75409.9	2218.07	18.1
		LNmax	0.0	-34.0	-34932.4	-75409.9	2218.07	18.1
		LNmin	0.0	-34.0	-34932.4	-75409.9	2218.07	18.1
	Group-IV	LMmax Temp. Rise	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LMmax Temp. Down	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LMmax Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LMmax Temp. Down+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LMmin Temp. Rise	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LMmin Temp. Down	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LMmin Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LMmin Temp. Down+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LNmax Temp. Rise	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LNmax Temp. Down	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LNmax Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LNmax Temp. Down+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LNmin Temp. Rise	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LNmin Temp. Down	0.0	-32.7	-34932.4	-75409.9	2306.82	18.1
		LNmin Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
		LNmin Temp. Down+Temp. Diff.	-9573.7	-7767.5	-23952.7	-64829.7	8.35	13.4
1-j	Group-I	LMmax	0.0	9035.7	42507.3	74876.3	8.29	10.2
		LMmin	0.0	6322.6	42507.3	74876.3	11.84	10.2
		LNmax	0.0	6497.6	42507.3	74876.3	11.52	10.2
		LNmin	0.0	6497.6	42507.3	74876.3	11.52	10.2
	Group-IV	LMmax Temp. Rise	0.0	7779.8	42507.3	74876.3	9.62	10.2
		LMmax Temp. Down	0.0	7648.6	42507.3	74876.3	9.79	10.2
		LMmax Temp. Diff.	-9573.7	236.8	33624.7	66678.8	281.60	7.4
		LMmax Temp. Rise+Temp. Diff.	-9573.7	302.4	33624.7	66678.8	220.50	7.4
		LMmax Temp. Down+Temp. Diff.	-9573.7	171.2	33624.7	66678.8	389.56	7.4
		LMmin Temp. Rise	0.0	6216.9	42507.3	74876.3	12.04	10.2
		LMmin Temp. Down	0.0	6085.7	42507.3	74876.3	12.30	10.2
		LMmin Temp. Diff.	-9573.7	-1326.1	-21505.2	-62418.6	47.07	13.3
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-1260.5	-21505.2	-62418.6	49.52	13.3
		LMmin Temp. Down+Temp. Diff.	-9573.7	-1391.7	-21505.2	-62418.6	44.85	13.3
		LNmax Temp. Rise	0.0	6317.7	42507.3	74876.3	11.85	10.2
		LNmax Temp. Down	0.0	6186.5	42507.3	74876.3	12.10	10.2
		LNmax Temp. Diff.	-9573.7	-1225.3	-21505.2	-62418.6	50.94	13.3
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-1159.7	-21505.2	-62418.6	53.82	13.3
		LNmax Temp. Down+Temp. Diff.	-9573.7	-1290.9	-21505.2	-62418.6	48.35	13.3
		LNmin Temp. Rise	0.0	6317.7	42507.3	74876.3	11.85	10.2
		LNmin Temp. Down	0.0	6186.5	42507.3	74876.3	12.10	10.2
		LNmin Temp. Diff.	-9573.7	-1225.3	-21505.2	-62418.6	50.94	13.3
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-1159.7	-21505.2	-62418.6	53.82	13.3
		LNmin Temp. Down+Temp. Diff.	-9573.7	-1290.9	-21505.2	-62418.6	48.35	13.3
2-i	Group-I	LMmax	0.0	9035.7	42507.3	74876.4	8.29	10.2
		LMmin	0.0	6322.6	42507.3	74876.4	11.84	10.2
		LNmax	0.0	6497.6	42507.3	74876.4	11.52	10.2
		LNmin	0.0	6497.6	42507.3	74876.4	11.52	10.2
	Group-IV	LMmax Temp. Rise	0.0	7779.8	42507.3	74876.4	9.62	10.2
		LMmax Temp. Down	0.0	7648.6	42507.3	74876.4	9.79	10.2
		LMmax Temp. Diff.	-9573.7	236.8	33624.7	66678.9	281.60	7.4
		LMmax Temp. Rise+Temp. Diff.	-9573.7	302.4	33624.7	66678.9	220.50	7.4
		LMmax Temp. Down+Temp. Diff.	-9573.7	171.2	33624.7	66678.9	389.56	7.4
		LMmin Temp. Rise	0.0	6216.9	42507.3	74876.4	12.04	10.2
		LMmin Temp. Down	0.0	6085.7	42507.3	74876.4	12.30	10.2
		LMmin Temp. Diff.	-9573.7	-1326.1	-21506.7	-62417.5	47.07	13.3
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-1260.5	-21506.7	-62417.5	49.52	13.3
		LMmin Temp. Down+Temp. Diff.	-9573.7	-1391.7	-21506.7	-62417.5	44.85	13.3
		LNmax Temp. Rise	0.0	6317.7	42507.3	74876.4	11.85	10.2
		LNmax Temp. Down	0.0	6186.5	42507.3	74876.4	12.10	10.2
		LNmax Temp. Diff.	-9573.7	-1225.3	-21506.7	-62417.5	50.94	13.3
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-1159.7	-21506.7	-62417.5	53.82	13.3
		LNmax Temp. Down+Temp. Diff.	-9573.7	-1290.9	-21506.7	-62417.5	48.35	13.3
		LNmin Temp. Rise	0.0	6317.7	42507.3	74876.4	11.85	10.2
		LNmin Temp. Down	0.0	6186.5	42507.3	74876.4	12.10	10.2
		LNmin Temp. Diff.	-9573.7	-1225.3	-21506.7	-62417.5	50.94	13.3
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-1159.7	-21506.7	-62417.5	53.82	13.3
		LNmin Temp. Down+Temp. Diff.	-9573.7	-1290.9	-21506.7	-62417.5	48.35	13.3

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
2-j	Group-I	LMmax	0.0	46886.0	56016.3	88463.6	1.89	10.2	
		LMmin	0.0	32328.2	56016.3	88463.6	2.74	10.2	
		LNmax	0.0	33492.2	56016.3	88463.6	2.64	10.2	
		LNmin	0.0	33492.2	56016.3	88463.6	2.64	10.2	
	Group-IV	LMmax Temp. Rise	0.0	40385.6	56016.3	88463.6	2.19	10.2	
		LMmax Temp. Down	0.0	39512.6	56016.3	88463.6	2.24	10.2	
		LMmax Temp. Diff.	-9426.2	35801.7	49059.2	82153.2	2.29	7.5	
		LMmax Temp. Rise+Temp. Diff.	-9426.2	36238.2	49059.2	82153.2	2.27	7.5	
		LMmax Temp. Down+Temp. Diff.	-9426.2	35365.2	49059.2	82153.2	2.32	7.5	
		LMmin Temp. Rise	0.0	31999.7	56016.3	88463.6	2.76	10.2	
		LMmin Temp. Down	0.0	31126.7	56016.3	88463.6	2.84	10.2	
		LMmin Temp. Diff.	-9426.2	27415.9	49059.2	82153.2	3.00	7.5	
		LMmin Temp. Rise+Temp. Diff.	-9426.2	27852.4	49059.2	82153.2	2.95	7.5	
		LMmin Temp. Down+Temp. Diff.	-9426.2	26979.4	49059.2	82153.2	3.05	7.5	
		LNmax Temp. Rise	0.0	32670.3	56016.3	88463.6	2.71	10.2	
		LNmax Temp. Down	0.0	31797.3	56016.3	88463.6	2.78	10.2	
		LNmax Temp. Diff.	-9426.2	28086.4	49059.2	82153.2	2.93	7.5	
		LNmax Temp. Rise+Temp. Diff.	-9426.2	28522.9	49059.2	82153.2	2.88	7.5	
		LNmax Temp. Down+Temp. Diff.	-9426.2	27649.9	49059.2	82153.2	2.97	7.5	
		LNmin Temp. Rise	0.0	32670.3	56016.3	88463.6	2.71	10.2	
		LNmin Temp. Down	0.0	31797.3	56016.3	88463.6	2.78	10.2	
		LNmin Temp. Diff.	-9426.2	28086.4	49059.2	82153.2	2.93	7.5	
		LNmin Temp. Rise+Temp. Diff.	-9426.2	28522.9	49059.2	82153.2	2.88	7.5	
		LNmin Temp. Down+Temp. Diff.	-9426.2	27649.9	49059.2	82153.2	2.97	7.5	
	3-i	Group-I	LMmax	0.0	46886.0	56016.3	88463.6	1.89	10.2
			LMmin	0.0	32328.2	56016.3	88463.6	2.74	10.2
LNmax			0.0	33492.2	56016.3	88463.6	2.64	10.2	
LNmin			0.0	33492.2	56016.3	88463.6	2.64	10.2	
Group-IV		LMmax Temp. Rise	0.0	40385.6	56016.3	88463.6	2.19	10.2	
		LMmax Temp. Down	0.0	39512.6	56016.3	88463.6	2.24	10.2	
		LMmax Temp. Diff.	-9426.2	35801.7	49059.2	82153.2	2.29	7.5	
		LMmax Temp. Rise+Temp. Diff.	-9426.2	36238.2	49059.2	82153.2	2.27	7.5	
		LMmax Temp. Down+Temp. Diff.	-9426.2	35365.2	49059.2	82153.2	2.32	7.5	
		LMmin Temp. Rise	0.0	31999.7	56016.3	88463.6	2.76	10.2	
		LMmin Temp. Down	0.0	31126.7	56016.3	88463.6	2.84	10.2	
		LMmin Temp. Diff.	-9426.2	27415.9	49059.2	82153.2	3.00	7.5	
		LMmin Temp. Rise+Temp. Diff.	-9426.2	27852.4	49059.2	82153.2	2.95	7.5	
		LMmin Temp. Down+Temp. Diff.	-9426.2	26979.4	49059.2	82153.2	3.05	7.5	
		LNmax Temp. Rise	0.0	32670.3	56016.3	88463.6	2.71	10.2	
		LNmax Temp. Down	0.0	31797.3	56016.3	88463.6	2.78	10.2	
		LNmax Temp. Diff.	-9426.2	28086.4	49059.2	82153.2	2.93	7.5	
		LNmax Temp. Rise+Temp. Diff.	-9426.2	28522.9	49059.2	82153.2	2.88	7.5	
		LNmax Temp. Down+Temp. Diff.	-9426.2	27649.9	49059.2	82153.2	2.97	7.5	
		LNmin Temp. Rise	0.0	32670.3	56016.3	88463.6	2.71	10.2	
		LNmin Temp. Down	0.0	31797.3	56016.3	88463.6	2.78	10.2	
		LNmin Temp. Diff.	-9426.2	28086.4	49059.2	82153.2	2.93	7.5	
		LNmin Temp. Rise+Temp. Diff.	-9426.2	28522.9	49059.2	82153.2	2.88	7.5	
		LNmin Temp. Down+Temp. Diff.	-9426.2	27649.9	49059.2	82153.2	2.97	7.5	
3-j		Group-I	LMmax	0.0	58538.5	63369.1	95816.4	1.64	10.2
			LMmin	0.0	40237.0	63369.1	95816.4	2.38	10.2
	LNmax		0.0	41956.5	63369.1	95816.4	2.28	10.2	
	LNmin		0.0	41956.5	63369.1	95816.4	2.28	10.2	
	Group-IV	LMmax Temp. Rise	0.0	50583.3	63369.1	95816.4	1.89	10.2	
		LMmax Temp. Down	0.0	49293.8	63369.1	95816.4	1.94	10.2	
		LMmax Temp. Diff.	-9426.2	46608.1	56412.0	89506.1	1.92	7.5	
		LMmax Temp. Rise+Temp. Diff.	-9426.2	47252.9	56412.0	89506.1	1.89	7.5	
		LMmax Temp. Down+Temp. Diff.	-9426.2	45963.4	56412.0	89506.1	1.95	7.5	
		LMmin Temp. Rise	0.0	40041.0	63369.1	95816.4	2.39	10.2	
		LMmin Temp. Down	0.0	38751.5	63369.1	95816.4	2.47	10.2	
		LMmin Temp. Diff.	-9426.2	36065.8	56412.0	89506.1	2.48	7.5	
		LMmin Temp. Rise+Temp. Diff.	-9426.2	36710.6	56412.0	89506.1	2.44	7.5	
		LMmin Temp. Down+Temp. Diff.	-9426.2	35421.1	56412.0	89506.1	2.53	7.5	
		LNmax Temp. Rise	0.0	41031.4	63369.1	95816.4	2.34	10.2	
		LNmax Temp. Down	0.0	39741.9	63369.1	95816.4	2.41	10.2	
		LNmax Temp. Diff.	-9426.2	37056.3	56412.0	89506.1	2.42	7.5	
		LNmax Temp. Rise+Temp. Diff.	-9426.2	37701.0	56412.0	89506.1	2.37	7.5	
		LNmax Temp. Down+Temp. Diff.	-9426.2	36411.5	56412.0	89506.1	2.46	7.5	
		LNmin Temp. Rise	0.0	41031.4	63369.1	95816.4	2.34	10.2	
		LNmin Temp. Down	0.0	39741.9	63369.1	95816.4	2.41	10.2	
		LNmin Temp. Diff.	-9426.2	37056.3	56412.0	89506.1	2.42	7.5	
		LNmin Temp. Rise+Temp. Diff.	-9426.2	37701.0	56412.0	89506.1	2.37	7.5	
		LNmin Temp. Down+Temp. Diff.	-9426.2	36411.5	56412.0	89506.1	2.46	7.5	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	ϕ Mn2 / Mu	Neutral Axis (cm)		
			Nu(kN)	Mu(kN.m)	ϕ Mn1(kN.m)	ϕ Mn2(kN.m)				
4-i	Group-I	LMmax	0.0	58538.5	63369.1	95816.4	1.64	10.2		
		LMmin	0.0	40237.0	63369.1	95816.4	2.38	10.2		
		LNmax	0.0	41956.5	63369.1	95816.4	2.28	10.2		
		LNmin	0.0	41956.5	63369.1	95816.4	2.28	10.2		
	Group-IV	LMmax Temp. Rise	0.0	50583.3	63369.1	95816.4	1.89	10.2		
		LMmax Temp. Down	0.0	49293.8	63369.1	95816.4	1.94	10.2		
		LMmax Temp. Diff.	-9426.2	46608.1	56412.0	89506.1	1.92	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	47252.9	56412.0	89506.1	1.89	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	45963.4	56412.0	89506.1	1.95	7.5		
		LMmin Temp. Rise	0.0	40041.0	63369.1	95816.4	2.39	10.2		
		LMmin Temp. Down	0.0	38751.5	63369.1	95816.4	2.47	10.2		
		LMmin Temp. Diff.	-9426.2	36065.8	56412.0	89506.1	2.48	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	36710.6	56412.0	89506.1	2.44	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	35421.1	56412.0	89506.1	2.53	7.5		
		LNmax Temp. Rise	0.0	41031.4	63369.1	95816.4	2.34	10.2		
		LNmax Temp. Down	0.0	39741.9	63369.1	95816.4	2.41	10.2		
		LNmax Temp. Diff.	-9426.2	37056.3	56412.0	89506.1	2.42	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	37701.0	56412.0	89506.1	2.37	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	36411.5	56412.0	89506.1	2.46	7.5		
		LNmin Temp. Rise	0.0	41031.4	63369.1	95816.4	2.34	10.2		
		LNmin Temp. Down	0.0	39741.9	63369.1	95816.4	2.41	10.2		
		LNmin Temp. Diff.	-9426.2	37056.3	56412.0	89506.1	2.42	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	37701.0	56412.0	89506.1	2.37	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	36411.5	56412.0	89506.1	2.46	7.5		
		4-j	Group-I	LMmax	0.0	64035.7	67971.5	100418.8	1.57	10.2
				LMmin	0.0	43673.3	67971.5	100418.8	2.30	10.2
				LNmax	0.0	46085.1	67971.5	100418.8	2.18	10.2
				LNmin	0.0	46085.1	67971.5	100418.8	2.18	10.2
Group-IV	LMmax Temp. Rise		0.0	55618.8	67971.5	100418.8	1.81	10.2		
	LMmax Temp. Down		0.0	53810.0	67971.5	100418.8	1.87	10.2		
	LMmax Temp. Diff.		-9426.2	52402.4	61014.4	94108.5	1.80	7.5		
	LMmax Temp. Rise+Temp. Diff.		-9426.2	53306.7	61014.4	94108.5	1.77	7.5		
	LMmax Temp. Down+Temp. Diff.		-9426.2	51498.0	61014.4	94108.5	1.83	7.5		
	LMmin Temp. Rise		0.0	43889.2	67971.5	100418.8	2.29	10.2		
	LMmin Temp. Down		0.0	42080.5	67971.5	100418.8	2.39	10.2		
	LMmin Temp. Diff.		-9426.2	40672.9	61014.4	94108.5	2.31	7.5		
	LMmin Temp. Rise+Temp. Diff.		-9426.2	41577.2	61014.4	94108.5	2.26	7.5		
	LMmin Temp. Down+Temp. Diff.		-9426.2	39768.5	61014.4	94108.5	2.37	7.5		
	LNmax Temp. Rise		0.0	45278.5	67971.5	100418.8	2.22	10.2		
	LNmax Temp. Down		0.0	43469.8	67971.5	100418.8	2.31	10.2		
	LNmax Temp. Diff.		-9426.2	42062.1	61014.4	94108.5	2.24	7.5		
	LNmax Temp. Rise+Temp. Diff.		-9426.2	42966.5	61014.4	94108.5	2.19	7.5		
	LNmax Temp. Down+Temp. Diff.		-9426.2	41157.8	61014.4	94108.5	2.29	7.5		
	LNmin Temp. Rise		0.0	45278.5	67971.5	100418.8	2.22	10.2		
	LNmin Temp. Down		0.0	43469.8	67971.5	100418.8	2.31	10.2		
	LNmin Temp. Diff.		-9426.2	42062.1	61014.4	94108.5	2.24	7.5		
	LNmin Temp. Rise+Temp. Diff.		-9426.2	42966.5	61014.4	94108.5	2.19	7.5		
	LNmin Temp. Down+Temp. Diff.		-9426.2	41157.8	61014.4	94108.5	2.29	7.5		
	5-i		Group-I	LMmax	0.0	64035.7	67971.5	100418.8	1.57	10.2
				LMmin	0.0	43673.3	67971.5	100418.8	2.30	10.2
				LNmax	0.0	46085.1	67971.5	100418.8	2.18	10.2
				LNmin	0.0	46085.1	67971.5	100418.8	2.18	10.2
Group-IV		LMmax Temp. Rise	0.0	55618.8	67971.5	100418.8	1.81	10.2		
		LMmax Temp. Down	0.0	53810.0	67971.5	100418.8	1.87	10.2		
		LMmax Temp. Diff.	-9426.2	52402.4	61014.4	94108.5	1.80	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	53306.7	61014.4	94108.5	1.77	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	51498.0	61014.4	94108.5	1.83	7.5		
		LMmin Temp. Rise	0.0	43889.2	67971.5	100418.8	2.29	10.2		
		LMmin Temp. Down	0.0	42080.5	67971.5	100418.8	2.39	10.2		
		LMmin Temp. Diff.	-9426.2	40672.9	61014.4	94108.5	2.31	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	41577.2	61014.4	94108.5	2.26	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	39768.5	61014.4	94108.5	2.37	7.5		
		LNmax Temp. Rise	0.0	45278.5	67971.5	100418.8	2.22	10.2		
		LNmax Temp. Down	0.0	43469.8	67971.5	100418.8	2.31	10.2		
		LNmax Temp. Diff.	-9426.2	42062.1	61014.4	94108.5	2.24	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	42966.5	61014.4	94108.5	2.19	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	41157.8	61014.4	94108.5	2.29	7.5		
		LNmin Temp. Rise	0.0	45278.5	67971.5	100418.8	2.22	10.2		
		LNmin Temp. Down	0.0	43469.8	67971.5	100418.8	2.31	10.2		
		LNmin Temp. Diff.	-9426.2	42062.1	61014.4	94108.5	2.24	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	42966.5	61014.4	94108.5	2.19	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	41157.8	61014.4	94108.5	2.29	7.5		

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)		
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)				
5-j	Group-I	LMmax	0.0	60156.8	67971.5	100418.8	1.67	10.2		
		LMmin	0.0	40011.1	67971.5	100418.8	2.51	10.2		
		LNmax	0.0	43115.2	67971.5	100418.8	2.33	10.2		
		LNmin	0.0	43115.2	67971.5	100418.8	2.33	10.2		
	Group-IV	LMmax Temp. Rise	0.0	52516.7	67971.5	100418.8	1.91	10.2		
		LMmax Temp. Down	0.0	50188.8	67971.5	100418.8	2.00	10.2		
		LMmax Temp. Diff.	-9426.2	50059.1	61014.4	94108.5	1.88	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	51223.1	61014.4	94108.5	1.84	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	48895.1	61014.4	94108.5	1.92	7.5		
		LMmin Temp. Rise	0.0	40912.0	67971.5	100418.8	2.45	10.2		
		LMmin Temp. Down	0.0	38584.1	67971.5	100418.8	2.60	10.2		
		LMmin Temp. Diff.	-9426.2	38454.4	61014.4	94108.5	2.45	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	39618.4	61014.4	94108.5	2.38	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	37290.4	61014.4	94108.5	2.52	7.5		
		LNmax Temp. Rise	0.0	42700.1	67971.5	100418.8	2.35	10.2		
		LNmax Temp. Down	0.0	40372.2	67971.5	100418.8	2.49	10.2		
		LNmax Temp. Diff.	-9426.2	40242.5	61014.4	94108.5	2.34	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	41406.5	61014.4	94108.5	2.27	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	39078.5	61014.4	94108.5	2.41	7.5		
		LNmin Temp. Rise	0.0	42700.1	67971.5	100418.8	2.35	10.2		
		LNmin Temp. Down	0.0	40372.2	67971.5	100418.8	2.49	10.2		
		LNmin Temp. Diff.	-9426.2	40242.5	61014.4	94108.5	2.34	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	41406.5	61014.4	94108.5	2.27	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	39078.5	61014.4	94108.5	2.41	7.5		
		6-i	Group-I	LMmax	0.0	60156.8	67971.5	100418.8	1.67	10.2
				LMmin	0.0	40011.1	67971.5	100418.8	2.51	10.2
				LNmax	0.0	43115.2	67971.5	100418.8	2.33	10.2
				LNmin	0.0	43115.2	67971.5	100418.8	2.33	10.2
Group-IV	LMmax Temp. Rise		0.0	52516.7	67971.5	100418.8	1.91	10.2		
	LMmax Temp. Down		0.0	50188.8	67971.5	100418.8	2.00	10.2		
	LMmax Temp. Diff.		-9426.2	50059.1	61014.4	94108.5	1.88	7.5		
	LMmax Temp. Rise+Temp. Diff.		-9426.2	51223.1	61014.4	94108.5	1.84	7.5		
	LMmax Temp. Down+Temp. Diff.		-9426.2	48895.1	61014.4	94108.5	1.92	7.5		
	LMmin Temp. Rise		0.0	40912.0	67971.5	100418.8	2.45	10.2		
	LMmin Temp. Down		0.0	38584.1	67971.5	100418.8	2.60	10.2		
	LMmin Temp. Diff.		-9426.2	38454.4	61014.4	94108.5	2.45	7.5		
	LMmin Temp. Rise+Temp. Diff.		-9426.2	39618.4	61014.4	94108.5	2.38	7.5		
	LMmin Temp. Down+Temp. Diff.		-9426.2	37290.4	61014.4	94108.5	2.52	7.5		
	LNmax Temp. Rise		0.0	42700.1	67971.5	100418.8	2.35	10.2		
	LNmax Temp. Down		0.0	40372.2	67971.5	100418.8	2.49	10.2		
	LNmax Temp. Diff.		-9426.2	40242.5	61014.4	94108.5	2.34	7.5		
	LNmax Temp. Rise+Temp. Diff.		-9426.2	41406.5	61014.4	94108.5	2.27	7.5		
	LNmax Temp. Down+Temp. Diff.		-9426.2	39078.5	61014.4	94108.5	2.41	7.5		
	LNmin Temp. Rise		0.0	42700.1	67971.5	100418.8	2.35	10.2		
	LNmin Temp. Down		0.0	40372.2	67971.5	100418.8	2.49	10.2		
	LNmin Temp. Diff.		-9426.2	40242.5	61014.4	94108.5	2.34	7.5		
	LNmin Temp. Rise+Temp. Diff.		-9426.2	41406.5	61014.4	94108.5	2.27	7.5		
	LNmin Temp. Down+Temp. Diff.		-9426.2	39078.5	61014.4	94108.5	2.41	7.5		
	6-j		Group-I	LMmax	0.0	46984.9	66272.9	98720.2	2.10	10.2
				LMmin	0.0	28782.3	66272.9	98720.2	3.43	10.2
				LNmax	0.0	32578.8	66272.9	98720.2	3.03	10.2
				LNmin	0.0	32578.8	66272.9	98720.2	3.03	10.2
Group-IV		LMmax Temp. Rise	0.0	41144.7	66272.9	98720.2	2.40	10.2		
		LMmax Temp. Down	0.0	38297.5	66272.9	98720.2	2.58	10.2		
		LMmax Temp. Diff.	-9426.2	39445.9	59315.8	92409.8	2.34	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	40869.5	59315.8	92409.8	2.26	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	38022.3	59315.8	92409.8	2.43	7.5		
		LMmin Temp. Rise	0.0	30659.3	66272.9	98720.2	3.22	10.2		
		LMmin Temp. Down	0.0	27812.1	66272.9	98720.2	3.55	10.2		
		LMmin Temp. Diff.	-9426.2	28960.5	59315.8	92409.8	3.19	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	30384.1	59315.8	92409.8	3.04	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	27536.9	59315.8	92409.8	3.36	7.5		
		LNmax Temp. Rise	0.0	32846.2	66272.9	98720.2	3.01	10.2		
		LNmax Temp. Down	0.0	29999.0	66272.9	98720.2	3.29	10.2		
		LNmax Temp. Diff.	-9426.2	31147.4	59315.8	92409.8	2.97	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	32571.0	59315.8	92409.8	2.84	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	29723.8	59315.8	92409.8	3.11	7.5		
		LNmin Temp. Rise	0.0	32846.2	66272.9	98720.2	3.01	10.2		
		LNmin Temp. Down	0.0	29999.0	66272.9	98720.2	3.29	10.2		
		LNmin Temp. Diff.	-9426.2	31147.4	59315.8	92409.8	2.97	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	32571.0	59315.8	92409.8	2.84	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	29723.8	59315.8	92409.8	3.11	7.5		

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)		
			7-i	Group-I	LMmax	0.0		
	LMmin	0.0	28782.3		66272.9	98720.2	3.43	10.2
	LNmax	0.0	32578.8		66272.9	98720.2	3.03	10.2
	LNmin	0.0	32578.8		66272.9	98720.2	3.03	10.2
	Group-IV	LMmax Temp. Rise	0.0	41144.7	66272.9	98720.2	2.40	10.2
		LMmax Temp. Down	0.0	38297.5	66272.9	98720.2	2.58	10.2
		LMmax Temp. Diff.	-9426.2	39445.9	59315.8	92409.8	2.34	7.5
		LMmax Temp. Rise+Temp. Diff.	-9426.2	40869.5	59315.8	92409.8	2.26	7.5
		LMmax Temp. Down+Temp. Diff.	-9426.2	38022.3	59315.8	92409.8	2.43	7.5
		LMmin Temp. Rise	0.0	30659.3	66272.9	98720.2	3.22	10.2
		LMmin Temp. Down	0.0	27812.1	66272.9	98720.2	3.55	10.2
		LMmin Temp. Diff.	-9426.2	28960.5	59315.8	92409.8	3.19	7.5
		LMmin Temp. Rise+Temp. Diff.	-9426.2	30384.1	59315.8	92409.8	3.04	7.5
		LMmin Temp. Down+Temp. Diff.	-9426.2	27536.9	59315.8	92409.8	3.36	7.5
		LNmax Temp. Rise	0.0	32846.2	66272.9	98720.2	3.01	10.2
		LNmax Temp. Down	0.0	29999.0	66272.9	98720.2	3.29	10.2
		LNmax Temp. Diff.	-9426.2	31147.4	59315.8	92409.8	2.97	7.5
		LNmax Temp. Rise+Temp. Diff.	-9426.2	32571.0	59315.8	92409.8	2.84	7.5
		LNmax Temp. Down+Temp. Diff.	-9426.2	29723.8	59315.8	92409.8	3.11	7.5
		LNmin Temp. Rise	0.0	32846.2	66272.9	98720.2	3.01	10.2
		LNmin Temp. Down	0.0	29999.0	66272.9	98720.2	3.29	10.2
		LNmin Temp. Diff.	-9426.2	31147.4	59315.8	92409.8	2.97	7.5
		LNmin Temp. Rise+Temp. Diff.	-9426.2	32571.0	59315.8	92409.8	2.84	7.5
		LNmin Temp. Down+Temp. Diff.	-9426.2	29723.8	59315.8	92409.8	3.11	7.5
7-j	Group-I	LMmax	0.0	24516.7	57135.5	89582.9	3.65	10.2
		LMmin	0.0	10517.6	57135.5	89582.9	8.52	10.2
		LNmax	0.0	15006.4	57135.5	89582.9	5.97	10.2
		LNmin	0.0	15006.4	57135.5	89582.9	5.97	10.2
	Group-IV	LMmax Temp. Rise	0.0	21705.3	57135.5	89582.9	4.13	10.2
		LMmax Temp. Down	0.0	18338.9	57135.5	89582.9	4.88	10.2
		LMmax Temp. Diff.	-9426.2	20765.2	50178.4	83272.5	4.01	7.5
		LMmax Temp. Rise+Temp. Diff.	-9426.2	22448.4	50178.4	83272.5	3.71	7.5
		LMmax Temp. Down+Temp. Diff.	-9426.2	19082.0	50178.4	83272.5	4.36	7.5
		LMmin Temp. Rise	0.0	13641.3	57135.5	89582.9	6.57	10.2
		LMmin Temp. Down	0.0	10274.9	57135.5	89582.9	8.72	10.2
		LMmin Temp. Diff.	-9426.2	12701.2	50178.4	83272.5	6.56	7.5
		LMmin Temp. Rise+Temp. Diff.	-9426.2	14384.4	50178.4	83272.5	5.79	7.5
		LMmin Temp. Down+Temp. Diff.	-9426.2	11018.0	50178.4	83272.5	7.56	7.5
		LNmax Temp. Rise	0.0	16227.0	57135.5	89582.9	5.52	10.2
		LNmax Temp. Down	0.0	12860.6	57135.5	89582.9	6.97	10.2
		LNmax Temp. Diff.	-9426.2	15286.9	50178.4	83272.5	5.45	7.5
		LNmax Temp. Rise+Temp. Diff.	-9426.2	16970.2	50178.4	83272.5	4.91	7.5
		LNmax Temp. Down+Temp. Diff.	-9426.2	13603.7	50178.4	83272.5	6.12	7.5
		LNmin Temp. Rise	0.0	16227.0	57135.5	89582.9	5.52	10.2
		LNmin Temp. Down	0.0	12860.6	57135.5	89582.9	6.97	10.2
		LNmin Temp. Diff.	-9426.2	15286.9	50178.4	83272.5	5.45	7.5
		LNmin Temp. Rise+Temp. Diff.	-9426.2	16970.2	50178.4	83272.5	4.91	7.5
		LNmin Temp. Down+Temp. Diff.	-9426.2	13603.7	50178.4	83272.5	6.12	7.5
8-i	Group-I	LMmax	0.0	24516.7	57135.5	89582.9	3.65	10.2
		LMmin	0.0	10517.6	57135.5	89582.9	8.52	10.2
		LNmax	0.0	15006.4	57135.5	89582.9	5.97	10.2
		LNmin	0.0	15006.4	57135.5	89582.9	5.97	10.2
	Group-IV	LMmax Temp. Rise	0.0	21705.3	57135.5	89582.9	4.13	10.2
		LMmax Temp. Down	0.0	18338.9	57135.5	89582.9	4.88	10.2
		LMmax Temp. Diff.	-9426.2	20765.2	50178.4	83272.5	4.01	7.5
		LMmax Temp. Rise+Temp. Diff.	-9426.2	22448.4	50178.4	83272.5	3.71	7.5
		LMmax Temp. Down+Temp. Diff.	-9426.2	19082.0	50178.4	83272.5	4.36	7.5
		LMmin Temp. Rise	0.0	13641.3	57135.5	89582.9	6.57	10.2
		LMmin Temp. Down	0.0	10274.9	57135.5	89582.9	8.72	10.2
		LMmin Temp. Diff.	-9426.2	12701.2	50178.4	83272.5	6.56	7.5
		LMmin Temp. Rise+Temp. Diff.	-9426.2	14384.4	50178.4	83272.5	5.79	7.5
		LMmin Temp. Down+Temp. Diff.	-9426.2	11018.0	50178.4	83272.5	7.56	7.5
		LNmax Temp. Rise	0.0	16227.0	57135.5	89582.9	5.52	10.2
		LNmax Temp. Down	0.0	12860.6	57135.5	89582.9	6.97	10.2
		LNmax Temp. Diff.	-9426.2	15286.9	50178.4	83272.5	5.45	7.5
		LNmax Temp. Rise+Temp. Diff.	-9426.2	16970.2	50178.4	83272.5	4.91	7.5
		LNmax Temp. Down+Temp. Diff.	-9426.2	13603.7	50178.4	83272.5	6.12	7.5
		LNmin Temp. Rise	0.0	16227.0	57135.5	89582.9	5.52	10.2
		LNmin Temp. Down	0.0	12860.6	57135.5	89582.9	6.97	10.2
		LNmin Temp. Diff.	-9426.2	15286.9	50178.4	83272.5	5.45	7.5
		LNmin Temp. Rise+Temp. Diff.	-9426.2	16970.2	50178.4	83272.5	4.91	7.5
		LNmin Temp. Down+Temp. Diff.	-9426.2	13603.7	50178.4	83272.5	6.12	7.5

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
8-j	Group-I	LMmax	0.0	-4246.8	-35116.5	-75600.7	17.80	18.0	
		LMmin	0.0	-16868.9	-35116.5	-75600.7	4.48	18.0	
		LNmax	0.0	-8721.0	-35116.5	-75600.7	8.67	18.0	
		LNmin	0.0	-8721.0	-35116.5	-75600.7	8.67	18.0	
	Group-IV	LMmax Temp. Rise	0.0	-3742.4	-35116.5	-75600.7	20.20	18.0	
		LMmax Temp. Down	0.0	-7610.9	-35116.5	-75600.7	9.93	18.0	
		LMmax Temp. Diff.	-9573.7	-4281.0	-22604.2	-63470.1	14.83	13.4	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-2346.7	-22604.2	-63470.1	27.05	13.4	
		LMmax Temp. Down+Temp. Diff.	-9573.7	-6215.3	-22604.2	-63470.1	10.21	13.4	
		LMmin Temp. Rise	0.0	-11013.1	-35116.5	-75600.7	6.86	18.0	
		LMmin Temp. Down	0.0	-14881.7	-35116.5	-75600.7	5.08	18.0	
		LMmin Temp. Diff.	-9573.7	-11551.8	-22604.2	-63470.1	5.49	13.4	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-9617.5	-22604.2	-63470.1	6.60	13.4	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-13486.0	-22604.2	-63470.1	4.71	13.4	
		LNmax Temp. Rise	0.0	-6319.6	-35116.5	-75600.7	11.96	18.0	
		LNmax Temp. Down	0.0	-10188.2	-35116.5	-75600.7	7.42	18.0	
		LNmax Temp. Diff.	-9573.7	-6858.3	-22604.2	-63470.1	9.25	13.4	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-4924.0	-22604.2	-63470.1	12.89	13.4	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-8792.6	-22604.2	-63470.1	7.22	13.4	
		LNmin Temp. Rise	0.0	-6319.6	-35116.5	-75600.7	11.96	18.0	
		LNmin Temp. Down	0.0	-10188.2	-35116.5	-75600.7	7.42	18.0	
		LNmin Temp. Diff.	-9573.7	-6858.3	-22604.2	-63470.1	9.25	13.4	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-4924.0	-22604.2	-63470.1	12.89	13.4	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-8792.6	-22604.2	-63470.1	7.22	13.4	
	9-i	Group-I	LMmax	0.0	-4246.8	-35124.2	-75603.4	17.80	18.1
			LMmin	0.0	-16868.9	-35124.2	-75603.4	4.48	18.1
LNmax			0.0	-8721.0	-35124.2	-75603.4	8.67	18.1	
LNmin			0.0	-8721.0	-35124.2	-75603.4	8.67	18.1	
Group-IV		LMmax Temp. Rise	0.0	-3742.4	-35124.2	-75603.4	20.20	18.1	
		LMmax Temp. Down	0.0	-7610.9	-35124.2	-75603.4	9.93	18.1	
		LMmax Temp. Diff.	-9573.7	-4281.0	-22611.6	-63477.9	14.83	13.5	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-2346.7	-22611.6	-63477.9	27.05	13.5	
		LMmax Temp. Down+Temp. Diff.	-9573.7	-6215.3	-22611.6	-63477.9	10.21	13.5	
		LMmin Temp. Rise	0.0	-11013.1	-35124.2	-75603.4	6.86	18.1	
		LMmin Temp. Down	0.0	-14881.7	-35124.2	-75603.4	5.08	18.1	
		LMmin Temp. Diff.	-9573.7	-11551.8	-22611.6	-63477.9	5.50	13.5	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-9617.5	-22611.6	-63477.9	6.60	13.5	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-13486.0	-22611.6	-63477.9	4.71	13.5	
		LNmax Temp. Rise	0.0	-6319.6	-35124.2	-75603.4	11.96	18.1	
		LNmax Temp. Down	0.0	-10188.2	-35124.2	-75603.4	7.42	18.1	
		LNmax Temp. Diff.	-9573.7	-6858.3	-22611.6	-63477.9	9.26	13.5	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-4924.0	-22611.6	-63477.9	12.89	13.5	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-8792.6	-22611.6	-63477.9	7.22	13.5	
		LNmin Temp. Rise	0.0	-6319.6	-35124.2	-75603.4	11.96	18.1	
		LNmin Temp. Down	0.0	-10188.2	-35124.2	-75603.4	7.42	18.1	
		LNmin Temp. Diff.	-9573.7	-6858.3	-22611.6	-63477.9	9.26	13.5	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-4924.0	-22611.6	-63477.9	12.89	13.5	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-8792.6	-22611.6	-63477.9	7.22	13.5	
9-j		Group-I	LMmax	0.0	-55723.8	-68294.4	-116137.4	2.08	19.1
			LMmin	0.0	-78226.3	-68294.4	-116137.4	1.48	19.1
	LNmax		0.0	-56750.8	-68294.4	-116137.4	2.05	19.1	
	LNmin		0.0	-56750.8	-68294.4	-116137.4	2.05	19.1	
	Group-IV	LMmax Temp. Rise	0.0	-51514.4	-68294.4	-116137.4	2.25	19.1	
		LMmax Temp. Down	0.0	-56124.7	-68294.4	-116137.4	2.07	19.1	
		LMmax Temp. Diff.	-9573.7	-52512.0	-57170.0	-105650.6	2.01	13.8	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-50206.9	-57170.0	-105650.6	2.10	13.8	
		LMmax Temp. Down+Temp. Diff.	-9573.7	-54817.2	-57170.0	-105650.6	1.93	13.8	
		LMmin Temp. Rise	0.0	-64476.7	-68294.4	-116137.4	1.80	19.1	
		LMmin Temp. Down	0.0	-69087.0	-68294.4	-116137.4	1.68	19.1	
		LMmin Temp. Diff.	-9573.7	-65474.3	-57170.0	-105650.6	1.61	13.8	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-63169.1	-57170.0	-105650.6	1.67	13.8	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-67779.4	-57170.0	-105650.6	1.56	13.8	
		LNmax Temp. Rise	0.0	-52106.0	-68294.4	-116137.4	2.23	19.1	
		LNmax Temp. Down	0.0	-56716.3	-68294.4	-116137.4	2.05	19.1	
		LNmax Temp. Diff.	-9573.7	-53103.6	-57170.0	-105650.6	1.99	13.8	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-50798.4	-57170.0	-105650.6	2.08	13.8	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-55408.7	-57170.0	-105650.6	1.91	13.8	
		LNmin Temp. Rise	0.0	-52106.0	-68294.4	-116137.4	2.23	19.1	
		LNmin Temp. Down	0.0	-56716.3	-68294.4	-116137.4	2.05	19.1	
		LNmin Temp. Diff.	-9573.7	-53103.6	-57170.0	-105650.6	1.99	13.8	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-50798.4	-57170.0	-105650.6	2.08	13.8	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-55408.7	-57170.0	-105650.6	1.91	13.8	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
14-i	Group-I	LMmax	-2850.8	-28676.2	-65844.5	-113859.3	3.97	17.5	
		LMmin	-2600.3	-51873.3	-66133.7	-114134.6	2.20	17.7	
		LNmax	-2115.4	-42768.3	-66691.8	-114660.0	2.68	18.0	
		LNmin	-3336.8	-37828.1	-65284.8	-113330.3	3.00	17.3	
	Group-IV	LMmax Temp. Rise	-2195.2	-30862.9	-66599.7	-114575.2	3.71	17.9	
		LMmax Temp. Down	-3266.6	-24658.1	-65365.2	-113408.3	4.60	17.3	
		LMmax Temp. Diff.	-12092.9	-28866.6	-54991.7	-103659.6	3.59	12.4	
		LMmax Temp. Rise+Temp. Diff.	-11557.2	-31969.0	-55631.4	-104259.5	3.26	12.7	
		LMmax Temp. Down+Temp. Diff.	-12628.6	-25764.1	-54350.7	-103060.2	4.00	12.1	
		LMmin Temp. Rise	-2050.9	-44225.3	-66764.5	-114729.4	2.59	18.0	
		LMmin Temp. Down	-3122.3	-38020.5	-65530.7	-113564.0	2.99	17.4	
		LMmin Temp. Diff.	-11948.6	-42228.9	-55165.6	-103821.6	2.46	12.5	
		LMmin Temp. Rise+Temp. Diff.	-11412.9	-45331.3	-55804.9	-104420.6	2.30	12.8	
		LMmin Temp. Down+Temp. Diff.	-12484.3	-39126.5	-54524.9	-103223.3	2.64	12.2	
		LNmax Temp. Rise	-1771.6	-38980.5	-67086.7	-115033.4	2.95	18.1	
		LNmax Temp. Down	-2843.0	-32775.7	-65854.3	-113867.1	3.47	17.6	
		LNmax Temp. Diff.	-11669.3	-36984.2	-55498.0	-104132.2	2.82	12.7	
		LNmax Temp. Rise+Temp. Diff.	-11133.6	-40086.6	-56136.6	-104729.2	2.61	13.0	
		LNmax Temp. Down+Temp. Diff.	-12205.0	-33881.8	-54858.0	-103535.7	3.06	12.4	
		LNmin Temp. Rise	-2475.1	-36134.8	-66277.0	-114270.0	3.16	17.8	
		LNmin Temp. Down	-3546.5	-29929.9	-65041.1	-113100.1	3.78	17.2	
		LNmin Temp. Diff.	-12372.9	-34138.4	-54658.7	-103347.5	3.03	12.3	
		LNmin Temp. Rise+Temp. Diff.	-11837.2	-37240.8	-55299.1	-103945.1	2.79	12.6	
		LNmin Temp. Down+Temp. Diff.	-12908.6	-31036.0	-54017.0	-102748.3	3.31	12.0	
	14-j	Group-I	LMmax	-2515.5	10223.5	26143.9	58828.5	5.75	9.5
			LMmin	-2749.4	-3877.8	-43590.1	-84212.7	21.72	17.6
LNmax			-2115.4	5338.3	26437.2	59082.8	11.07	9.6	
LNmin			-3336.8	-820.7	-42802.6	-83456.2	101.69	17.3	
Group-IV		LMmax Temp. Rise	-2002.1	6152.5	26520.5	59153.2	9.61	9.7	
		LMmax Temp. Down	-3073.5	10828.2	25734.2	58481.0	5.40	9.3	
		LMmax Temp. Diff.	-11752.3	9147.9	19273.3	52484.4	5.74	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11216.6	6810.0	19677.4	52861.4	7.76	6.9	
		LMmax Temp. Down+Temp. Diff.	-12288.0	11485.8	18868.4	52106.8	4.54	6.6	
		LMmin Temp. Rise	-2136.8	-1970.4	-44412.8	-85002.4	43.14	17.9	
		LMmin Temp. Down	-3208.2	2705.3	25636.7	58395.6	21.59	9.3	
		LMmin Temp. Diff.	-11887.0	1025.0	19171.3	52388.3	51.11	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11351.3	-1312.8	-31876.4	-73010.5	55.61	12.8	
		LMmin Temp. Down+Temp. Diff.	-12422.7	3362.9	18766.2	52012.8	15.47	6.6	
		LNmax Temp. Rise	-1771.6	3338.4	26686.9	59300.9	17.76	9.7	
		LNmax Temp. Down	-2843.0	8014.1	25902.8	58623.1	7.32	9.4	
		LNmax Temp. Diff.	-11521.8	6333.8	19445.2	52646.1	8.31	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	3995.9	19849.1	53020.4	13.27	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	8671.6	19040.6	52271.1	6.03	6.7	
		LNmin Temp. Rise	-2475.1	-209.4	-43957.8	-84565.2	403.80	17.8	
		LNmin Temp. Down	-3546.5	4466.3	25385.7	58164.0	13.02	9.2	
		LNmin Temp. Diff.	-12225.4	2786.0	18914.6	52153.7	18.72	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	448.1	19319.4	52529.0	117.22	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	5123.8	18507.5	51773.1	10.10	6.5	
15-i		Group-I	LMmax	-2515.5	10223.5	26143.9	58828.5	5.75	9.5
			LMmin	-2749.4	-3877.8	-43590.1	-84212.7	21.72	17.6
	LNmax		-2115.4	5338.3	26437.2	59082.8	11.07	9.6	
	LNmin		-3336.8	-820.7	-42802.6	-83456.2	101.69	17.3	
	Group-IV	LMmax Temp. Rise	-2002.1	6152.5	26520.5	59153.2	9.61	9.7	
		LMmax Temp. Down	-3073.5	10828.2	25734.2	58481.0	5.40	9.3	
		LMmax Temp. Diff.	-11752.3	9147.9	19273.3	52484.4	5.74	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11216.6	6810.0	19677.4	52861.4	7.76	6.9	
		LMmax Temp. Down+Temp. Diff.	-12288.0	11485.8	18868.4	52106.8	4.54	6.6	
		LMmin Temp. Rise	-2136.8	-1970.4	-44412.8	-85002.4	43.14	17.9	
		LMmin Temp. Down	-3208.2	2705.3	25636.7	58395.6	21.59	9.3	
		LMmin Temp. Diff.	-11887.0	1025.0	19171.3	52388.3	51.11	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11351.3	-1312.8	-31876.4	-73010.5	55.61	12.8	
		LMmin Temp. Down+Temp. Diff.	-12422.7	3362.9	18766.2	52012.9	15.47	6.6	
		LNmax Temp. Rise	-1771.6	3338.4	26686.9	59300.9	17.76	9.7	
		LNmax Temp. Down	-2843.0	8014.1	25902.8	58623.1	7.32	9.4	
		LNmax Temp. Diff.	-11521.8	6333.8	19445.2	52646.1	8.31	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	3995.9	19849.1	53020.4	13.27	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	8671.6	19040.6	52271.1	6.03	6.7	
		LNmin Temp. Rise	-2475.1	-209.4	-43957.8	-84565.2	403.80	17.8	
		LNmin Temp. Down	-3546.5	4466.3	25385.7	58164.0	13.02	9.2	
		LNmin Temp. Diff.	-12225.4	2786.0	18914.6	52153.7	18.72	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	448.1	19319.4	52529.0	117.22	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	5123.8	18507.5	51773.1	10.10	6.5	

Member No.	Combination Group	Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)		
		Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)				
15-j	Group-I	LMmax	-2341.6	30087.9	47634.9	80306.0	2.67	9.6	
		LMmin	-3125.5	15184.7	47059.9	79809.8	5.26	9.3	
		LNmax	-2115.4	28663.2	47801.6	80447.1	2.81	9.6	
		LNmin	-3336.8	15806.5	46905.0	79673.9	5.04	9.3	
	Group-IV	LMmax Temp. Rise	-1901.9	24235.9	47955.8	80580.9	3.32	9.7	
		LMmax Temp. Down	-2973.3	27876.6	47171.3	79902.2	2.87	9.4	
		LMmax Temp. Diff.	-11652.1	26638.3	40710.9	73919.1	2.77	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11116.4	24817.9	41114.9	74295.9	2.99	6.9	
		LMmax Temp. Down+Temp. Diff.	-12187.8	28458.6	40306.1	73541.6	2.58	6.6	
		LMmin Temp. Rise	-2353.4	15651.2	47625.6	80298.9	5.13	9.5	
		LMmin Temp. Down	-3424.8	19291.8	46840.0	79614.8	4.13	9.2	
		LMmin Temp. Diff.	-12103.6	18053.5	40369.9	73602.6	4.08	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11567.9	16233.2	40774.5	73977.6	4.56	6.8	
		LMmin Temp. Down+Temp. Diff.	-12639.3	19873.8	39964.5	73226.8	3.68	6.5	
		LNmax Temp. Rise	-1771.6	23415.3	48051.3	80665.3	3.44	9.7	
		LNmax Temp. Down	-2843.0	27055.9	47267.2	79987.4	2.96	9.4	
		LNmax Temp. Diff.	-11521.8	25817.6	40809.6	74010.4	2.87	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	23997.3	41213.4	74384.7	3.10	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	27637.9	40405.0	73635.4	2.66	6.7	
		LNmin Temp. Rise	-2475.1	16009.3	47536.1	80221.2	5.01	9.5	
		LNmin Temp. Down	-3546.5	19650.0	46750.1	79528.3	4.05	9.2	
		LNmin Temp. Diff.	-12225.4	18411.7	40279.0	73518.1	3.99	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	16591.3	40683.8	73893.3	4.45	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	20232.0	39871.9	73137.5	3.61	6.5	
	16-i	Group-I	LMmax	-2341.6	30087.9	47634.9	80306.0	2.67	9.6
			LMmin	-3125.5	15184.7	47059.9	79809.8	5.26	9.3
LNmax			-2115.4	28663.2	47801.6	80447.1	2.81	9.6	
LNmin			-3336.8	15806.5	46905.0	79673.9	5.04	9.3	
Group-IV		LMmax Temp. Rise	-1901.9	24235.9	47955.8	80580.9	3.32	9.7	
		LMmax Temp. Down	-2973.3	27876.6	47171.3	79902.2	2.87	9.4	
		LMmax Temp. Diff.	-11652.1	26638.3	40710.9	73919.1	2.77	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11116.4	24817.9	41114.9	74295.9	2.99	6.9	
		LMmax Temp. Down+Temp. Diff.	-12187.8	28458.6	40306.1	73541.6	2.58	6.6	
		LMmin Temp. Rise	-2353.4	15651.2	47625.6	80299.0	5.13	9.5	
		LMmin Temp. Down	-3424.8	19291.8	46840.0	79614.8	4.13	9.2	
		LMmin Temp. Diff.	-12103.6	18053.5	40369.9	73602.6	4.08	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11567.9	16233.2	40774.6	73977.7	4.56	6.8	
		LMmin Temp. Down+Temp. Diff.	-12639.3	19873.8	39964.5	73226.8	3.68	6.5	
		LNmax Temp. Rise	-1771.6	23415.3	48051.3	80665.3	3.44	9.7	
		LNmax Temp. Down	-2843.0	27055.9	47267.2	79987.4	2.96	9.4	
		LNmax Temp. Diff.	-11521.8	25817.6	40809.6	74010.4	2.87	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	23997.3	41213.5	74384.7	3.10	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	27637.9	40405.0	73635.4	2.66	6.7	
		LNmin Temp. Rise	-2475.1	16009.3	47536.1	80221.2	5.01	9.5	
		LNmin Temp. Down	-3546.5	19650.0	46750.1	79528.3	4.05	9.2	
		LNmin Temp. Diff.	-12225.4	18411.7	40279.0	73518.1	3.99	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	16591.3	40683.8	73893.3	4.45	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	20232.0	39871.9	73137.5	3.61	6.5	
16-j		Group-I	LMmax	-2252.8	42933.9	66198.3	98861.1	2.30	9.6
			LMmin	-3194.8	25630.0	65508.9	98265.7	3.83	9.3
	LNmax		-2115.4	41924.6	66300.1	98945.7	2.36	9.6	
	LNmin		-3336.8	26141.1	65403.6	98172.5	3.76	9.3	
	Group-IV	LMmax Temp. Rise	-1850.7	35858.7	66491.3	99114.7	2.76	9.7	
		LMmax Temp. Down	-2922.2	38428.9	65707.0	98436.3	2.56	9.4	
		LMmax Temp. Diff.	-11601.0	37647.7	59250.9	92452.8	2.46	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11065.3	36362.6	59654.8	92827.2	2.55	7.0	
		LMmax Temp. Down+Temp. Diff.	-12136.7	38932.8	58844.6	92077.7	2.37	6.6	
		LMmin Temp. Rise	-2393.4	25890.9	66096.4	98769.3	3.81	9.5	
		LMmin Temp. Down	-3464.8	28461.2	65310.7	98086.1	3.45	9.2	
		LMmin Temp. Diff.	-12143.6	27680.0	58839.8	92073.0	3.33	6.6	
		LMmin Temp. Rise+Temp. Diff.	-11607.9	26394.8	59244.5	92448.1	3.50	6.8	
		LMmin Temp. Down+Temp. Diff.	-12679.3	28965.1	58434.4	91697.2	3.17	6.5	
		LNmax Temp. Rise	-1771.6	35277.3	66549.9	99163.9	2.81	9.7	
		LNmax Temp. Down	-2843.0	37847.5	65765.8	98486.0	2.60	9.4	
		LNmax Temp. Diff.	-11521.8	37066.3	59308.2	92509.0	2.50	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	35781.2	59712.0	92883.3	2.60	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	38351.4	58903.6	92134.0	2.40	6.7	
		LNmin Temp. Rise	-2475.1	26185.4	66034.7	98719.8	3.77	9.5	
		LNmin Temp. Down	-3546.5	28755.6	65248.7	98026.9	3.41	9.2	
		LNmin Temp. Diff.	-12225.4	27974.4	58777.6	92016.7	3.29	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	26689.3	59182.4	92391.9	3.46	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	29259.5	58370.5	91636.1	3.13	6.5	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	ϕ Mn2 / Mu	Neutral Axis (cm)
			Nu(kN)	Mu(kN.m)	ϕ Mn1(kN.m)	ϕ Mn2(kN.m)		
17-i	Group-I	LMmax	-2252.8	42933.9	66198.3	98861.1	2.30	9.6
		LMmin	-3194.8	25630.0	65508.9	98265.7	3.83	9.3
		LNmax	-2115.4	41924.6	66300.1	98945.7	2.36	9.6
		LNmin	-3336.8	26141.1	65403.6	98172.5	3.76	9.3
	Group-IV	LMmax Temp. Rise	-1850.7	35858.7	66491.3	99114.7	2.76	9.7
		LMmax Temp. Down	-2922.2	38428.9	65707.0	98436.3	2.56	9.4
		LMmax Temp. Diff.	-11601.0	37647.7	59250.9	92452.8	2.46	6.8
		LMmax Temp. Rise+Temp. Diff.	-11065.3	36362.6	59654.8	92827.2	2.55	7.0
		LMmax Temp. Down+Temp. Diff.	-12136.7	38932.8	58844.6	92077.7	2.37	6.6
		LMmin Temp. Rise	-2393.4	25890.9	66096.4	98769.3	3.81	9.5
		LMmin Temp. Down	-3464.8	28461.2	65310.7	98086.1	3.45	9.2
		LMmin Temp. Diff.	-12143.6	27680.0	58839.8	92073.0	3.33	6.6
		LMmin Temp. Rise+Temp. Diff.	-11607.9	26394.8	59244.5	92448.1	3.50	6.8
		LMmin Temp. Down+Temp. Diff.	-12679.3	28965.1	58434.4	91697.2	3.17	6.5
		LNmax Temp. Rise	-1771.6	35277.3	66549.9	99163.9	2.81	9.7
		LNmax Temp. Down	-2843.0	37847.5	65765.8	98486.0	2.60	9.4
		LNmax Temp. Diff.	-11521.8	37066.3	59308.2	92509.0	2.50	6.8
		LNmax Temp. Rise+Temp. Diff.	-10986.1	35781.2	59712.0	92883.3	2.60	7.0
		LNmax Temp. Down+Temp. Diff.	-12057.5	38351.4	58903.6	92134.0	2.40	6.7
		LNmin Temp. Rise	-2475.1	26185.4	66034.7	98719.8	3.77	9.5
		LNmin Temp. Down	-3546.5	28755.6	65248.7	98026.9	3.41	9.2
		LNmin Temp. Diff.	-12225.4	27974.4	58777.6	92016.7	3.29	6.6
		LNmin Temp. Rise+Temp. Diff.	-11689.7	26689.3	59182.4	92391.9	3.46	6.8
		LNmin Temp. Down+Temp. Diff.	-12761.1	29259.5	58370.5	91636.1	3.13	6.5
17-j	Group-I	LMmax	-2300.0	46460.2	66294.1	98962.6	2.13	9.6
		LMmin	-3201.0	29029.6	65632.5	98388.3	3.39	9.3
		LNmax	-2115.4	45069.9	66429.9	99075.5	2.20	9.6
		LNmin	-3336.8	29501.3	65533.4	98302.3	3.33	9.3
	Group-IV	LMmax Temp. Rise	-1877.9	39424.2	66602.6	99223.3	2.52	9.7
		LMmax Temp. Down	-2949.3	40924.1	65818.2	98551.9	2.41	9.4
		LMmax Temp. Diff.	-11628.1	40599.9	59358.3	92563.8	2.28	6.8
		LMmax Temp. Rise+Temp. Diff.	-11092.4	39850.0	59762.3	92938.3	2.33	7.0
		LMmax Temp. Down+Temp. Diff.	-12163.9	41349.9	58953.6	92188.7	2.23	6.6
		LMmin Temp. Rise	-2396.9	29383.6	66223.1	98899.0	3.37	9.5
		LMmin Temp. Down	-3468.3	30883.4	65437.3	98211.3	3.18	9.2
		LMmin Temp. Diff.	-12147.2	30559.3	58966.3	92198.1	3.02	6.6
		LMmin Temp. Rise+Temp. Diff.	-11611.5	29809.3	59371.0	92577.9	3.11	6.8
		LMmin Temp. Down+Temp. Diff.	-12682.9	31309.2	58560.9	91822.2	2.93	6.5
		LNmax Temp. Rise	-1771.6	38623.3	66679.6	99293.6	2.57	9.7
		LNmax Temp. Down	-2843.0	40123.2	65895.5	98615.8	2.46	9.4
		LNmax Temp. Diff.	-11521.8	39799.1	59437.9	92638.8	2.33	6.8
		LNmax Temp. Rise+Temp. Diff.	-10986.1	39049.1	59841.8	93013.1	2.38	7.0
		LNmax Temp. Down+Temp. Diff.	-12057.5	40549.0	59033.3	92263.8	2.28	6.7
		LNmin Temp. Rise	-2475.1	29655.3	66164.4	98849.5	3.33	9.5
		LNmin Temp. Down	-3546.5	31155.2	65378.4	98156.7	3.15	9.2
		LNmin Temp. Diff.	-12225.4	30831.0	58907.3	92146.4	2.99	6.6
		LNmin Temp. Rise+Temp. Diff.	-11689.7	30081.1	59312.1	92521.7	3.08	6.8
		LNmin Temp. Down+Temp. Diff.	-12761.1	31580.9	58500.2	91765.8	2.91	6.5
18-i	Group-I	LMmax	-2300.0	46460.2	66294.1	98962.6	2.13	9.6
		LMmin	-3201.0	29029.6	65632.5	98388.3	3.39	9.3
		LNmax	-2115.4	45069.9	66429.9	99075.5	2.20	9.6
		LNmin	-3336.8	29501.3	65533.4	98302.3	3.33	9.3
	Group-IV	LMmax Temp. Rise	-1877.9	39424.2	66602.6	99223.3	2.52	9.7
		LMmax Temp. Down	-2949.3	40924.1	65818.2	98551.9	2.41	9.4
		LMmax Temp. Diff.	-11628.1	40599.9	59358.3	92563.8	2.28	6.8
		LMmax Temp. Rise+Temp. Diff.	-11092.4	39850.0	59762.3	92938.3	2.33	7.0
		LMmax Temp. Down+Temp. Diff.	-12163.9	41349.9	58953.6	92188.7	2.23	6.6
		LMmin Temp. Rise	-2396.9	29383.6	66223.1	98899.0	3.37	9.5
		LMmin Temp. Down	-3468.3	30883.4	65437.3	98211.3	3.18	9.2
		LMmin Temp. Diff.	-12147.2	30559.3	58966.3	92198.1	3.02	6.6
		LMmin Temp. Rise+Temp. Diff.	-11611.5	29809.3	59371.0	92577.9	3.11	6.8
		LMmin Temp. Down+Temp. Diff.	-12682.9	31309.2	58560.9	91822.2	2.93	6.5
		LNmax Temp. Rise	-1771.6	38623.3	66679.6	99293.6	2.57	9.7
		LNmax Temp. Down	-2843.0	40123.2	65895.5	98615.8	2.46	9.4
		LNmax Temp. Diff.	-11521.8	39799.1	59437.9	92638.8	2.33	6.8
		LNmax Temp. Rise+Temp. Diff.	-10986.1	39049.1	59841.8	93013.1	2.38	7.0
		LNmax Temp. Down+Temp. Diff.	-12057.5	40549.0	59033.3	92263.8	2.28	6.7
		LNmin Temp. Rise	-2475.1	29655.3	66164.4	98849.5	3.33	9.5
		LNmin Temp. Down	-3546.5	31155.2	65378.4	98156.7	3.15	9.2
		LNmin Temp. Diff.	-12225.4	30831.0	58907.3	92146.4	2.99	6.6
		LNmin Temp. Rise+Temp. Diff.	-11689.7	30081.1	59312.1	92521.7	3.08	6.8
		LNmin Temp. Down+Temp. Diff.	-12761.1	31580.9	58500.2	91765.8	2.91	6.5

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
18-j	Group-I	LMmax	-2263.9	40857.5	66247.7	98912.6	2.42	9.6	
		LMmin	-3204.6	24937.5	65558.3	98317.1	3.94	9.3	
		LNmax	-2115.4	38340.0	66358.8	99004.3	2.58	9.6	
		LNmin	-3336.8	25387.8	65462.2	98231.1	3.87	9.3	
	Group-IV	LMmax Temp. Rise	-1857.1	34850.0	66546.9	99166.2	2.85	9.7	
		LMmax Temp. Down	-2928.5	35279.6	65762.5	98487.8	2.79	9.4	
		LMmax Temp. Diff.	-11607.4	35412.5	59303.1	92506.7	2.61	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11071.7	35197.7	59707.1	92883.5	2.64	7.0	
		LMmax Temp. Down+Temp. Diff.	-12143.1	35627.2	58898.4	92131.6	2.59	6.6	
		LMmin Temp. Rise	-2399.0	25679.5	66148.9	98827.9	3.85	9.5	
		LMmin Temp. Down	-3470.4	26109.0	65363.1	98140.1	3.76	9.2	
		LMmin Temp. Diff.	-12149.2	26241.9	58895.2	92126.9	3.51	6.6	
		LMmin Temp. Rise+Temp. Diff.	-11613.5	26027.2	59299.9	92502.1	3.55	6.8	
		LMmin Temp. Down+Temp. Diff.	-12684.9	26456.7	58489.8	91751.1	3.47	6.5	
		LNmax Temp. Rise	-1771.6	33399.9	66608.5	99222.5	2.97	9.7	
		LNmax Temp. Down	-2843.0	33829.4	65824.4	98544.6	2.91	9.4	
		LNmax Temp. Diff.	-11521.8	33962.3	59366.8	92567.6	2.73	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	33747.5	59770.7	92941.9	2.75	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	34177.0	58962.2	92192.6	2.70	6.7	
		LNmin Temp. Rise	-2475.1	25938.9	66093.3	98778.4	3.81	9.5	
		LNmin Temp. Down	-3546.5	26368.4	65307.3	98085.5	3.72	9.2	
		LNmin Temp. Diff.	-12225.4	26501.3	58836.2	92075.3	3.47	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	26286.6	59241.0	92450.5	3.52	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	26716.1	58429.1	91694.7	3.43	6.5	
	19-i	Group-I	LMmax	-2263.9	40857.5	66247.7	98912.6	2.42	9.6
			LMmin	-3204.6	24937.5	65558.3	98317.1	3.94	9.3
LNmax			-2115.4	38340.0	66358.8	99004.3	2.58	9.6	
LNmin			-3336.8	25387.8	65462.2	98231.1	3.87	9.3	
Group-IV		LMmax Temp. Rise	-1857.1	34850.0	66546.9	99166.2	2.85	9.7	
		LMmax Temp. Down	-2928.5	35279.6	65762.5	98487.8	2.79	9.4	
		LMmax Temp. Diff.	-11607.4	35412.5	59303.1	92506.7	2.61	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11071.7	35197.7	59707.1	92883.5	2.64	7.0	
		LMmax Temp. Down+Temp. Diff.	-12143.1	35627.2	58898.4	92131.6	2.59	6.6	
		LMmin Temp. Rise	-2399.0	25679.5	66148.9	98827.9	3.85	9.5	
		LMmin Temp. Down	-3470.4	26109.0	65363.1	98140.1	3.76	9.2	
		LMmin Temp. Diff.	-12149.2	26241.9	58895.2	92126.9	3.51	6.6	
		LMmin Temp. Rise+Temp. Diff.	-11613.5	26027.2	59299.9	92502.1	3.55	6.8	
		LMmin Temp. Down+Temp. Diff.	-12684.9	26456.7	58489.8	91751.1	3.47	6.5	
		LNmax Temp. Rise	-1771.6	33399.9	66608.5	99222.5	2.97	9.7	
		LNmax Temp. Down	-2843.0	33829.4	65824.4	98544.6	2.91	9.4	
		LNmax Temp. Diff.	-11521.8	33962.3	59366.8	92567.6	2.73	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	33747.5	59770.7	92941.9	2.75	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	34177.0	58962.2	92192.6	2.70	6.7	
		LNmin Temp. Rise	-2475.1	25938.9	66093.3	98778.4	3.81	9.5	
		LNmin Temp. Down	-3546.5	26368.4	65307.3	98085.5	3.72	9.2	
		LNmin Temp. Diff.	-12225.4	26501.3	58836.2	92075.3	3.47	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	26286.6	59241.0	92450.5	3.52	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	26716.1	58429.1	91694.7	3.43	6.5	
19-j		Group-I	LMmax	-2768.2	26345.5	49914.0	82628.3	3.14	9.4
			LMmin	-2713.6	13415.6	49954.2	82663.7	6.16	9.4
	LNmax		-2115.4	21727.9	50392.7	83038.3	3.82	9.6	
	LNmin		-3336.8	14299.9	49496.2	82265.1	5.75	9.3	
	Group-IV	LMmax Temp. Rise	-2147.6	22455.1	50368.1	83017.2	3.70	9.6	
		LMmax Temp. Down	-3219.0	21814.2	49582.9	82344.0	3.77	9.3	
		LMmax Temp. Diff.	-11897.8	22404.2	43117.3	76339.2	3.41	6.7	
		LMmax Temp. Rise+Temp. Diff.	-11362.1	22724.6	43521.7	76714.0	3.38	6.9	
		LMmax Temp. Down+Temp. Diff.	-12433.5	22083.8	42712.2	75959.0	3.44	6.6	
		LMmin Temp. Rise	-2116.2	15007.0	50389.6	83038.3	5.53	9.6	
		LMmin Temp. Down	-3187.6	14366.2	49604.6	82358.2	5.73	9.3	
		LMmin Temp. Diff.	-11866.4	14956.1	43142.8	76357.9	5.11	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11330.7	15276.6	43547.1	76737.4	5.02	6.9	
		LMmin Temp. Down+Temp. Diff.	-12402.1	14635.7	42737.7	75982.5	5.19	6.6	
		LNmax Temp. Rise	-1771.6	19795.2	50642.5	83256.4	4.21	9.7	
		LNmax Temp. Down	-2843.0	19154.3	49858.4	82578.6	4.31	9.4	
		LNmax Temp. Diff.	-11521.8	19744.3	43400.7	76601.6	3.88	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10986.1	20064.7	43804.6	76975.9	3.84	7.0	
		LNmax Temp. Down+Temp. Diff.	-12057.5	19423.9	42996.2	76226.6	3.92	6.7	
		LNmin Temp. Rise	-2475.1	15516.4	50127.3	82812.4	5.34	9.5	
		LNmin Temp. Down	-3546.5	14875.5	49341.3	82119.5	5.52	9.2	
		LNmin Temp. Diff.	-12225.4	15465.5	42870.2	76109.3	4.92	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11689.7	15785.9	43275.0	76484.5	4.85	6.8	
		LNmin Temp. Down+Temp. Diff.	-12761.1	15145.1	42463.1	75728.7	5.00	6.5	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only φMn1(kN.m)	Flexural Strength PC+Re Bar φMn2(kN.m)	φMn2 / Mu	Neutral Axis (cm)
			Nu(kN)	Mu(kN.m)				
			20-i	Group-I				
	LMmin	-2713.6	13415.6		49954.2	82663.7	6.16	9.4
	LNmax	-2115.4	21727.9		50392.7	83038.3	3.82	9.6
	LNmin	-3336.8	14299.9		49496.2	82265.1	5.75	9.3
	Group-IV	LMmax Temp. Rise	-2147.6	22455.1	50368.0	83017.1	3.70	9.6
		LMmax Temp. Down	-3219.0	21814.2	49582.9	82344.0	3.77	9.3
		LMmax Temp. Diff.	-11897.8	22404.2	43117.3	76339.2	3.41	6.7
		LMmax Temp. Rise+Temp. Diff.	-11362.1	22724.6	43521.7	76714.0	3.38	6.9
		LMmax Temp. Down+Temp. Diff.	-12433.5	22083.8	42712.2	75959.0	3.44	6.6
		LMmin Temp. Rise	-2116.2	15007.0	50389.6	83038.3	5.53	9.6
		LMmin Temp. Down	-3187.6	14366.2	49604.6	82358.2	5.73	9.3
		LMmin Temp. Diff.	-11866.4	14956.1	43142.8	76357.9	5.11	6.7
		LMmin Temp. Rise+Temp. Diff.	-11330.7	15276.6	43547.1	76737.4	5.02	6.9
		LMmin Temp. Down+Temp. Diff.	-12402.1	14635.7	42737.7	75982.5	5.19	6.6
		LNmax Temp. Rise	-1771.6	19795.2	50642.5	83256.4	4.21	9.7
		LNmax Temp. Down	-2843.0	19154.3	49858.4	82578.6	4.31	9.4
		LNmax Temp. Diff.	-11521.8	19744.3	43400.7	76601.6	3.88	6.8
		LNmax Temp. Rise+Temp. Diff.	-10986.1	20064.7	43804.6	76975.9	3.84	7.0
		LNmax Temp. Down+Temp. Diff.	-12057.5	19423.9	42996.1	76226.6	3.92	6.7
		LNmin Temp. Rise	-2475.1	15516.4	50127.2	82812.4	5.34	9.5
		LNmin Temp. Down	-3546.5	14875.5	49341.3	82119.5	5.52	9.2
		LNmin Temp. Diff.	-12225.4	15465.5	42870.2	76109.3	4.92	6.6
		LNmin Temp. Rise+Temp. Diff.	-11689.7	15785.9	43275.0	76484.5	4.85	6.8
		LNmin Temp. Down+Temp. Diff.	-12761.1	15145.1	42463.0	75728.6	5.00	6.5
20-j	Group-I	LMmax	-2955.8	5172.9	28410.5	61145.2	11.82	9.4
		LMmin	-2300.2	-7498.7	-41601.2	-82202.7	10.96	17.9
		LNmax	-2115.4	-2289.8	-41849.8	-82439.7	36.00	18.0
		LNmin	-3336.8	-3055.8	-40211.4	-80865.0	26.46	17.3
	Group-IV	LMmax Temp. Rise	-2255.7	3799.3	28923.4	61584.2	16.21	9.6
		LMmax Temp. Down	-3327.1	2123.4	28138.0	60906.6	28.68	9.3
		LMmax Temp. Diff.	-12005.9	3155.4	21671.6	54897.8	17.40	6.7
		LMmax Temp. Rise+Temp. Diff.	-11470.2	3993.3	22077.8	55272.6	13.84	6.8
		LMmax Temp. Down+Temp. Diff.	-12541.6	2317.4	21266.4	54522.2	23.53	6.5
		LMmin Temp. Rise	-1878.1	-3500.0	-42166.0	-82746.4	23.64	18.1
		LMmin Temp. Down	-2949.5	-5175.9	-40730.0	-81363.2	15.72	17.5
		LMmin Temp. Diff.	-11628.3	-4144.0	-28903.4	-70055.6	16.91	12.7
		LMmin Temp. Rise+Temp. Diff.	-11092.6	-3306.0	-29643.5	-70762.5	21.40	13.0
		LMmin Temp. Down+Temp. Diff.	-12164.0	-4981.9	-28162.1	-69353.9	13.92	12.4
		LNmax Temp. Rise	-1771.6	-499.5	-42309.8	-82881.9	165.94	18.1
		LNmax Temp. Down	-2843.0	-2175.4	-40874.4	-81502.4	37.47	17.6
		LNmax Temp. Diff.	-11521.8	-1143.4	-29049.2	-70196.4	61.39	12.7
		LNmax Temp. Rise+Temp. Diff.	-10986.1	-305.5	-29789.0	-70899.9	232.10	13.0
		LNmax Temp. Down+Temp. Diff.	-12057.5	-1981.4	-28308.1	-69490.7	35.07	12.5
		LNmin Temp. Rise	-2475.1	-940.7	-41366.7	-81974.1	87.14	17.8
		LNmin Temp. Down	-3546.5	-2616.6	-39927.8	-80594.0	30.80	17.2
		LNmin Temp. Diff.	-12225.4	-1584.7	-28075.9	-69270.7	43.71	12.4
		LNmin Temp. Rise+Temp. Diff.	-11689.7	-746.7	-28818.8	-69977.9	93.72	12.7
		LNmin Temp. Down+Temp. Diff.	-12761.1	-2422.7	-27333.0	-68568.7	28.30	12.1
21-i	Group-I	LMmax	-2955.8	5172.9	28410.5	61145.2	11.82	9.4
		LMmin	-2300.2	-7498.7	-41601.3	-82202.7	10.96	17.9
		LNmax	-2115.4	-2289.8	-41849.8	-82439.7	36.00	18.0
		LNmin	-3336.8	-3055.8	-40211.4	-80865.0	26.46	17.3
	Group-IV	LMmax Temp. Rise	-2255.7	3799.3	28923.4	61584.1	16.21	9.6
		LMmax Temp. Down	-3327.1	2123.4	28138.0	60906.6	28.68	9.3
		LMmax Temp. Diff.	-12005.9	3155.4	21671.6	54897.8	17.40	6.7
		LMmax Temp. Rise+Temp. Diff.	-11470.2	3993.3	22077.7	55272.6	13.84	6.8
		LMmax Temp. Down+Temp. Diff.	-12541.6	2317.4	21266.4	54522.2	23.53	6.5
		LMmin Temp. Rise	-1878.1	-3500.0	-42166.0	-82746.4	23.64	18.1
		LMmin Temp. Down	-2949.5	-5175.9	-40730.0	-81363.2	15.72	17.5
		LMmin Temp. Diff.	-11628.3	-4144.0	-28903.4	-70055.6	16.91	12.7
		LMmin Temp. Rise+Temp. Diff.	-11092.6	-3306.0	-29643.5	-70762.5	21.40	13.0
		LMmin Temp. Down+Temp. Diff.	-12164.0	-4981.9	-28162.1	-69353.9	13.92	12.4
		LNmax Temp. Rise	-1771.6	-499.5	-42309.8	-82881.9	165.94	18.1
		LNmax Temp. Down	-2843.0	-2175.4	-40874.4	-81502.4	37.47	17.6
		LNmax Temp. Diff.	-11521.8	-1143.4	-29049.2	-70196.4	61.39	12.7
		LNmax Temp. Rise+Temp. Diff.	-10986.1	-305.5	-29789.0	-70899.9	232.10	13.0
		LNmax Temp. Down+Temp. Diff.	-12057.5	-1981.4	-28308.1	-69490.7	35.07	12.5
		LNmin Temp. Rise	-2475.1	-940.7	-41366.7	-81974.1	87.14	17.8
		LNmin Temp. Down	-3546.5	-2616.6	-39927.8	-80594.1	30.80	17.2
		LNmin Temp. Diff.	-12225.4	-1584.7	-28075.9	-69270.7	43.71	12.4
		LNmin Temp. Rise+Temp. Diff.	-11689.7	-746.7	-28818.9	-69977.9	93.72	12.7
		LNmin Temp. Down+Temp. Diff.	-12761.1	-2422.7	-27333.0	-68568.7	28.30	12.1

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
21-j	Group-I	LMmax	-3232.0	-35078.6	-62870.6	-110909.7	3.16	17.3	
		LMmin	-2221.4	-57431.7	-64037.0	-112010.7	1.95	17.9	
		LNmax	-2115.4	-50728.7	-64158.2	-112126.5	2.21	18.0	
		LNmin	-3336.8	-41139.3	-62751.2	-110796.7	2.69	17.3	
	Group-IV	LMmax Temp. Rise	-2414.8	-33727.0	-63813.8	-111802.2	3.31	17.8	
		LMmax Temp. Down	-3486.2	-36932.0	-62578.2	-110632.9	3.00	17.2	
		LMmax Temp. Diff.	-12312.5	-37122.3	-52195.8	-100882.4	2.72	12.3	
		LMmax Temp. Rise+Temp. Diff.	-11776.8	-35519.8	-52836.0	-101479.6	2.86	12.6	
		LMmax Temp. Down+Temp. Diff.	-12848.2	-38724.8	-51554.3	-100281.5	2.59	12.0	
		LMmin Temp. Rise	-1832.6	-46603.2	-64482.9	-112434.5	2.41	18.1	
		LMmin Temp. Down	-2904.0	-49808.2	-63250.2	-111267.5	2.23	17.5	
		LMmin Temp. Diff.	-11730.4	-49998.5	-52891.4	-101530.6	2.03	12.6	
		LMmin Temp. Rise+Temp. Diff.	-11194.7	-48396.0	-53530.2	-102128.1	2.11	12.9	
		LMmin Temp. Down+Temp. Diff.	-12266.1	-51601.0	-52251.3	-100933.7	1.96	12.3	
		LNmax Temp. Rise	-1771.6	-42742.0	-64553.1	-112499.8	2.63	18.1	
		LNmax Temp. Down	-2843.0	-45947.0	-63320.7	-111333.5	2.42	17.6	
		LNmax Temp. Diff.	-11669.3	-46137.3	-52964.4	-101598.6	2.20	12.7	
		LNmax Temp. Rise+Temp. Diff.	-11133.6	-44534.8	-53603.0	-102195.6	2.29	13.0	
		LNmax Temp. Down+Temp. Diff.	-12205.0	-47739.8	-52324.5	-101002.1	2.12	12.4	
		LNmin Temp. Rise	-2475.1	-37218.1	-63743.4	-111736.4	3.00	17.8	
		LNmin Temp. Down	-3546.5	-40423.2	-62507.5	-110566.5	2.74	17.2	
		LNmin Temp. Diff.	-12372.9	-40613.5	-52125.1	-100813.9	2.48	12.3	
		LNmin Temp. Rise+Temp. Diff.	-11837.2	-39010.9	-52765.5	-101411.5	2.60	12.6	
		LNmin Temp. Down+Temp. Diff.	-12908.6	-42216.0	-51483.5	-100214.7	2.37	12.0	
	26-i	Group-I	LMmax	-3197.9	-35436.0	-62912.0	-110948.7	3.13	17.4
			LMmin	-2188.6	-57776.1	-64073.4	-112045.5	1.94	17.9
LNmax			-2082.7	-51072.0	-64194.6	-112161.1	2.20	18.0	
LNmin			-3301.8	-41491.0	-62790.2	-110835.7	2.67	17.3	
Group-IV		LMmax Temp. Rise	-2383.6	-34053.4	-63850.2	-111837.0	3.28	17.8	
		LMmax Temp. Down	-3455.1	-37257.4	-62614.8	-110668.0	2.97	17.2	
		LMmax Temp. Diff.	-12281.2	-37449.4	-52233.6	-100916.6	2.69	12.3	
		LMmax Temp. Rise+Temp. Diff.	-11745.5	-35847.4	-52873.8	-101513.6	2.83	12.6	
		LMmax Temp. Down+Temp. Diff.	-12817.0	-39051.4	-51592.2	-100315.9	2.57	12.0	
		LMmin Temp. Rise	-1802.2	-46922.1	-64516.8	-112469.1	2.40	18.1	
		LMmin Temp. Down	-2873.7	-50126.1	-63284.2	-111302.5	2.22	17.5	
		LMmin Temp. Diff.	-11699.8	-50318.1	-52929.2	-101564.6	2.02	12.7	
		LMmin Temp. Rise+Temp. Diff.	-11164.1	-48716.1	-53567.9	-102161.9	2.10	12.9	
		LMmin Temp. Down+Temp. Diff.	-12235.6	-51920.1	-52289.1	-100967.9	1.94	12.4	
		LNmax Temp. Rise	-1741.2	-43060.3	-64587.0	-112534.4	2.61	18.2	
		LNmax Temp. Down	-2812.7	-46264.3	-63354.7	-111368.4	2.41	17.6	
		LNmax Temp. Diff.	-11638.9	-46456.3	-53002.2	-101632.6	2.19	12.7	
		LNmax Temp. Rise+Temp. Diff.	-11103.1	-44854.3	-53640.7	-102229.4	2.28	13.0	
		LNmax Temp. Down+Temp. Diff.	-12174.6	-48058.3	-52362.3	-101036.3	2.10	12.4	
		LNmin Temp. Rise	-2443.5	-37541.3	-63779.8	-111771.2	2.98	17.8	
		LNmin Temp. Down	-3515.0	-40745.3	-62544.1	-110601.6	2.71	17.2	
		LNmin Temp. Diff.	-12341.1	-40937.3	-52163.0	-100848.2	2.46	12.3	
		LNmin Temp. Rise+Temp. Diff.	-11805.4	-39335.3	-52803.3	-101445.6	2.58	12.6	
		LNmin Temp. Down+Temp. Diff.	-12876.9	-42539.3	-51521.4	-100251.4	2.36	12.0	
26-j		Group-I	LMmax	-2922.4	4948.2	28377.6	61103.9	12.35	9.4
			LMmin	-2267.4	-7720.1	-41704.0	-82299.8	10.66	17.9
	LNmax		-2082.7	-2510.7	-41949.8	-82536.8	32.87	18.0	
	LNmin		-3301.8	-3277.3	-40314.4	-80966.9	24.71	17.3	
	Group-IV	LMmax Temp. Rise	-2224.9	3588.3	28890.5	61549.6	17.15	9.6	
		LMmax Temp. Down	-3296.4	1912.8	28105.2	60868.5	31.82	9.3	
		LMmax Temp. Diff.	-11975.0	2944.0	21638.0	54861.6	18.63	6.7	
		LMmax Temp. Rise+Temp. Diff.	-11439.3	3781.8	22042.4	55236.4	14.61	6.9	
		LMmax Temp. Down+Temp. Diff.	-12510.8	2106.3	21232.8	54486.2	25.87	6.5	
		LMmin Temp. Rise	-1847.6	-3709.1	-42265.9	-82839.0	22.33	18.1	
		LMmin Temp. Down	-2919.1	-5384.6	-40830.1	-81458.4	15.13	17.5	
		LMmin Temp. Diff.	-11597.7	-4353.3	-29001.8	-70152.1	16.11	12.7	
		LMmin Temp. Rise+Temp. Diff.	-11062.0	-3515.6	-29741.8	-70858.6	20.16	13.0	
		LMmin Temp. Down+Temp. Diff.	-12133.5	-5191.1	-28260.5	-69450.6	13.38	12.4	
		LNmax Temp. Rise	-1741.2	-708.3	-42406.9	-82978.9	117.15	18.2	
		LNmax Temp. Down	-2812.7	-2383.8	-40971.6	-81595.3	34.23	17.6	
		LNmax Temp. Diff.	-11491.4	-1352.6	-29150.5	-70292.8	51.97	12.8	
		LNmax Temp. Rise+Temp. Diff.	-10955.6	-514.8	-29890.2	-70998.4	137.92	13.1	
		LNmax Temp. Down+Temp. Diff.	-12027.1	-2190.3	-28409.5	-69587.3	31.77	12.5	
		LNmin Temp. Rise	-2443.5	-1149.9	-41466.7	-82071.2	71.37	17.8	
		LNmin Temp. Down	-3515.0	-2825.4	-40027.9	-80691.6	28.56	17.2	
		LNmin Temp. Diff.	-12193.6	-1794.1	-28178.7	-69372.3	38.67	12.4	
		LNmin Temp. Rise+Temp. Diff.	-11657.9	-956.4	-28920.2	-70074.3	73.27	12.7	
		LNmin Temp. Down+Temp. Diff.	-12729.4	-2631.9	-27434.5	-68665.6	26.09	12.1	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)		
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)				
27-i	Group-I	LMmax	-2922.4	4948.2	28377.6	61103.9	12.35	9.4		
		LMmin	-2267.4	-7720.1	-41704.0	-82299.8	10.66	17.9		
		LNmax	-2082.7	-2510.7	-41949.8	-82536.8	32.87	18.0		
		LNmin	-3301.8	-3277.3	-40314.4	-80966.9	24.71	17.3		
	Group-IV	LMmax Temp. Rise	-2224.9	3588.3	28890.6	61549.6	17.15	9.6		
		LMmax Temp. Down	-3296.4	1912.8	28105.2	60868.5	31.82	9.3		
		LMmax Temp. Diff.	-11975.0	2944.0	21638.0	54861.6	18.63	6.7		
		LMmax Temp. Rise+Temp. Diff.	-11439.3	3781.8	22042.4	55236.4	14.61	6.9		
		LMmax Temp. Down+Temp. Diff.	-12510.8	2106.3	21232.8	54486.2	25.87	6.5		
		LMmin Temp. Rise	-1847.6	-3709.1	-42265.9	-82838.9	22.33	18.1		
		LMmin Temp. Down	-2919.1	-5384.6	-40830.1	-81458.4	15.13	17.5		
		LMmin Temp. Diff.	-11597.7	-4353.3	-29001.8	-70152.1	16.11	12.7		
		LMmin Temp. Rise+Temp. Diff.	-11062.0	-3515.6	-29741.8	-70858.6	20.16	13.0		
		LMmin Temp. Down+Temp. Diff.	-12133.5	-5191.1	-28260.5	-69450.6	13.38	12.4		
		LNmax Temp. Rise	-1741.2	-708.3	-42406.9	-82978.9	117.15	18.2		
		LNmax Temp. Down	-2812.7	-2383.8	-40971.6	-81595.3	34.23	17.6		
		LNmax Temp. Diff.	-11491.4	-1352.6	-29150.5	-70292.8	51.97	12.8		
		LNmax Temp. Rise+Temp. Diff.	-10955.6	-514.8	-29890.2	-70998.4	137.92	13.1		
		LNmax Temp. Down+Temp. Diff.	-12027.1	-2190.3	-28409.5	-69587.3	31.77	12.5		
		LNmin Temp. Rise	-2443.5	-1149.9	-41466.6	-82071.2	71.37	17.8		
		LNmin Temp. Down	-3515.0	-2825.4	-40027.9	-80691.6	28.56	17.2		
		LNmin Temp. Diff.	-12193.6	-1794.1	-28178.7	-69372.3	38.67	12.4		
		LNmin Temp. Rise+Temp. Diff.	-11657.9	-956.4	-28920.2	-70074.3	73.27	12.7		
		LNmin Temp. Down+Temp. Diff.	-12729.4	-2631.9	-27434.5	-68665.6	26.09	12.1		
		27-j	Group-I	LMmax	-2734.9	26208.1	49881.2	82591.9	3.15	9.4
				LMmin	-2680.8	13277.5	49921.4	82620.3	6.22	9.5
				LNmax	-2082.7	21589.8	50356.7	83001.9	3.84	9.6
				LNmin	-3301.8	14166.5	49463.4	82230.3	5.80	9.3
Group-IV	LMmax Temp. Rise		-2116.9	22320.7	50332.1	82980.7	3.72	9.6		
	LMmax Temp. Down		-3188.4	21679.9	49547.0	82300.6	3.80	9.3		
	LMmax Temp. Diff.		-11867.0	22269.8	43082.0	76300.4	3.43	6.7		
	LMmax Temp. Rise+Temp. Diff.		-11331.3	22590.3	43487.9	76677.5	3.39	6.9		
	LMmax Temp. Down+Temp. Diff.		-12402.8	21949.4	42677.0	75924.9	3.46	6.6		
	LMmin Temp. Rise		-2085.7	14872.3	50356.7	83001.9	5.58	9.6		
	LMmin Temp. Down		-3157.2	14231.4	49571.8	82322.0	5.78	9.3		
	LMmin Temp. Diff.		-11835.9	14821.4	43107.5	76323.8	5.15	6.7		
	LMmin Temp. Rise+Temp. Diff.		-11300.1	15141.8	43511.8	76698.5	5.07	6.9		
	LMmin Temp. Down+Temp. Diff.		-12371.6	14500.9	42702.5	75948.4	5.24	6.6		
	LNmax Temp. Rise		-1741.2	19660.5	50606.5	83219.9	4.23	9.7		
	LNmax Temp. Down		-2812.7	19019.6	49822.4	82542.3	4.34	9.4		
	LNmax Temp. Diff.		-11491.4	19609.6	43368.6	76567.4	3.90	6.8		
	LNmax Temp. Rise+Temp. Diff.		-10955.6	19930.0	43772.5	76941.7	3.86	7.0		
	LNmax Temp. Down+Temp. Diff.		-12027.1	19289.1	42962.5	76187.8	3.95	6.7		
	LNmin Temp. Rise		-2443.5	15384.4	50094.4	82776.0	5.38	9.5		
	LNmin Temp. Down		-3515.0	14743.5	49308.5	82084.7	5.57	9.2		
	LNmin Temp. Diff.		-12193.6	15333.5	42836.5	76070.5	4.96	6.6		
	LNmin Temp. Rise+Temp. Diff.		-11657.9	15653.9	43241.3	76450.3	4.88	6.8		
	LNmin Temp. Down+Temp. Diff.		-12729.4	15013.0	42431.0	75694.6	5.04	6.5		
	28-i		Group-I	LMmax	-2734.9	26208.1	49881.2	82591.9	3.15	9.4
				LMmin	-2680.8	13277.5	49921.4	82620.3	6.22	9.5
				LNmax	-2082.7	21589.8	50356.7	83001.9	3.84	9.6
				LNmin	-3301.8	14166.5	49463.4	82230.3	5.80	9.3
Group-IV		LMmax Temp. Rise	-2116.9	22320.7	50332.1	82980.7	3.72	9.6		
		LMmax Temp. Down	-3188.4	21679.9	49547.0	82300.7	3.80	9.3		
		LMmax Temp. Diff.	-11867.0	22269.8	43082.0	76300.4	3.43	6.7		
		LMmax Temp. Rise+Temp. Diff.	-11331.3	22590.3	43487.9	76677.5	3.39	6.9		
		LMmax Temp. Down+Temp. Diff.	-12402.8	21949.4	42677.0	75924.9	3.46	6.6		
		LMmin Temp. Rise	-2085.7	14872.3	50356.7	83001.9	5.58	9.6		
		LMmin Temp. Down	-3157.2	14231.4	49571.8	82322.0	5.78	9.3		
		LMmin Temp. Diff.	-11835.9	14821.4	43107.5	76323.8	5.15	6.7		
		LMmin Temp. Rise+Temp. Diff.	-11300.1	15141.8	43511.8	76698.5	5.07	6.9		
		LMmin Temp. Down+Temp. Diff.	-12371.6	14500.9	42702.5	75948.4	5.24	6.6		
		LNmax Temp. Rise	-1741.2	19660.5	50606.5	83219.9	4.23	9.7		
		LNmax Temp. Down	-2812.7	19019.6	49822.4	82542.3	4.34	9.4		
		LNmax Temp. Diff.	-11491.4	19609.6	43368.6	76567.4	3.90	6.8		
		LNmax Temp. Rise+Temp. Diff.	-10955.6	19930.0	43772.5	76941.7	3.86	7.0		
		LNmax Temp. Down+Temp. Diff.	-12027.1	19289.1	42962.5	76187.8	3.95	6.7		
		LNmin Temp. Rise	-2443.5	15384.4	50094.4	82776.0	5.38	9.5		
		LNmin Temp. Down	-3515.0	14743.5	49308.5	82084.7	5.57	9.2		
		LNmin Temp. Diff.	-12193.6	15333.5	42836.5	76070.5	4.96	6.6		
		LNmin Temp. Rise+Temp. Diff.	-11657.9	15653.9	43241.3	76450.3	4.88	6.8		
		LNmin Temp. Down+Temp. Diff.	-12729.4	15013.0	42431.0	75694.6	5.04	6.5		

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	ϕ Mn2 / Mu	Neutral Axis (cm)
			Nu(kN)	Mu(kN.m)	ϕ Mn1(kN.m)	ϕ Mn2(kN.m)		
28-j	Group-I	LMmax	-2231.5	40806.7	66256.4	98917.8	2.42	9.6
		LMmin	-3169.7	24889.8	65570.1	98322.5	3.95	9.3
		LNmax	-2082.7	38287.6	66364.3	99009.5	2.59	9.6
		LNmin	-3301.8	25345.5	65471.0	98237.9	3.88	9.3
	Group-IV	LMmax Temp. Rise	-1826.9	34792.8	66552.4	99171.3	2.85	9.7
		LMmax Temp. Down	-2898.4	35222.0	65768.2	98493.1	2.80	9.4
		LMmax Temp. Diff.	-11577.1	35355.5	59309.4	92514.2	2.62	6.8
		LMmax Temp. Rise+Temp. Diff.	-11041.3	35141.0	59713.3	92888.5	2.64	7.0
		LMmax Temp. Down+Temp. Diff.	-12112.8	35570.1	58904.7	92134.4	2.59	6.7
		LMmin Temp. Rise	-2367.3	25624.1	66157.6	98833.1	3.86	9.5
		LMmin Temp. Down	-3438.8	26053.3	65371.9	98142.3	3.77	9.2
		LMmin Temp. Diff.	-12117.5	26186.8	58901.5	92134.4	3.52	6.7
		LMmin Temp. Rise+Temp. Diff.	-11581.7	25972.3	59306.2	92509.5	3.56	6.8
		LMmin Temp. Down+Temp. Diff.	-12653.2	26401.4	58496.2	91753.9	3.48	6.5
		LNmax Temp. Rise	-1741.2	33341.8	66614.1	99227.5	2.98	9.7
		LNmax Temp. Down	-2812.7	33770.9	65830.0	98549.9	2.92	9.4
		LNmax Temp. Diff.	-11491.4	33904.4	59376.2	92575.0	2.73	6.8
		LNmax Temp. Rise+Temp. Diff.	-10955.6	33689.9	59780.1	92949.3	2.76	7.0
		LNmax Temp. Down+Temp. Diff.	-12027.1	34119.0	58970.1	92195.4	2.70	6.7
		LNmin Temp. Rise	-2443.5	25886.7	66102.0	98783.6	3.82	9.5
LNmin Temp. Down	-3515.0	26315.8	65316.1	98092.3	3.73	9.2		
LNmin Temp. Diff.	-12193.6	26449.3	58844.1	92078.1	3.48	6.6		
LNmin Temp. Rise+Temp. Diff.	-11657.9	26234.8	59248.9	92457.9	3.52	6.8		
LNmin Temp. Down+Temp. Diff.	-12729.4	26663.9	58438.6	91702.2	3.44	6.5		
29-i	Group-I	LMmax	-2231.5	40806.7	66256.4	98917.8	2.42	9.6
		LMmin	-3169.7	24889.8	65570.1	98322.5	3.95	9.3
		LNmax	-2082.7	38287.6	66364.3	99009.5	2.59	9.6
		LNmin	-3301.8	25345.5	65471.0	98237.9	3.88	9.3
	Group-IV	LMmax Temp. Rise	-1826.9	34792.8	66552.4	99171.3	2.85	9.7
		LMmax Temp. Down	-2898.4	35222.0	65768.2	98493.1	2.80	9.4
		LMmax Temp. Diff.	-11577.1	35355.5	59309.4	92514.2	2.62	6.8
		LMmax Temp. Rise+Temp. Diff.	-11041.3	35141.0	59713.3	92888.5	2.64	7.0
		LMmax Temp. Down+Temp. Diff.	-12112.8	35570.1	58904.7	92134.4	2.59	6.7
		LMmin Temp. Rise	-2367.3	25624.1	66157.6	98833.1	3.86	9.5
		LMmin Temp. Down	-3438.8	26053.3	65371.9	98142.3	3.77	9.2
		LMmin Temp. Diff.	-12117.5	26186.8	58901.5	92134.4	3.52	6.7
		LMmin Temp. Rise+Temp. Diff.	-11581.7	25972.3	59306.2	92509.5	3.56	6.8
		LMmin Temp. Down+Temp. Diff.	-12653.2	26401.4	58496.2	91753.9	3.48	6.5
		LNmax Temp. Rise	-1741.2	33341.8	66614.1	99227.5	2.98	9.7
		LNmax Temp. Down	-2812.7	33770.9	65830.0	98549.9	2.92	9.4
		LNmax Temp. Diff.	-11491.4	33904.4	59376.2	92575.0	2.73	6.8
		LNmax Temp. Rise+Temp. Diff.	-10955.6	33689.9	59780.1	92949.3	2.76	7.0
		LNmax Temp. Down+Temp. Diff.	-12027.1	34119.0	58970.1	92195.4	2.70	6.7
		LNmin Temp. Rise	-2443.5	25886.7	66102.0	98783.6	3.82	9.5
LNmin Temp. Down	-3515.0	26315.8	65316.1	98092.3	3.73	9.2		
LNmin Temp. Diff.	-12193.6	26449.3	58844.1	92078.1	3.48	6.6		
LNmin Temp. Rise+Temp. Diff.	-11657.9	26234.8	59248.9	92457.9	3.52	6.8		
LNmin Temp. Down+Temp. Diff.	-12729.4	26663.9	58438.6	91702.2	3.44	6.5		
29-j	Group-I	LMmax	-2267.7	46496.0	66318.8	98976.7	2.13	9.6
		LMmin	-3166.3	29073.7	65658.8	98409.6	3.38	9.3
		LNmax	-2082.7	45103.1	66451.5	99096.6	2.20	9.6
		LNmin	-3301.8	29550.2	65558.2	98325.0	3.33	9.3
	Group-IV	LMmax Temp. Rise	-1847.8	39444.2	66624.2	99244.4	2.52	9.7
		LMmax Temp. Down	-2919.3	40943.3	65839.8	98566.1	2.41	9.4
		LMmax Temp. Diff.	-11597.9	40620.5	59380.6	92587.2	2.28	6.8
		LMmax Temp. Rise+Temp. Diff.	-11062.2	39870.9	59784.6	92961.6	2.33	7.0
		LMmax Temp. Down+Temp. Diff.	-12133.7	41370.0	58975.9	92207.5	2.23	6.6
		LMmin Temp. Rise	-2365.4	29408.3	66244.7	98920.2	3.36	9.5
		LMmin Temp. Down	-3436.9	30907.4	65459.0	98234.0	3.18	9.2
		LMmin Temp. Diff.	-12115.5	30584.6	58991.9	92221.5	3.02	6.7
		LMmin Temp. Rise+Temp. Diff.	-11579.8	29835.1	59396.5	92596.6	3.10	6.8
		LMmin Temp. Down+Temp. Diff.	-12651.3	31334.2	58584.9	91845.8	2.93	6.5
		LNmax Temp. Rise	-1741.2	38641.9	66701.2	99314.7	2.57	9.7
		LNmax Temp. Down	-2812.7	40140.9	65917.2	98637.0	2.46	9.4
		LNmax Temp. Diff.	-11491.4	39818.1	59463.4	92662.2	2.33	6.8
		LNmax Temp. Rise+Temp. Diff.	-10955.6	39068.6	59867.2	93036.4	2.38	7.0
		LNmax Temp. Down+Temp. Diff.	-12027.1	40567.7	59057.2	92282.5	2.27	6.7
		LNmin Temp. Rise	-2443.5	29682.8	66189.1	98870.7	3.33	9.5
LNmin Temp. Down	-3515.0	31181.9	65403.2	98179.4	3.15	9.2		
LNmin Temp. Diff.	-12193.6	30859.1	58931.2	92165.2	2.99	6.6		
LNmin Temp. Rise+Temp. Diff.	-11657.9	30109.5	59336.0	92545.1	3.07	6.8		
LNmin Temp. Down+Temp. Diff.	-12729.4	31608.6	58525.8	91789.3	2.90	6.5		

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)		
30-i	Group-I	LMmax	-2267.7	46496.0	66318.8	98976.7	2.13	9.6
		LMmin	-3166.3	29073.7	65658.8	98409.6	3.38	9.3
		LNmax	-2082.7	45103.1	66451.5	99096.6	2.20	9.6
		LNmin	-3301.8	29550.2	65558.2	98325.0	3.33	9.3
	Group-IV	LMmax Temp. Rise	-1847.8	39444.2	66624.2	99244.4	2.52	9.7
		LMmax Temp. Down	-2919.3	40943.3	65839.8	98566.1	2.41	9.4
		LMmax Temp. Diff.	-11597.9	40620.5	59380.6	92587.2	2.28	6.8
		LMmax Temp. Rise+Temp. Diff.	-11062.2	39870.9	59784.6	92961.6	2.33	7.0
		LMmax Temp. Down+Temp. Diff.	-12133.7	41370.0	58975.9	92207.5	2.23	6.6
		LMmin Temp. Rise	-2365.4	29408.3	66244.7	98920.2	3.36	9.5
		LMmin Temp. Down	-3436.9	30907.4	65459.0	98234.0	3.18	9.2
		LMmin Temp. Diff.	-12115.5	30584.6	58991.9	92221.5	3.02	6.7
		LMmin Temp. Rise+Temp. Diff.	-11579.8	29835.1	59396.5	92596.6	3.10	6.8
		LMmin Temp. Down+Temp. Diff.	-12651.3	31334.2	58584.9	91845.8	2.93	6.5
		LNmax Temp. Rise	-1741.2	38641.9	66701.2	99314.7	2.57	9.7
		LNmax Temp. Down	-2812.7	40140.9	65917.2	98637.0	2.46	9.4
		LNmax Temp. Diff.	-11491.4	39818.1	59463.4	92662.2	2.33	6.8
		LNmax Temp. Rise+Temp. Diff.	-10955.6	39068.6	59867.2	93036.4	2.38	7.0
		LNmax Temp. Down+Temp. Diff.	-12027.1	40567.7	59057.2	92282.5	2.27	6.7
		LNmin Temp. Rise	-2443.5	29682.8	66189.1	98870.7	3.33	9.5
		LNmin Temp. Down	-3515.0	31181.9	65403.2	98179.4	3.15	9.2
		LNmin Temp. Diff.	-12193.6	30859.1	58931.2	92165.2	2.99	6.6
		LNmin Temp. Rise+Temp. Diff.	-11657.9	30109.5	59336.0	92545.1	3.07	6.8
		LNmin Temp. Down+Temp. Diff.	-12729.4	31608.6	58525.8	91789.3	2.90	6.5
30-j	Group-I	LMmax	-2220.4	43055.3	66223.0	98882.3	2.30	9.6
		LMmin	-3160.2	25765.1	65533.7	98287.0	3.81	9.3
		LNmax	-2082.7	42043.6	66321.7	98966.9	2.35	9.6
		LNmin	-3301.8	26281.1	65428.4	98195.3	3.74	9.3
	Group-IV	LMmax Temp. Rise	-1820.5	35955.2	66516.0	99135.7	2.76	9.7
		LMmax Temp. Down	-2892.0	38524.3	65731.8	98457.6	2.56	9.4
		LMmax Temp. Diff.	-11570.7	37745.1	59273.1	92476.2	2.45	6.8
		LMmax Temp. Rise+Temp. Diff.	-11034.9	36460.6	59677.1	92850.6	2.55	7.0
		LMmax Temp. Down+Temp. Diff.	-12106.4	39029.6	58868.5	92096.5	2.36	6.7
		LMmin Temp. Rise	-2361.9	25995.4	66118.1	98790.5	3.80	9.5
		LMmin Temp. Down	-3433.4	28564.5	65332.4	98104.3	3.43	9.2
		LMmin Temp. Diff.	-12112.0	27785.3	58862.1	92094.1	3.31	6.7
		LMmin Temp. Rise+Temp. Diff.	-11576.3	26500.8	59266.8	92471.6	3.49	6.8
		LMmin Temp. Down+Temp. Diff.	-12647.8	29069.8	58456.7	91716.0	3.16	6.5
		LNmax Temp. Rise	-1741.2	35372.4	66571.5	99184.9	2.80	9.7
		LNmax Temp. Down	-2812.7	37941.5	65787.4	98507.3	2.60	9.4
		LNmax Temp. Diff.	-11491.4	37162.3	59333.6	92532.4	2.49	6.8
		LNmax Temp. Rise+Temp. Diff.	-10955.6	35877.8	59737.5	92906.7	2.59	7.0
		LNmax Temp. Down+Temp. Diff.	-12027.1	38446.8	58927.5	92152.8	2.40	6.7
		LNmin Temp. Rise	-2443.5	26292.7	66059.4	98741.0	3.76	9.5
		LNmin Temp. Down	-3515.0	28861.7	65273.5	98049.7	3.40	9.2
		LNmin Temp. Diff.	-12193.6	28082.5	58801.5	92035.5	3.28	6.6
		LNmin Temp. Rise+Temp. Diff.	-11657.9	26798.0	59206.3	92415.3	3.45	6.8
		LNmin Temp. Down+Temp. Diff.	-12729.4	29367.1	58396.0	91659.6	3.12	6.5
31-i	Group-I	LMmax	-2220.4	43055.3	66223.0	98882.2	2.30	9.6
		LMmin	-3160.2	25765.1	65533.7	98287.0	3.81	9.3
		LNmax	-2082.7	42043.6	66321.7	98966.9	2.35	9.6
		LNmin	-3301.8	26281.1	65428.4	98195.3	3.74	9.3
	Group-IV	LMmax Temp. Rise	-1820.5	35955.2	66516.0	99135.7	2.76	9.7
		LMmax Temp. Down	-2892.0	38524.3	65731.8	98457.6	2.56	9.4
		LMmax Temp. Diff.	-11570.7	37745.1	59273.1	92476.2	2.45	6.8
		LMmax Temp. Rise+Temp. Diff.	-11034.9	36460.6	59677.1	92850.6	2.55	7.0
		LMmax Temp. Down+Temp. Diff.	-12106.4	39029.6	58868.5	92096.5	2.36	6.7
		LMmin Temp. Rise	-2361.9	25995.4	66118.1	98790.5	3.80	9.5
		LMmin Temp. Down	-3433.4	28564.5	65332.4	98104.3	3.43	9.2
		LMmin Temp. Diff.	-12112.0	27785.3	58862.1	92094.1	3.31	6.7
		LMmin Temp. Rise+Temp. Diff.	-11576.3	26500.8	59266.8	92471.6	3.49	6.8
		LMmin Temp. Down+Temp. Diff.	-12647.8	29069.8	58456.7	91716.0	3.16	6.5
		LNmax Temp. Rise	-1741.2	35372.4	66571.5	99184.9	2.80	9.7
		LNmax Temp. Down	-2812.7	37941.5	65787.4	98507.3	2.60	9.4
		LNmax Temp. Diff.	-11491.4	37162.3	59333.6	92532.4	2.49	6.8
		LNmax Temp. Rise+Temp. Diff.	-10955.6	35877.8	59737.5	92906.7	2.59	7.0
		LNmax Temp. Down+Temp. Diff.	-12027.1	38446.8	58927.5	92152.8	2.40	6.7
		LNmin Temp. Rise	-2443.5	26292.7	66059.4	98741.0	3.76	9.5
		LNmin Temp. Down	-3515.0	28861.7	65273.5	98049.7	3.40	9.2
		LNmin Temp. Diff.	-12193.6	28082.5	58801.5	92035.5	3.28	6.6
		LNmin Temp. Rise+Temp. Diff.	-11657.9	26798.0	59206.3	92415.3	3.45	6.8
		LNmin Temp. Down+Temp. Diff.	-12729.4	29367.1	58396.0	91659.6	3.12	6.5

Member No.	Combination Group	Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)		
		Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)				
31-j	Group-I	LMmax	-2309.2	30295.6	49699.0	82366.6	2.72	9.6	
		LMmin	-3090.9	15410.0	49124.0	81870.5	5.31	9.3	
		LNmax	-2082.7	28867.8	49862.6	82507.7	2.86	9.6	
		LNmin	-3301.8	16037.7	48969.2	81736.1	5.10	9.3	
	Group-IV	LMmax Temp. Rise	-1871.6	24409.5	50016.7	82641.4	3.39	9.7	
		LMmax Temp. Down	-2943.1	28048.5	49232.3	81962.9	2.92	9.4	
		LMmax Temp. Diff.	-11621.8	26812.9	42775.7	75979.6	2.83	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11086.1	24993.4	43179.8	76354.0	3.05	7.0	
		LMmax Temp. Down+Temp. Diff.	-12157.6	28632.4	42371.0	75604.4	2.64	6.6	
		LMmin Temp. Rise	-2322.0	15834.9	49689.7	82359.5	5.20	9.6	
		LMmin Temp. Down	-3393.5	19473.9	48904.2	81672.4	4.19	9.2	
		LMmin Temp. Diff.	-12072.1	18238.3	42434.8	75663.1	4.15	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11536.4	16418.8	42839.4	76040.5	4.63	6.8	
		LMmin Temp. Down+Temp. Diff.	-12607.9	20057.8	42029.5	75285.0	3.75	6.5	
		LNmax Temp. Rise	-1741.2	23587.0	50112.3	82725.7	3.51	9.7	
		LNmax Temp. Down	-2812.7	27226.0	49328.2	82048.1	3.01	9.4	
		LNmax Temp. Diff.	-11491.4	25990.5	42874.4	76073.2	2.93	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10955.6	24171.0	43278.3	76447.5	3.16	7.0	
		LNmax Temp. Down+Temp. Diff.	-12027.1	27810.0	42468.3	75693.6	2.72	6.7	
		LNmin Temp. Rise	-2443.5	16196.4	49600.2	82281.8	5.08	9.5	
		LNmin Temp. Down	-3515.0	19835.4	48814.3	81590.5	4.11	9.2	
		LNmin Temp. Diff.	-12193.6	18599.8	42342.3	75576.3	4.06	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11657.9	16780.3	42747.1	75956.1	4.53	6.8	
		LNmin Temp. Down+Temp. Diff.	-12729.4	20419.3	41936.8	75200.4	3.68	6.5	
	32-i	Group-I	LMmax	-2309.2	30295.6	49699.0	82366.6	2.72	9.6
			LMmin	-3090.9	15410.0	49124.0	81870.5	5.31	9.3
LNmax			-2082.7	28867.8	49862.5	82507.7	2.86	9.6	
LNmin			-3301.8	16037.7	48969.2	81736.1	5.10	9.3	
Group-IV		LMmax Temp. Rise	-1871.6	24409.5	50016.7	82641.4	3.39	9.7	
		LMmax Temp. Down	-2943.1	28048.5	49232.3	81962.9	2.92	9.4	
		LMmax Temp. Diff.	-11621.8	26812.9	42775.7	75979.6	2.83	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11086.1	24993.4	43179.7	76354.0	3.05	7.0	
		LMmax Temp. Down+Temp. Diff.	-12157.6	28632.4	42371.0	75604.4	2.64	6.6	
		LMmin Temp. Rise	-2322.0	15834.9	49689.7	82359.5	5.20	9.6	
		LMmin Temp. Down	-3393.5	19473.9	48904.2	81672.4	4.19	9.2	
		LMmin Temp. Diff.	-12072.1	18238.3	42434.8	75663.1	4.15	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11536.4	16418.8	42839.4	76040.5	4.63	6.8	
		LMmin Temp. Down+Temp. Diff.	-12607.9	20057.8	42029.5	75285.0	3.75	6.5	
		LNmax Temp. Rise	-1741.2	23587.0	50112.3	82725.7	3.51	9.7	
		LNmax Temp. Down	-2812.7	27226.0	49328.2	82048.1	3.01	9.4	
		LNmax Temp. Diff.	-11491.4	25990.5	42874.4	76073.2	2.93	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10955.6	24171.0	43278.3	76447.5	3.16	7.0	
		LNmax Temp. Down+Temp. Diff.	-12027.1	27810.0	42468.3	75693.6	2.72	6.7	
		LNmin Temp. Rise	-2443.5	16196.4	49600.2	82281.8	5.08	9.5	
		LNmin Temp. Down	-3515.0	19835.4	48814.3	81590.5	4.11	9.2	
		LNmin Temp. Diff.	-12193.6	18599.8	42342.3	75576.3	4.06	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11657.9	16780.3	42747.1	75956.1	4.53	6.8	
		LNmin Temp. Down+Temp. Diff.	-12729.4	20419.3	41936.8	75200.4	3.68	6.5	
32-j		Group-I	LMmax	-2483.7	10517.1	27298.9	59983.1	5.70	9.5
			LMmin	-2714.9	-3565.0	-42504.9	-83123.5	23.32	17.6
	LNmax		-2082.7	5625.7	27592.1	60237.2	10.71	9.6	
	LNmin		-3301.8	-501.4	-41714.6	-82367.2	164.27	17.3	
	Group-IV	LMmax Temp. Rise	-1972.2	6401.9	27675.4	60307.7	9.42	9.7	
		LMmax Temp. Down	-3043.7	11075.6	26890.8	59628.5	5.38	9.3	
		LMmax Temp. Diff.	-11722.3	9398.7	20428.9	53638.9	5.71	6.8	
		LMmax Temp. Rise+Temp. Diff.	-11186.6	7061.8	20833.0	54013.4	7.65	6.9	
		LMmax Temp. Down+Temp. Diff.	-12258.1	11735.5	20024.0	53263.6	4.54	6.6	
		LMmin Temp. Rise	-2105.4	-1710.0	-43321.8	-83910.7	49.07	18.0	
		LMmin Temp. Down	-3176.9	2963.7	26791.7	59543.2	20.09	9.3	
		LMmin Temp. Diff.	-11855.5	1286.9	20327.0	53545.1	41.61	6.7	
		LMmin Temp. Rise+Temp. Diff.	-11319.8	-1050.0	-30786.8	-71920.7	68.50	12.9	
		LMmin Temp. Down+Temp. Diff.	-12391.3	3623.7	19921.9	53169.7	14.67	6.6	
		LNmax Temp. Rise	-1741.2	3584.3	27841.9	60455.3	16.87	9.7	
		LNmax Temp. Down	-2812.7	8257.9	27057.8	59777.7	7.24	9.4	
		LNmax Temp. Diff.	-11491.4	6581.1	20604.0	53802.8	8.18	6.8	
		LNmax Temp. Rise+Temp. Diff.	-10955.6	4244.2	21007.8	54177.1	12.76	7.0	
		LNmax Temp. Down+Temp. Diff.	-12027.1	8917.9	20197.9	53423.2	5.99	6.7	
		LNmin Temp. Rise	-2443.5	54.8	27329.8	53423.2	975.11	9.5	
		LNmin Temp. Down	-3515.0	4728.5	26543.9	59320.1	12.55	9.2	
		LNmin Temp. Diff.	-12193.6	3051.6	20071.9	53305.9	17.47	6.6	
		LNmin Temp. Rise+Temp. Diff.	-11657.9	714.8	20476.7	53685.7	75.11	6.8	
		LNmin Temp. Down+Temp. Diff.	-12729.4	5388.4	19666.4	52930.0	9.82	6.5	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)		
			33-i	Group-I	LMmax	-2483.7		
	LMmin	-2714.9	-3565.0		-42504.9	-83123.5	23.32	17.6
	LNmax	-2082.7	5625.7		27592.1	60237.2	10.71	9.6
	LNmin	-3301.8	-501.4		-41714.6	-82367.2	164.27	17.3
	Group-IV	LMmax Temp. Rise	-1972.2	6401.9	27675.4	60307.7	9.42	9.7
		LMmax Temp. Down	-3043.7	11075.6	26890.8	59628.5	5.38	9.3
		LMmax Temp. Diff.	-11722.3	9398.7	20428.9	53638.9	5.71	6.8
		LMmax Temp. Rise+Temp. Diff.	-11186.6	7061.8	20833.0	54013.4	7.65	6.9
		LMmax Temp. Down+Temp. Diff.	-12258.1	11735.5	20024.0	53263.6	4.54	6.6
		LMmin Temp. Rise	-2105.4	-1710.0	-43321.8	-83910.7	49.07	18.0
		LMmin Temp. Down	-3176.9	2963.7	26791.7	59543.2	20.09	9.3
		LMmin Temp. Diff.	-11855.5	1286.9	20326.9	53545.1	41.61	6.7
		LMmin Temp. Rise+Temp. Diff.	-11319.8	-1050.0	-30786.8	-71920.7	68.50	12.9
		LMmin Temp. Down+Temp. Diff.	-12391.3	3623.7	19921.9	53169.7	14.67	6.6
		LNmax Temp. Rise	-1741.2	3584.3	27841.8	60455.3	16.87	9.7
		LNmax Temp. Down	-2812.7	8257.9	27057.8	59777.7	7.24	9.4
		LNmax Temp. Diff.	-11491.4	6581.1	20604.0	53802.8	8.18	6.8
		LNmax Temp. Rise+Temp. Diff.	-10955.6	4244.2	21007.8	54177.1	12.76	7.0
		LNmax Temp. Down+Temp. Diff.	-12027.1	8917.9	20197.9	53423.2	5.99	6.7
		LNmin Temp. Rise	-2443.5	54.8	27329.8	53423.2	975.11	9.5
		LNmin Temp. Down	-3515.0	4728.5	26543.9	59320.1	12.55	9.2
		LNmin Temp. Diff.	-12193.6	3051.6	20071.9	53305.9	17.47	6.6
		LNmin Temp. Rise+Temp. Diff.	-11657.9	714.8	20476.7	53685.7	75.11	6.8
		LNmin Temp. Down+Temp. Diff.	-12729.4	5388.4	19666.4	52930.0	9.82	6.5
33-j	Group-I	LMmax	-2818.2	-28262.3	-65883.4	-113894.3	4.03	17.6
		LMmin	-2568.0	-51419.9	-66170.2	-114169.4	2.22	17.7
		LNmax	-2082.7	-42358.5	-66728.2	-114694.7	2.71	18.0
		LNmin	-3301.8	-37378.6	-65323.8	-113369.3	3.03	17.3
	Group-IV	LMmax Temp. Rise	-2164.9	-30505.2	-66633.6	-114606.1	3.76	17.9
		LMmax Temp. Down	-3236.4	-24303.0	-65399.3	-113439.4	4.67	17.3
		LMmax Temp. Diff.	-12062.5	-28507.1	-55029.5	-103693.7	3.64	12.4
		LMmax Temp. Rise+Temp. Diff.	-11526.8	-31608.2	-55669.1	-104291.3	3.30	12.7
		LMmax Temp. Down+Temp. Diff.	-12598.3	-25406.0	-54388.6	-103094.6	4.06	12.2
		LMmin Temp. Rise	-2020.7	-43844.9	-66800.9	-114764.1	2.62	18.0
		LMmin Temp. Down	-3092.2	-37642.7	-65567.3	-113595.1	3.02	17.4
		LMmin Temp. Diff.	-11918.4	-41846.7	-55200.9	-103855.7	2.48	12.5
		LMmin Temp. Rise+Temp. Diff.	-11382.6	-44947.8	-55840.1	-104450.2	2.32	12.8
		LMmin Temp. Down+Temp. Diff.	-12454.1	-38745.6	-54560.3	-103257.6	2.67	12.2
		LNmax Temp. Rise	-1741.2	-38625.2	-67120.5	-115068.0	2.98	18.2
		LNmax Temp. Down	-2812.7	-32423.0	-65888.3	-113902.0	3.51	17.6
		LNmax Temp. Diff.	-11638.9	-36627.0	-55535.7	-104166.1	2.84	12.7
		LNmax Temp. Rise+Temp. Diff.	-11103.1	-39728.1	-56174.3	-104763.0	2.64	13.0
		LNmax Temp. Down+Temp. Diff.	-12174.6	-33525.9	-54895.9	-103569.9	3.09	12.4
		LNmin Temp. Rise	-2443.5	-35756.6	-66313.4	-114304.8	3.20	17.8
		LNmin Temp. Down	-3515.0	-29554.4	-65077.7	-113135.2	3.83	17.2
		LNmin Temp. Diff.	-12341.1	-33758.4	-54696.6	-103381.8	3.06	12.3
		LNmin Temp. Rise+Temp. Diff.	-11805.4	-36859.5	-55336.9	-103979.2	2.82	12.6
		LNmin Temp. Down+Temp. Diff.	-12876.9	-30657.3	-54055.0	-102784.9	3.35	12.0
38-i	Group-I	LMmax	0.0	-54718.5	-68294.4	-116137.4	2.12	19.1
		LMmin	0.0	-77149.4	-68294.4	-116137.4	1.51	19.1
		LNmax	0.0	-55745.3	-68294.4	-116137.4	2.08	19.1
		LNmin	0.0	-55745.3	-68294.4	-116137.4	2.08	19.1
	Group-IV	LMmax Temp. Rise	0.0	-50608.9	-68294.4	-116137.4	2.29	19.1
		LMmax Temp. Down	0.0	-55223.0	-68294.4	-116137.4	2.10	19.1
		LMmax Temp. Diff.	-9573.7	-51604.2	-57170.0	-105650.6	2.05	13.8
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-49297.2	-57170.0	-105650.6	2.14	13.8
		LMmax Temp. Down+Temp. Diff.	-9573.7	-53911.3	-57170.0	-105650.6	1.96	13.8
		LMmin Temp. Rise	0.0	-63529.9	-68294.4	-116137.4	1.83	19.1
		LMmin Temp. Down	0.0	-68144.0	-68294.4	-116137.4	1.70	19.1
		LMmin Temp. Diff.	-9573.7	-64525.3	-57170.0	-105650.6	1.64	13.8
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-62218.2	-57170.0	-105650.6	1.70	13.8
		LMmin Temp. Down+Temp. Diff.	-9573.7	-66832.3	-57170.0	-105650.6	1.58	13.8
		LNmax Temp. Rise	0.0	-51200.4	-68294.4	-116137.4	2.27	19.1
		LNmax Temp. Down	0.0	-55814.5	-68294.4	-116137.4	2.08	19.1
		LNmax Temp. Diff.	-9573.7	-52195.8	-57170.0	-105650.6	2.02	13.8
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-49888.7	-57170.0	-105650.6	2.12	13.8
		LNmax Temp. Down+Temp. Diff.	-9573.7	-54502.8	-57170.0	-105650.6	1.94	13.8
		LNmin Temp. Rise	0.0	-51200.4	-68294.4	-116137.4	2.27	19.1
		LNmin Temp. Down	0.0	-55814.5	-68294.4	-116137.4	2.08	19.1
		LNmin Temp. Diff.	-9573.7	-52195.8	-57170.0	-105650.6	2.02	13.8
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-49888.7	-57170.0	-105650.6	2.12	13.8
		LNmin Temp. Down+Temp. Diff.	-9573.7	-54502.8	-57170.0	-105650.6	1.94	13.8

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
38-j	Group-I	LMmax	0.0	-3932.5	-35128.0	-75605.2	19.23	18.1	
		LMmin	0.0	-16508.0	-35128.0	-75605.2	4.58	18.1	
		LNmax	0.0	-8400.7	-35128.0	-75605.2	9.00	18.1	
		LNmin	0.0	-8400.7	-35128.0	-75605.2	9.00	18.1	
	Group-IV	LMmax Temp. Rise	0.0	-3491.0	-35128.0	-75605.2	21.66	18.1	
		LMmax Temp. Down	0.0	-7359.1	-35128.0	-75605.2	10.27	18.1	
		LMmax Temp. Diff.	-9573.7	-4033.2	-22610.1	-63482.2	15.74	13.5	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-2099.2	-22610.1	-63482.2	30.24	13.5	
		LMmax Temp. Down+Temp. Diff.	-9573.7	-5967.2	-22610.1	-63482.2	10.64	13.5	
		LMmin Temp. Rise	0.0	-10735.0	-35128.0	-75605.2	7.04	18.1	
		LMmin Temp. Down	0.0	-14603.1	-35128.0	-75605.2	5.18	18.1	
		LMmin Temp. Diff.	-9573.7	-11277.2	-22610.1	-63482.2	5.63	13.5	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-9343.2	-22610.1	-63482.2	6.79	13.5	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-13211.2	-22610.1	-63482.2	4.81	13.5	
		LNmax Temp. Rise	0.0	-6064.9	-35128.0	-75605.2	12.47	18.1	
		LNmax Temp. Down	0.0	-9932.9	-35128.0	-75605.2	7.61	18.1	
		LNmax Temp. Diff.	-9573.7	-6607.1	-22610.1	-63482.2	9.61	13.5	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-4673.1	-22610.1	-63482.2	13.58	13.5	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-8541.1	-22610.1	-63482.2	7.43	13.5	
		LNmin Temp. Rise	0.0	-6064.9	-35128.0	-75605.2	12.47	18.1	
		LNmin Temp. Down	0.0	-9932.9	-35128.0	-75605.2	7.61	18.1	
		LNmin Temp. Diff.	-9573.7	-6607.1	-22610.1	-63482.2	9.61	13.5	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-4673.1	-22610.1	-63482.2	13.58	13.5	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-8541.1	-22610.1	-63482.2	7.43	13.5	
	39-i	Group-I	LMmax	0.0	-3932.5	-35119.5	-75598.8	19.22	18.0
			LMmin	0.0	-16508.0	-35119.5	-75598.8	4.58	18.0
LNmax			0.0	-8400.7	-35119.5	-75598.8	9.00	18.0	
LNmin			0.0	-8400.7	-35119.5	-75598.8	9.00	18.0	
Group-IV		LMmax Temp. Rise	0.0	-3491.0	-35119.5	-75598.8	21.66	18.0	
		LMmax Temp. Down	0.0	-7359.1	-35119.5	-75598.8	10.27	18.0	
		LMmax Temp. Diff.	-9573.7	-4033.2	-22604.8	-63472.8	15.74	13.4	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-2099.2	-22604.8	-63472.8	30.24	13.4	
		LMmax Temp. Down+Temp. Diff.	-9573.7	-5967.2	-22604.8	-63472.8	10.64	13.4	
		LMmin Temp. Rise	0.0	-10735.0	-35119.5	-75598.8	7.04	18.0	
		LMmin Temp. Down	0.0	-14603.1	-35119.5	-75598.8	5.18	18.0	
		LMmin Temp. Diff.	-9573.7	-11277.2	-22604.8	-63472.8	5.63	13.4	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-9343.2	-22604.8	-63472.8	6.79	13.4	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-13211.2	-22604.8	-63472.8	4.80	13.4	
		LNmax Temp. Rise	0.0	-6064.9	-35119.5	-75598.8	12.46	18.0	
		LNmax Temp. Down	0.0	-9932.9	-35119.5	-75598.8	7.61	18.0	
		LNmax Temp. Diff.	-9573.7	-6607.1	-22604.8	-63472.8	9.61	13.4	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-4673.1	-22604.8	-63472.8	13.58	13.4	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-8541.1	-22604.8	-63472.8	7.43	13.4	
		LNmin Temp. Rise	0.0	-6064.9	-35119.5	-75598.8	12.46	18.0	
		LNmin Temp. Down	0.0	-9932.9	-35119.5	-75598.8	7.61	18.0	
		LNmin Temp. Diff.	-9573.7	-6607.1	-22604.8	-63472.8	9.61	13.4	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-4673.1	-22604.8	-63472.8	13.58	13.4	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-8541.1	-22604.8	-63472.8	7.43	13.4	
39-j		Group-I	LMmax	0.0	24359.3	57135.5	89582.9	3.68	10.2
			LMmin	0.0	10386.1	57135.5	89582.9	8.63	10.2
	LNmax		0.0	14867.6	57135.5	89582.9	6.03	10.2	
	LNmin		0.0	14867.6	57135.5	89582.9	6.03	10.2	
	Group-IV	LMmax Temp. Rise	0.0	21513.3	57135.5	89582.9	4.16	10.2	
		LMmax Temp. Down	0.0	18150.2	57135.5	89582.9	4.94	10.2	
		LMmax Temp. Diff.	-9426.2	20565.7	50178.4	83272.5	4.05	7.5	
		LMmax Temp. Rise+Temp. Diff.	-9426.2	22247.2	50178.4	83272.5	3.74	7.5	
		LMmax Temp. Down+Temp. Diff.	-9426.2	18884.2	50178.4	83272.5	4.41	7.5	
		LMmin Temp. Rise	0.0	13464.2	57135.5	89582.9	6.65	10.2	
		LMmin Temp. Down	0.0	10101.2	57135.5	89582.9	8.87	10.2	
		LMmin Temp. Diff.	-9426.2	12516.7	50178.4	83272.5	6.65	7.5	
		LMmin Temp. Rise+Temp. Diff.	-9426.2	14198.2	50178.4	83272.5	5.87	7.5	
		LMmin Temp. Down+Temp. Diff.	-9426.2	10835.2	50178.4	83272.5	7.69	7.5	
		LNmax Temp. Rise	0.0	16045.7	57135.5	89582.9	5.58	10.2	
		LNmax Temp. Down	0.0	12682.7	57135.5	89582.9	7.06	10.2	
		LNmax Temp. Diff.	-9426.2	15098.2	50178.4	83272.5	5.52	7.5	
		LNmax Temp. Rise+Temp. Diff.	-9426.2	16779.7	50178.4	83272.5	4.96	7.5	
		LNmax Temp. Down+Temp. Diff.	-9426.2	13416.7	50178.4	83272.5	6.21	7.5	
		LNmin Temp. Rise	0.0	16045.7	57135.5	89582.9	5.58	10.2	
		LNmin Temp. Down	0.0	12682.7	57135.5	89582.9	7.06	10.2	
		LNmin Temp. Diff.	-9426.2	15098.2	50178.4	83272.5	5.52	7.5	
		LNmin Temp. Rise+Temp. Diff.	-9426.2	16779.7	50178.4	83272.5	4.96	7.5	
		LNmin Temp. Down+Temp. Diff.	-9426.2	13416.7	50178.4	83272.5	6.21	7.5	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)		
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)				
40-i	Group-I	LMmax	0.0	24359.3	57135.5	89582.9	3.68	10.2		
		LMmin	0.0	10386.1	57135.5	89582.9	8.63	10.2		
		LNmax	0.0	14867.6	57135.5	89582.9	6.03	10.2		
		LNmin	0.0	14867.6	57135.5	89582.9	6.03	10.2		
	Group-IV	LMmax Temp. Rise	0.0	21513.3	57135.5	89582.9	4.16	10.2		
		LMmax Temp. Down	0.0	18150.2	57135.5	89582.9	4.94	10.2		
		LMmax Temp. Diff.	-9426.2	20565.7	50178.4	83272.5	4.05	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	22247.2	50178.4	83272.5	3.74	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	18884.2	50178.4	83272.5	4.41	7.5		
		LMmin Temp. Rise	0.0	13464.2	57135.5	89582.9	6.65	10.2		
		LMmin Temp. Down	0.0	10101.2	57135.5	89582.9	8.87	10.2		
		LMmin Temp. Diff.	-9426.2	12516.7	50178.4	83272.5	6.65	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	14198.2	50178.4	83272.5	5.87	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	10835.2	50178.4	83272.5	7.69	7.5		
		LNmax Temp. Rise	0.0	16045.7	57135.5	89582.9	5.58	10.2		
		LNmax Temp. Down	0.0	12682.7	57135.5	89582.9	7.06	10.2		
		LNmax Temp. Diff.	-9426.2	15098.2	50178.4	83272.5	5.52	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	16779.7	50178.4	83272.5	4.96	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	13416.7	50178.4	83272.5	6.21	7.5		
		LNmin Temp. Rise	0.0	16045.7	57135.5	89582.9	5.58	10.2		
		LNmin Temp. Down	0.0	12682.7	57135.5	89582.9	7.06	10.2		
		LNmin Temp. Diff.	-9426.2	15098.2	50178.4	83272.5	5.52	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	16779.7	50178.4	83272.5	4.96	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	13416.7	50178.4	83272.5	6.21	7.5		
		40-j	Group-I	LMmax	0.0	46347.9	66272.9	98720.2	2.13	10.2
				LMmin	0.0	28209.8	66272.9	98720.2	3.50	10.2
				LNmax	0.0	31995.3	66272.9	98720.2	3.09	10.2
				LNmin	0.0	31995.3	66272.9	98720.2	3.09	10.2
Group-IV	LMmax Temp. Rise		0.0	40510.5	66272.9	98720.2	2.44	10.2		
	LMmax Temp. Down		0.0	37669.8	66272.9	98720.2	2.62	10.2		
	LMmax Temp. Diff.		-9426.2	38800.2	59315.8	92409.8	2.38	7.5		
	LMmax Temp. Rise+Temp. Diff.		-9426.2	40220.6	59315.8	92409.8	2.30	7.5		
	LMmax Temp. Down+Temp. Diff.		-9426.2	37379.8	59315.8	92409.8	2.47	7.5		
	LMmin Temp. Rise		0.0	30062.3	66272.9	98720.2	3.28	10.2		
	LMmin Temp. Down		0.0	27221.5	66272.9	98720.2	3.63	10.2		
	LMmin Temp. Diff.		-9426.2	28352.0	59315.8	92409.8	3.26	7.5		
	LMmin Temp. Rise+Temp. Diff.		-9426.2	29772.4	59315.8	92409.8	3.10	7.5		
	LMmin Temp. Down+Temp. Diff.		-9426.2	26931.6	59315.8	92409.8	3.43	7.5		
	LNmax Temp. Rise		0.0	32242.9	66272.9	98720.2	3.06	10.2		
	LNmax Temp. Down		0.0	29402.2	66272.9	98720.2	3.36	10.2		
	LNmax Temp. Diff.		-9426.2	30532.6	59315.8	92409.8	3.03	7.5		
	LNmax Temp. Rise+Temp. Diff.		-9426.2	31953.0	59315.8	92409.8	2.89	7.5		
	LNmax Temp. Down+Temp. Diff.		-9426.2	29112.2	59315.8	92409.8	3.17	7.5		
	LNmin Temp. Rise		0.0	32242.9	66272.9	98720.2	3.06	10.2		
	LNmin Temp. Down		0.0	29402.2	66272.9	98720.2	3.36	10.2		
	LNmin Temp. Diff.		-9426.2	30532.6	59315.8	92409.8	3.03	7.5		
	LNmin Temp. Rise+Temp. Diff.		-9426.2	31953.0	59315.8	92409.8	2.89	7.5		
	LNmin Temp. Down+Temp. Diff.		-9426.2	29112.2	59315.8	92409.8	3.17	7.5		
	41-i		Group-I	LMmax	0.0	46347.9	66272.9	98720.2	2.13	10.2
				LMmin	0.0	28209.8	66272.9	98720.2	3.50	10.2
				LNmax	0.0	31995.3	66272.9	98720.2	3.09	10.2
				LNmin	0.0	31995.3	66272.9	98720.2	3.09	10.2
Group-IV		LMmax Temp. Rise	0.0	40510.5	66272.9	98720.2	2.44	10.2		
		LMmax Temp. Down	0.0	37669.8	66272.9	98720.2	2.62	10.2		
		LMmax Temp. Diff.	-9426.2	38800.2	59315.8	92409.8	2.38	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	40220.6	59315.8	92409.8	2.30	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	37379.8	59315.8	92409.8	2.47	7.5		
		LMmin Temp. Rise	0.0	30062.3	66272.9	98720.2	3.28	10.2		
		LMmin Temp. Down	0.0	27221.5	66272.9	98720.2	3.63	10.2		
		LMmin Temp. Diff.	-9426.2	28352.0	59315.8	92409.8	3.26	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	29772.4	59315.8	92409.8	3.10	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	26931.6	59315.8	92409.8	3.43	7.5		
		LNmax Temp. Rise	0.0	32242.9	66272.9	98720.2	3.06	10.2		
		LNmax Temp. Down	0.0	29402.2	66272.9	98720.2	3.36	10.2		
		LNmax Temp. Diff.	-9426.2	30532.6	59315.8	92409.8	3.03	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	31953.0	59315.8	92409.8	2.89	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	29112.2	59315.8	92409.8	3.17	7.5		
		LNmin Temp. Rise	0.0	32242.9	66272.9	98720.2	3.06	10.2		
		LNmin Temp. Down	0.0	29402.2	66272.9	98720.2	3.36	10.2		
		LNmin Temp. Diff.	-9426.2	30532.6	59315.8	92409.8	3.03	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	31953.0	59315.8	92409.8	2.89	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	29112.2	59315.8	92409.8	3.17	7.5		

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)		
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)				
41-j	Group-I	LMmax	0.0	59081.5	67971.5	100418.8	1.70	10.2		
		LMmin	0.0	39059.0	67971.5	100418.8	2.57	10.2		
		LNmax	0.0	42148.7	67971.5	100418.8	2.38	10.2		
		LNmin	0.0	42148.7	67971.5	100418.8	2.38	10.2		
	Group-IV	LMmax Temp. Rise	0.0	51487.9	67971.5	100418.8	1.95	10.2		
		LMmax Temp. Down	0.0	49169.4	67971.5	100418.8	2.04	10.2		
		LMmax Temp. Diff.	-9426.2	49014.8	61014.4	94108.5	1.92	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	50174.1	61014.4	94108.5	1.88	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	47855.6	61014.4	94108.5	1.97	7.5		
		LMmin Temp. Rise	0.0	39954.2	67971.5	100418.8	2.51	10.2		
		LMmin Temp. Down	0.0	37635.7	67971.5	100418.8	2.67	10.2		
		LMmin Temp. Diff.	-9426.2	37481.1	61014.4	94108.5	2.51	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	38640.4	61014.4	94108.5	2.44	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	36321.9	61014.4	94108.5	2.59	7.5		
		LNmax Temp. Rise	0.0	41734.0	67971.5	100418.8	2.41	10.2		
		LNmax Temp. Down	0.0	39415.5	67971.5	100418.8	2.55	10.2		
		LNmax Temp. Diff.	-9426.2	39260.9	61014.4	94108.5	2.40	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	40420.2	61014.4	94108.5	2.33	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	38101.6	61014.4	94108.5	2.47	7.5		
		LNmin Temp. Rise	0.0	41734.0	67971.5	100418.8	2.41	10.2		
		LNmin Temp. Down	0.0	39415.5	67971.5	100418.8	2.55	10.2		
		LNmin Temp. Diff.	-9426.2	39260.9	61014.4	94108.5	2.40	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	40420.2	61014.4	94108.5	2.33	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	38101.6	61014.4	94108.5	2.47	7.5		
		42-i	Group-I	LMmax	0.0	59081.5	67971.5	100418.8	1.70	10.2
				LMmin	0.0	39059.0	67971.5	100418.8	2.57	10.2
				LNmax	0.0	42148.7	67971.5	100418.8	2.38	10.2
				LNmin	0.0	42148.7	67971.5	100418.8	2.38	10.2
Group-IV	LMmax Temp. Rise		0.0	51487.9	67971.5	100418.8	1.95	10.2		
	LMmax Temp. Down		0.0	49169.4	67971.5	100418.8	2.04	10.2		
	LMmax Temp. Diff.		-9426.2	49014.8	61014.4	94108.5	1.92	7.5		
	LMmax Temp. Rise+Temp. Diff.		-9426.2	50174.1	61014.4	94108.5	1.88	7.5		
	LMmax Temp. Down+Temp. Diff.		-9426.2	47855.6	61014.4	94108.5	1.97	7.5		
	LMmin Temp. Rise		0.0	39954.2	67971.5	100418.8	2.51	10.2		
	LMmin Temp. Down		0.0	37635.7	67971.5	100418.8	2.67	10.2		
	LMmin Temp. Diff.		-9426.2	37481.1	61014.4	94108.5	2.51	7.5		
	LMmin Temp. Rise+Temp. Diff.		-9426.2	38640.4	61014.4	94108.5	2.44	7.5		
	LMmin Temp. Down+Temp. Diff.		-9426.2	36321.9	61014.4	94108.5	2.59	7.5		
	LNmax Temp. Rise		0.0	41734.0	67971.5	100418.8	2.41	10.2		
	LNmax Temp. Down		0.0	39415.5	67971.5	100418.8	2.55	10.2		
	LNmax Temp. Diff.		-9426.2	39260.9	61014.4	94108.5	2.40	7.5		
	LNmax Temp. Rise+Temp. Diff.		-9426.2	40420.2	61014.4	94108.5	2.33	7.5		
	LNmax Temp. Down+Temp. Diff.		-9426.2	38101.6	61014.4	94108.5	2.47	7.5		
	LNmin Temp. Rise		0.0	41734.0	67971.5	100418.8	2.41	10.2		
	LNmin Temp. Down		0.0	39415.5	67971.5	100418.8	2.55	10.2		
	LNmin Temp. Diff.		-9426.2	39260.9	61014.4	94108.5	2.40	7.5		
	LNmin Temp. Rise+Temp. Diff.		-9426.2	40420.2	61014.4	94108.5	2.33	7.5		
	LNmin Temp. Down+Temp. Diff.		-9426.2	38101.6	61014.4	94108.5	2.47	7.5		
	42-j		Group-I	LMmax	0.0	62644.1	67971.5	100418.8	1.60	10.2
				LMmin	0.0	42434.6	67971.5	100418.8	2.37	10.2
				LNmax	0.0	44828.3	67971.5	100418.8	2.24	10.2
				LNmin	0.0	44828.3	67971.5	100418.8	2.24	10.2
Group-IV		LMmax Temp. Rise	0.0	54301.4	67971.5	100418.8	1.85	10.2		
		LMmax Temp. Down	0.0	52505.1	67971.5	100418.8	1.91	10.2		
		LMmax Temp. Diff.	-9426.2	51065.5	61014.4	94108.5	1.84	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	51963.6	61014.4	94108.5	1.81	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	50167.3	61014.4	94108.5	1.88	7.5		
		LMmin Temp. Rise	0.0	42659.9	67971.5	100418.8	2.35	10.2		
		LMmin Temp. Down	0.0	40863.6	67971.5	100418.8	2.46	10.2		
		LMmin Temp. Diff.	-9426.2	39424.0	61014.4	94108.5	2.39	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	40322.2	61014.4	94108.5	2.33	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	38525.9	61014.4	94108.5	2.44	7.5		
		LNmax Temp. Rise	0.0	44038.8	67971.5	100418.8	2.28	10.2		
		LNmax Temp. Down	0.0	42242.5	67971.5	100418.8	2.38	10.2		
		LNmax Temp. Diff.	-9426.2	40802.9	61014.4	94108.5	2.31	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	41701.1	61014.4	94108.5	2.26	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	39904.8	61014.4	94108.5	2.36	7.5		
		LNmin Temp. Rise	0.0	44038.8	67971.5	100418.8	2.28	10.2		
		LNmin Temp. Down	0.0	42242.5	67971.5	100418.8	2.38	10.2		
		LNmin Temp. Diff.	-9426.2	40802.9	61014.4	94108.5	2.31	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	41701.1	61014.4	94108.5	2.26	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	39904.8	61014.4	94108.5	2.36	7.5		

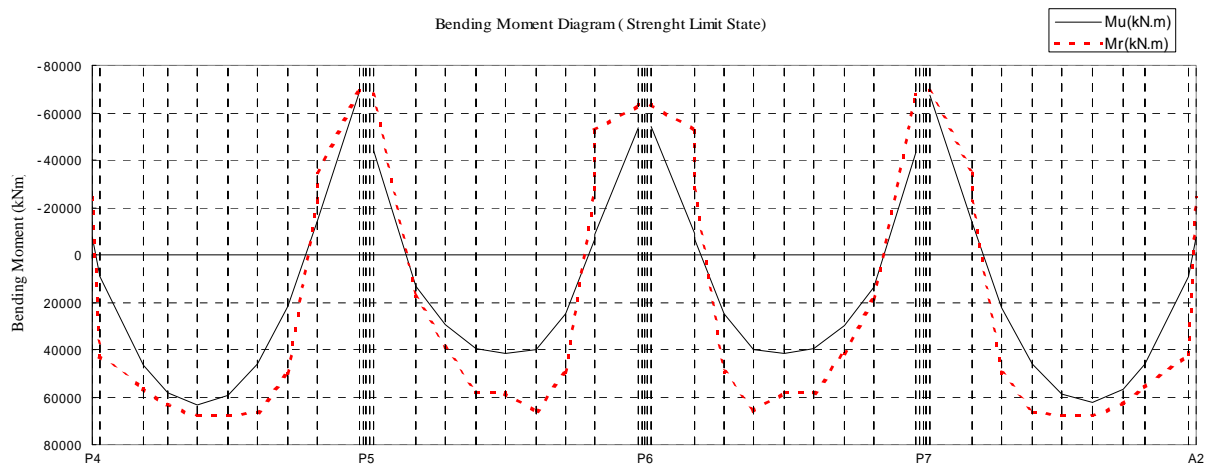
Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)		
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)				
43-i	Group-I	LMmax	0.0	62644.1	67971.5	100418.8	1.60	10.2		
		LMmin	0.0	42434.6	67971.5	100418.8	2.37	10.2		
		LNmax	0.0	44828.3	67971.5	100418.8	2.24	10.2		
		LNmin	0.0	44828.3	67971.5	100418.8	2.24	10.2		
	Group-IV	LMmax Temp. Rise	0.0	54301.4	67971.5	100418.8	1.85	10.2		
		LMmax Temp. Down	0.0	52505.1	67971.5	100418.8	1.91	10.2		
		LMmax Temp. Diff.	-9426.2	51065.5	61014.4	94108.5	1.84	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	51963.6	61014.4	94108.5	1.81	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	50167.3	61014.4	94108.5	1.88	7.5		
		LMmin Temp. Rise	0.0	42659.9	67971.5	100418.8	2.35	10.2		
		LMmin Temp. Down	0.0	40863.6	67971.5	100418.8	2.46	10.2		
		LMmin Temp. Diff.	-9426.2	39424.0	61014.4	94108.5	2.39	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	40322.2	61014.4	94108.5	2.33	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	38525.9	61014.4	94108.5	2.44	7.5		
		LNmax Temp. Rise	0.0	44038.8	67971.5	100418.8	2.28	10.2		
		LNmax Temp. Down	0.0	42242.5	67971.5	100418.8	2.38	10.2		
		LNmax Temp. Diff.	-9426.2	40802.9	61014.4	94108.5	2.31	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	41701.1	61014.4	94108.5	2.26	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	39904.8	61014.4	94108.5	2.36	7.5		
		LNmin Temp. Rise	0.0	44038.8	67971.5	100418.8	2.28	10.2		
		LNmin Temp. Down	0.0	42242.5	67971.5	100418.8	2.38	10.2		
		LNmin Temp. Diff.	-9426.2	40802.9	61014.4	94108.5	2.31	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	41701.1	61014.4	94108.5	2.26	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	39904.8	61014.4	94108.5	2.36	7.5		
		43-j	Group-I	LMmax	0.0	56898.9	62664.1	95111.4	1.67	10.2
				LMmin	0.0	38835.7	62664.1	95111.4	2.45	10.2
				LNmax	0.0	40533.5	62664.1	95111.4	2.35	10.2
				LNmin	0.0	40533.5	62664.1	95111.4	2.35	10.2
Group-IV	LMmax Temp. Rise		0.0	49064.5	62664.1	95111.4	1.94	10.2		
	LMmax Temp. Down		0.0	47790.5	62664.1	95111.4	1.99	10.2		
	LMmax Temp. Diff.		-9426.2	45065.9	55706.9	88801.0	1.97	7.5		
	LMmax Temp. Rise+Temp. Diff.		-9426.2	45702.9	55706.9	88801.0	1.94	7.5		
	LMmax Temp. Down+Temp. Diff.		-9426.2	44428.8	55706.9	88801.0	2.00	7.5		
	LMmin Temp. Rise		0.0	38659.5	62664.1	95111.4	2.46	10.2		
	LMmin Temp. Down		0.0	37385.4	62664.1	95111.4	2.54	10.2		
	LMmin Temp. Diff.		-9426.2	34660.8	55706.9	88801.0	2.56	7.5		
	LMmin Temp. Rise+Temp. Diff.		-9426.2	35297.8	55706.9	88801.0	2.52	7.5		
	LMmin Temp. Down+Temp. Diff.		-9426.2	34023.8	55706.9	88801.0	2.61	7.5		
	LNmax Temp. Rise		0.0	39637.5	62664.1	95111.4	2.40	10.2		
	LNmax Temp. Down		0.0	38363.4	62664.1	95111.4	2.48	10.2		
	LNmax Temp. Diff.		-9426.2	35638.8	55706.9	88801.0	2.49	7.5		
	LNmax Temp. Rise+Temp. Diff.		-9426.2	36275.8	55706.9	88801.0	2.45	7.5		
	LNmax Temp. Down+Temp. Diff.		-9426.2	35001.8	55706.9	88801.0	2.54	7.5		
	LNmin Temp. Rise		0.0	39637.5	62664.1	95111.4	2.40	10.2		
	LNmin Temp. Down		0.0	38363.4	62664.1	95111.4	2.48	10.2		
	LNmin Temp. Diff.		-9426.2	35638.8	55706.9	88801.0	2.49	7.5		
	LNmin Temp. Rise+Temp. Diff.		-9426.2	36275.8	55706.9	88801.0	2.45	7.5		
	LNmin Temp. Down+Temp. Diff.		-9426.2	35001.8	55706.9	88801.0	2.54	7.5		
	44-i		Group-I	LMmax	0.0	56898.9	62664.1	95111.4	1.67	10.2
				LMmin	0.0	38835.7	62664.1	95111.4	2.45	10.2
				LNmax	0.0	40533.5	62664.1	95111.4	2.35	10.2
				LNmin	0.0	40533.5	62664.1	95111.4	2.35	10.2
Group-IV		LMmax Temp. Rise	0.0	49064.5	62664.1	95111.4	1.94	10.2		
		LMmax Temp. Down	0.0	47790.5	62664.1	95111.4	1.99	10.2		
		LMmax Temp. Diff.	-9426.2	45065.9	55706.9	88801.0	1.97	7.5		
		LMmax Temp. Rise+Temp. Diff.	-9426.2	45702.9	55706.9	88801.0	1.94	7.5		
		LMmax Temp. Down+Temp. Diff.	-9426.2	44428.8	55706.9	88801.0	2.00	7.5		
		LMmin Temp. Rise	0.0	38659.5	62664.1	95111.4	2.46	10.2		
		LMmin Temp. Down	0.0	37385.4	62664.1	95111.4	2.54	10.2		
		LMmin Temp. Diff.	-9426.2	34660.8	55706.9	88801.0	2.56	7.5		
		LMmin Temp. Rise+Temp. Diff.	-9426.2	35297.8	55706.9	88801.0	2.52	7.5		
		LMmin Temp. Down+Temp. Diff.	-9426.2	34023.8	55706.9	88801.0	2.61	7.5		
		LNmax Temp. Rise	0.0	39637.5	62664.1	95111.4	2.40	10.2		
		LNmax Temp. Down	0.0	38363.4	62664.1	95111.4	2.48	10.2		
		LNmax Temp. Diff.	-9426.2	35638.8	55706.9	88801.0	2.49	7.5		
		LNmax Temp. Rise+Temp. Diff.	-9426.2	36275.8	55706.9	88801.0	2.45	7.5		
		LNmax Temp. Down+Temp. Diff.	-9426.2	35001.8	55706.9	88801.0	2.54	7.5		
		LNmin Temp. Rise	0.0	39637.5	62664.1	95111.4	2.40	10.2		
		LNmin Temp. Down	0.0	38363.4	62664.1	95111.4	2.48	10.2		
		LNmin Temp. Diff.	-9426.2	35638.8	55706.9	88801.0	2.49	7.5		
		LNmin Temp. Rise+Temp. Diff.	-9426.2	36275.8	55706.9	88801.0	2.45	7.5		
		LNmin Temp. Down+Temp. Diff.	-9426.2	35001.8	55706.9	88801.0	2.54	7.5		

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
44-j	Group-I	LMmax	0.0	45967.1	55714.1	88161.4	1.92	10.2	
		LMmin	0.0	31457.9	55714.1	88161.4	2.80	10.2	
		LNmax	0.0	32628.0	55714.1	88161.4	2.70	10.2	
		LNmin	0.0	32628.0	55714.1	88161.4	2.70	10.2	
	Group-IV	LMmax Temp. Rise	0.0	39513.8	55714.1	88161.4	2.23	10.2	
		LMmax Temp. Down	0.0	38635.7	55714.1	88161.4	2.28	10.2	
		LMmax Temp. Diff.	-9426.2	34936.7	48757.0	81851.1	2.34	7.5	
		LMmax Temp. Rise+Temp. Diff.	-9426.2	35375.7	48757.0	81851.1	2.31	7.5	
		LMmax Temp. Down+Temp. Diff.	-9426.2	34497.7	48757.0	81851.1	2.37	7.5	
		LMmin Temp. Rise	0.0	31155.9	55714.1	88161.4	2.83	10.2	
		LMmin Temp. Down	0.0	30277.9	55714.1	88161.4	2.91	10.2	
		LMmin Temp. Diff.	-9426.2	26578.9	48757.0	81851.1	3.08	7.5	
		LMmin Temp. Rise+Temp. Diff.	-9426.2	27017.9	48757.0	81851.1	3.03	7.5	
		LMmin Temp. Down+Temp. Diff.	-9426.2	26139.8	48757.0	81851.1	3.13	7.5	
		LNmax Temp. Rise	0.0	31829.9	55714.1	88161.4	2.77	10.2	
		LNmax Temp. Down	0.0	30951.9	55714.1	88161.4	2.85	10.2	
		LNmax Temp. Diff.	-9426.2	27252.9	48757.0	81851.1	3.00	7.5	
		LNmax Temp. Rise+Temp. Diff.	-9426.2	27691.9	48757.0	81851.1	2.96	7.5	
		LNmax Temp. Down+Temp. Diff.	-9426.2	26813.8	48757.0	81851.1	3.05	7.5	
		LNmin Temp. Rise	0.0	31829.9	55714.1	88161.4	2.77	10.2	
		LNmin Temp. Down	0.0	30951.9	55714.1	88161.4	2.85	10.2	
		LNmin Temp. Diff.	-9426.2	27252.9	48757.0	81851.1	3.00	7.5	
		LNmin Temp. Rise+Temp. Diff.	-9426.2	27691.9	48757.0	81851.1	2.96	7.5	
		LNmin Temp. Down+Temp. Diff.	-9426.2	26813.8	48757.0	81851.1	3.05	7.5	
	45-i	Group-I	LMmax	0.0	45967.1	55714.1	88161.4	1.92	10.2
			LMmin	0.0	31457.9	55714.1	88161.4	2.80	10.2
			LNmax	0.0	32628.0	55714.1	88161.4	2.70	10.2
			LNmin	0.0	32628.0	55714.1	88161.4	2.70	10.2
Group-IV		LMmax Temp. Rise	0.0	39513.8	55714.1	88161.4	2.23	10.2	
		LMmax Temp. Down	0.0	38635.7	55714.1	88161.4	2.28	10.2	
		LMmax Temp. Diff.	-9426.2	34936.7	48757.0	81851.1	2.34	7.5	
		LMmax Temp. Rise+Temp. Diff.	-9426.2	35375.7	48757.0	81851.1	2.31	7.5	
		LMmax Temp. Down+Temp. Diff.	-9426.2	34497.7	48757.0	81851.1	2.37	7.5	
		LMmin Temp. Rise	0.0	31155.9	55714.1	88161.4	2.83	10.2	
		LMmin Temp. Down	0.0	30277.9	55714.1	88161.4	2.91	10.2	
		LMmin Temp. Diff.	-9426.2	26578.9	48757.0	81851.1	3.08	7.5	
		LMmin Temp. Rise+Temp. Diff.	-9426.2	27017.9	48757.0	81851.1	3.03	7.5	
		LMmin Temp. Down+Temp. Diff.	-9426.2	26139.8	48757.0	81851.1	3.13	7.5	
		LNmax Temp. Rise	0.0	31829.9	55714.1	88161.4	2.77	10.2	
		LNmax Temp. Down	0.0	30951.9	55714.1	88161.4	2.85	10.2	
		LNmax Temp. Diff.	-9426.2	27252.9	48757.0	81851.1	3.00	7.5	
		LNmax Temp. Rise+Temp. Diff.	-9426.2	27691.9	48757.0	81851.1	2.96	7.5	
		LNmax Temp. Down+Temp. Diff.	-9426.2	26813.8	48757.0	81851.1	3.05	7.5	
		LNmin Temp. Rise	0.0	31829.9	55714.1	88161.4	2.77	10.2	
		LNmin Temp. Down	0.0	30951.9	55714.1	88161.4	2.85	10.2	
		LNmin Temp. Diff.	-9426.2	27252.9	48757.0	81851.1	3.00	7.5	
		LNmin Temp. Rise+Temp. Diff.	-9426.2	27691.9	48757.0	81851.1	2.96	7.5	
		LNmin Temp. Down+Temp. Diff.	-9426.2	26813.8	48757.0	81851.1	3.05	7.5	
45-j		Group-I	LMmax	0.0	8859.2	42190.1	74553.5	8.42	10.2
			LMmin	0.0	6153.3	42190.1	74553.5	12.12	10.2
			LNmax	0.0	6329.2	42190.1	74553.5	11.78	10.2
			LNmin	0.0	6329.2	42190.1	74553.5	11.78	10.2
	Group-IV	LMmax Temp. Rise	0.0	7611.8	42190.1	74553.5	9.79	10.2	
		LMmax Temp. Down	0.0	7479.8	42190.1	74553.5	9.97	10.2	
		LMmax Temp. Diff.	-9573.7	69.8	33307.4	66355.0	950.21	7.4	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	135.8	33307.4	66355.0	488.51	7.4	
		LMmax Temp. Down+Temp. Diff.	-9573.7	3.8	33307.4	74553.5	19445.35	7.4	
		LMmin Temp. Rise	0.0	6053.1	42190.1	74553.5	12.32	10.2	
		LMmin Temp. Down	0.0	5921.1	42190.1	74553.5	12.59	10.2	
		LMmin Temp. Diff.	-9573.7	-1488.9	-21825.2	-62733.7	42.14	13.3	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-1422.9	-21825.2	-62733.7	44.09	13.3	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-1554.9	-21825.2	-62733.7	40.35	13.3	
		LNmax Temp. Rise	0.0	6154.5	42190.1	74553.5	12.11	10.2	
		LNmax Temp. Down	0.0	6022.5	42190.1	74553.5	12.38	10.2	
		LNmax Temp. Diff.	-9573.7	-1387.5	-21825.2	-62733.7	45.21	13.3	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-1321.5	-21825.2	-62733.7	47.47	13.3	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-1453.5	-21825.2	-62733.7	43.16	13.3	
		LNmin Temp. Rise	0.0	6154.5	42190.1	74553.5	12.11	10.2	
		LNmin Temp. Down	0.0	6022.5	42190.1	74553.5	12.38	10.2	
		LNmin Temp. Diff.	-9573.7	-1387.5	-21825.2	-62733.7	45.21	13.3	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-1321.5	-21825.2	-62733.7	47.47	13.3	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-1453.5	-21825.2	-62733.7	43.16	13.3	

Member No.	Combination Group		Factored Force		Flexural Strength PC Only	Flexural Strength PC+Re Bar	φMn2 / Mu	Neutral Axis (cm)	
			Nu(kN)	Mu(kN.m)	φMn1(kN.m)	φMn2(kN.m)			
46-i	Group-I	LMmax	0.0	8859.2	42190.1	74553.3	8.42	10.2	
		LMmin	0.0	6153.3	42190.1	74553.3	12.12	10.2	
		LNmax	0.0	6329.2	42190.1	74553.3	11.78	10.2	
		LNmin	0.0	6329.2	42190.1	74553.3	11.78	10.2	
	Group-IV	LMmax Temp. Rise	0.0	7611.8	42190.1	74553.3	9.79	10.2	
		LMmax Temp. Down	0.0	7479.8	42190.1	74553.3	9.97	10.2	
		LMmax Temp. Diff.	-9573.7	69.8	33307.4	66354.8	950.21	7.4	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	135.8	33307.4	66354.8	488.51	7.4	
		LMmax Temp. Down+Temp. Diff.	-9573.7	3.8	33307.4	74553.3	19445.30	7.4	
		LMmin Temp. Rise	0.0	6053.1	42190.1	74553.3	12.32	10.2	
		LMmin Temp. Down	0.0	5921.1	42190.1	74553.3	12.59	10.2	
		LMmin Temp. Diff.	-9573.7	-1488.9	-21824.5	-62734.6	42.14	13.3	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-1422.9	-21824.5	-62734.6	44.09	13.3	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-1554.9	-21824.5	-62734.6	40.35	13.3	
		LNmax Temp. Rise	0.0	6154.5	42190.1	74553.3	12.11	10.2	
		LNmax Temp. Down	0.0	6022.5	42190.1	74553.3	12.38	10.2	
		LNmax Temp. Diff.	-9573.7	-1387.5	-21824.5	-62734.6	45.21	13.3	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-1321.5	-21824.5	-62734.6	47.47	13.3	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-1453.5	-21824.5	-62734.6	43.16	13.3	
		LNmin Temp. Rise	0.0	6154.5	42190.1	74553.3	12.11	10.2	
		LNmin Temp. Down	0.0	6022.5	42190.1	74553.3	12.38	10.2	
		LNmin Temp. Diff.	-9573.7	-1387.5	-21824.5	-62734.6	45.21	13.3	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-1321.5	-21824.5	-62734.6	47.47	13.3	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-1453.5	-21824.5	-62734.6	43.16	13.3	
	46-j	Group-I	LMmax	0.0	-34.0	-35252.1	-75724.1	2227.31	18.1
			LMmin	0.0	-34.0	-35252.1	-75724.1	2227.31	18.1
			LNmax	0.0	-34.0	-35252.1	-75724.1	2227.31	18.1
			LNmin	0.0	-34.0	-35252.1	-75724.1	2227.31	18.1
Group-IV		LMmax Temp. Rise	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LMmax Temp. Down	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LMmax Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LMmax Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LMmax Temp. Down+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LMmin Temp. Rise	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LMmin Temp. Down	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LMmin Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LMmin Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LMmin Temp. Down+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LNmax Temp. Rise	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LNmax Temp. Down	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LNmax Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LNmax Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LNmax Temp. Down+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LNmin Temp. Rise	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LNmin Temp. Down	0.0	-32.7	-35252.1	-75724.1	2316.43	18.1	
		LNmin Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LNmin Temp. Rise+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	
		LNmin Temp. Down+Temp. Diff.	-9573.7	-7767.5	-24274.9	-65145.4	8.39	13.5	

(2) Load Factor Design

a. Bending Moment and Bending Strength Diagram for Load Factor Design (Group-I)



2.8.2 Shear Stress Check

b. Shear Stress

Shear stress due to service load shown as following table.

Allowable shear stress is assumed to resist shear force by concrete only.

So that reason, When shear stress exceed allowable shear stress, it should be calculate required reinforcement area, and develop reinforcement that amount should be exceed required reinforcement area.

		Shear Stress τ_m (N/mm ²)		Allowable Shear Stress τ_a (N/mm ²)			Shear Stress τ_m (N/mm ²)		Allowable Shear Stress τ_a (N/mm ²)
		Service Load	Thermal Effect				Service Load	Thermal Effect	
2	i	1.446	1.615	0.470	26	i	2.649	2.779	0.470
	j	0.990	1.245	0.470		j	1.411	1.606	0.470
3	i	0.991	1.120	0.470	27	i	1.362	1.426	0.470
	j	0.376	0.505	0.470		j	0.647	0.711	0.470
4	i	0.376	0.505	0.470	28	i	0.647	0.711	0.470
	j	0.307	0.436	0.470		j	1.124	1.188	0.470
5	i	0.307	0.436	0.470	29	i	1.124	1.188	0.470
	j	-0.934	-0.964	0.470		j	0.538	0.602	0.470
6	i	-0.980	-1.010	0.470	30	i	0.492	0.556	0.470
	j	-1.397	-1.427	0.470		j	-0.601	-0.662	0.470
7	i	-1.397	-1.427	0.470	31	i	-0.601	-0.662	0.470
	j	-1.652	-1.681	0.470		j	0.657	0.721	0.470
8	i	-1.651	-1.681	0.470	32	i	0.657	0.721	0.470
	j	-1.055	-1.075	0.470		j	-0.663	-0.724	0.470
9	i	-1.065	-1.088	0.470	33	i	-0.686	-0.876	0.470
	j	-2.565	-2.588	0.470		j	-2.347	-2.474	0.470
14	i	2.356	2.483	0.470	38	i	2.531	2.554	0.470
	j	0.763	0.954	0.470		j	1.019	1.042	0.470
15	i	0.738	0.799	0.470	39	i	1.019	1.039	0.470
	j	-0.585	-0.649	0.470		j	1.599	1.629	0.470
16	i	-0.585	-0.649	0.470	40	i	1.599	1.629	0.470
	j	0.613	0.674	0.470		j	1.350	1.380	0.470
17	i	0.613	0.674	0.470	41	i	1.350	1.380	0.470
	j	-0.481	-0.544	0.470		j	0.941	0.970	0.470
18	i	-0.526	-0.590	0.470	42	i	0.895	0.924	0.470
	j	-1.128	-1.191	0.470		j	0.151	-0.466	0.470
19	i	-1.128	-1.191	0.470	43	i	0.151	0.180	0.470
	j	-0.631	-0.695	0.470		j	-0.393	-0.522	0.470
20	i	-0.631	-0.695	0.470	44	i	-0.393	-0.522	0.470
	j	-1.346	-1.410	0.470		j	-0.963	-1.093	0.470
21	i	-1.394	-1.590	0.470	45	i	-0.963	-1.218	0.470
	j	-2.641	-2.771	0.470		j	-1.410	-1.580	0.470

. Necessary Stirrup at the Section, Shear Stress " τ_c " above 0.47N/mm²

Member No.	S (kN)	N (kN)	M (kNm)	Sh (kN)	Sc (kN)	σ_s (N/mm ²)	Awmin (cm ²)	Awreq (cm ²)	As (cm ²)
26 - i	7056.5	-2849.5	-38226.2	7056.5	2022.5	165.0	24.0	158.0	59.9
26 - j	4967.7	-2849.2	-783.4	4967.7	1669.4	165.0	16.0	26.2	9.9
27 - i	4967.7	-2849.2	-783.4	4967.7	1729.6	165.0	16.0	23.5	9.3
27 - j	3680.9	-2844.7	16251.1	3680.9	1729.6	165.0	16.0	0.0	0.0
28 - i	3680.9	-2844.7	16251.1	3680.9	1729.6	165.0	16.0	0.0	0.0
28 - j	2338.9	-2849.2	27926.0	2338.9	1729.6	165.0	16.0	10.3	4.0
29 - i	2338.9	-2849.2	27926.0	2338.9	1729.6	165.0	16.0	10.3	4.0
29 - j	989.9	-2858.6	33429.1	989.9	1681.5	165.0	16.0	0.0	0.0
30 - i	905.5	-2858.6	33429.1	905.5	1681.5	165.0	16.0	0.0	0.0
30 - j	-438.5	-2880.4	32299.6	-438.5	1717.6	165.0	16.0	0.0	0.0
31 - i	-438.5	-2880.4	32299.6	-438.5	1717.6	165.0	16.0	0.0	0.0
31 - j	-1741.0	-2966.4	24981.5	-1741.0	1665.8	165.0	16.0	0.0	0.0
32 - i	-1741.0	-2966.4	24981.5	-1741.0	1665.8	165.0	16.0	0.0	0.0
32 - j	-2971.5	-2980.9	13005.0	-2971.5	1515.8	165.0	16.0	0.0	0.0
33 - i	-2971.5	-2980.9	13005.0	-2971.5	1463.5	165.0	16.0	0.0	0.0
33 - j	-6253.7	-2941.5	-22567.5	-6253.7	2504.2	165.0	24.0	117.7	44.6
34 - i	-6253.7	-2941.5	-22567.5	-6253.7	2504.2	165.0	24.0	117.7	44.6
34 - j	-6453.5	-2943.2	-25933.1	-6453.5	2504.2	165.0	24.0	124.0	47.0
35 - i	-6453.5	-2943.2	-25933.1	-6453.5	2504.2	165.0	24.0	124.0	47.0
35 - j	-6601.1	-2943.3	-28496.2	-6601.1	2504.2	165.0	24.0	130.3	49.4
36 - i	8206.8	0.0	-55958.3	8206.8	1964.4	165.0	24.0	194.3	73.7
36 - j	8060.8	0.0	-52726.2	8060.8	2000.7	165.0	24.0	180.0	68.3
37 - i	8060.8	0.0	-52726.2	8060.8	2000.7	165.0	24.0	180.0	68.3
37 - j	7863.0	0.0	-48446.8	7863.0	2041.9	165.0	24.0	147.6	56.0
38 - i	7863.0	0.0	-48446.8	7863.0	2041.6	165.0	24.0	147.6	56.0
38 - j	5744.9	0.0	-7241.5	5744.9	2504.2	165.0	24.0	6.6	2.5
39 - i	5744.9	0.0	-7241.5	5744.9	2594.4	165.0	24.0	6.6	2.6
39 - j	4419.7	0.0	14380.0	4419.7	1729.6	165.0	16.0	36.8	14.4
40 - i	4419.7	0.0	14380.0	4419.7	1729.6	165.0	16.0	36.8	14.4
40 - j	3085.3	0.0	29515.0	3085.3	1729.6	165.0	16.0	22.9	9.0
41 - i	3085.3	0.0	29515.0	3085.3	1729.6	165.0	16.0	22.9	9.0
41 - j	1730.5	0.0	38422.4	1730.5	1720.9	165.0	16.0	0.3	0.1
42 - i	1646.1	0.0	38422.4	1646.1	1720.9	165.0	16.0	0.0	0.0
42 - j	277.5	0.0	40339.7	277.5	1675.0	165.0	16.0	0.0	0.0
43 - i	277.5	0.0	40339.7	277.5	1675.0	165.0	16.0	0.0	0.0
43 - j	-1075.2	0.0	35771.4	-1075.2	1667.3	165.0	16.0	0.0	0.0
44 - i	-1075.2	0.0	35771.4	-1075.2	1667.3	165.0	16.0	0.0	0.0
44 - j	-2983.9	0.0	31021.3	-2983.9	1652.8	165.0	16.0	3.6	1.4
45 - i	-2983.9	0.0	31021.3	-2983.9	1653.1	165.0	16.0	3.6	1.4
45 - j	-5136.9	0.0	6089.5	-5136.9	2594.4	165.0	24.0	39.3	15.4
46 - i	-5136.9	0.0	6089.5	-5136.9	2594.4	165.0	24.0	39.3	15.4
46 - j	-5557.9	0.0	-26.2	-5557.9	2594.4	165.0	24.0	52.2	20.5

Note: S : shear force
N : axial force
M : bending moment
Sh : shear force considered with effective height
Sc : shear force beared by concrete
 s : limit of tensile stress bear shear force by stirrup
Awmin : minimum requirement stirrup area
Awreq : requied stirrup area due to shear force
As : required area of longitudinal reinforcement

a. Required Shear Reinforcement due to Thermal Effect

Member No.	S (kN)	N (kN)	M (kNm)	Sh (kN)	Sc (kN)	σ_s (N/mm ²)	Awmin (cm ²)	Awreq (cm ²)	As (cm ²)
1 - i	5905.4	-7658.9	-6214.0	5905.4	2477.6	210.0	24.0	69.5	26.0
1 - j	5474.6	-7658.9	295.6	5474.6	2594.4	210.0	24.0	58.4	19.4
2 - i	5705.4	-7658.9	295.6	5705.4	2594.4	210.0	24.0	63.1	22.2
2 - j	3503.3	-7540.9	28756.8	3503.3	1606.2	210.0	16.0	57.7	8.1
3 - i	3272.5	-7540.9	28756.8	3272.5	1605.9	210.0	16.0	50.7	5.4
3 - j	1979.6	0.0	39955.7	1979.6	1593.3	210.0	16.0	11.8	0.0
4 - i	1979.6	0.0	39955.7	1979.6	1593.3	210.0	16.0	11.8	0.0
4 - j	618.8	0.0	43719.4	618.8	1612.6	210.0	16.0	0.0	0.0
5 - i	618.8	0.0	43719.4	618.8	1612.6	210.0	16.0	0.0	0.0
5 - j	-1773.6	0.0	37885.3	-1773.6	1729.6	210.0	16.0	1.3	0.5
6 - i	-1858.0	0.0	37885.3	-1858.0	1729.6	210.0	16.0	3.9	1.5
6 - j	-3224.7	0.0	28363.3	-3224.7	1729.6	210.0	16.0	45.5	10.7
7 - i	-3224.7	0.0	28363.3	-3224.7	1729.6	210.0	16.0	45.5	10.7
7 - j	-4566.0	0.0	12576.3	-4566.0	1729.6	210.0	16.0	86.3	16.2
8 - i	-4566.0	0.0	12576.3	-4566.0	1729.6	210.0	16.0	86.3	16.2
8 - j	-5770.7	-7658.9	-8432.7	-5770.7	1854.1	210.0	24.0	79.4	11.8
9 - i	-5900.2	-7658.9	-8432.7	-5900.2	1827.8	210.0	24.0	82.6	12.7
9 - j	-8018.1	-7658.9	-50642.7	-8018.1	1868.9	210.0	24.0	124.7	59.8
10 - i	-8011.6	0.0	-51863.8	-8011.6	1992.4	210.0	24.0	122.1	58.3
10 - j	-8209.3	0.0	-56227.6	-8209.3	1956.8	210.0	24.0	126.8	70.5
11 - i	-8209.3	0.0	-56227.6	-8209.3	1956.8	210.0	24.0	126.8	70.5
11 - j	-8355.2	0.0	-59521.9	-8355.2	1924.4	210.0	24.0	130.4	75.9
12 - i	6730.7	-9899.6	-33221.2	6730.7	2160.7	210.0	24.0	92.7	55.0
12 - j	6583.1	-9899.6	-30602.5	6583.1	2233.8	210.0	24.0	88.2	51.8
13 - i	6583.1	-9899.6	-30602.5	6583.1	2233.8	210.0	24.0	88.2	51.8
13 - j	6383.2	-9897.7	-27160.6	6383.2	2352.7	210.0	24.0	81.7	48.0
14 - i	6614.0	-9897.7	-27160.6	6614.0	2351.8	210.0	24.0	86.4	50.7
14 - j	4414.5	-10325.8	9593.5	4414.5	1306.7	210.0	16.0	94.5	3.3
15 - i	4300.6	-2461.0	7016.9	4300.6	1729.6	210.0	16.0	78.2	0.0
15 - j	3009.9	-2478.5	21130.9	3009.9	1729.6	210.0	16.0	38.9	0.0
16 - i	3009.9	-2478.5	21130.9	3009.9	1729.6	210.0	16.0	38.9	0.0
16 - j	1659.9	-2499.3	29809.1	1659.9	1729.6	210.0	16.0	0.0	0.0
17 - i	1659.9	-2499.3	29809.1	1659.9	1729.6	210.0	16.0	0.0	0.0
17 - j	301.9	-2510.9	32280.3	301.9	1716.8	210.0	16.0	0.0	0.0
18 - i	217.5	-2510.9	32280.3	217.5	1716.8	210.0	16.0	0.0	0.0
18 - j	-2434.7	-10749.8	28424.0	-2434.7	1678.3	210.0	16.0	0.0	6.1
19 - i	-2434.7	-10749.8	28424.0	-2434.7	1678.3	210.0	16.0	23.0	6.1
19 - j	-2423.1	-2616.0	17643.8	-2423.1	1729.6	210.0	16.0	21.1	0.0
20 - i	-2423.1	-2616.0	17643.8	-2423.1	1729.6	210.0	16.0	21.1	0.0
20 - j	-5063.4	-10749.6	-1142.5	-5063.4	1729.6	210.0	16.0	101.4	10.3
21 - i	-5294.2	-10749.6	-1142.5	-5294.2	1669.4	210.0	16.0	110.3	13.7
21 - j	-7383.0	-10867.8	-40707.6	-7383.0	1791.7	210.0	24.0	113.4	66.6
22 - i	-7152.2	-10867.8	-40707.6	-7152.2	1791.9	210.0	24.0	108.7	63.8
22 - j	-7352.4	-10870.0	-44605.7	-7352.4	1747.7	210.0	24.0	113.7	66.7
23 - i	-7352.4	-10870.0	-44605.7	-7352.4	1747.7	210.0	24.0	113.7	66.7
23 - j	-7500.8	-10872.0	-46059.2	-7500.8	1734.4	210.0	24.0	117.0	68.6
24 - i	7522.1	-10836.6	-46441.4	7522.1	1731.7	210.0	24.0	117.4	68.9
24 - j	7373.6	-10834.5	-44978.7	7373.6	1744.8	210.0	24.0	114.2	67.0
25 - i	7373.6	-10834.5	-44978.7	7373.6	1744.8	210.0	24.0	114.2	67.0
25 - j	7173.5	-10832.3	-41068.3	7173.5	1788.0	210.0	24.0	109.2	64.1

Member No.	S (kN)	N (kN)	M (kNm)	Sh (kN)	Sc (kN)	σ_s (N/mm ²)	Awmin (cm ²)	Awreq (cm ²)	As (cm ²)
26 - i	7404.3	-10832.3	-41068.3	7404.3	1787.9	210.0	24.0	113.9	66.9
26 - j	5315.5	-10714.0	-1364.9	5315.5	1669.4	210.0	16.0	110.9	14.1
27 - i	5084.7	-10714.0	-1364.9	5084.7	1729.6	210.0	16.0	102.1	10.6
27 - j	3568.9	-2312.1	16556.9	3568.9	1729.6	210.0	16.0	56.0	0.0
28 - i	3568.9	-2312.1	16556.9	3568.9	1729.6	210.0	16.0	56.0	0.0
28 - j	2455.9	-10714.0	28391.6	2455.9	1676.8	210.0	16.0	23.7	6.1
29 - i	2455.9	-10714.0	28391.6	2455.9	1676.8	210.0	16.0	23.7	6.1
29 - j	877.9	-2326.0	32715.9	877.9	1706.4	210.0	16.0	0.0	0.0
30 - i	793.5	-2326.0	32715.9	793.5	1706.4	210.0	16.0	0.0	0.0
30 - j	-550.5	-2347.7	31077.0	-550.5	1729.6	210.0	16.0	0.0	0.0
31 - i	-550.5	-2347.7	31077.0	-550.5	1729.6	210.0	16.0	0.0	0.0
31 - j	-1853.0	-2433.7	23249.3	-1853.0	1729.6	210.0	16.0	3.8	0.0
32 - i	-1853.0	-2433.7	23249.3	-1853.0	1729.6	210.0	16.0	3.8	0.0
32 - j	-3083.4	-2448.3	10780.2	-3083.4	1671.8	210.0	16.0	42.9	0.0
33 - i	-4392.0	-10287.4	9968.8	-4392.0	1346.1	210.0	16.0	92.7	1.2
33 - j	-6591.4	-9859.0	-26635.2	-6591.4	2371.2	210.0	24.0	85.6	50.2
34 - i	-6360.6	-9859.0	-26635.2	-6360.6	2372.1	210.0	24.0	80.9	47.5
34 - j	-6560.5	-9860.8	-30062.4	-6560.5	2249.4	210.0	24.0	87.4	51.3
35 - i	-6560.5	-9860.8	-30062.4	-6560.5	2249.4	210.0	24.0	87.4	51.3
35 - j	-6708.1	-9860.8	-32670.9	-6708.1	2174.1	210.0	24.0	92.0	54.6
36 - i	8261.4	0.0	-58208.6	8261.4	1936.8	210.0	24.0	128.3	74.6
36 - j	8115.4	0.0	-54953.3	8115.4	1970.4	210.0	24.0	124.6	69.3
37 - i	8115.4	0.0	-54953.3	8115.4	1970.4	210.0	24.0	124.6	69.3
37 - j	7917.6	0.0	-50642.5	7917.6	2007.6	210.0	24.0	119.9	57.0
38 - i	7923.1	-7658.9	-49418.0	7923.1	1881.5	210.0	24.0	122.5	58.6
38 - j	5805.0	-7658.9	-7821.9	5805.0	1888.0	210.0	24.0	79.4	10.6
39 - i	5675.5	-7658.9	-7821.9	5675.5	1900.5	210.0	24.0	76.6	10.0
39 - j	4474.3	0.0	12779.6	4474.3	1729.6	210.0	16.0	83.5	15.1
40 - i	4474.3	0.0	12779.6	4474.3	1729.6	210.0	16.0	83.5	15.1
40 - j	3139.9	0.0	28163.2	3139.9	1729.6	210.0	16.0	42.9	9.6
41 - i	3139.9	0.0	28163.2	3139.9	1729.6	210.0	16.0	42.9	9.6
41 - j	1785.2	0.0	37319.1	1785.2	1729.6	210.0	16.0	1.7	0.7
42 - i	1591.5	0.0	39525.7	1591.5	1697.0	210.0	16.0	0.0	0.0
42 - j	222.9	0.0	41194.5	222.9	1658.2	210.0	16.0	0.0	0.0
43 - i	222.9	0.0	41194.5	222.9	1658.2	210.0	16.0	0.0	0.0
43 - j	-1129.8	0.0	36377.7	-1129.8	1654.0	210.0	16.0	0.0	0.0
44 - i	-1129.8	0.0	36377.7	-1129.8	1654.0	210.0	16.0	0.0	0.0
44 - j	-3222.9	-7540.9	28162.0	-3222.9	1615.9	210.0	16.0	48.9	4.7
45 - i	-3453.7	-7540.9	28162.0	-3453.7	1616.2	210.0	16.0	55.9	7.4
45 - j	-5606.7	-7658.9	176.5	-5606.7	2594.4	210.0	24.0	61.1	21.0
46 - i	-5375.9	-7658.9	176.5	-5375.9	2594.4	210.0	24.0	56.4	18.3
46 - j	-5796.9	-7658.9	-6214.0	-5796.9	2516.0	210.0	24.0	66.5	24.3

Note: S : shear force
N : axial force
M : bending moment
Sh : shear force considered with effective height
Sc : shear force beared by concrete
 σ_s : limit of tensile stress bear shear force by stirrup
Awmin : minimum requirement stirrup area
Awreq : requied stirrup area due to shear force
As : required area of longitudinal reinforcement

2.8.5 Required Shear Reinforcement due to Load Factor Design (Group-I)

Member No.	S (kN)	N (kN)	M (kNm)	Sh (kN)	Sc (kN)	σ_s (N/mm ²)	A _{wmin} (cm ²)	A _{wreq} (cm ²)	A _s (cm ²)
1 - i	8261.7	0.0	-34.0	8261.7	2594.4	420.0	24.0	52.7	52.7
1 - j	7650.4	0.0	9042.0	7650.4	2594.4	420.0	24.0	45.3	45.3
2 - i	7650.4	0.0	9042.0	7650.4	2594.4	420.0	24.0	45.3	45.3
2 - j	4537.6	0.0	45645.5	4537.6	1404.0	420.0	16.0	22.9	22.9
3 - i	4537.6	0.0	45645.5	4537.6	1403.8	420.0	16.0	22.9	22.9
3 - j	2972.6	0.0	56453.0	2972.6	1380.4	420.0	16.0	4.3	4.3
4 - i	2972.6	0.0	56453.0	2972.6	1380.4	420.0	16.0	4.3	4.3
4 - j	1066.1	0.0	60982.5	1066.1	1400.9	420.0	16.0	0.0	0.0
5 - i	1066.1	0.0	60982.5	1066.1	1400.9	420.0	16.0	0.0	0.0
5 - j	-2848.0	0.0	54241.7	-2848.0	1470.6	420.0	16.0	16.4	16.4
6 - i	-2957.7	0.0	54241.7	-2957.7	1470.6	420.0	16.0	17.7	17.7
6 - j	-4886.4	0.0	40827.6	-4886.4	1627.6	420.0	16.0	31.7	31.7
7 - i	-4886.4	0.0	40827.6	-4886.4	1627.6	420.0	16.0	31.7	31.7
7 - j	-6764.4	0.0	18526.9	-6764.4	1729.6	420.0	16.0	42.4	42.4
8 - i	-6764.4	0.0	18526.9	-6764.4	1729.6	420.0	16.0	42.4	42.4
8 - j	-8618.5	0.0	-13734.2	-8618.5	2247.6	420.0	24.0	41.0	41.0
9 - i	-8618.5	0.0	-13734.2	-8618.5	2192.8	420.0	24.0	42.2	40.8
9 - j	-11542.8	0.0	-72813.2	-11542.8	1779.3	420.0	24.0	106.6	102.9
10 - i	-11542.8	0.0	-72813.2	-11542.8	1779.4	420.0	24.0	106.6	102.9
10 - j	-11814.2	0.0	-78877.9	-11814.2	1754.4	420.0	24.0	120.0	115.9
11 - i	-11814.2	0.0	-78877.9	-11814.2	1754.4	420.0	24.0	120.0	115.9
11 - j	-12014.4	0.0	-83451.9	-12014.4	1731.6	420.0	24.0	126.2	121.8
12 - i	9942.2	-3111.3	-52971.8	9942.2	1941.5	420.0	24.0	99.3	95.9
12 - j	9738.4	-3111.1	-49246.5	9738.4	1990.8	420.0	24.0	95.6	92.2
13 - i	9738.4	-3111.1	-49246.5	9738.4	1990.8	420.0	24.0	95.6	92.2
13 - j	9462.1	-3107.0	-44346.7	9462.1	2069.0	420.0	24.0	91.2	88.0
14 - i	9462.1	-3107.0	-44346.7	9462.1	2068.5	420.0	24.0	91.2	88.0
14 - j	6555.2	-3136.4	4237.8	6555.2	1669.4	420.0	16.0	25.3	24.4
15 - i	6555.2	-3136.4	4237.8	6555.2	1729.6	420.0	16.0	23.7	23.7
15 - j	4746.2	-3174.6	24828.1	4746.2	1625.5	420.0	16.0	3.4	3.4
16 - i	4746.2	-3174.6	24828.1	4746.2	1625.5	420.0	16.0	3.4	3.4
16 - j	2842.6	-3219.7	37871.1	2842.6	1589.0	420.0	16.0	9.9	9.9
17 - i	2842.6	-3219.7	37871.1	2842.6	1589.0	420.0	16.0	9.9	9.9
17 - j	921.5	-3244.8	42112.4	921.5	1510.2	420.0	16.0	0.0	0.0
18 - i	-1519.1	-2921.3	42917.9	-1519.1	1501.4	420.0	16.0	0.2	0.2
18 - j	-3420.7	-2900.9	36171.9	-3420.7	1598.8	420.0	16.0	18.8	18.8
19 - i	-3420.7	-2900.9	36171.9	-3420.7	1598.8	420.0	16.0	18.8	18.8
19 - j	-5306.9	-2890.9	20700.3	-5306.9	1729.6	420.0	16.0	12.8	12.8
20 - i	-5306.9	-2890.9	20700.3	-5306.9	1729.6	420.0	16.0	12.8	12.8
20 - j	-7107.1	-2900.5	-2286.9	-7107.1	1729.6	420.0	16.0	34.6	34.6
21 - i	-7107.1	-2900.5	-2286.9	-7107.1	1669.4	420.0	16.0	36.6	35.3
21 - j	-10016.8	-2901.0	-54560.5	-10016.8	1790.9	420.0	24.0	101.5	97.9
22 - i	-10016.8	-2901.0	-54560.5	-10016.8	1791.0	420.0	24.0	101.5	97.9
22 - j	-10293.6	-2905.8	-59809.7	-10293.6	1746.0	420.0	24.0	105.4	101.8
23 - i	-10293.6	-2905.8	-59809.7	-10293.6	1746.0	420.0	24.0	105.4	101.8
23 - j	-10499.3	-2909.9	-60533.0	-10499.3	1741.8	420.0	24.0	108.0	104.3
24 - i	10533.2	-2859.3	-61098.0	10533.2	1738.5	420.0	24.0	108.5	104.7
24 - j	10327.4	-2854.8	-60359.9	10327.4	1742.6	420.0	24.0	105.9	102.2
25 - i	10327.4	-2854.8	-60359.9	10327.4	1742.6	420.0	24.0	105.9	102.2
25 - j	10050.6	-2850.0	-55091.2	10050.6	1786.8	420.0	24.0	101.9	98.4

Member No.	S (kN)	N (kN)	M (kNm)	Sh (kN)	Sc (kN)	σ_s (N/mm ²)	Awmin (cm ²)	Awreq (cm ²)	As (cm ²)
26 - i	10050.6	-2850.0	-55091.2	10050.6	1786.7	420.0	24.0	101.9	98.4
26 - j	7140.9	-2849.3	-2597.9	7140.9	1669.4	420.0	16.0	37.1	35.8
27 - i	7140.9	-2849.3	-2597.9	7140.9	1729.6	420.0	16.0	35.1	35.1
27 - j	5340.6	-2839.5	20537.9	5340.6	1729.6	420.0	16.0	13.3	13.3
28 - i	5340.6	-2839.5	20537.9	5340.6	1729.6	420.0	16.0	13.3	13.3
28 - j	3454.4	-2849.2	36162.5	3454.4	1597.3	420.0	16.0	18.9	18.9
29 - i	3454.4	-2849.2	36162.5	3454.4	1597.3	420.0	16.0	18.9	18.9
29 - j	1552.8	-2869.7	43061.7	1552.8	1498.7	420.0	16.0	0.6	0.6
30 - i	1443.1	-2869.7	43061.7	1443.1	1498.7	420.0	16.0	0.0	0.0
30 - j	-2807.6	-3164.6	38183.6	-2807.6	1582.9	420.0	16.0	9.6	9.6
31 - i	-2807.6	-3164.6	38183.6	-2807.6	1582.9	420.0	16.0	9.6	9.6
31 - j	-4710.6	-3118.6	25308.8	-4710.6	1652.8	420.0	16.0	1.3	1.3
32 - i	-4710.6	-3118.6	25308.8	-4710.6	1652.8	420.0	16.0	1.3	1.3
32 - j	-6519.0	-3079.4	4887.1	-6519.0	1729.6	420.0	16.0	21.9	21.9
33 - i	-6519.0	-3079.4	4887.1	-6519.0	1669.4	420.0	16.0	23.5	22.6
33 - j	-9425.7	-3049.5	-43456.3	-9425.7	2084.2	420.0	24.0	90.5	87.4
34 - i	-9425.7	-3049.5	-43456.3	-9425.7	2084.8	420.0	24.0	90.5	87.4
34 - j	-9701.8	-3053.4	-48331.2	-9701.8	2003.8	420.0	24.0	94.9	91.6
35 - i	-9701.8	-3053.4	-48331.2	-9701.8	2003.8	420.0	24.0	94.9	91.6
35 - j	-9905.7	-3053.5	-52039.8	-9905.7	1953.0	420.0	24.0	98.7	95.3
36 - i	11883.2	0.0	-81429.9	11883.2	1741.6	420.0	24.0	124.4	120.1
36 - j	11682.9	0.0	-76909.8	11682.9	1765.3	420.0	24.0	118.3	114.2
37 - i	11682.9	0.0	-76909.8	11682.9	1765.3	420.0	24.0	118.3	114.2
37 - j	11411.2	0.0	-70918.5	11411.2	1791.6	420.0	24.0	104.8	101.2
38 - i	11411.2	0.0	-70918.5	11411.2	1791.4	420.0	24.0	104.8	101.2
38 - j	8486.4	0.0	-12687.0	8486.4	2279.9	420.0	24.0	39.2	37.8
39 - i	8486.4	0.0	-12687.0	8486.4	2327.8	420.0	24.0	38.4	38.4
39 - j	6635.7	0.0	18998.6	6635.7	1729.6	420.0	16.0	40.8	40.8
40 - i	6635.7	0.0	18998.6	6635.7	1729.6	420.0	16.0	40.8	40.8
40 - j	4765.8	0.0	40729.7	4765.8	1631.4	420.0	16.0	30.2	30.2
41 - i	4765.8	0.0	40729.7	4765.8	1631.4	420.0	16.0	30.2	30.2
41 - j	2851.8	0.0	53614.1	2851.8	1478.4	420.0	16.0	16.4	16.4
42 - i	2742.1	0.0	53614.1	2742.1	1478.4	420.0	16.0	15.0	15.0
42 - j	797.9	0.0	56331.6	797.9	1445.0	420.0	16.0	0.0	0.0
43 - i	797.9	0.0	56331.6	797.9	1445.0	420.0	16.0	0.0	0.0
43 - j	-3023.0	0.0	55104.3	-3023.0	1385.8	420.0	16.0	4.8	4.8
44 - i	-3023.0	0.0	55104.3	-3023.0	1385.8	420.0	16.0	4.8	4.8
44 - j	-4475.7	0.0	44891.5	-4475.7	1409.3	420.0	16.0	22.1	22.1
45 - i	-4475.7	0.0	44891.5	-4475.7	1409.5	420.0	16.0	22.1	22.1
45 - j	-7524.6	0.0	8890.0	-7524.6	2594.4	420.0	24.0	43.9	43.9
46 - i	-7524.6	0.0	8890.0	-7524.6	2594.4	420.0	24.0	43.9	43.9
46 - j	-8123.1	0.0	-34.0	-8123.1	2594.4	420.0	24.0	51.0	51.0

Note: S : shear force
N : axial force
M : bending moment
Sh : shear force considered with effective height
Sc : shear force beared by concrete
 σ_s : limit of tensile stress bear shear force by stirrup
Awmin : minimum requirement stirrup area
Awreq : requied stirrup area due to shear force
As : required area of longitudinal reinforcement

Member No.	S (kN)	N (kN)	M (kNm)	Sh (kN)	Sc (kN)	σ_s (N/mm ²)	Awmin (cm ²)	Awreq (cm ²)	As (cm ²)
1 - i	7343.7	-9573.7	-7767.5	7343.7	2003.2	420.0	24.0	48.8	48.8
1 - j	6805.3	-9573.7	325.8	6805.3	2594.4	420.0	24.0	35.3	35.3
2 - i	7093.8	-9573.7	325.8	7093.8	2594.4	420.0	24.0	38.7	38.7
2 - j	4341.2	-9426.2	35655.5	4341.2	1439.7	420.0	16.0	20.1	20.1
3 - i	4052.7	-9426.2	35655.5	4052.7	1439.4	420.0	16.0	16.7	16.7
3 - j	2665.7	-9426.2	46246.4	2665.7	1405.2	420.0	16.0	0.3	0.3
4 - i	2665.7	-9426.2	46246.4	2665.7	1405.2	420.0	16.0	0.3	0.3
4 - j	735.5	0.0	54047.5	735.5	1469.7	420.0	16.0	0.0	0.0
5 - i	735.5	0.0	54047.5	735.5	1469.7	420.0	16.0	0.0	0.0
5 - j	-2254.9	0.0	46582.0	-2254.9	1570.2	420.0	16.0	8.2	8.2
6 - i	-2360.4	0.0	46582.0	-2360.4	1570.2	420.0	16.0	9.4	9.4
6 - j	-4068.9	0.0	34506.8	-4068.9	1729.6	420.0	16.0	20.7	20.7
7 - i	-4068.9	0.0	34506.8	-4068.9	1729.6	420.0	16.0	20.7	20.7
7 - j	-5745.5	0.0	14600.2	-5745.5	1729.6	420.0	16.0	30.3	30.3
8 - i	-5745.5	0.0	14600.2	-5745.5	1729.6	420.0	16.0	30.3	30.3
8 - j	-7251.4	-9573.7	-11828.1	-7251.4	1517.6	420.0	24.0	33.4	33.4
9 - i	-7413.2	-9573.7	-11828.1	-7413.2	1492.1	420.0	24.0	36.0	34.8
9 - j	-10060.6	-9573.7	-64837.4	-10060.6	1706.3	420.0	24.0	89.2	86.1
10 - i	-10052.5	0.0	-66363.7	-10052.5	1830.6	420.0	24.0	87.5	84.5
10 - j	-10299.6	0.0	-71840.3	-10299.6	1803.6	420.0	24.0	100.8	97.2
11 - i	-10299.6	0.0	-71840.3	-10299.6	1803.6	420.0	24.0	100.8	97.2
11 - j	-10481.9	0.0	-75974.3	-10481.9	1778.8	420.0	24.0	106.7	103.0
12 - i	8578.8	-11744.1	-48321.2	8578.8	1841.2	420.0	24.0	83.8	80.8
12 - j	8394.2	-11744.0	-44977.5	8394.2	1881.8	420.0	24.0	80.3	77.5
13 - i	8394.2	-11744.0	-44977.5	8394.2	1881.8	420.0	24.0	80.3	77.5
13 - j	8144.4	-11741.7	-40580.0	8144.4	1946.3	420.0	24.0	76.4	73.8
14 - i	8432.9	-11741.7	-40580.0	8432.9	1945.8	420.0	24.0	80.0	77.2
14 - j	5543.4	-12942.5	9219.7	5543.4	1206.2	420.0	16.0	18.6	17.9
15 - i	5254.9	-12942.5	9219.7	5254.9	1249.0	420.0	16.0	14.0	14.0
15 - j	3927.6	-2467.7	21586.4	3927.6	1729.6	420.0	16.0	0.0	0.0
16 - i	3927.6	-2467.7	21586.4	3927.6	1729.6	420.0	16.0	0.0	0.0
16 - j	2234.0	-11659.0	33569.6	2234.0	1572.0	420.0	16.0	2.9	2.9
17 - i	2234.0	-11659.0	33569.6	2234.0	1572.0	420.0	16.0	2.9	2.9
17 - j	542.7	-2508.2	37027.6	542.7	1607.6	420.0	16.0	0.0	0.0
18 - i	437.2	-2508.2	37027.6	437.2	1607.6	420.0	16.0	0.0	0.0
18 - j	-2878.1	-12806.8	32959.4	-2878.1	1539.1	420.0	16.0	13.0	13.0
19 - i	-2878.1	-12806.8	32959.4	-2878.1	1539.1	420.0	16.0	13.0	13.0
19 - j	-4555.5	-12801.1	18573.2	-4555.5	1601.7	420.0	16.0	5.4	5.4
20 - i	-4555.5	-12801.1	18573.2	-4555.5	1601.7	420.0	16.0	5.4	5.4
20 - j	-6163.9	-12806.6	-2519.0	-6163.9	1729.6	420.0	16.0	23.4	23.4
21 - i	-6452.4	-12806.6	-2519.0	-6452.4	1669.4	420.0	16.0	28.5	27.5
21 - j	-9063.5	-12954.4	-50900.7	-9063.5	1645.4	420.0	24.0	91.5	88.3
22 - i	-8775.0	-12954.4	-50900.7	-8775.0	1645.5	420.0	24.0	87.9	84.9
22 - j	-9025.1	-12957.1	-55678.3	-9025.1	1614.2	420.0	24.0	91.4	88.2
23 - i	-9025.1	-12957.1	-55678.3	-9025.1	1614.2	420.0	24.0	91.4	88.2
23 - j	-9210.7	-12959.5	-57424.9	-9210.7	1605.0	420.0	24.0	93.8	90.5
24 - i	9242.4	-12910.8	-57959.5	9242.4	1603.0	420.0	24.0	94.2	90.9
24 - j	9056.8	-12908.2	-56199.2	9056.8	1612.0	420.0	24.0	91.8	88.6
25 - i	9056.8	-12908.2	-56199.2	9056.8	1612.0	420.0	24.0	91.8	88.6
25 - j	8806.7	-12905.4	-51403.3	8806.7	1642.6	420.0	24.0	88.4	85.3

Member No.	S (kN)	N (kN)	M (kNm)	Sh (kN)	Sc (kN)	σ_s (N/mm ²)	Awmin (cm ²)	Awreq (cm ²)	As (cm ²)
26 - i	9095.2	-12905.4	-51403.3	9095.2	1642.5	420.0	24.0	91.9	88.7
26 - j	6484.1	-12757.5	-2815.5	6484.1	1650.3	420.0	16.0	29.2	28.2
27 - i	6195.6	-12757.5	-2815.5	6195.6	1707.1	420.0	16.0	24.1	24.1
27 - j	4587.1	-12751.9	18416.1	4587.1	1604.4	420.0	16.0	5.9	5.9
28 - i	4587.1	-12751.9	18416.1	4587.1	1604.4	420.0	16.0	5.9	5.9
28 - j	2909.7	-12757.5	32946.1	2909.7	1537.4	420.0	16.0	13.1	13.1
29 - i	2909.7	-12757.5	32946.1	2909.7	1537.4	420.0	16.0	13.1	13.1
29 - j	937.2	-2272.5	37622.4	937.2	1597.3	420.0	16.0	0.0	0.0
30 - i	831.7	-2272.5	37622.4	831.7	1597.3	420.0	16.0	0.0	0.0
30 - j	-2201.5	-11607.6	33854.5	-2201.5	1565.9	420.0	16.0	2.6	2.6
31 - i	-2201.5	-11607.6	33854.5	-2201.5	1565.9	420.0	16.0	2.6	2.6
31 - j	-2476.4	-2407.2	24331.1	-2476.4	1697.3	420.0	16.0	0.0	0.0
32 - i	-2476.4	-2407.2	24331.1	-2476.4	1697.3	420.0	16.0	0.0	0.0
32 - j	-5221.8	-12890.1	9806.5	-5221.8	1286.9	420.0	16.0	11.8	11.8
33 - i	-5510.3	-12890.1	9806.5	-5510.3	1242.7	420.0	16.0	16.3	15.7
33 - j	-8399.5	-11688.8	-39771.1	-8399.5	1958.7	420.0	24.0	79.4	76.7
34 - i	-8111.0	-11688.8	-39771.1	-8111.0	1959.3	420.0	24.0	75.9	73.2
34 - j	-8360.8	-11691.0	-44147.1	-8360.8	1892.5	420.0	24.0	79.8	77.0
35 - i	-8360.8	-11691.0	-44147.1	-8360.8	1892.5	420.0	24.0	79.8	77.0
35 - j	-8545.3	-11691.1	-47475.9	-8545.3	1850.6	420.0	24.0	83.2	80.3
36 - i	10359.0	0.0	-74091.9	10359.0	1790.0	420.0	24.0	105.0	101.4
36 - j	10176.6	0.0	-70009.0	10176.6	1815.9	420.0	24.0	99.1	95.7
37 - i	10176.6	0.0	-70009.0	10176.6	1815.9	420.0	24.0	99.1	95.7
37 - j	9929.4	0.0	-64602.0	9929.4	1844.4	420.0	24.0	85.9	82.9
38 - i	9936.2	-9573.7	-63071.4	9936.2	1716.9	420.0	24.0	87.6	84.5
38 - j	7288.6	-9573.7	-10866.3	7288.6	1524.3	420.0	24.0	33.7	32.6
39 - i	7126.7	-9573.7	-10866.3	7126.7	1539.2	420.0	24.0	31.6	31.6
39 - j	5625.2	0.0	15027.9	5625.2	1729.6	420.0	16.0	28.8	28.8
40 - i	5625.2	0.0	15027.9	5625.2	1729.6	420.0	16.0	28.8	28.8
40 - j	3957.2	0.0	34404.4	3957.2	1729.6	420.0	16.0	19.4	19.4
41 - i	3957.2	0.0	34404.4	3957.2	1729.6	420.0	16.0	19.4	19.4
41 - j	2263.8	0.0	45996.3	2263.8	1580.0	420.0	16.0	8.1	8.1
42 - i	2158.2	0.0	45996.3	2158.2	1580.0	420.0	16.0	6.9	6.9
42 - j	310.9	0.0	50987.4	310.9	1505.8	420.0	16.0	0.0	0.0
43 - i	310.9	0.0	50987.4	310.9	1505.8	420.0	16.0	0.0	0.0
43 - j	-2711.5	-9426.2	44958.1	-2711.5	1411.8	420.0	16.0	0.8	0.8
44 - i	-2711.5	-9426.2	44958.1	-2711.5	1411.8	420.0	16.0	0.8	0.8
44 - j	-3996.3	-9426.2	34955.3	-3996.3	1446.4	420.0	16.0	15.9	15.9
45 - i	-4284.8	-9426.2	34955.3	-4284.8	1446.6	420.0	16.0	19.4	19.4
45 - j	-6976.1	-9573.7	183.5	-6976.1	2594.4	420.0	24.0	37.3	37.3
46 - i	-6687.6	-9573.7	183.5	-6687.6	2594.4	420.0	24.0	33.9	33.9
46 - j	-7213.8	-9573.7	-7767.5	-7213.8	2034.0	420.0	24.0	46.9	46.9

Note: S : shear force
N : axial force
M : bending moment
Sh : shear force considered with effective height
Sc : shear force beared by concrete
 σ_s : limit of tensile stress bear shear force by stirrup
Awmin : minimum requirement stirrup area
Awreq : reqiued stirrup area due to shear force
As : required area of longitudinal reinforcement

2.8.6 Summary of Required Shear Reinforce

Member No.	Awmin (cm ²)	Awreq(cm ²)			Aw (cm ²)	
		Service Load	Thermal Effect	Strength Limit		
1 - i	24.0	55.5	57.6	52.7	48.8	57.6
1 - j	24.0	42.3	43.0	45.3	35.3	45.3
2 - i	24.0	42.3	49.1	45.3	38.7	49.1
2 - j	16.0	5.4	18.0	22.9	20.1	22.9
3 - i	16.0	5.5	12.0	22.9	16.7	22.9
3 - j	16.0	0.0	0.0	4.3	0.3	16.0
4 - i	16.0	0.0	0.0	4.3	0.3	16.0
4 - j	16.0	0.0	0.0	0.0	0.0	16.0
5 - i	16.0	0.0	0.0	0.0	0.0	16.0
5 - j	16.0	0.4	1.2	16.4	8.2	16.4
6 - i	16.0	2.9	3.4	17.7	9.4	17.7
6 - j	16.0	25.5	23.6	31.7	20.7	31.7
7 - i	16.0	25.5	23.6	31.7	20.7	31.7
7 - j	16.0	39.7	35.9	42.4	30.3	42.4
8 - i	16.0	39.7	35.9	42.4	30.3	42.4
8 - j	24.0	9.6	26.1	41.0	33.4	41.0
9 - i	24.0	10.5	29.2	42.2	36.0	42.2
9 - j	24.0	151.0	137.2	106.6	89.2	151.0
10 - i	24.0	151.0	133.6	106.6	87.5	151.0
10 - j	24.0	183.4	161.8	120.0	100.8	183.4
11 - i	24.0	183.4	161.8	120.0	100.8	183.4
11 - j	24.0	197.7	174.1	126.2	106.7	197.7
12 - i	24.0	131.0	126.2	99.3	83.8	131.0
12 - j	24.0	124.7	118.7	95.6	80.3	124.7
13 - i	24.0	124.7	118.7	95.6	80.3	124.7
13 - j	24.0	118.4	110.0	91.2	76.4	118.4
14 - i	24.0	118.4	116.4	91.2	80.0	118.4
14 - j	16.0	0.0	7.5	25.3	18.6	25.3
15 - i	16.0	0.0	0.0	23.7	14.0	23.7
15 - j	16.0	0.0	0.0	3.4	0.0	16.0
16 - i	16.0	0.0	0.0	3.4	0.0	16.0
16 - j	16.0	0.0	0.0	9.9	2.9	16.0
17 - i	16.0	0.0	0.0	9.9	2.9	16.0
17 - j	16.0	0.0	0.0	0.0	0.0	16.0
18 - i	16.0	0.0	0.0	0.2	0.0	16.0
18 - j	16.0	10.5	13.5	18.8	13.0	18.8
19 - i	16.0	10.5	13.5	18.8	13.0	18.8
19 - j	16.0	0.0	0.0	12.8	5.4	16.0
20 - i	16.0	0.0	0.0	12.8	5.4	16.0
20 - j	16.0	22.6	22.8	34.6	23.4	34.6
21 - i	16.0	25.3	31.5	36.6	28.5	36.6
21 - j	24.0	157.2	152.6	101.5	91.5	157.2
22 - i	24.0	157.2	146.3	101.5	87.9	157.2
22 - j	24.0	165.6	153.0	105.4	91.4	165.6
23 - i	24.0	165.6	153.0	105.4	91.4	165.6
23 - j	24.0	170.9	157.4	108.0	93.8	170.9
24 - i	24.0	171.7	158.1	108.5	94.2	171.7
24 - j	24.0	166.4	153.7	105.9	91.8	166.4
25 - i	24.0	166.4	153.7	105.9	91.8	166.4
25 - j	24.0	158.0	147.0	101.9	88.4	158.0

Member No.	Awmin (cm2)	Awreq(cm2)				Aw (cm2)
		Service Load	Thermal Effect	Strength Limit		
26 - i	24.0	158.0	153.3	101.9	91.9	158.0
26 - j	16.0	26.2	32.3	37.1	29.2	37.1
27 - i	16.0	23.5	23.6	35.1	24.1	35.1
27 - j	16.0	0.0	0.0	13.3	5.9	16.0
28 - i	16.0	0.0	0.0	13.3	5.9	16.0
28 - j	16.0	10.3	13.4	18.9	13.1	18.9
29 - i	16.0	10.3	13.4	18.9	13.1	18.9
29 - j	16.0	0.0	0.0	0.6	0.0	16.0
30 - i	16.0	0.0	0.0	0.0	0.0	16.0
30 - j	16.0	0.0	0.0	9.6	2.6	16.0
31 - i	16.0	0.0	0.0	9.6	2.6	16.0
31 - j	16.0	0.0	0.0	1.3	0.0	16.0
32 - i	16.0	0.0	0.0	1.3	0.0	16.0
32 - j	16.0	0.0	0.0	21.9	11.8	21.9
33 - i	16.0	0.0	2.7	23.5	16.3	23.5
33 - j	24.0	117.7	115.2	90.5	79.4	117.7
34 - i	24.0	117.7	108.9	90.5	75.9	117.7
34 - j	24.0	124.0	117.7	94.9	79.8	124.0
35 - i	24.0	124.0	117.7	94.9	79.8	124.0
35 - j	24.0	130.3	125.2	98.7	83.2	130.3
36 - i	24.0	194.3	171.2	124.4	105.0	194.3
36 - j	24.0	180.0	158.9	118.3	99.1	180.0
37 - i	24.0	180.0	158.9	118.3	99.1	180.0
37 - j	24.0	147.6	130.8	104.8	85.9	147.6
38 - i	24.0	147.6	134.4	104.8	87.6	147.6
38 - j	24.0	6.6	24.2	39.2	33.7	39.2
39 - i	24.0	6.6	22.2	38.4	31.6	38.4
39 - j	16.0	36.8	33.4	40.8	28.8	40.8
40 - i	16.0	36.8	33.4	40.8	28.8	40.8
40 - j	16.0	22.9	21.3	30.2	19.4	30.2
41 - i	16.0	22.9	21.3	30.2	19.4	30.2
41 - j	16.0	0.3	1.5	16.4	8.1	16.4
42 - i	16.0	0.0	0.0	15.0	6.9	16.0
42 - j	16.0	0.0	0.0	0.0	0.0	16.0
43 - i	16.0	0.0	0.0	0.0	0.0	16.0
43 - j	16.0	0.0	0.0	4.8	0.8	16.0
44 - i	16.0	0.0	0.0	4.8	0.8	16.0
44 - j	16.0	3.6	10.4	22.1	15.9	22.1
45 - i	16.0	3.6	16.5	22.1	19.4	22.1
45 - j	24.0	39.3	46.5	43.9	37.3	46.5
46 - i	24.0	39.3	40.4	43.9	33.9	43.9
46 - j	24.0	52.2	53.7	51.0	46.9	53.7

2.8.7. Checking for Torsional Strength

		Factored T Tu (kN)	Torsional Strength ϕT_n (kN)	$\phi T_n / T_u$
MemberNo.[2-i]	Group-I	-6591	70974	10.769
	Group-IV	-3831	70974	18.527
MemberNo.[2-j]	Group-I	-6591	51916	7.877
	Group-IV	-3831	51916	13.552
MemberNo.[3-i]	Group-I	-5534	51916	9.382
	Group-IV	-3214	51916	16.153
MemberNo.[3-j]	Group-I	-5534	51916	9.382
	Group-IV	-3214	51916	16.153
MemberNo.[4-i]	Group-I	-4685	51916	11.082
	Group-IV	-2718	51916	19.098
MemberNo.[4-j]	Group-I	-4685	51916	11.082
	Group-IV	-2718	51916	19.098
MemberNo.[5-i]	Group-I	-4041	51916	12.849
	Group-IV	-2340	51916	22.187
MemberNo.[5-j]	Group-I	-4041	51916	12.849
	Group-IV	-2340	51916	22.187
MemberNo.[6-i]	Group-I	-3572	51916	14.535
	Group-IV	-2063	51916	25.170
MemberNo.[6-j]	Group-I	-3572	51916	14.535
	Group-IV	-2063	51916	25.170
MemberNo.[7-i]	Group-I	4028	51916	12.890
	Group-IV	-2300	51916	22.577
MemberNo.[7-j]	Group-I	4028	51916	12.890
	Group-IV	-2300	51916	22.577
MemberNo.[8-i]	Group-I	5054	51916	10.273
	Group-IV	3008	51916	17.258
MemberNo.[8-j]	Group-I	5054	75675	14.974
	Group-IV	3008	75675	25.156
MemberNo.[9-i]	Group-I	5645	75675	13.405
	Group-IV	-3270	75675	23.143
MemberNo.[9-j]	Group-I	5645	70974	12.572
	Group-IV	-3270	70974	21.705
MemberNo.[14-i]	Group-I	-7616	70974	9.319
	Group-IV	-4734	70974	14.994
MemberNo.[14-j]	Group-I	-7616	51916	6.816
	Group-IV	-4734	51916	10.968
MemberNo.[15-i]	Group-I	-7056	51916	7.358
	Group-IV	-4579	51916	11.337
MemberNo.[15-j]	Group-I	-7056	51916	7.358
	Group-IV	-4579	51916	11.337
MemberNo.[16-i]	Group-I	-6039	51916	8.597
	Group-IV	-3922	51916	13.236
MemberNo.[16-j]	Group-I	-6039	51916	8.597
	Group-IV	-3922	51916	13.236
MemberNo.[17-i]	Group-I	-4742	51916	10.949
	Group-IV	-2960	51916	17.539

		Factoered T Tu (kN)	Torsional Strength ϕT_n (kN)	$\phi T_n / T_u$
MemberNo.[17-j]	Group-I	-4742	51916	10.949
	Group-IV	-2960	51916	17.539
MemberNo.[18-i]	Group-I	4790	51916	10.839
	Group-IV	2782	51916	18.663
MemberNo.[18-j]	Group-I	4790	51916	10.839
	Group-IV	2782	51916	18.663
MemberNo.[19-i]	Group-I	6335	51916	8.195
	Group-IV	3922	51916	13.236
MemberNo.[19-j]	Group-I	6335	51916	8.195
	Group-IV	3922	51916	13.236
MemberNo.[20-i]	Group-I	7598	51916	6.833
	Group-IV	4789	51916	10.840
MemberNo.[20-j]	Group-I	7598	51916	6.833
	Group-IV	4789	51916	10.840
MemberNo.[21-i]	Group-I	8417	51916	6.168
	Group-IV	5218	51916	9.950
MemberNo.[21-j]	Group-I	8417	70974	8.432
	Group-IV	5218	70974	13.602
MemberNo.[26-i]	Group-I	-7770	70974	9.134
	Group-IV	-4871	70974	14.571
MemberNo.[26-j]	Group-I	-7770	51916	6.681
	Group-IV	-4871	51916	10.658
MemberNo.[27-i]	Group-I	-7288	51916	7.124
	Group-IV	-4771	51916	10.881
MemberNo.[27-j]	Group-I	-7288	51916	7.124
	Group-IV	-4771	51916	10.881
MemberNo.[28-i]	Group-I	-7698	51916	6.744
	Group-IV	-5298	51916	9.800
MemberNo.[28-j]	Group-I	-7698	51916	6.744
	Group-IV	-5298	51916	9.800
MemberNo.[29-i]	Group-I	-4847	51916	10.710
	Group-IV	-3020	51916	17.190
MemberNo.[29-j]	Group-I	-4847	51916	10.710
	Group-IV	-3020	51916	17.190
MemberNo.[30-i]	Group-I	5204	51916	9.977
	Group-IV	3065	51916	16.941
MemberNo.[30-j]	Group-I	5204	51916	9.977
	Group-IV	3065	51916	16.941
MemberNo.[31-i]	Group-I	6642	51916	7.816
	Group-IV	4119	51916	12.603
MemberNo.[31-j]	Group-I	6642	51916	7.816
	Group-IV	4119	51916	12.603
MemberNo.[32-i]	Group-I	7664	51916	6.774
	Group-IV	4798	51916	10.821
MemberNo.[32-j]	Group-I	7664	51916	6.774
	Group-IV	4798	51916	10.821
MemberNo.[33-i]	Group-I	8060	51916	6.442
	Group-IV	4889	51916	10.618

		Factored T Tu (kN)	Torsional Strength ϕT_n (kN)	$\phi T_n / T_u$
MemberNo.[33-j]	Group-I	8060	70974	8.806
	Group-IV	4889	70974	14.516
MemberNo.[38-i]	Group-I	9534	70974	7.444
	Group-IV	6603	70974	10.748
MemberNo.[38-j]	Group-I	9534	75675	7.937
	Group-IV	6603	75675	11.461
MemberNo.[39-i]	Group-I	8453	75675	8.953
	Group-IV	5811	75675	13.024
MemberNo.[39-j]	Group-I	8453	51916	6.142
	Group-IV	5811	51916	8.935
MemberNo.[40-i]	Group-I	8557	51916	6.067
	Group-IV	5999	51916	8.654
MemberNo.[40-j]	Group-I	8557	51916	6.067
	Group-IV	5999	51916	8.654
MemberNo.[41-i]	Group-I	9482	51916	5.475
	Group-IV	6855	51916	7.573
MemberNo.[41-j]	Group-I	9482	51916	5.475
	Group-IV	6855	51916	7.573
MemberNo.[42-i]	Group-I	11761	51916	4.414
	Group-IV	8619	51916	6.024
MemberNo.[42-j]	Group-I	11761	51916	4.414
	Group-IV	8619	51916	6.024
MemberNo.[43-i]	Group-I	14257	51916	3.641
	Group-IV	10527	51916	4.932
MemberNo.[43-j]	Group-I	14257	51916	3.641
	Group-IV	10527	51916	4.932
MemberNo.[44-i]	Group-I	16341	51916	3.177
	Group-IV	12105	51916	4.289
MemberNo.[44-j]	Group-I	16341	51916	3.177
	Group-IV	12105	51916	4.289
MemberNo.[45-i]	Group-I	18349	51916	2.829
	Group-IV	13643	51916	3.805
MemberNo.[45-j]	Group-I	18349	70974	3.868
	Group-IV	13643	70974	5.202

2.9 Design of Cross Section

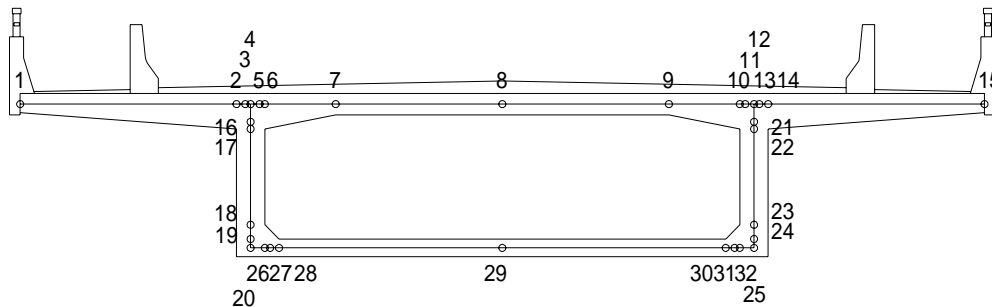
2.9.1 General of Analysis

(1) Analysis model

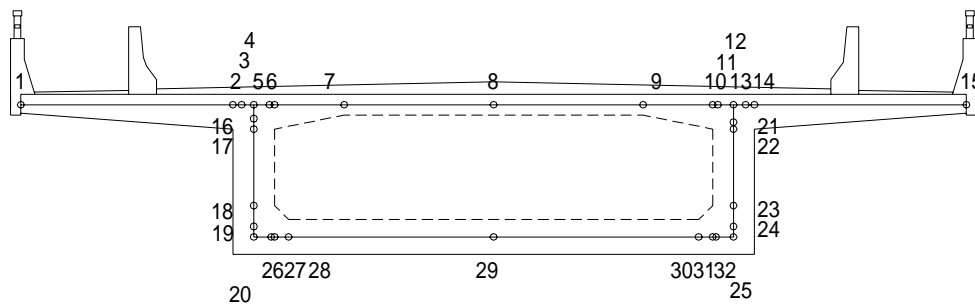
Cross section design should be analyzed by plain frame method.

Modeling of each member, plain frame configure as centurial axis of each member. Analysis model is shown as following figure.

a. Intermediate Span



b. Girder End



(2) Loadings

a. Unit weight

Self-weight of girder and wearing surface load should be considered as distribution load.

Unit weight for calculate load intensity which should be taken as following value.

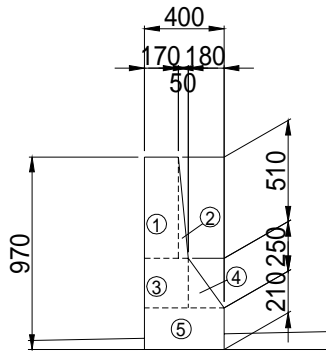
Reinforced Concrete	24.5 kN/m ³
Leveling Concrete	23.0 kN/m ³
Asphalt Pavement	22.5 kN/m ³

b. Girder self-weight

Load of girder self-weight is calculated automatically by design calculation software. Load intensity is collected from section area of each member.

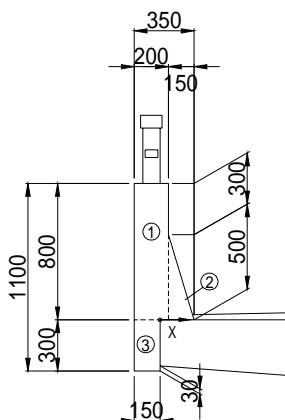
c. Wearing surface

Concrete barrier for carriage way



	A	X	AX
	$0.170 \times 0.510 \times 1.0 = 0.087$	0.085	0.007
	$0.050 \times 0.510 \times 0.5 = 0.013$	0.187	0.002
	$0.220 \times 0.250 \times 1.0 = 0.055$	0.110	0.006
	$0.180 \times 0.250 \times 0.5 = 0.023$	0.280	0.006
	$0.400 \times 0.210 \times 1.0 = 0.084$	0.200	0.017
Total	0.261		0.038

Concrete barrier for foot way



	A	X	AX
	$0.200 \times 0.800 \times 1.0 = 0.160$	-0.050	-0.00800
	$0.150 \times 0.500 \times 0.5 = 0.038$	0.100	0.00380
	$0.150 \times 0.300 \times 1.0 = 0.045$	-0.075	-0.00338
Total	0.243		-0.00758

$$X = \frac{AX}{A} = -0.031 \text{ m}$$

$$P = 0.243 \times 24.5 = 5.954 \text{ kN/m}$$

$$M = -0.031 \times 5.954 = -0.185 \text{ kN} \cdot \text{m/m}$$

Steel railing for foot way barrier

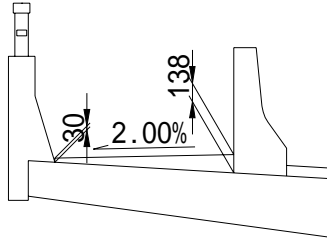
$$W = 0.30 \text{ kN/m}$$

Asphalt Pavement

Foot way(t = 30mm)

$$W = 0.03 \times 22.5 = 0.675 \text{ kN/m}^2$$

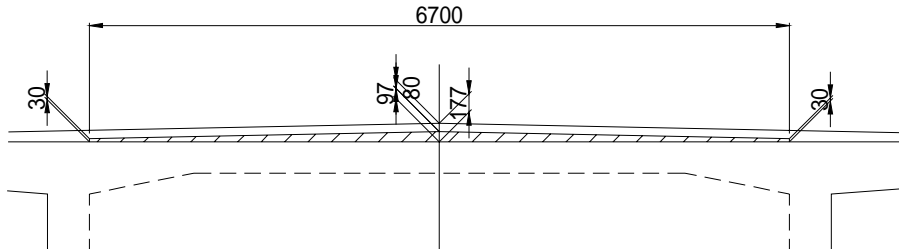
$$W = 0.138 \times 22.5 = 3.105 \text{ kN/m}^2$$



Carriage way(t = 80mm)

$$W = 0.080 \times 22.5 = 1.80 \text{ kN/m}^2$$

Leveling concrete



$$W = 0.03 \times 23.0 = 0.69 \text{ kN/m}^2$$

$$W = 0.097 \times 23.0 = 2.231 \text{ kN/m}^2$$

d. Temperature difference

Temperature difference between top fiber of girder to lower fiber of girder should be taken as following value.

Temperature difference

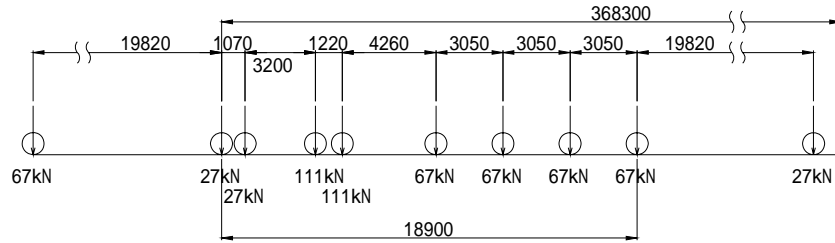
T= 5.0 Degree Celsius

e. Live Load

Load Intensity due to Live Load

For section design, live load is according to Class A Loading. And load should be taken from most heavy axle load of Class A Loading. So that reason, loading for section design is taken as 111kN axle load.

Loading for plain frame model, which act distributed from road surface to centurial axis of slab for 45 degree.



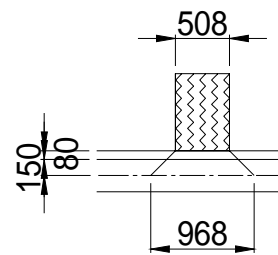
Loaded width of wheel load 0.508m

Distance from surface to centurial axis of slab 0.230m

Distribution width at centurial axis of slab 0.968m

Loading at centurial axis of slab

$$w = 111 / 2 / 0.968 = 57.335\text{kN/m (half side of axle load)}$$



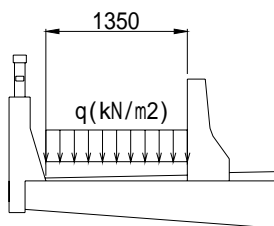
Impact coefficient

$$i = 15.24 / (L + 38)$$

Intermediate span L = 6.700m , i = 0.341

Girder end L = 6.300m , i = 0.344

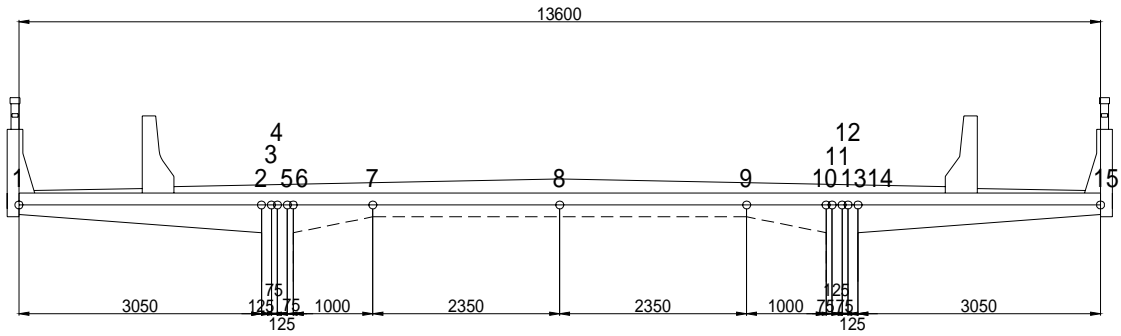
Pedestrian Live Load



$$q = (1435 + 43800 / L) \times (16.7 - W) / 15.2$$

	L(m)	W(m)	q(kN/m ²)
P4 ~ P5	41.450	1.350	2.52
P5 ~ P7	42.000	1.350	2.5
P7 ~ A2	41.400	1.350	2.52

Standard Section



PC CABLE (3S15.2 etc 500)

			1-j		6-i	
			Upper Fiber	Lower Fiber	Upper Fiber	Lower Fiber
Load Combination			Service	Service	Thermal	Thermal
Bending Moment	max	kN·m	-132.06		-47.21	
	min		-133.67		-219.52	
Dominant Combination	max	N/mm ²	0.92	2.56	2.93	4.61
	min		0.88	2.52	-1.21	0.47
Allowable Stress			-2.95 < σ_c < 14.0		-2.95 < σ_c < 14.0	
Required reinforcement			0.000	0.000	5.840	0.000
Safety Factor			3.130		1.500	
Reinforcement Arrangement			D16ctc125	D16ctc250	D16ctc125	D16ctc250

			7-j		8-i	
			Upper Fiber	Lower Fiber	Upper Fiber	Lower Fiber
Load Combination			Service	Service	Service	Service
Bending Moment	max	kN·m	80.04		80.04	
	min		11.12		11.12	
Dominant Combination	max	N/mm ²	6.55	3.80	6.55	3.80
	min		1.95	-0.81	1.95	-0.81
Allowable Stress			-2.95 < σ_c < 14.0		-2.95 < σ_c < 14.0	
Required reinforcement			0.000	2.060	0.000	2.060
Safety Factor			1.480		1.480	
Reinforcement Arrangement			D16ctc125	D16ctc250	D16ctc125	D16ctc250

			9-j		14-i	
			Upper Fiber	Lower Fiber	Upper Fiber	Lower Fiber
Load Combination			Thermal	Thermal	Service	Service
Bending Moment	max	kN·m	-46.23		-130.77	
	min		-218.54		-132.38	
Dominant Combination	max	N/mm ²	2.96	4.58	0.95	2.53
	min		-1.19	0.45	0.91	2.49
Allowable Stress			-2.95 < σ_c < 14.0		-2.95 < σ_c < 14.0	
Required reinforcement			5.790	0.000	0.000	0.000
Safety Factor			1.510		3.150	
Reinforcement Arrangement			D16ctc125	D16ctc250	D16ctc125	D16ctc250

2.10 Design of Cross Beam

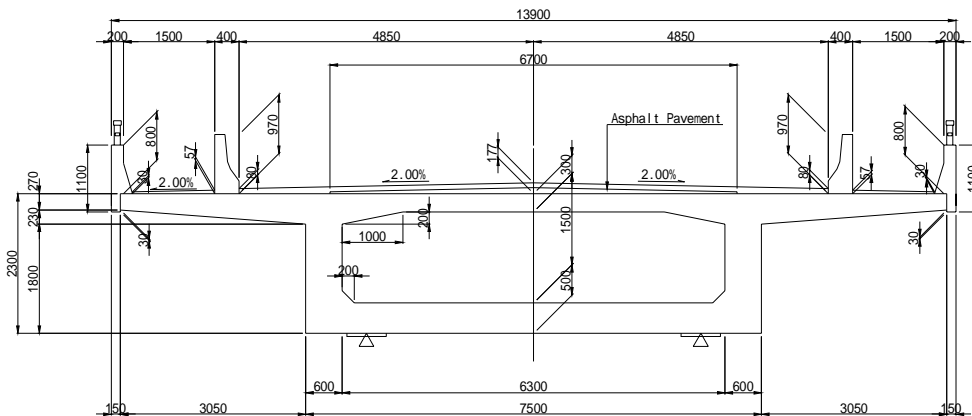
2.10.1 Design of End Cross Beam at P4

(1) Analysis Model

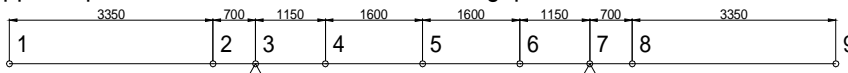
Design calculation for cross beam analysis model should be considered two type of support condition is apply for model.

Model-1 : Cross beam support by bearing and overlying load affect web as concentrate load

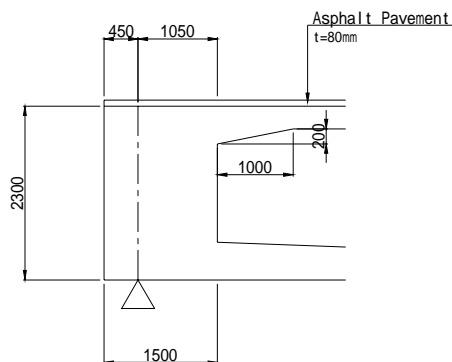
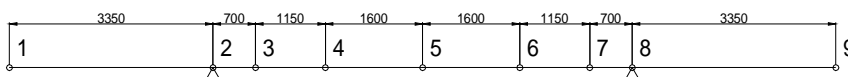
Model-2 : Cross beam support by web and overlying load affect as distribution load



Support position considered as bearing position



Support position considered as center of web



(2) Effective section of cross beam

Calculation of effective width of cross beam should be calculated as following formula.

$$b_e = d_s + n \times \lambda$$

b_e : Effective width of cross beam (m)

d_s : Width of cross beam (m) = 1.500 m

n : for end cross beam : $n = 1$, for intermediate cross beam : $n = 2$

λ : Effective width of compressive flange (m) $L/8 + b_s$ (m)

L : Span length = bearing spacing (5.500 m)

b_s : Effective width of hunch (m)

$$\lambda = 5.500 \times 1/8 + 0.200 = 0.888 \text{ (m)}$$

$$b_e = 1.500 + 0.888 \times 1 = 2.388 \text{ (m)}$$

(3) Loadings

1) Dead Load

a. Self-weight and surfacing

Standard section of cross beam

$$\begin{aligned} A &= 0.888 \times 1 \times (0.322 + 0.500) + 1.500 \times 2.300 \\ &+ 1/2 \times 0.178 \times 0.888 - 1/2 \times (0.50 - 0.466) \times 0.888 \\ &= 4.244 \text{ (m}^2 \text{)} \end{aligned}$$

$$W = 4.244 \times 24.5 = 103.978 \text{ (kN/m)}$$

Base of cantilever slab

$$W = 2.388 \times 0.500 \times 24.5 = 29.253 \text{ (kN/m)}$$

Tip of cantilever slab

$$W = 2.388 \times 0.270 \times 24.5 = 15.797 \text{ (kN/m)}$$

b. Asphalt pavement

Carriage way

$$W = 2.388 \times 0.080 \times 22.5 = 4.298 \text{ (kN/m)}$$

Foot way

$$W = 2.388 \times 0.030 \times 22.5 = 1.612 \text{ (kN/m)}$$

$$W = 2.388 \times 0.057 \times 22.5 = 3.063 \text{ (kN/m)}$$

c. Leveling concrete

$$W = 2.388 \times 0.030 \times 23.0 = 1.648 \text{ (kN/m)}$$

$$W = 2.388 \times 0.097 \times 23.0 = 5.328 \text{ (kN/m)}$$

d. Concrete barrier and steel railing

Concrete barrier for carriage way (Left side)

$$P = 2.388 \times 6.393 = 15.266 \text{ (kN)}$$

Concrete barrier for carriage way (Right side)

$$P = 2.388 \times 6.393 = 15.266 \text{ (kN)}$$

Concrete barrier for foot way (left side)

$$P = 2.388 \times 5.954 = 14.218 \text{ (kN)}$$

Concrete barrier for foot way (Right side)

$$P = 2.388 \times 5.954 = 14.218 \text{ (kN)}$$

Steel railing

$$P = 2.388 \times 0.300 = 0.716 \text{ (kN) one side}$$

Foot way live load (consider as concentrate load)

$$P = 2.388 \times 3.402 = 8.124 \text{ (kN) one side}$$

e. Outlying dead load diffuse from web

The position of bearing assumed as support. The force due to outlying dead load diffused from web, which consider as reaction force affect on web or distribution load affect on slab girder.

$$\Sigma R_d = 5,045.201 \text{ (kN)}$$

$$\Sigma W_d = 1,065.257 \text{ (kN)}$$

Concentrate load

$$P_d = (\Sigma R_d - \Sigma W_d) / n_w$$

Distribution load

$$q_d = (\Sigma R_d - \Sigma W_d) / B$$

where

ΣR_d : Reaction force due to dead load calculated by overall bridge model

ΣW_d : Dead load affect on effective width directory

n_w : Nos of web = 2 nos

B : Slab girder width = 7.500 m

$$P_d = (5,045.201 - 1,065.257) \times 1/2 = 1,989.972 \text{ (kN)}$$

$$q_d = (5,045.201 - 1,065.257) \times 1/7.500 = 530.659 \text{ (kN/m)}$$

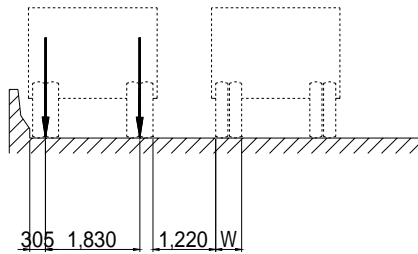
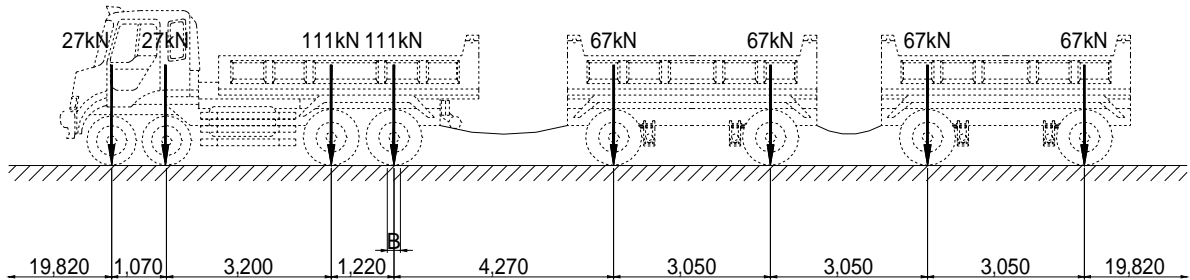
2) Live Load

a. Class A Load affect on effective width

$$i = \frac{15.24}{38 + L} = \frac{15.24}{38 + 5.500} = 0.350$$

i : impact coefficient (max 0.30)

$$P = 111 \times 1.300 = 144.300 \text{ (kN)}$$



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

b. Class A Loading affected beyond effective width

The position of bearing assumed as support. The force due to outlying Class A Loading diffused from web, which consider as reaction force affect on web or distribution load affect on slab girder.

$$\Sigma R1 = 1079.582 \text{ (kN)}$$

Concentrate load

$$P1 = (\Sigma R1 - \Sigma W1) / nw$$

Distribution load

$$q1 = (\Sigma R1 - \Sigma W1) / B$$

where

$\Sigma R1$: Reaction force due to dead load calculated by overall bridge model

$\Sigma W1$: Dead load affect on effective width directory

nw : Nos of web = 2 nos

B : Slab girder width = 7.500 m

Class A Loading one lane

$$P = (1,079.582 - 144.300 \times 2) / 2 = 395.491 \text{ (kN)}$$

$$q = (1,079.582 - 144.300 \times 2) / 7.500 = 105.464 \text{ (kN/m)}$$

Class A Loading two lane

$$P = (1,079.582 - 144.300 \times 4) / 2 = 251.191 \text{ (kN)}$$

$$q = (1,079.582 - 144.300 \times 4) / 7.500 = 66.984 \text{ (kN/m)}$$

(4) Calculation Result

End Cross Beam at P4				
Section Profile				
Reinforcement Arrangement				
Bending Moment			Upper Fiber	Lower Fiber
Bending Moment	Dead Load	(kN·m)	-1750.31	1809.65
	Service Load	(kN·m)	-2070.96	2420.50
Dominant Combination	Dead Load	(N/mm ²)	-0.14	-0.19
	Allowable Bending Stress	(N/mm ²)	-2.96 < σ < 14.0	-2.96 < σ < 14.0
	Service Load	(N/mm ²)	-0.31	-0.50
	Allowable Bending Stress	(N/mm ²)	-2.96 < σ < 14.0	-2.96 < σ < 14.0
PC Cable			12S15.2 2nos	12S15.2 2nos
Strength		(N/mm ²)	969.9	969.5
Safety Factor		(>1.00)	2.2	1.7
Shear Force				
Service Load	Section Force	(kN)	1378.40	
	Shear Stress	(N/mm ²)	0.40	
	Allowable Shear Stress	(N/mm ²)	0.47	
	Check		Arrangement of minimum reinforced concrete	
Ultimate Load	Section Force	(kN)	2095.5	
	Required Stirrup Area	(cm ²)	0.0	
	Minimum Stirrup Area	(cm ²)	30.0	

(5) Calculation of Required Reinforcement

Load Case " Group-I "

Member		Upper Stress $\sigma_c(N/mm^2)$	Lower Stress $\sigma_c(N/mm^2)$	Neutral Axis (m)	Tensile Force T(kN)	Required Bar Area T/fsa(m,m ²)	0.005Ac (mm ²)	Re-Bar Arrangement (mm ²)
No.2-j	Upper	-0.306	1.811	0.333	121.622	579.2	3970.8	3970.8
No.3-i	Upper	-0.306	1.811	0.333	121.622	723.9	3970.8	3970.8
No.3-j	Upper	-1.003	2.494	0.660	746.445	3554.5	6771.9	6771.9
No.4-i	Upper	-1.003	2.494	0.660	746.445	4443.1	6771.9	6771.9
No.4-j	Upper	-1.077	2.567	0.680	821.686	3912.8	6923.5	6923.5
	Lower	2.051	-0.503	0.453	271.779	1617.7	5406.1	5406.1
No.5-i	Upper	-1.077	2.567	0.680	821.686	3912.8	6923.5	6923.5
	Lower	2.051	-0.503	0.453	271.779	1617.7	5406.1	5406.1
No.5-j	Upper	-1.003	2.494	0.660	746.445	3554.5	6771.9	6771.9
No.6-i	Upper	-1.003	2.494	0.660	746.445	4443.1	6771.9	6771.9
No.6-j	Upper	-0.306	1.811	0.333	121.622	579.2	3970.8	3970.8
No.7-i	Upper	-0.306	1.811	0.333	121.622	723.9	3970.8	3970.8

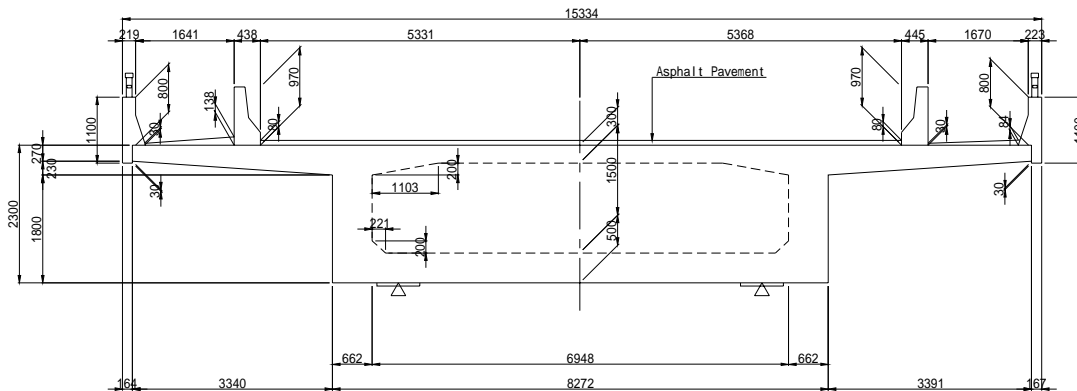
2.10.2 Design of Intermediate Cross Beam at A2

(1) Analysis Model

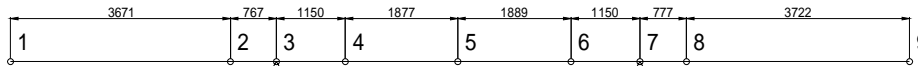
Design calculation for cross beam analysis model should be considered two type of support condition is apply for model.

Model-1 : Cross beam support by bearing and overlying load affect web as concentrate load

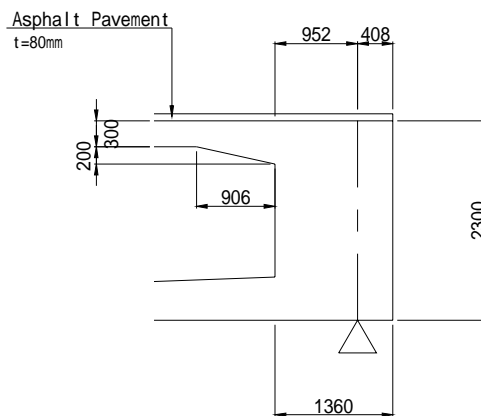
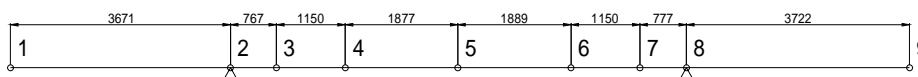
Model-2 : Cross beam support by web and overlying load affect as distribution load



Support position considered as bearing position



Support position considered as center of web



(2) Effective section of cross beam

Calculation of effective width of cross beam should be calculated as following formula.

$$b_e = d_s + n \times \lambda$$

b_e : Effective width of cross beam (m)

d_s : Width of cross beam (m) = 1.360 m

n : for end cross beam : $n = 1$, for intermediate cross beam : $n = 2$

λ : Effective width of compressive flange (m) $L/8 + b_s$ (m)

L : Span length = bearing spacing (6.066 m)

b_s : Effective width of hunch (m)

$$\lambda = 6.066 \times 1/8 + 0.200 = 0.958 \text{ (m)}$$

$$b_e = 1.360 + 0.958 \times 1 = 2.318 \text{ (m)}$$

(3) Loadings

1) Dead Load

a. Self-weight and surfacing

Standard section of cross beam

$$\begin{aligned} A &= 0.958 \times 1 \times (0.300 + 0.500) + 1.360 \times 2.300 \\ &+ 1/2 \times 0.200 \times 0.906 - 1/2 \times (0.50 - 0.463) \times 0.958 \\ &= 3.967 \text{ (m}^2 \text{)} \end{aligned}$$

$$W = 3.967 \times 24.5 = 97.192 \text{ (kN/m)}$$

Base of cantilever slab

$$W = 2.318 \times 0.500 \times 24.5 = 28.396 \text{ (kN/m)}$$

Tip of cantilever slab

$$W = 2.318 \times 0.270 \times 24.5 = 15.334 \text{ (kN/m)}$$

b. Asphalt pavement

Carriage way

$$W = 2.318 \times 0.080 \times 22.5 = 4.172 \text{ (kN/m)}$$

Foot way

Left Side

$$W = 2.318 \times 0.030 \times 22.5 = 1.565 \text{ (kN/m)}$$

$$W = 2.318 \times 0.138 \times 22.5 = 7.197 \text{ (kN/m)}$$

Right Side

$$W = 2.318 \times 0.030 \times 22.5 = 1.565 \text{ (kN/m)}$$

$$W = 2.318 \times 0.084 \times 22.5 = 4.381 \text{ (kN/m)}$$

c. Concrete barrier and steel railing

Concrete barrier for carriage way (Left side)

$$P = 2.318 \times 6.393 \times 1.103 = 16.345 \text{ (kN)}$$

Concrete barrier for carriage way (Right side)

$$P = 2.318 \times 6.393 \times 1.103 = 16.345 \text{ (kN)}$$

Concrete barrier for foot way (left side)

$$P = 2.318 \times 5.954 \times 1.103 = 15.223 \text{ (kN)}$$

Concrete barrier for foot way (Right side)

$$P = 2.318 \times 5.954 \times 1.103 = 15.223 \text{ (kN)}$$

Steel railing

$$P = 2.318 \times 0.300 \times 1.103 = 0.767 \text{ (kN) one side}$$

Foot way live load (consider as concentrate load)

$$P = 2.318 \times 3.402 \times 1.103 = 8.698 \text{ (kN) one side}$$

d. Outlying dead load diffuse from web

The position of bearing assumed as support. The force due to outlying dead load diffused from web, which consider as reaction force affect on web or distribution load affect on slab girder.

$$\Sigma R_d = 4,938.127 \text{ (kN)}$$

$$\Sigma W_d = 1,088.731 \text{ (kN)}$$

Concentrate load

$$P_d = (\Sigma R_d - \Sigma W_d) / n_w$$

Distribution load

$$q_d = (\Sigma R_d - \Sigma W_d) / B$$

where

ΣR_d : Reaction force due to dead load calculated by overall bridge model

ΣW_d : Dead load affect on effective width directory

n_w : Nos of web = 2 nos

B : Slab girder width = 8.272 m

$$P_d = (4,938.127 - 1,088.731) \times 1/2 = 1,924.698 \text{ (kN)}$$

$$q_d = (4,938.127 - 1,088.731) \times 1/8.272 = 465.353 \text{ (kN/m)}$$

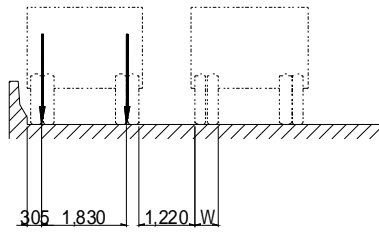
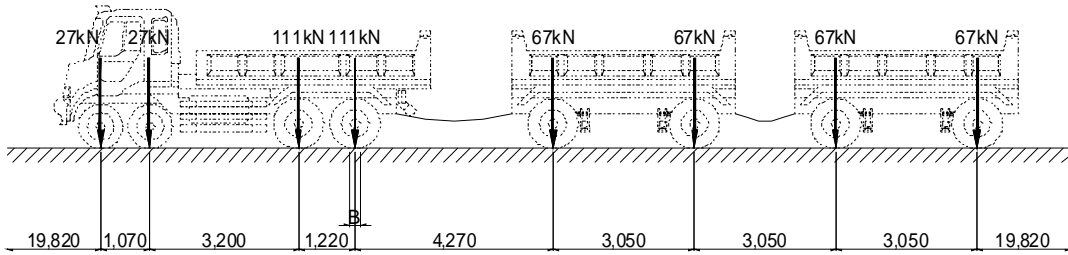
2) Live Load

a. Class A Load affect on effective width

$$i = \frac{15.24}{38 + L} = \frac{15.24}{38 + 6.066} = 0.346$$

i : impact coefficient (max 0.30)

$$P = 111 \times 1.300 = 144.300 \text{ (kN)}$$



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

b. Class A Loading affected beyond effective width

The position of bearing assumed as support. The force due to outlying Class A Loading diffused from web, which consider as reaction force affect on web or distribution load affect on slab girder.

$$\Sigma R1 = 1076.579 \text{ (kN)}$$

Concentrate load

$$P1 = (\Sigma R1 - \Sigma W1) / nw$$

Distribution load

$$q1 = (\Sigma R1 - \Sigma W1) / B$$

where

$\Sigma R1$: Reaction force due to dead load calculated by overall bridge model

$\Sigma W1$: Dead load affect on effective width directory

nw : Nos of web = 2 nos

B : Slab girder width = 8.272 m

Class A Loading one lane

$$P = (1,076.579 - 144.300 \times 2) / 2 = 393.990 \text{ (kN)}$$

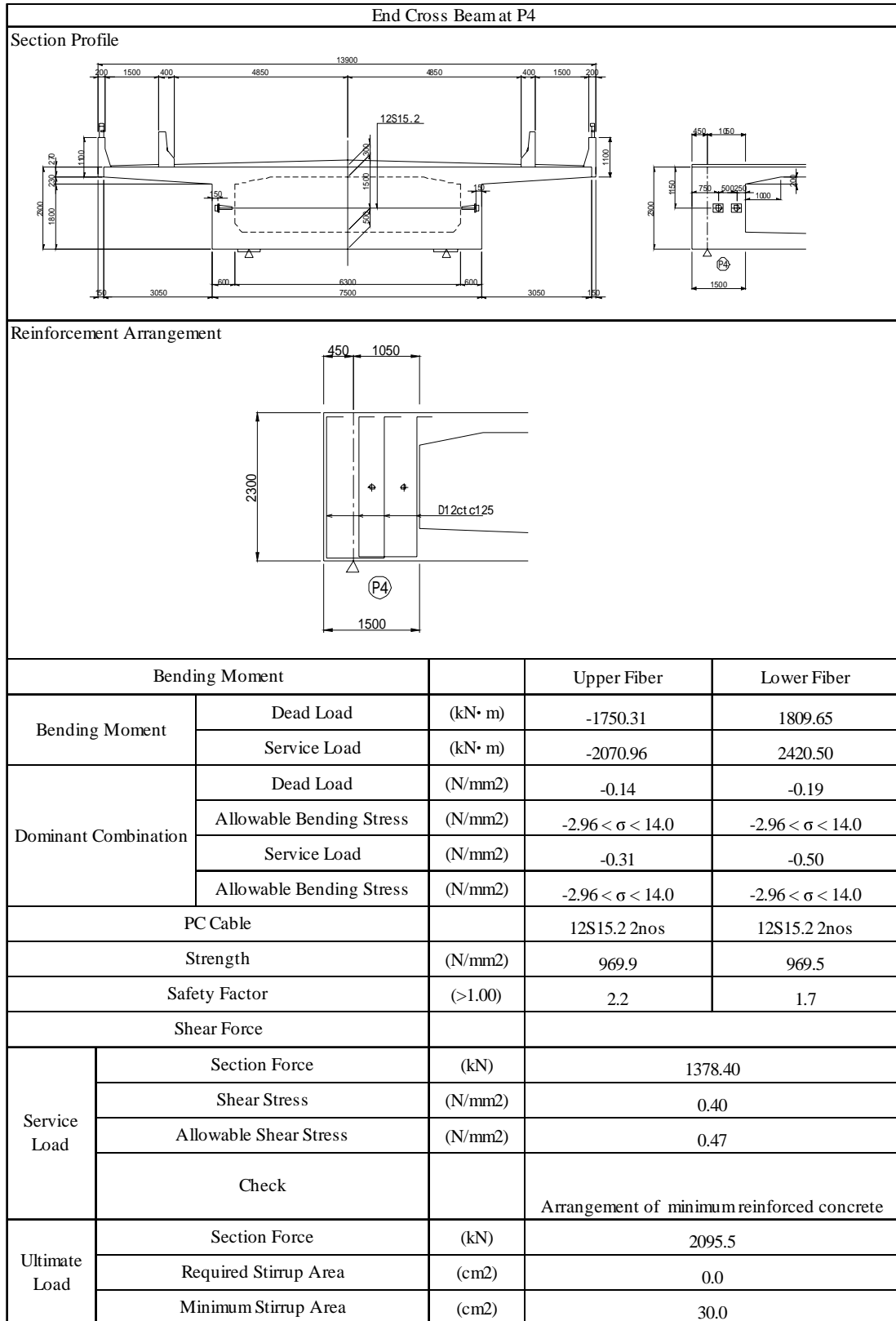
$$q = (1,076.579 - 144.300 \times 2) / 8.272 = 95.259 \text{ (kN/m)}$$

Class A Loading two lane

$$P = (1,076.579 - 144.300 \times 4) / 2 = 249.690 \text{ (kN)}$$

$$q = (1,076.579 - 144.300 \times 4) / 8.272 = 60.370 \text{ (kN/m)}$$

(4) Calculation Result



(5) Calculation of Required Reinforcement

Load Case " Group-I "

Member	Upper Stress $\sigma_c'(N/mm^2)$	Lower Stress $\sigma_c(N/mm^2)$	Neutral Axis (m)	Tensile Force T(kN)	Required Bar Area T/fsa(m,m ²)	0.005Ac (mm ²)	Re-Bar Arrangement (mm ²)	
No.2-j Upper	-0.388	2.023	0.370	166.327	792.0	4218.8	4218.8	
No.3-i Upper	-0.388	2.023	0.370	166.327	990.0	4218.8	4218.8	
No.3-j Upper	-1.141	2.756	0.674	824.956	3928.4	6470.4	6470.4	
No.4-i Upper	-1.141	2.756	0.674	824.956	4910.5	6470.4	6470.4	
No.4-j	Upper	-1.234	2.846	0.696	914.527	4354.9	6619.8	6619.8
	Lower	2.280	-0.575	0.463	308.566	1836.7	5367.9	5367.9
No.5-i	Upper	-1.234	2.846	0.696	914.527	4354.9	6619.8	6619.8
	Lower	2.280	-0.575	0.463	308.566	1836.7	5367.9	5367.9
No.5-j Upper	-1.150	2.765	0.676	833.508	3969.1	6485.4	6485.4	
No.6-i Upper	-1.150	2.765	0.676	833.508	4961.4	6485.4	6485.4	
No.6-j Upper	-0.397	2.031	0.376	172.378	820.8	4271.7	4271.7	
No.7-i Upper	-0.397	2.031	0.376	172.378	1026.1	4271.7	4271.7	

2.10.3 Design of Intermediate Cross Beam at P5

1. Summary of Axial Force

1) Difference of Axial Force

(1) Bending Sterss at Gravity of Bottom Slab

P5 Leftside

Girder Height : 2.300 m

Thickness of Bottom Slab : 0.500 m

	Bending Stress		
	Upper Edge (N/mm ²)	Gravity of Bottom Slab (N/mm ²)	Lower Edge (N/mm ²)
Dead Load + Live Load Maximum	-1.61	5.50	6.37
Dead Load + Live Load Minimum	-2.94	6.88	8.07

P5 Rightside

Girder Height : 2.300 m

Thickness of Bottom Slab : 0.500 m

	Bending Stress		
	Upper Edge (N/mm ²)	Gravity of Bottom Slab (N/mm ²)	Lower Edge (N/mm ²)
Dead Load + Live Load Maximum	1.71	1.51	1.48
Dead Load + Live Load Minimum	0.35	2.94	3.25

P6 Leftside

Girder Height : 2.300 m

Thickness of Bottom Slab : 0.500 m

	Bending Stress		
	Upper Edge (N/mm ²)	Gravity of Bottom Slab (N/mm ²)	Lower Edge (N/mm ²)
Dead Load + Live Load Maximum	-1.19	3.69	4.28
Dead Load + Live Load Minimum	-2.46	5.07	5.99

P6 Rightside

Girder Height : 2.300 m

Thickness of Bottom Slab : 0.500 m

	Bending Stress		
	Upper Edge (N/mm ²)	Gravity of Bottom Slab (N/mm ²)	Lower Edge (N/mm ²)
Dead Load + Live Load Maximum	-1.24	3.74	4.35
Dead Load + Live Load Minimum	-2.50	5.12	6.05

P7 Leftside

Girder Height : 2.300 m

Thickness of Bottom Slab : 0.500 m

	Bending Stress		
	Upper Edge (N/mm ²)	Gravity of Bottom Slab (N/mm ²)	Lower Edge (N/mm ²)
Dead Load + Live Load Maximum	1.76	1.45	1.41
Dead Load + Live Load Minimum	0.41	2.88	3.18

P7 Rightside

Girder Height : 2.300 m

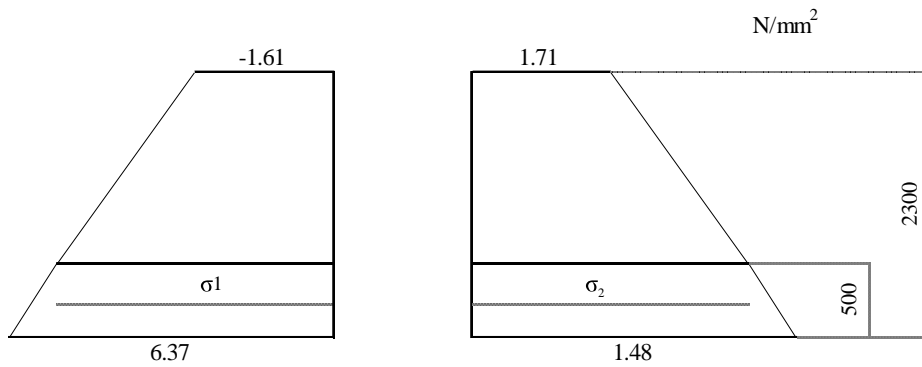
Thickness of Bottom Slab : 0.500 m

	Bending Stress		
	Upper Edge (N/mm ²)	Gravity of Bottom Slab (N/mm ²)	Lower Edge (N/mm ²)
Dead Load + Live Load Maximum	-1.47	5.35	6.18
Dead Load + Live Load Minimum	-2.79	6.71	7.87

N/mm²

	D.L + LL Max		D.L + LL Min	
	Stress	Diffrence	Stress	Diffrence
P5 Pier	5.50	4.00	6.88	3.94
	1.51		2.94	
P5 Pier	3.69	0.05	0.00	0.00
	3.74		0.00	
P5 Pier	1.45	3.90	0.00	0.00
	5.35		0.00	

2. Design of Bottom Slab



$$\sigma_1 = 5.50 \text{ N/mm}^2 \quad \sigma_2 = 1.51 \text{ N/mm}^2$$

$$N1 = \sigma_1 \times t = 5.50 \times 500 = 2752 \text{ N/mm}$$

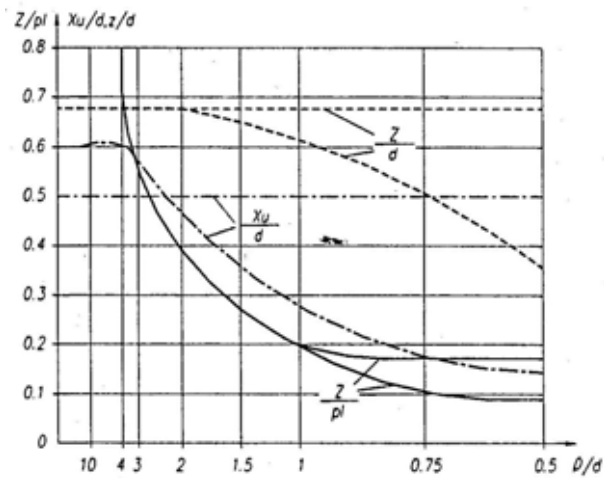
$$N2 = \sigma_2 \times t = 1.51 \times 500 = 753 \text{ N/mm}$$

Maximum Difference

$$\Delta N = N1 - N2 = 2752 - 753 = 1999 \text{ N/mm}$$

Maximum Difference

$$\begin{aligned} \Delta N &= P = 1999 \text{ N/mm} \\ L/d &= 6.300 / 4.000 = 1.575 \\ Z/PL &= 0.3 \end{aligned}$$



$$\begin{aligned} Z &= 0.3 \times P \times L \\ &= 0.3 \times 1999 \times 6300 = 378891 \text{ N} \end{aligned}$$

Required PC Steel

PC Steel Type 12S15.2

$$P_e = 1581 \text{ kN}$$

Required Nos of PC Steel (12S15.2)

$$N = \frac{Z}{P_e} = \frac{3778.9}{1581.2} = 2.4 \text{ Nos}$$

Arrangement of PC Steel 4 Nos

4. Design of Diaphragm

1) Summary of Vertical Force

		kN		
		P5	P6	P7
Self Weight of Girder		10055	10543	10005
Creep Effect		78	-39	73
Surfacing Dead Load		2758	2313	2701
Live Load (CLASS-A) with Impact	Nmax	1801	1630	1797
	Nmin	-84	-223	-84
Total of Dead Load		12891	12816	12779
Dead Load + Live Load	Nmax	14692	14446	14576
	Nmin	12807	12593	12695

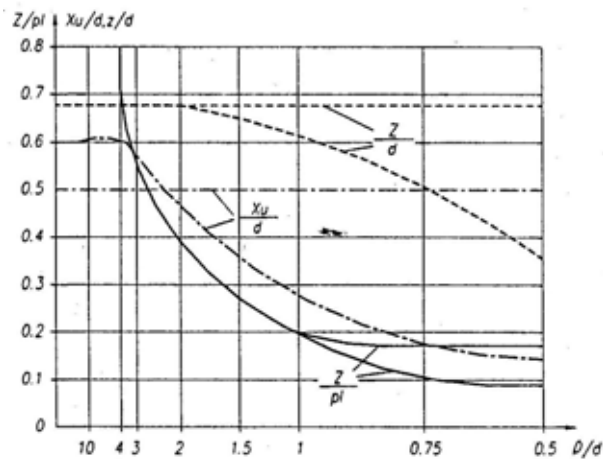
2) Required PC Steel

$$N_{max} = 14692 \text{ kN}$$

$$P = N_{max}/L/2 = 14692 / 2.300 / 2 = 3194 \text{ kN/m}$$

$$L/d = 6.300 / 2.300 = 2.739$$

$$Z/PL = 0.46$$



$$Z = 0.46 \times P \times L = 0.46 \times 3194 \times 6.300 = 9256 \text{ kN}$$

Required PC Steel

PC Steel Type 12S15.2

$$P_e = 1581 \text{ kN}$$

Required Nos of PC Steel (12S15.2)

$$N = \frac{Z}{P_e} = \frac{9256.0}{1581.2} = 5.9 \text{ Nos}$$

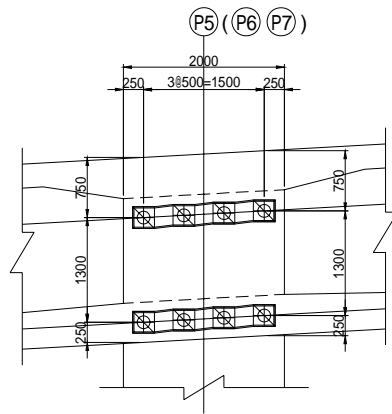
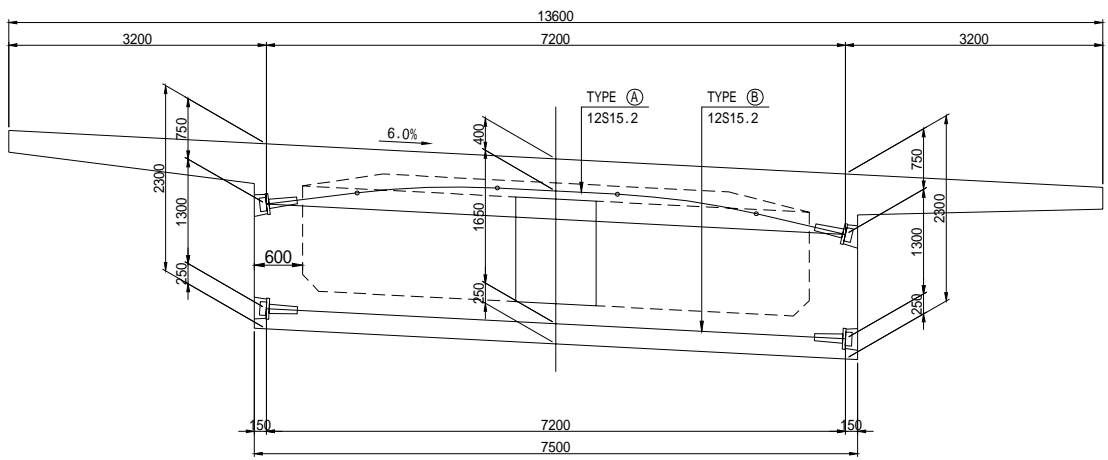
Transverse PC Cable at Top Slab "3S15.2" are 8 Nos within Effective Section of Cross Bear
Converted Nos of Transverse Cable is $8 \times 3S15.2 / 12S15.2 = 2.0$ Nos

Required Nos of PC Steel (12S15.2)

$$N^1 = 5.9 - 2.0 = 3.9 \text{ Nos}$$

Arrangement of PC Steel 4 Nos

Arrangement of PC Cable at Cross Beam



Design Calculation of Substructure

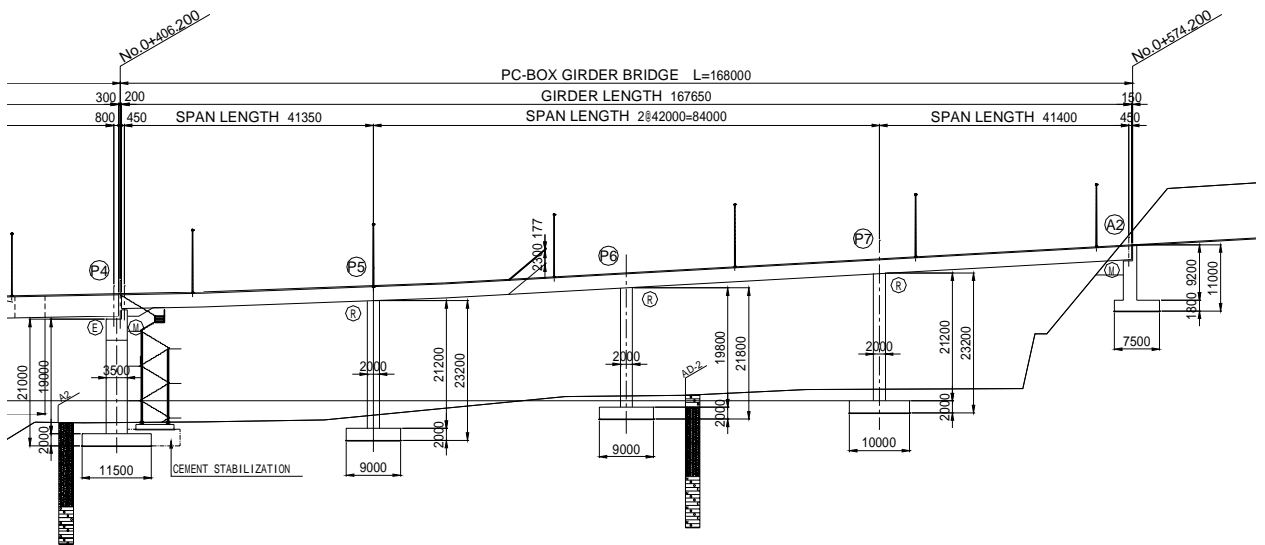
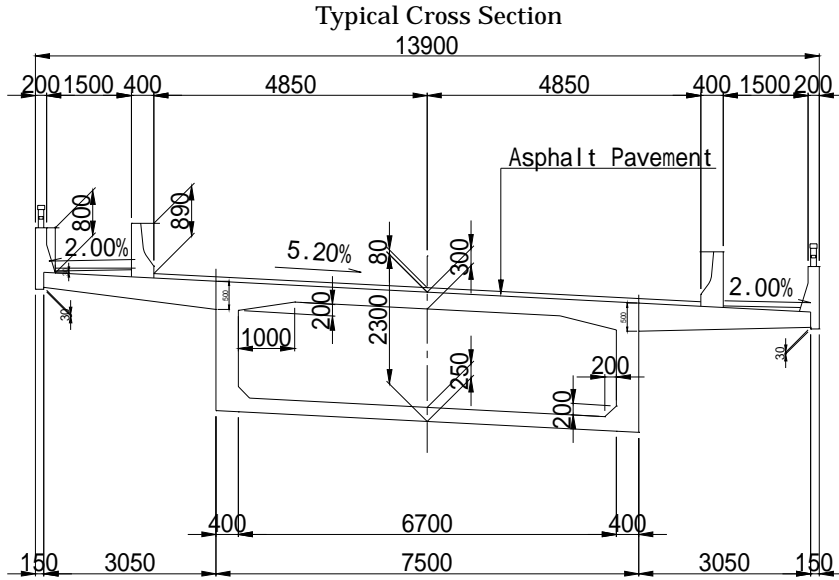
1. DESIGN CRITERIA

1.1 Design Criteria

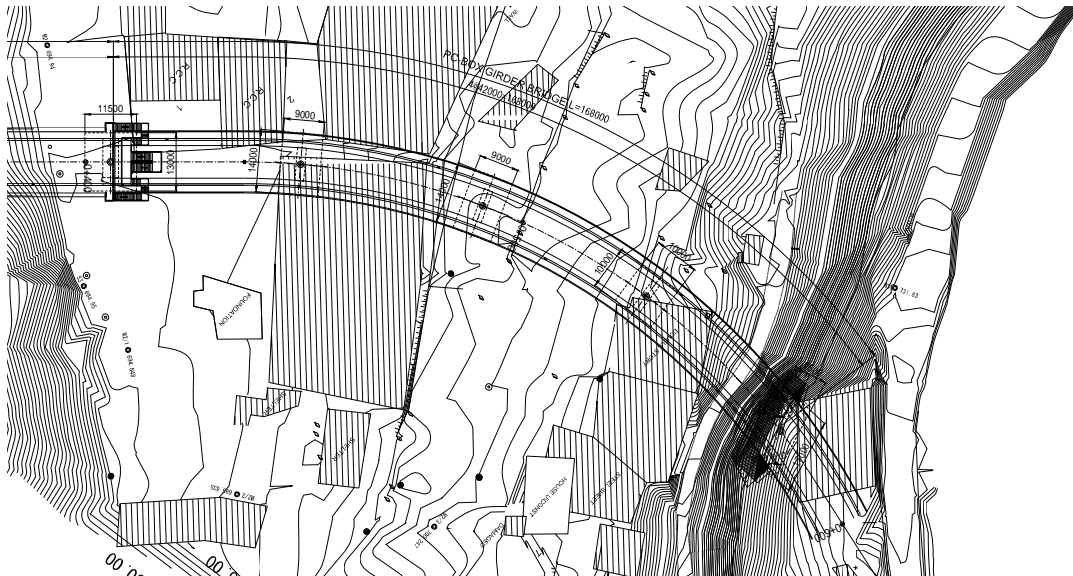
Design criteria of West Side Approach Viaduct shown as following.

Superstructure	: 2Spans Continuous PC-Slab girder
Bridge Length	: 168.000m
Girder Length	: 167.750m
Span Length	: 41.450+2@42.000+41.400
Bridge Width	: 13.900m
Effective Width	: Carriage Way 9.70m : Foot Way 2 x 1.50m
Live Load	: Class-A, Class-AA
Curvature	: R= ~ 150m ~
Gradient	: i = 2.000% ▲ ~ 5.564% ▲
Super Elevation	: i = 2.000% ▲ \▲ ~ 5.200% ▲
Skew Angle	: P4 ~ P7 $\theta = 90$ deg : A2 $\theta = 65$ deg
Support Condition	: P4, A2 Movable Support : P5 ~ P7 Rigid
Asphalt Pavement	: Carriage Way 80mm ~ : Foot Way 30mm ~
Substructure	: P4 Column type pier : A2 Inverted T shaped abutment
Foundation	: P4 ~ A2 Spread Footing

1.2 Bridge Profile



Plan



1.3 Materials Property

1.3.1 Concrete

Table 1.3.1 Material Property of Concrete

Concrete	(N/mm ²)	
	Wall Column RC	Footing, Pilecap RC
Class	A1-1	A1-2
28Days Cylinder Strength	24	24
Modulus of Elasticity	2.50×10^4	2.50×10^4
Allowable Compression Stress	9.60	9.60
Allowable Tensile Stress	-2.45	-
Temperature coefficient	10×10^{-6}	10×10^{-6}
Allowable Shear Stress	0.39	0.39
Maximum Average Shear Stress	2.16	2.16

1.3.2 Reinforcement

Table 1.3.2 Material Property of Reinforcement

	(N/mm ²)
Yield strength	420
Modulus of Elasticity ($\times 10^5$)	2.0
Allowable Tensile Stress	168

1.3.3 Seismic Design Condition

For Naluchi Bridge seismic design, the design section force should be taken as maximum response section force which calculate from dynamic analysis.

The maximum response section force calculated by dynamic analysis as following below.

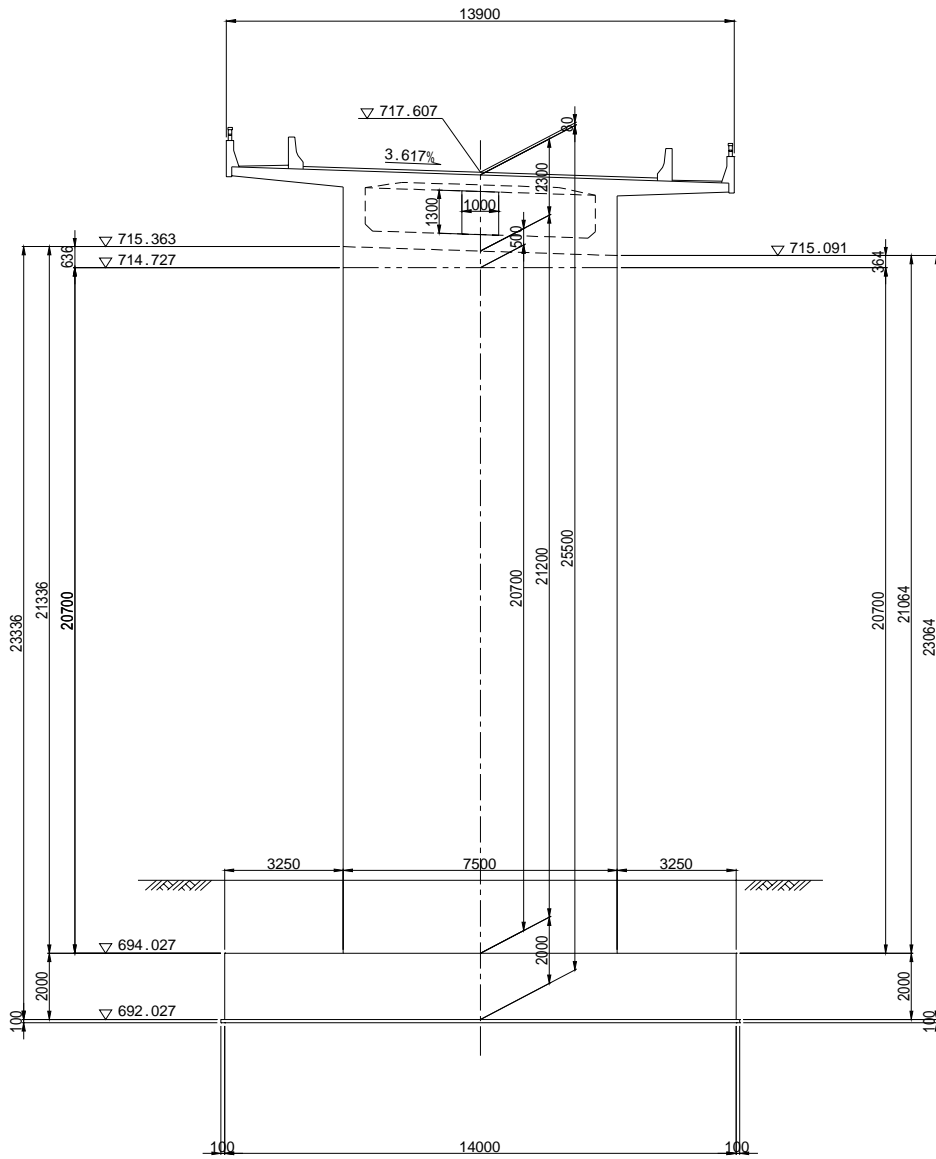
Response force at base of column

	Longitudinal Seismic Movement			Transverse Seismic Movement		
	V (kN)	H (kN)	M (kNm)	V (kN)	H (kN)	M (kNm)
P5	22517.5	7189.6	69319.8	20485.7	5997.3	114645.1
P6	19921.9	6730.3	59080.8	19916.2	6587.3	112382.0
P7	22198.3	6379.9	66557.7	20365.6	4464.2	70921.9

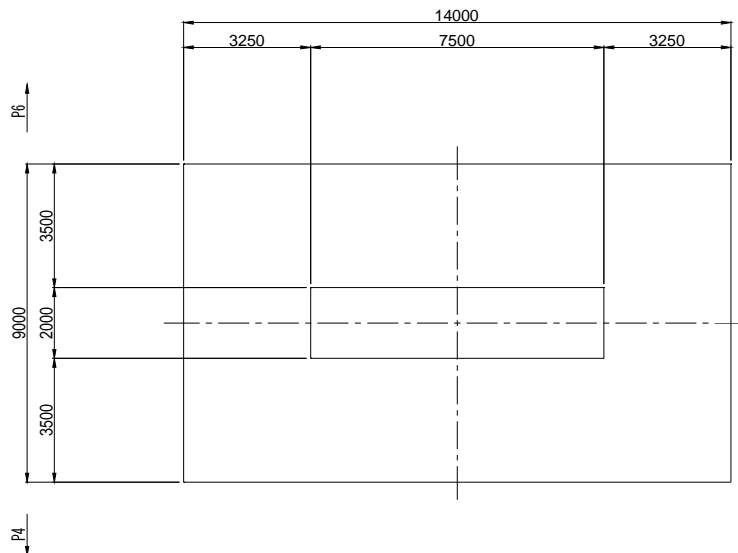
Response force at bottom of column

	Longitudinal Seismic Movement			Transverse Seismic Movement		
	V (kN)	H (kN)	M (kNm)	V (kN)	H (kN)	M (kNm)
P5	26437.5	7889.5	85092.1	24405.7	6669.9	125293.9
P6	23841.9	7363.8	73010.7	23836.2	7258.9	125689.2
P7	26118.3	6740.4	79946.2	24285.6	5069.0	78666.2

Front Elevation

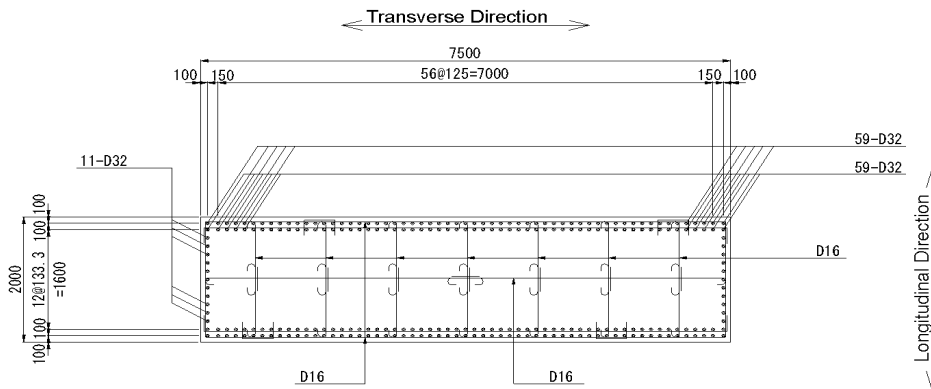


Plan

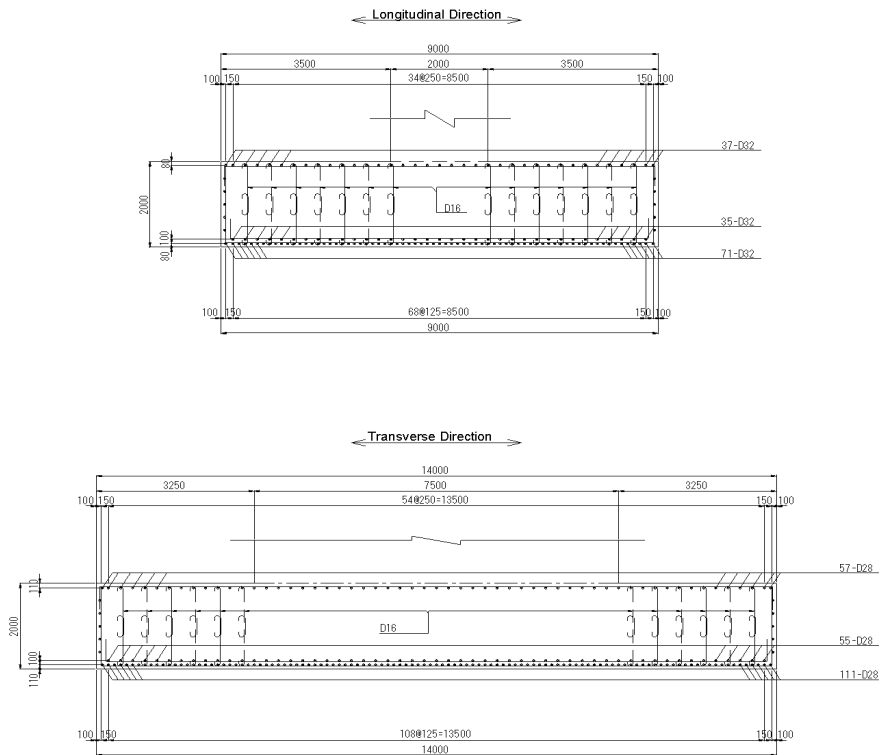


2.2 Bar Arrangement

P5 Wall



P5 Footing



2.3 Summary of Sectional Force at Bottom of Wall from Static Analysis Model

2.3.1 List of Sectional Force

Category	Description	Sectional Force					
		Longitudinal Direction			Transverse Direction		
		M(kNm)	S(kN)	N(kN)	M(kNm)	S(kN)	N(kN)
D	Self Weight	5297	723	17003	0	0	17003
D	Surfacing	1519	207	2767	0	0	2767
D	Prestress	4384	-32	-764	0	0	-764
D	Creep Effect	-222	-4	77	0	0	77
L	CLASS-A Live Load (Mmax)	2197	289	951	0	0	951
L	CLASS-A Live Load (Mmin)	-1461	-193	691	0	0	691
L	CLASS-A Live Load (Nmax)	336	41	1808	0	0	1808
L	CLASS-A Live Load (Nmin)	371	45	-92	0	0	-92
CF	Centrifugal Force	0	0	0	8710	343	0
E	Earth Pressure	0	0	0	0	0	0
LF	Longitudinal Force	1927	76	0	0	0	0
S	Shrinkage	20412	1611	-383	0	0	0
T	Temperature Rise	-5258	-429	48	0	0	0
T	Temperature Down	5258	429	-48	0	0	0

2.3.2 Combination Force for Service Load Design

Group		Longitudinal Direction				Transverse Direction			
		M(kNm)	S(kN)	N(kN)	Calc.Stress	M(kNm)	S(kN)	N(kN)	Calc.Stress
I	Mmax	13175	1184	20034	Calc.	8710	343	20034	-
	Mmin	9517	702	19774	-	8710	343	19774	-
	Nmin	11349	939	18991	-	8710	343	18991	Calc
II		10978	895	19083	Calc	0	0	19083	Calc
III	Mmax	15102	1260	20034	Calc	8710	343	20034	-
	Mmin	7590	626	19774	-	8710	343	19774	-
	Nmin	13241	1012	20891	-	8710	343	20891	Calc
IV	Mmax	28329	2366	19700	-	8710	343	20034	-
	Mmin	35187	2741	19343	-	8710	343	19774	-
	Nmin	36984	2975	20459	Calc	8710	343	20891	Calc
V		26132	2077	18748	Calc	0	0	19083	Calc
VI	Mmax	30256	2442	19700	-	8710	343	20034	-
	Mmin	33260	2665	19343	Calc	8710	343	19774	-
	Nmin	28395	2194	20556	-	8710	343	20891	Calc

2.3.3 Combination Force for Load Factor Design

Group		Longitudinal Direction				Transverse Direction			
		M(kNm)	S(kN)	N(kN)	Check	M(kNm)	S(kN)	N(kN)	Check
I	Mmax	19041	1791	26873	Check	11323	446	26045	-
	Mmin	11100	744	26308	-	11323	446	25706	Check
	Nmin	15000	1252	28733	-	11323	446	27158	-
II		14271	1163	24808	Check	0	0	24808	Check
III	Mmax	19633	1638	26045	Check	11323	446	26045	-
	Mmin	9867	814	25706	-	11323	446	25706	-
	Nmin	17213	1315	27158	-	11323	446	27158	Check
IV	Mmax	36828	3076	25610	Check	11323	446	26045	-
	Mmin	32073	2449	25271	-	11323	446	25706	-
	Nmin	34408	2753	26723	-	11323	446	27158	Check
V		32665	2596	23435	Check	0	0	23854	Check
VI	Mmax	37820	3052	24625	-	10888	428	25043	-
	Mmin	41575	3331	24178	Check	10888	428	24717	-
	Nmin	35494	2742	25695	-	10888	428	26114	Check

2.4 Sectional Force for Seismic Design

	Longitudinal Direction				Transverse Direction			
	M(kNm)	S(kN)	N(kN)	Calc.Stress	M(kNm)	S(kN)	N(kN)	Calc.Stress
Seismic Design	69320	7190	22518	Calc.	114645	5997	20486	Calc.

*) Sectional Force for Seismic Design is Calculated from Dynamic Analysis

2.5 Design of Spread Footing

2.5.1 Calculation of Stability

(1) Concrete Volume and Self Weight of Spread Footing

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)	Gravity y(m)	Vi x y
1	14.000 x 9.000 x 2.000	252.00	1.000	252.000
Σ		252.00	1.000	252.000

Self Weight of Substructure $24.5 \times \Sigma V = 6174.00$ kN

(2) Backfill Soil Covering on Footing

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)
1	(14.000 x 9.000 - 7.500 x 2.000) x 2.20	244.20
Σ		244.20

Weight of Soil on Spread Footing $19 \times \Sigma V = 4639.80$ kN

(3) Buoyancy

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)
1	14.000 x 9.000 x 0.0	0.00
Σ		0.00

Buoyancy $-10 \times \Sigma V = 0.00$ kN

(4) Summary of Force at Bottom of Footing for Service Load Design

1) Longitudinal Direction

Group-I	D+SD+L+CF+E+B				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi · Yi	
Force at Bottom of Wall	20034.3	1183.9	13.128	15542.9	
Self Weight of Footing D	6174.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	4639.8	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	30848.1	1183.9	-	15542.9	

Group-II	D+SD+E+B+W				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi · Yi	
Force at Bottom of Wall	19082.9	894.7	14.271	12767.3	
Self Weight of Footing D	6174.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	4639.8	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	29896.7	894.7	-	12767.3	

Group-III	D+SD+L+CF+E+B+0.3W+WL+LF				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi · Yi	
Force at Bottom of Wall	20034.3	1259.8	13.988	17621.6	
Self Weight of Footing D	6174.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	4639.8	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	30848.1	1259.8	-	17621.6	

Group-IV		D+SD+L+CF+E+B+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		20459.4	2975.0	14.432	42933.5
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		31273.2	2975.0	-	42933.5

Group-V		D+SD+E+B+W+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18748.4	2076.7	14.584	30285.5
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29562.2	2076.7	-	30285.5

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		19342.5	2665.0	14.480	38590.0
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		30156.3	2665.0	-	38590.0

2) Transvers Direction

Group-I		D+SD+L+CF+E+B			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18990.9	342.8	27.410	9395.9
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29804.7	342.8	-	9395.9

Group-II		D+SD+E+B+W			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		19082.9	0.0	0.000	0.0
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29896.7	0.0	-	0.0

Group-III		D+SD+L+CF+E+B+0.3W+WL+LF			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		20890.8	342.8	27.410	9395.9
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		31704.6	342.8	-	9395.9

Group-IV		D+SD+L+CF+E+B+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		20890.8	342.8	27.410	9395.9
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		31704.6	342.8	-	9395.9

Group-V		D+SD+E+B+W+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		19082.9	0.0	0.000	0.0
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	2.750	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29896.7	0.0	-	0.0

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		20890.8	342.8	27.410	9395.9
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		31704.6	342.8	-	9395.9

(5) Summary of Force at Bottom of Footing for Load Factor Design

1) Longitudinal Direction

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	26873.2	1791.1	12.631	22623.3
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			40931.1	1791.1	-	22623.3

Group-II		$\gamma(D+SD+E+B+W)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	24807.7	1163.1	14.271	16597.5
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			38865.7	1163.1	-	16597.5

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	26044.5	1637.7	13.988	22908.1
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			40102.5	1637.7	-	22908.1

Group-IV $\gamma(D+SD+L+CF+E+B+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	25609.7	3075.7	13.974	42979.4
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	4639.8	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			38275.7	3075.7	-	42979.4

Group-V $\gamma(D+SD+E+B+W+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	23435.5	2595.8	14.584	37856.9
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			36952.7	2595.8	-	37856.9

Group-VI $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	24178.2	3331.2	14.480	48237.5
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			37695.4	3331.2	-	48237.5

2) Transvers Direction

Group-I $\gamma(D+SD+1.67L+CF+E+B)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	25706.1	445.6	27.410	12214.6
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			39764.0	445.6	-	12214.6

Group-II $\gamma(D+SD+E+B+W)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	24807.7	0.0	0.000	0.0
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			38865.7	0.0	-	0.0

Group-III $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	27158.1	445.6	27.410	12214.6
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			41216.0	445.6	-	12214.6

Group-IV $\gamma(D+SD+L+CF+E+B+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	27158.1	445.6	27.410	12214.6
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			41216.0	445.6	-	12214.6

Group-V $\gamma(D+SD+E+B+W+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	23853.6	0.0	0.000	0.0
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			37370.8	0.0	-	0.0

Group-VI $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	26113.6	428.5	27.410	11744.9
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			39630.8	428.5	-	11744.9

(5) Summary of Force at Bottom of Footing

		Longitudinal Direction			Transverse Direction		
		V(kN)	H(kN)	M(kNm)	V(kN)	H(kN)	M(kNm)
Service Load Design	Group-I	30848.1	1183.9	15542.9	29804.7	342.8	9395.9
	Group-II	29896.7	894.7	12767.3	29896.7	0.0	0.0
	Group-III	30848.1	1259.8	17621.6	31704.6	342.8	9395.9
	Group-IV	31273.2	2975.0	42933.5	31704.6	342.8	9395.9
	Group-V	29562.2	2076.7	30285.5	29896.7	0.0	0.0
	Group-VI	30156.3	2665.0	38590.0	31704.6	342.8	9395.9
Load Factor Design	Group-I	40931.1	1791.1	22623.3	39764.0	445.6	12214.6
	Group-II	38865.7	1163.1	16597.5	38865.7	0.0	0.0
	Group-III	40102.5	1637.7	22908.1	41216.0	445.6	12214.6
	Group-IV	38275.7	3075.7	42979.4	41216.0	445.6	12214.6
	Group-V	36952.7	2595.8	37856.9	37370.8	0.0	0.0
	Group-VI	37695.4	3331.2	48237.5	39630.8	428.5	11744.9
Seismic Design		32690.0	9350.9	85860.9	30660.0	8160.9	128810.9

*) Sectional Force for Seismic Design is Calculated from Dynamic Analysis

Eccentric Distance for Load Factor Design

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	40931.1	1791.1	22623.3	0.553
Group-II	38865.7	1163.1	16597.5	0.427
Group-III	40102.5	1637.7	22908.1	0.571
Group-IV	38275.7	3075.7	42979.4	1.123
Group-V	36952.7	2595.8	37856.9	1.024
Group-VI	37695.4	3331.2	48237.5	1.280

Safety Factor for Horizontal Force

	V (kN)	H (kN)	M (kN)	S.F	Limit of S.F	
Group-I	30848.1	1183.9	15542.9	15.633	1.500	OK
Group-II	29896.7	894.7	12767.3	20.050	1.500	OK
Group-III	30848.1	1259.8	17621.6	14.692	1.500	OK
Group-IV	31273.2	2975.0	42933.5	6.307	1.500	OK
Group-V	29562.2	2076.7	30285.5	8.541	1.500	OK
Group-VI	30156.3	2665.0	38590.0	6.789	1.500	OK
Seismic Design	32690.0	9350.9	85860.9	2.098	1.200	OK

Ground Reaction

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)	qa (kN/m ²)	
Group-I	30848.1	1183.9	15542.9	9.000	327.06	162.59	700	OK
Group-II	29896.7	894.7	12767.3	9.000	304.83	169.72	700	OK
Group-III	30848.1	1259.8	17621.6	9.000	338.06	151.59	700	OK
Group-IV	31273.2	2975.0	42933.5	9.000	475.36	21.04	700	OK
Group-V	29562.2	2076.7	30285.5	9.000	394.86	74.38	700	OK
Group-VI	30156.3	2665.0	38590.0	9.000	443.52	35.16	700	OK
Seismic Design	32690.0	9350.9	85860.9	5.620	830.90	0.00	1050	OK

Ground Reaction for Load Factor Design

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)
Group-I	40931.1	1791.1	22623.3	9.000	444.55	205.15
Group-II	38865.7	1163.1	16597.5	9.000	396.28	220.64
Group-III	40102.5	1637.7	22908.1	9.000	439.48	197.07
Group-IV	38275.7	3075.7	42979.4	9.000	531.18	76.37
Group-V	36952.7	2595.8	37856.9	9.000	493.58	92.97
Group-VI	37695.4	3331.2	48237.5	9.000	554.39	43.94

2) Transverse Direction

Dimension of Footing B= 14.000 m

D= 9.000 m

Eccentric Distance from Center of Footing to Vertical Force

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	29804.7	342.8	9395.9	0.315
Group-II	29896.7	0.0	0.0	0.000
Group-III	31704.6	342.8	9395.9	0.296
Group-IV	31704.6	342.8	9395.9	0.296
Group-V	29896.7	0.0	0.0	0.000
Group-VI	31704.6	342.8	9395.9	0.296
Seismic Design	30660.0	8160.9	128810.9	4.201

Eccentric Distance for Load Factor Design

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	39764.0	445.6	12214.6	0.307
Group-II	38865.7	0.0	0.0	0.000
Group-III	41216.0	445.6	12214.6	0.296
Group-IV	41216.0	445.6	12214.6	0.296
Group-V	37370.8	0.0	0.0	0.000
Group-VI	39630.8	428.5	11744.9	0.296

Safety Factor for Horizontal Force

	V (kN)	H (kN)	M (kN)	S.F	Limit of S.F	
Group-I	29804.7	342.8	9395.9	52.168	1.500	OK
Group-II	29896.7	0.0	0.0	-	1.500	OK
Group-III	31704.6	342.8	9395.9	55.494	1.500	OK
Group-IV	31704.6	342.8	9395.9	55.494	1.500	OK
Group-V	29896.7	0.0	0.0	-	1.500	OK
Group-VI	31704.6	342.8	9395.9	55.494	1.500	OK
Seismic Design	30660.0	8160.9	128810.9	2.254	1.200	OK

Ground Reaction

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)	qa (kN/m ²)	
Group-I	29804.7	342.8	9395.9	14.000	268.50	204.59	700	OK
Group-II	29896.7	0.0	0.0	14.000	237.28	237.28	700	OK
Group-III	31704.6	342.8	9395.9	14.000	283.58	219.67	700	OK
Group-IV	31704.6	342.8	9395.9	14.000	283.58	219.67	700	OK
Group-V	29896.7	0.0	0.0	14.000	237.28	237.28	700	OK
Group-VI	31704.6	342.8	9395.9	14.000	283.58	219.67	700	OK
Seismic Design	30660.0	8160.9	128810.9	8.396	811.48	0.00	1050	OK

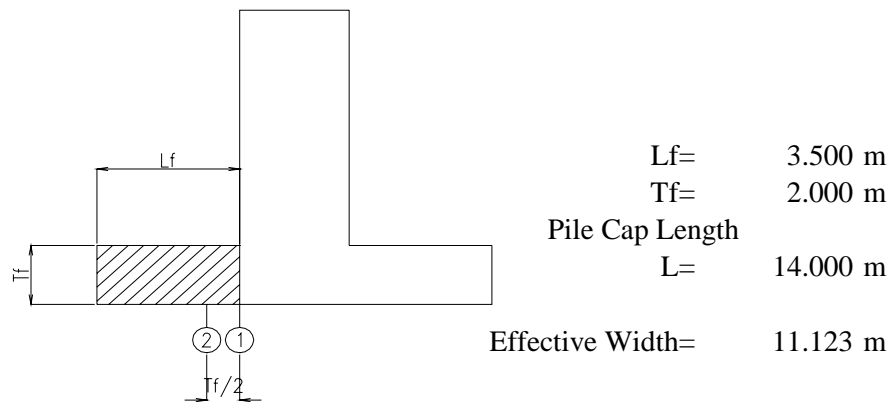
Ground Reaction for Load Factor Design

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)
Group-I	39764.0	445.6	12214.6	14.000	357.13	274.04
Group-II	38865.7	0.0	0.0	14.000	308.46	308.46
Group-III	41216.0	445.6	12214.6	14.000	368.66	285.56
Group-IV	41216.0	445.6	12214.6	14.000	368.66	285.56
Group-V	37370.8	0.0	0.0	14.000	296.59	296.59
Group-VI	39630.8	428.5	11744.9	14.000	354.48	274.58

2.5.2 Design of Spread Footing

(1) Block data that doesn't consider water level for Longitudinal Direction

1) Self Weight for Section-



Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(\text{m}^3)$	Barycentric Position $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.5 \times 2 \times 14$	98.0	1.750	171.500
Σ		98.0	---	171.500

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 98 = 2401.00 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(\text{m}^3)$	Barycentric Position $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.5 \times 0 \times 14$	0.0	1.750	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(\text{m}^3)$	Barycentric Position $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.5 \times 2.2 \times 14$	107.8	1.750	188.650
Σ		107.8	---	188.650

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 107.8 = 2048.20 \text{ kN}$

1) Self Weight for Section-

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	2.5 x 2 x 14	70.0	1.250	87.500
Σ		70.0	---	87.500

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 70 = 1715.00 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	2.5 x 0 x 14	0.0	1.250	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

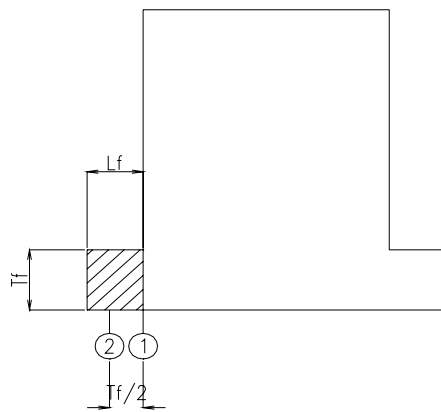
Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	2.5 x 2.2 x 14	77.0	1.250	96.250
Σ		77.0	---	96.250

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 77 = 1463.00 \text{ kN}$

(2) Block data that doesn't consider water level for Transverse Direction

1) Self Weight for Section-



$L_f = 3.250 \text{ m}$
 $T_f = 2.000 \text{ m}$
 Pile Cap Length
 $L = 9.000 \text{ m}$
 Effective Width = 5.773 m

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(\text{m}^3)$	Barycentric $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.25 \times 2 \times 9$	58.5	1.625	95.063
Σ		58.5	---	95.063

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 58.5 = 1433.25 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(\text{m}^3)$	Barycentric $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.25 \times 0 \times 9$	0.0	1.625	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(\text{m}^3)$	Barycentric $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.25 \times 2.2 \times 9$	64.4	1.625	104.569
Σ		64.4	---	104.569

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 64.4 = 1222.65 \text{ kN}$

1) Self Weight for Section-

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(\text{m}^3)$	Barycentric $X_i(\text{m})$	$V_i \cdot X_i$
1	$2.25 \times 2 \times 9$	40.5	1.125	45.563
Σ		40.5	---	45.563

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 40.5 = 992.25 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00$ m (equally Top of Footing)

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V_i $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	2.25 \times 0 \times 9	0.0	1.125	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00$ kN

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200$ m

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V_i $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	2.25 \times 2.2 \times 9	44.6	1.125	50.119
Σ		44.6	---	50.119

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 44.6 = 846.45$ kN

(3) Summary of Sectional Force for Service Load Design

Longitudinal Direction at Section-

Group-I	D+SD+L+CF+E+B			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-14459.02	1.81322213	-26217.4
Total		-10009.82		-18431.2
Per 1 meter		-714.99		-1657.0

Group-II	D+SD+E+B+W			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-13649.28	1.80501298	-24637.1
Total		-9200.08		-16850.9
Per 1 meter		-657.15		-1515.0

Group-III	D+SD+L+CF+E+B+0.3W+WL+LF			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-14788.37	1.820	-26916.0
Total		-10339.17		-19129.8
Per 1 meter		-738.51		-1719.8

Group-IV		D+SD+L+CF+E+B+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-18964.03	1.883	-35712.1
Total		-14514.83		-27925.9
Per 1 meter		-1036.77		-2510.6

Group-V		D+SD+E+B+W+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-16294.72	1.859	-30297.0
Total		-11845.52		-22510.8
Per 1 meter		-846.11		-2023.8

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-17841.52	1.877	-33492.3
Total		-13392.32		-25706.1
Per 1 meter		-956.59		-2311.1

Transverse Direction at Section-

Group-I		D+SD+L+CF+E+B		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-7636.75	1.64039201	-12527.3
Total		-4980.85		-8211.5
Per 1 meter		-553.43		-1422.4

Group-II		D+SD+E+B+W		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-6940.30	1.625	-11278.0
Total		-4284.40		-6962.2
Per 1 meter		-476.04		-1206.0

Group-III		D+SD+L+CF+E+B+0.3W+WL+LF		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-8077.79	1.640	-13244.0
Total		-5421.89		-8928.2
Per 1 meter		-602.43		-1546.5

Group-IV		D+SD+L+CF+E+B+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-8077.79	1.640	-13244.0
Total		-5421.89		-8928.2
Per 1 meter		-602.43		-1546.5

Group-V		D+SD+E+B+W+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-6940.30	1.625	-11278.0
Total		-4284.40		-6962.2
Per 1 meter		-476.04		-1206.0

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-8077.79	1.640	-13244.0
Total		-5421.89		-8928.2
Per 1 meter		-602.43		-1546.5

(4) Summary of Sectional Force for Load Factor Design

Longitudinal Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-19502.01	1.81822646	-35459.1
Total			-13718.05		-25337.1
Per 1 meter			-979.86		-2277.9

Group-II		$\gamma(D+SD+E+B+W)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-17744.07	1.80501298	-32028.3
Total			-11960.11		-21906.3
Per 1 meter			-854.29		-1969.5

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-19224.88	1.820	-34990.8
Total			-13440.92		-24868.8
Per 1 meter			-960.07		-2235.8

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-21694.49	1.867	-40493.1
Total			-15910.53		-30371.1
Per 1 meter			-1136.47		-2730.5

Group-V		$\gamma(D+SD+E+B+W+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	3001.25	1.750	5252.2
Backfill Soil Covering on Footing	D	1.250	2560.25	1.750	4480.4
Buoyancy	B	1.250	0.00	1.750	0.0
Ground Reaction	-	-	-20368.40	1.859	-37871.2
Total			-14806.90		-28138.6
Per 1 meter			-1057.64		-2529.8

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	3001.25	1.750	5252.2
Backfill Soil Covering on Footing	D	1.250	2560.25	1.750	4480.4
Buoyancy	B	1.250	0.00	1.750	0.0
Ground Reaction	-	-	-22301.90	1.877	-41865.3
Total			-16740.40		-32132.7
Per 1 meter			-1195.74		-2888.9

Longitudinal Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-14395.51
Total			-10264.11
Per 1 meter			-733.15

Group-II		$\gamma(D+SD+E+B+W)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-13015.85
Total			-8884.45
Per 1 meter			-634.60

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-14203.41
Total			-10072.01
Per 1 meter			-719.43

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-16380.41
Total			-12249.01
Per 1 meter			-874.93

Group-V		$\gamma(D+SD+E+B+W+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	2143.75
Backfill Soil Covering on Footing	D	1.250	1828.75
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-15327.80
Total			-11355.30
Per 1 meter			-811.09

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	2143.75
Backfill Soil Covering on Footing	D	1.250	1828.75
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-16922.47
Total			-12949.97
Per 1 meter			-925.00

Transverse Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-10164.06	1.64003417	-16669.4
Total			-6711.39		-11058.9
Per 1 meter			-745.71		-1915.6

Group-II		$\gamma(D+SD+E+B+W)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-9022.39	1.625	-14661.4
Total			-5569.72		-9050.9
Per 1 meter			-618.86		-1567.8

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-10501.13	1.640	-17217.1
Total			-7048.46		-11606.6
Per 1 meter			-783.16		-2010.5

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-10501.13	1.640	-17217.1
Total			-7048.46		-11606.6
Per 1 meter			-783.16		-2010.5

Group-V		$\gamma(D+SD+E+B+W+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	1791.56	1.625	2911.3
Backfill Soil Covering on Footing	D	1.250	1528.31	1.625	2483.5
Buoyancy	B	1.250	0.00	1.625	0.0
Ground Reaction	-	-	-8675.37	1.625	-14097.5
Total			-5355.50		-8702.7
Per 1 meter			-595.06		-1507.5

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	1791.56	1.625	2911.3
Backfill Soil Covering on Footing	D	1.250	1528.31	1.625	2483.5
Buoyancy	B	1.250	0.00	1.625	0.0
Ground Reaction	-	-	-10097.24	1.640	-16554.9
Total			-6777.37		-11160.1
Per 1 meter			-753.04		-1933.2

Transverse Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-7096.75
Total			-4706.44
Per 1 meter			-522.94

Group-II		$\gamma(D+SD+E+B+W)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-6246.27
Total			-3855.96
Per 1 meter			-428.44

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-7330.11
Total			-4939.80
Per 1 meter			-548.87

Group-IV $\gamma(D+SD+L+CF+E+B+S+T)$			
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-7330.11
Total			-4939.80
Per 1 meter			-548.87

Group-V $\gamma(D+SD+E+B+W+S+T)$			
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1240.31
Backfill Soil Covering on Footing	D	1.250	1058.06
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-6006.03
Total			-3707.66
Per 1 meter			-411.96

Group-VI $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$			
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1240.31
Backfill Soil Covering on Footing	D	1.250	1058.06
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-7048.18
Total			-4749.81
Per 1 meter			-527.76

(5) Summary of Sectional Force for Seismic Design

Section- Longitudinal Direction				
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-28037.06	2.014	-56459.7
Total		-23587.86		-48673.5
Per 1 meter		-1684.85		-4375.9

Section- Transverse Direction				
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-19141.94	1.755	-33594.0
Total		-16486.04		-29278.2
Per 1 meter		-1831.78		-5071.6

Section- Longitudinal Direction		
		Vi(kN)
Self Weight of Footing	D	1715.00
Backfill Soil Covering on Footing	D	1463.00
Buoyancy	B	0.00
Ground Reaction	-	-22613.58
Total		-19435.58
Per 1 meter		-1388.26

Section- Transverse Direction		
		Vi(kN)
Self Weight of Footing	D	1433.25
Backfill Soil Covering on Footing	D	1222.65
Buoyancy	B	0.00
Ground Reaction	-	-14230.67
Total		-11574.77
Per 1 meter		-1286.09

(6) Calculation of Stress for Service Load Design and Seismic Design

Stress Equation

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^2 + \frac{2 \cdot n}{b} \{A_{s'} \cdot (x-d') + A_s \cdot (x-d)\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm), h = 2000mm

b : Width in section (mm), b = 1000mm

d : Effective height (mm)

d' : Concrete Cover (mm)

As : Sectional area of reinforcing bar arranged on tension side (mm²)

As': Sectional area of reinforcing bar arranged on compression side (mm²)

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

σc: Compressive Stress of Concrete (N/mm²)

σs: Tensile Stress of Reinforcing (N/mm²)

M: Bending Moment (kN.m)

Bar Arrangement

		Longitudinal Direction		Transverse Direction	
Dimension	b(mm)	1000		1000	
	h(mm)	2000		2000	
	d1(mm)	1890		1920	
	d2(mm)	1790		1820	
Bar Arrangement	As1(mm ²)	8-D28	4926	8-D32	6434
	As2(mm ²)	4-D28	2463	4-D32	3217

Calculation Result of Bending Stress

	Longitudinal Direction					Remarks
	M (kNm)	σc (N/mm ²)	σs (N/mm ²)	σca (N/mm ²)	σsa (N/mm ²)	
Group-I	1657.0	3.67	137.00	9.60	168.00	OK
Group-II	1515.0	3.36	125.26	12.00	210.00	OK
Group-III	1719.8	3.81	142.20	12.00	210.00	OK
Group-IV	2510.6	5.57	207.58	12.00	210.00	OK
Group-V	2023.8	4.49	167.33	13.44	235.20	OK
Group-VI	2311.1	5.12	191.08	13.44	235.20	OK
Seismic Design	4375.9	9.70	361.80	20.40	378.00	OK

	Transverse Direction					Remarks
	M (kNm)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	1422.4	2.78	89.72	9.60	168.00	OK
Group-II	1206.0	2.35	76.07	12.00	210.00	OK
Group-III	1546.5	3.02	97.55	12.00	210.00	OK
Group-IV	1546.5	3.02	97.55	12.00	210.00	OK
Group-V	1206.0	2.35	76.07	13.44	235.20	OK
Group-VI	1546.5	3.02	97.55	13.44	235.20	OK
Seismic Design	5071.6	9.90	319.90	20.40	378.00	OK

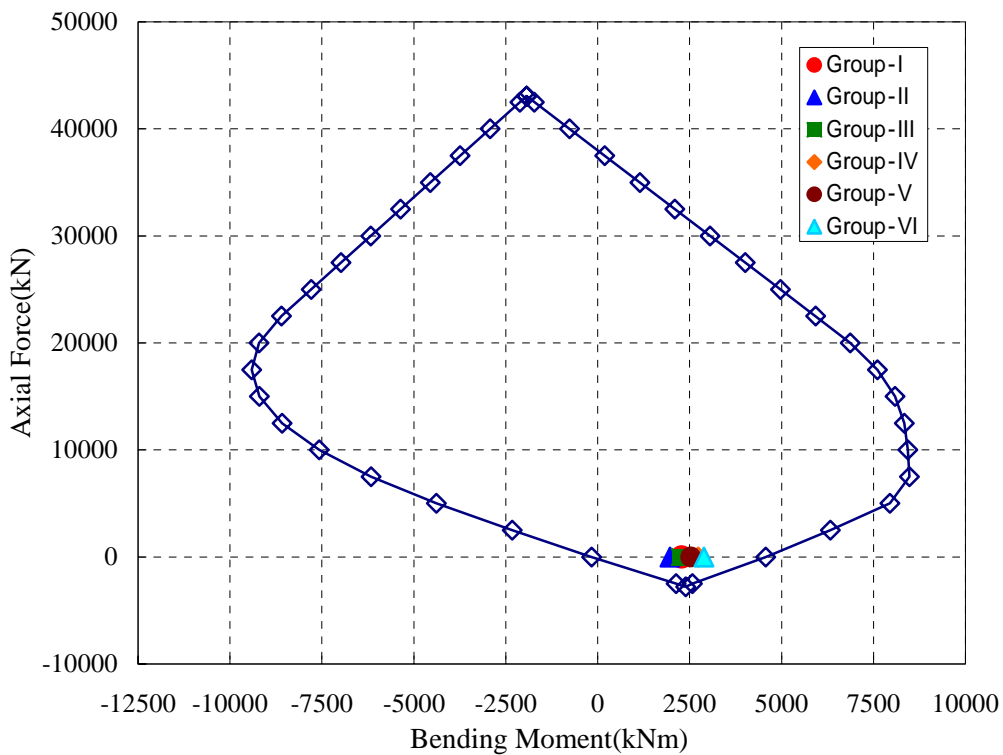
(6) Calculation of Strength for Load Factor Design

*) Flexural Strength

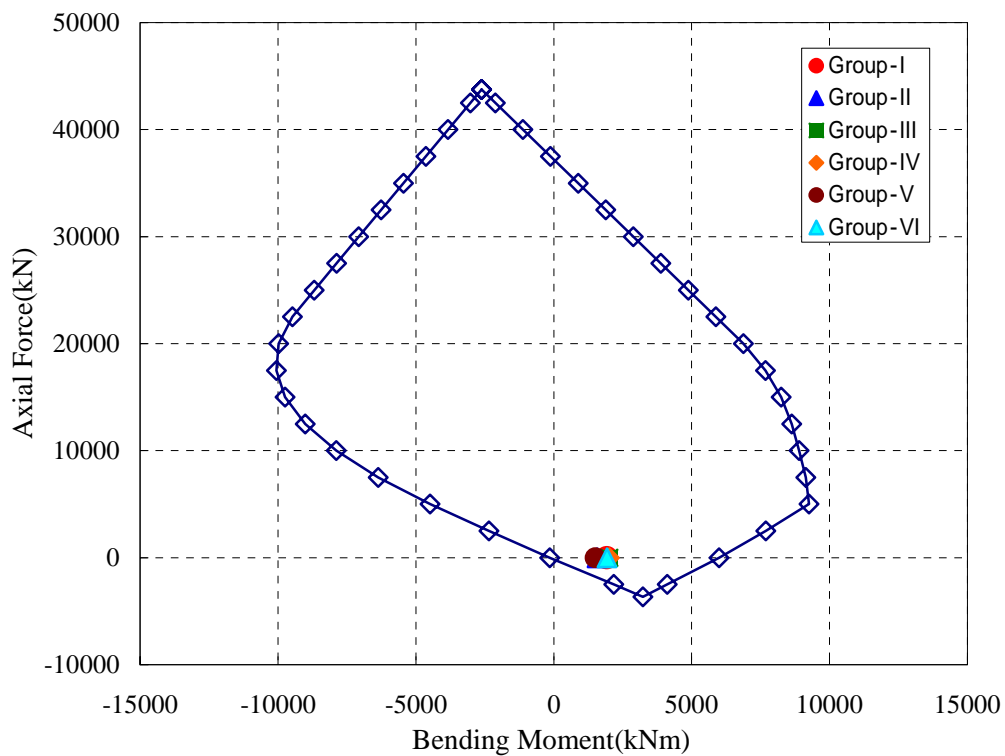
Factored Bending Moment for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	2277.9 kNm	1915.62 kNm
Group-II	1969.5 kNm	1567.80 kNm
Group-III	2235.8 kNm	2010.50 kNm
Group-IV	2730.5 kNm	2010.50 kNm
Group-V	2529.8 kNm	1507.48 kNm
Group-VI	2888.9 kNm	1933.15 kNm

Interaction of Longitudinal Direction



Interaction of Transverse Direction



*) Shear Strength

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 1/6 \times f_c)$$

$$= 1/6 \times f_c \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	733.2 kN	522.94 kN
Group-II	634.6 kN	428.44 kN
Group-III	719.4 kN	548.87 kN
Group-IV	874.9 kN	548.87 kN
Group-V	811.1 kN	411.96 kN
Group-VI	925.0 kN	527.76 kN
Seismic Design	1388.3 kN	1286.09 kN

Calculation of Shear Strength

$$v_c = 1/6x \quad f_c = 1/6x \quad (24) = 0.816\text{N/mm}^2 \rightarrow 816\text{kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 1.000 \text{ m}$$

Longitudinal Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	733.2	1.000	1.790	1241.54	0.00	0.0
Group-II	634.6	1.000	1.790	1241.54	0.00	0.0
Group-III	719.4	1.000	1.790	1241.54	0.00	0.0
Group-IV	874.9	1.000	1.790	1241.54	0.00	0.0
Group-V	811.1	1.000	1.790	1241.54	0.00	0.0
Group-VI	925.0	1.000	1.790	1241.54	0.00	0.0
Seismic Design	1388.3	1.000	1.790	1241.54	172.60	229.6

Arrangement of Stirrup D16 -ctc.500 804.25 mm²/m > 229.6 mm²/m

Transverse Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	522.9	1.000	1.820	1262.35	0.00	0.0
Group-II	428.4	1.000	1.820	1262.35	0.00	0.0
Group-III	548.9	1.000	1.820	1262.35	0.00	0.0
Group-IV	548.9	1.000	1.820	1262.35	0.00	0.0
Group-V	412.0	1.000	1.820	1262.35	0.00	0.0
Group-VI	527.8	1.000	1.820	1262.35	0.00	0.0
Seismic Design	1286.1	1.000	1.820	1262.35	27.92	36.5

Arrangement of Stirrup D16 -ctc.500 804.25 mm²/m > 36.5 mm²/m

2.6 Design of Wall

2.6.1 Summary of Sectional Force at Base of Wall

		Longitudinal Direction			Transverse Direction		
		N(kN)	S(kN)	M(kNm)	V(kN)	H(kN)	M(kNm)
Service Load Design	Group-I	20034.3	1183.9	13175.0	18990.9	342.8	8710.3
	Group-II	19082.9	894.7	10978.0	19082.9	0.0	0.0
	Group-III	20034.3	1259.8	15102.0	20890.8	342.8	8710.3
	Group-IV	20459.4	2975.0	36983.6	20890.8	342.8	8710.3
	Group-V	18748.4	2076.7	26132.1	19082.9	0.0	0.0
	Group-VI	19342.5	2665.0	33260.1	20890.8	342.8	8710.3
Load Factor Design	Group-I	26873.2	1791.1	19041.1	25706.1	445.6	11323.4
	Group-II	24807.7	1163.1	14271.4	24807.7	0.0	0.0
	Group-III	26044.5	1637.7	19632.7	27158.1	445.6	11323.4
	Group-IV	25609.7	3075.7	36827.9	27158.1	445.6	11323.4
	Group-V	23435.5	2595.8	32665.2	23853.6	0.0	0.0
	Group-VI	24178.2	3331.2	41575.1	26113.6	428.5	10887.9
Seismic Design		22517.5	7189.6	69319.8	20485.7	5997.3	114645.1

*) Sectional Force of Seismic Design is Calculated by Dynamic Analysis.

2.6.2 Calculation of Stress for Service Load Design and Seismic Design

Stress Equation

$$\sigma_c = \frac{N}{\frac{b \cdot x}{2} - n \cdot A_s \cdot \frac{d-x}{x} + n \cdot A_s' \cdot \frac{x-d'}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^3 - 3 \cdot \left(\frac{h}{2} - e \right) \cdot x^2 - \frac{6n}{b} \left\{ A_s' \cdot \left(\frac{h}{2} - d' - e \right) + A_s \cdot \left(\frac{h}{2} - d - e \right) \right\} \cdot x + \frac{6n}{b} \left\{ A_s' \cdot d' \cdot \left(\frac{h}{2} - d' - e \right) + A_s \cdot d \cdot \left(\frac{h}{2} - d - e \right) \right\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm)

b : Width in section (mm)

d : Effective height (mm)

d' : Concrete Cover (mm)

A_s : Sectional area of reinforcing bar arranged on tension side (mm²)

A_s' : Sectional area of reinforcing bar arranged on compression side (mm²)

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

e : Axis force eccentric distance (mm)

σ_c: Compressive Stress of Concrete (N/mm²)

σ_s: Tensile Stress of Reinforcing (N/mm²)

N: Axial Force (kN)

M: Bending Moment (kN.m)

Bar Arrangement

		Vertical Direction	Longitudinal Direction
Dimension	b(mm)	7500	2000
	h(mm)	2000	7500
	d1(mm)	1900	7400
	d2(mm)	1800	-
Bar Arrangement	As1(mm ²)	59-D32 47451	11-D32 8847
	As2(mm ²)	59-D32 47451	-

Calculation Result of Bending Stress

	Longitudinal Direction						Remarks
	M (kNm)	N (kN)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	13175.0	20034.3	4.10	21.60	9.60	168.00	OK
Group-II	10978.0	19082.9	3.60	13.60	12.00	210.00	OK
Group-III	15102.0	20034.3	4.60	31.10	12.00	210.00	OK
Group-IV	36983.6	20459.4	10.20	163.60	12.00	210.00	OK
Group-V	26132.1	18748.4	7.40	100.00	13.44	235.20	OK
Group-VI	33260.1	19342.5	9.20	143.60	13.44	235.20	OK
Seismic Design	69319.8	22517.5	18.40	369.40	20.40	378.00	OK

	Transverse Direction						Remarks
	M (kNm)	N (kN)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	8710.3	18990.9	1.70	-11.80	9.60	168.00	OK
Group-II	0.0	19082.9	1.30	-18.50	12.00	210.00	OK
Group-III	8710.3	20890.8	1.90	-13.60	12.00	210.00	OK
Group-IV	8710.3	20890.8	1.90	-13.60	12.00	210.00	OK
Group-V	0.0	19082.9	1.30	-18.50	13.44	235.20	OK
Group-VI	8710.3	20890.8	1.90	-13.60	13.44	235.20	OK
Seismic Design	114645.1	20485.7	8.40	175.30	20.40	378.00	OK

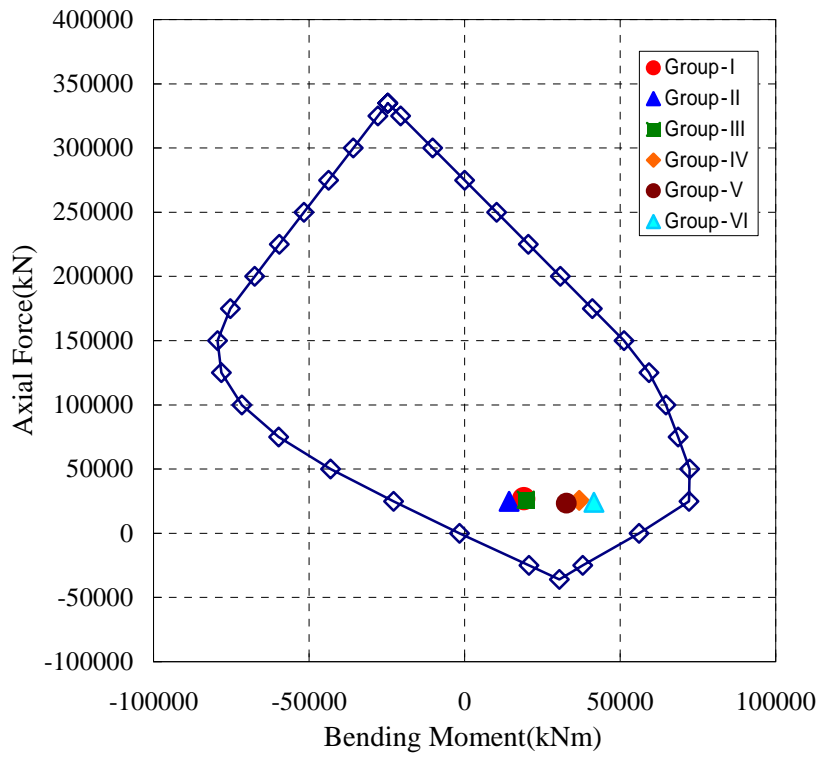
(6) Calculation of Strength for Load Factor Design

*) Flexural Strength

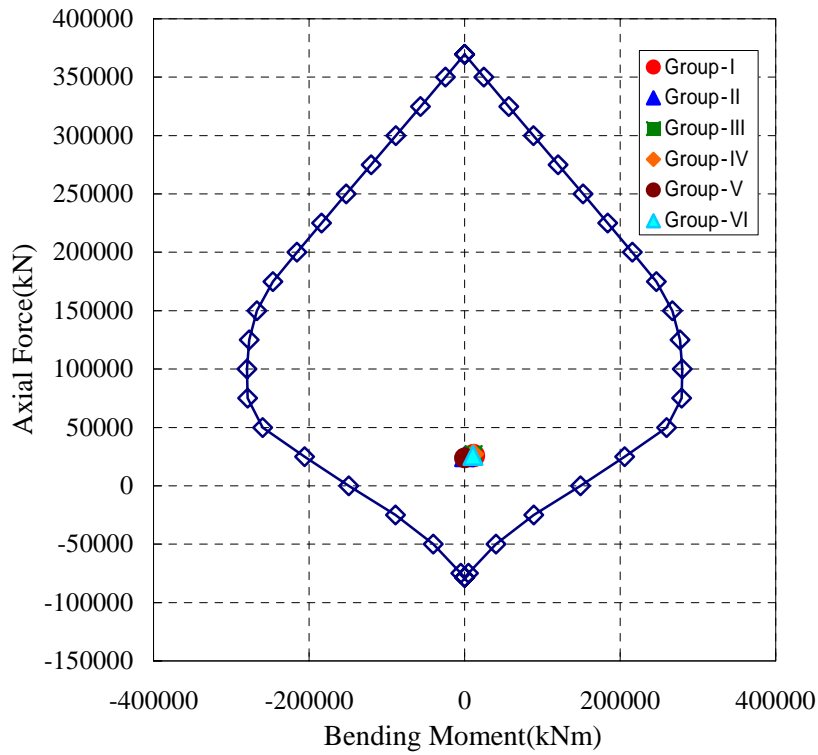
Factored Bending Moment for Load Factor Design

	Vertical Direction		Longitudinal Direction	
	M(kNm)	N(kN)	M(kNm)	N(kN)
Group-I	19041.1	26873.2	11323.4	25706.1
Group-II	14271.4	24807.7	0.0	24807.7
Group-III	19632.7	26044.5	11323.4	27158.1
Group-IV	36827.9	25609.7	11323.4	27158.1
Group-V	32665.2	23435.5	0.0	23853.6
Group-VI	41575.1	24178.2	10887.9	26113.6

Interaction of Longitudinal Direction



Interaction of Transverse Direction



*) Shear Strength

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 1/6 \times f_c)$$

$$= 1/6 \times f_c \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	1791.1 kN	445.6 kN
Group-II	1163.1 kN	0.0 kN
Group-III	1637.7 kN	445.6 kN
Group-IV	3075.7 kN	445.6 kN
Group-V	2595.8 kN	0.0 kN
Group-VI	3331.2 kN	428.5 kN
Seismic Design	7189.6 kN	5997.3 kN

Calculation of Shear Strength

$$v_c = 1/6 \times f_c = 1/6 \times (24) = 0.816 \text{ N/mm}^2 \rightarrow 816 \text{ kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 1.000 \text{ m}$$

Longitudinal Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	1791.1	7.400	1.900	9752.0	0.0	0.0
Group-II	1163.1	7.400	1.900	9752.0	0.0	0.0
Group-III	1637.7	7.400	1.900	9752.0	0.0	0.0
Group-IV	3075.7	7.400	1.900	9752.0	0.0	0.0
Group-V	2595.8	7.400	1.900	9752.0	0.0	0.0
Group-VI	3331.2	7.400	1.900	9752.0	0.0	0.0
Seismic Design	7189.6	7.400	1.900	9752.0	0.0	0.0

Arrangement of Stirr D16 -ctc.150 12064 mm²/m > 0 mm²/m

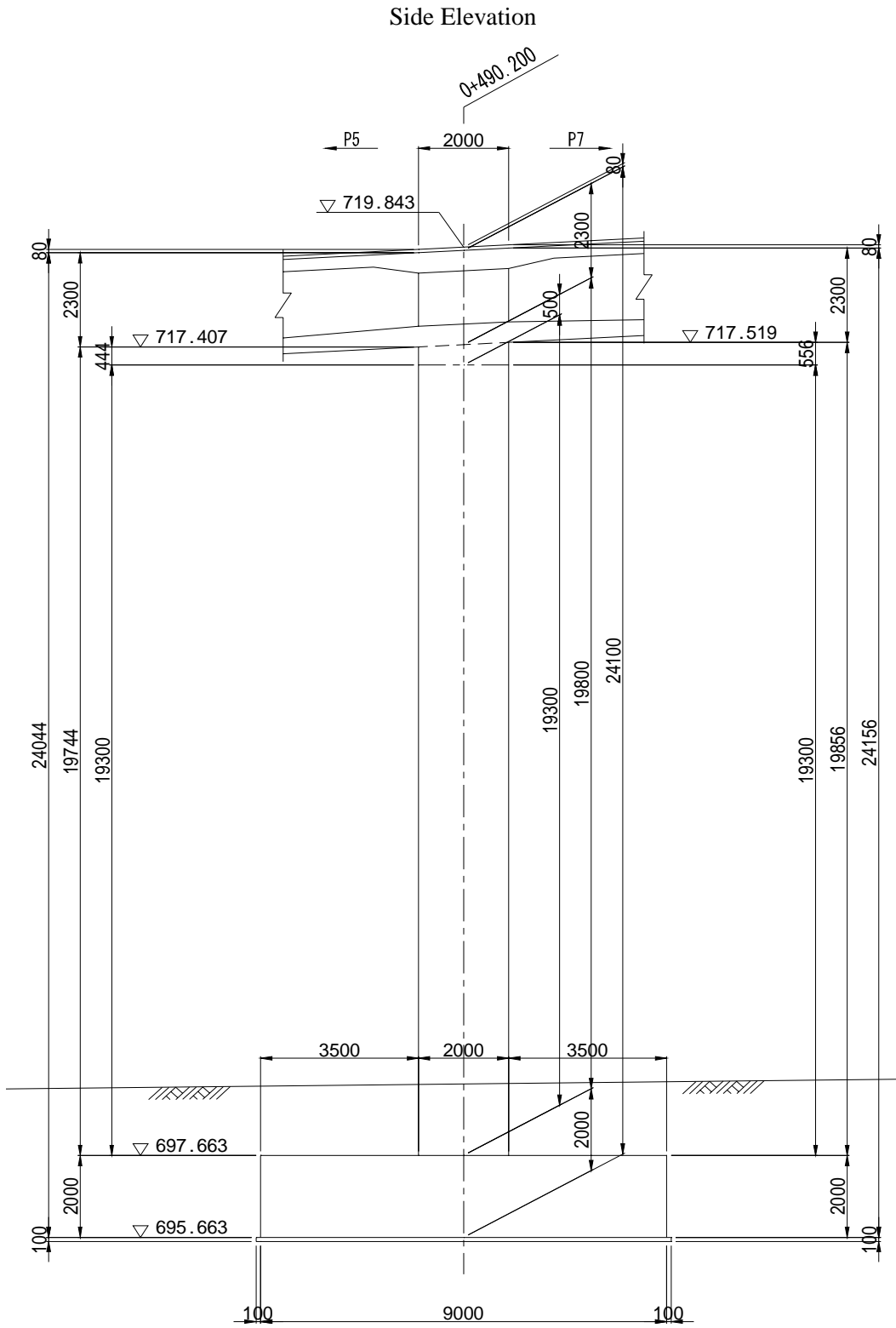
Transverse Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	445.6	2.000	7.400	10265.3	0.0	0.0
Group-II	0.0	2.000	7.400	10265.3	0.0	0.0
Group-III	445.6	2.000	7.400	10265.3	0.0	0.0
Group-IV	445.6	2.000	7.400	10265.3	0.0	0.0
Group-V	0.0	2.000	7.400	10265.3	0.0	0.0
Group-VI	428.5	2.000	7.400	10265.3	0.0	0.0
Seismic Design	5997.3	2.000	7.400	10265.3	0.0	0.0

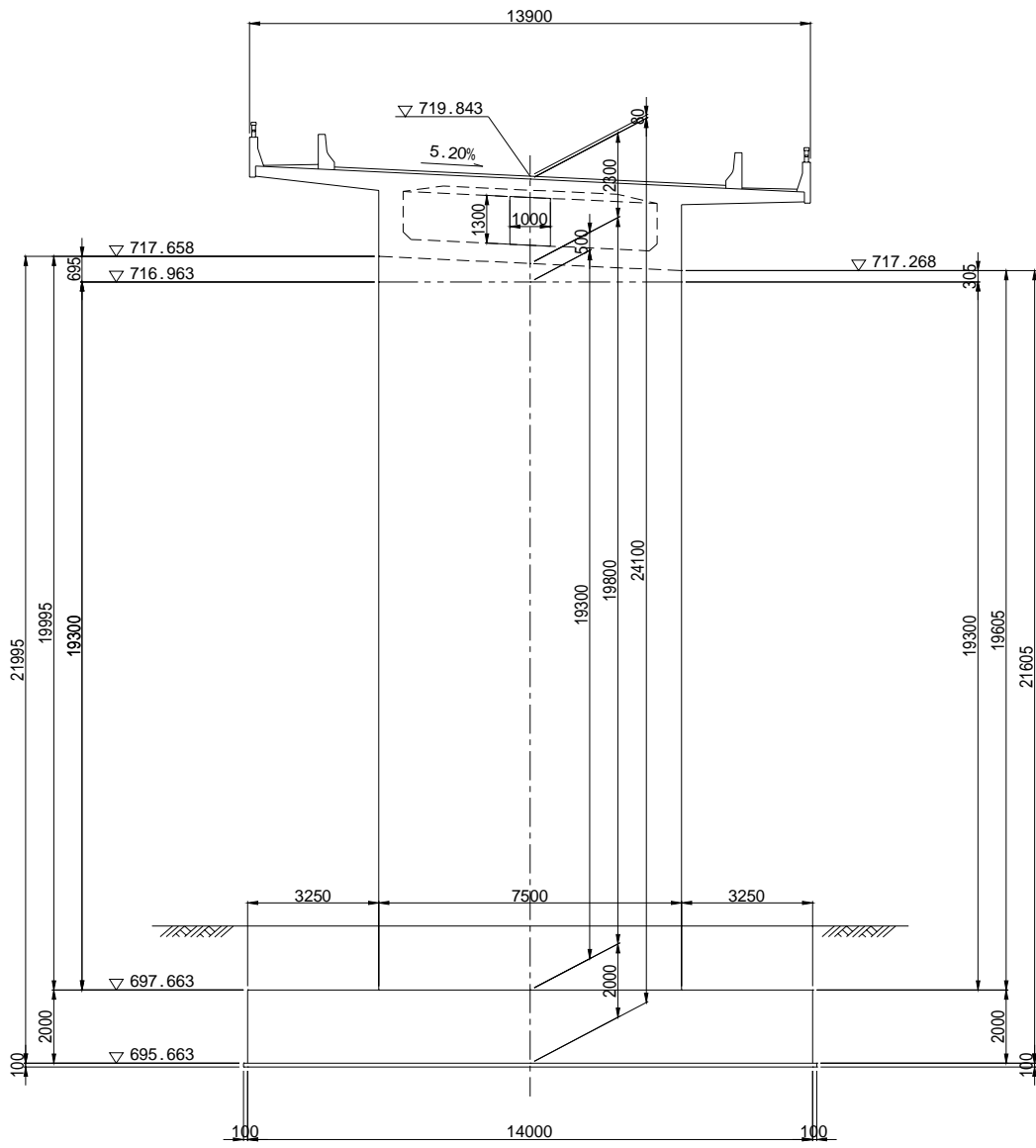
Arrangement of Stirrups D16 -c/c.250 2413 mm²/m > 0 mm²/m

3. Design of P6 Pier

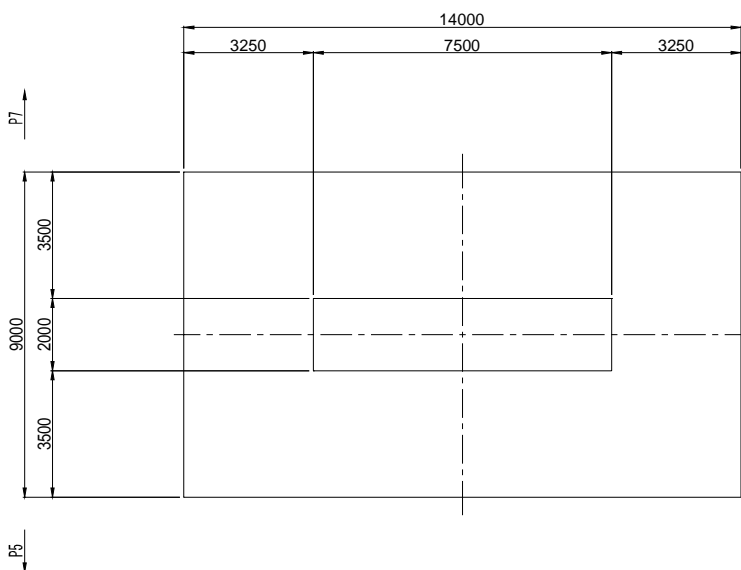
3.1 General Arrangement



Front Elevation

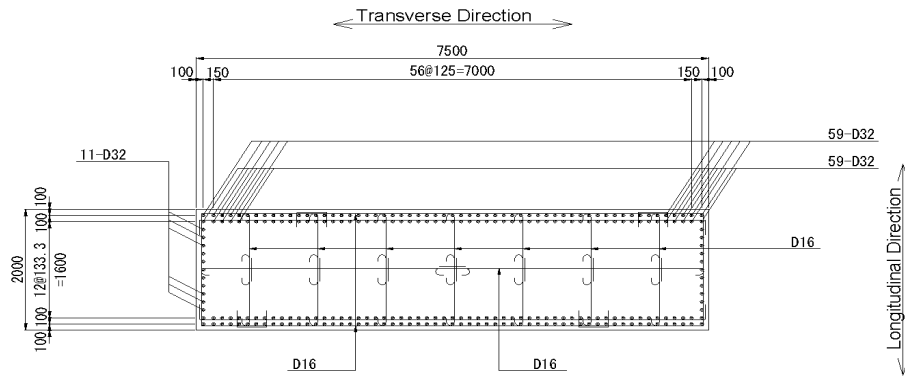


Plan

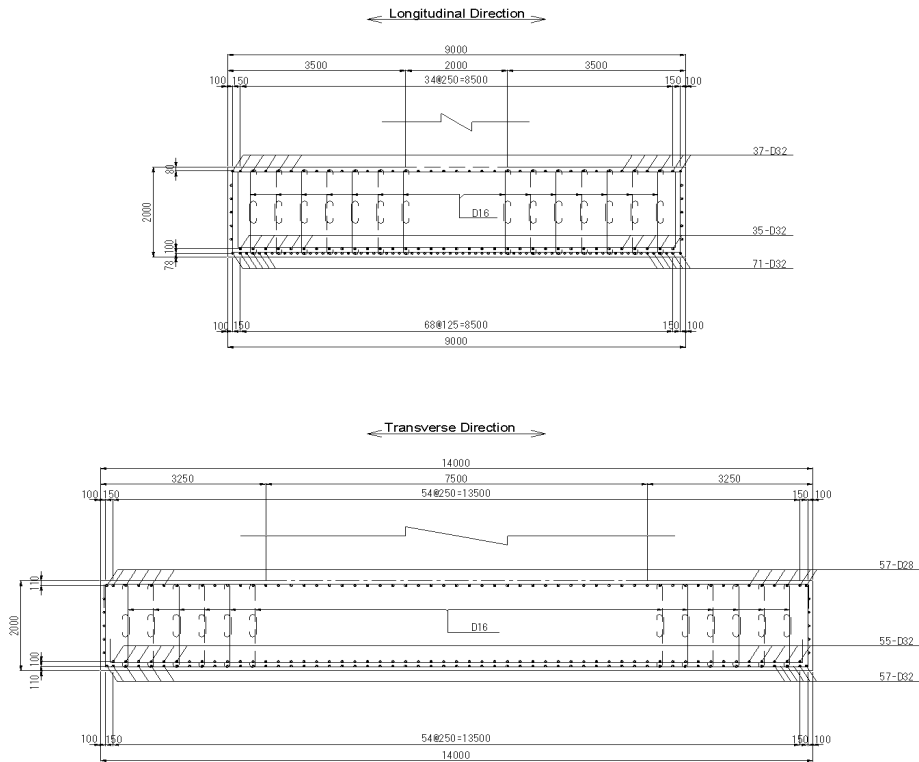


3.2 Bar Arrangement

P6 Wall



P6 Footing



3.3 Summary of Sectional Force at Bottom of Wall from Static Analysis Model

3.3.1 List of Sectional Force

Category	Description	Sectional Force					
		Longitudinal Direction			Transverse Direction		
		M(kNm)	S(kN)	N(kN)	M(kNm)	S(kN)	N(kN)
D	Self Weight	-235	-6	14243	0	0	14243
D	Surfacing	-84	-8	2284	0	0	2284
D	Prestress	220	6	497	0	0	497
D	Creep Effect	-39	-4	-39	0	0	-39
L	CLASS-A Live Load (Mmax)	2861	357	690	0	0	690
L	CLASS-A Live Load (Mmin)	-2865	-357	690	0	0	690
L	CLASS-A Live Load (Nmax)	15	1	1648	0	0	1648
L	CLASS-A Live Load (Nmin)	0	0	-252	0	0	-252
CF	Centrifugal Force	0	0	0	7500	312	0
E	Earth Pressure	0	0	0	0	0	0
LF	Longitudinal Force	1659	69	0	0	0	0
S	Shrinkage	-57	-6	941	0	0	0
T	Temperature Rise	0	0	-188	0	0	0
T	Temperature Down	0	0	188	0	0	0

3.3.2 Combination Force for Service Load Design

Group		Longitudinal Direction				Transverse Direction			
		M(kNm)	S(kN)	N(kN)	Calc.Stress	M(kNm)	S(kN)	N(kN)	Calc.Stress
I	Mmax	2724	345	17675	-	7500	312	17675	-
	Mmin	3003	370	17675	Calc.	7500	312	17675	-
	Nmin	138	12	16733	-	7500	312	16733	Calc
II		138	12	16985	Calc	0	0	16985	Calc
III	Mmax	4383	414	17675	Calc	7500	312	17675	-
	Mmin	1344	301	17675	-	7500	312	17675	Calc
	Nmin	1521	57	16733	-	7500	312	18633	-
IV	Mmax	2667	339	18428	-	7500	312	17675	-
	Mmin	3059	376	18804	Calc	7500	312	17675	Calc
	Nmin	195	18	17486	-	7500	312	18633	-
V		194	18	18115	Calc	0	0	16985	Calc
VI	Mmax	4326	408	18428	Calc	7500	312	17675	-
	Mmin	1400	307	18804	-	7500	312	17675	Calc
	Nmin	1464	51	17486	-	7500	312	18633	-

3.3.3 Combination Force for Load Factor Design

Group		Longitudinal Direction				Transverse Direction			
		M(kNm)	S(kN)	N(kN)	Check	M(kNm)	S(kN)	N(kN)	Check
I	Mmax	6033	759	23579	-	9750	406	22978	-
	Mmin	6400	792	23578	Check	9750	406	22977	Check
	Nmin	180	16	21534	-	9750	406	24223	-
II		179	16	22081	Check	0	0	22081	Check
III	Mmax	5698	538	22978	Check	9750	406	22978	-
	Mmin	1747	391	22977	-	9750	406	22977	Check
	Nmin	1978	74	21753	-	9750	406	24223	-
IV	Mmax	3466	440	23957	-	9750	406	22978	-
	Mmin	3977	488	24446	Check	9750	406	22977	Check
	Nmin	253	24	23222	-	9750	406	24223	-
V		243	23	22173	Check	0	0	21232	Check
VI	Mmax	5407	510	23035	Check	9375	390	22094	-
	Mmin	1750	383	23505	-	9375	390	22094	Check
	Nmin	1831	64	22328	-	9375	390	23291	-

3.4 Sectional Force for Seismic Design

	Longitudinal Direction				Transverse Direction			
	M(kNm)	S(kN)	N(kN)	Calc.Stress	M(kNm)	S(kN)	N(kN)	Calc.Stress
Seismic Design	59081	6730	19922	Calc.	112382	6587	19916	Calc.

*) Sectional Force for Seismic Design is Calculated from Dynamic Analysis

3.5 Design of Spread Footing

3.5.1 Calculation of Stability

(1) Concrete Volume and Self Weight of Spread Footing

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)	Gravity y(m)	Vi x y
1	14.000 x 9.000 x 2.000	252.00	1.000	252.000
Σ		252.00	1.000	252.000

Self Weight of Substructure $24.5 \times \Sigma V = 6174.00$ kN

(2) Backfill Soil Covering on Footing

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)
1	(14.000 x 9.000 - 7.500 x 2.000) x 2.20	244.20
Σ		244.20

Weight of Soil on Spread Footing $19 \times \Sigma V = 4639.80$ kN

(3) Buoyancy

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)
1	14.000 x 9.000 x 0.0	0.00
Σ		0.00

Buoyancy $-10 \times \Sigma V = 0.00$ kN

(4) Summary of Force at Bottom of Footing for Service Load Design

1) Longitudinal Direction

Group-I	D+SD+L+CF+E+B				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi • Yi	
Force at Bottom of Wall	17675.0	369.8	10.120	3742.5	
Self Weight of Footing D	6174.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	4639.8	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	28488.8	369.8	-	3742.5	

Group-II	D+SD+E+B+W				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi • Yi	
Force at Bottom of Wall	16985.2	12.3	13.176	162.2	
Self Weight of Footing D	6174.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	4639.8	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	27799.0	12.3	-	162.2	

Group-III	D+SD+L+CF+E+B+0.3W+WL+LF				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi • Yi	
Force at Bottom of Wall	17675.4	413.9	12.591	5210.7	
Self Weight of Footing D	6174.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	4639.8	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	28489.2	413.9	-	5210.7	

Group-IV		D+SD+L+CF+E+B+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18804.3	375.7	10.142	3810.9
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29618.1	375.7	-	3810.9

Group-V		D+SD+E+B+W+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18114.5	18.3	12.630	230.6
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		28928.3	18.3	-	230.6

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18428.4	407.8	12.607	5141.4
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29242.2	407.8	-	5141.4

2) Transvers Direction

Group-I		D+SD+L+CF+E+B			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		16733.4	312.4	26.010	8124.8
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27547.2	312.4	-	8124.8

Group-II		D+SD+E+B+W			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		16985.2	0.0	0.000	0.0
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27799.0	0.0	-	0.0

Group-III		D+SD+L+CF+E+B+0.3W+WL+LF			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		17675.0	312.4	26.010	8124.8
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		28488.8	312.4	-	8124.8

Group-IV		D+SD+L+CF+E+B+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		17675.0	312.4	26.010	8124.8
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		28488.8	312.4	-	8124.8

Group-V		D+SD+E+B+W+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		16985.2	0.0	0.000	0.0
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	2.750	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27799.0	0.0	-	0.0

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		17675.0	312.4	26.010	8124.8
Self Weight of Footing	D	6174.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	4639.8	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		28488.8	312.4	-	8124.8

(5) Summary of Force at Bottom of Footing for Load Factor Design

1) Longitudinal Direction

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	23578.2	792.1	10.079	7983.7
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			37636.2	792.1	-	7983.7

Group-II		$\gamma(D+SD+E+B+W)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	22080.8	16.0	13.176	210.9
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			36138.7	16.0	-	210.9

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	22978.0	538.0	12.591	6773.9
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			37035.9	538.0	-	6773.9

Group-IV $\gamma(D+SD+L+CF+E+B+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	24445.6	488.5	10.142	4954.2
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	4639.8	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			37111.6	488.5	-	4954.2

Group-V $\gamma(D+SD+E+B+W+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	22172.8	22.9	12.625	289.3
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			35690.0	22.9	-	289.3

Group-VI $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	23035.4	509.8	12.607	6426.8
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			36552.7	509.8	-	6426.8

2) Transvers Direction

Group-I $\gamma(D+SD+1.67L+CF+E+B)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	22977.4	406.1	26.010	10562.2
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			37035.4	406.1	-	10562.2

Group-II $\gamma(D+SD+E+B+W)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	22080.8	0.0	0.000	0.0
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			36138.7	0.0	-	0.0

Group-III $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	22977.4	406.1	26.010	10562.2
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			37035.4	406.1	-	10562.2

Group-IV $\gamma(D+SD+L+CF+E+B+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	22977.4	406.1	26.010	10562.2
Self Weight of Footing	D	1.300	8026.2	0.0	1.000	0.0
Backfill Soil	D	1.300	6031.7	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			37035.4	406.1	-	10562.2

Group-V $\gamma(D+SD+E+B+W+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	21231.5	0.0	0.000	0.0
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			34748.8	0.0	-	0.0

Group-VI $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	22093.7	390.5	26.010	10155.9
Self Weight of Footing	D	1.250	7717.5	0.0	1.000	0.0
Backfill Soil	D	1.250	5799.8	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			35610.9	390.5	-	10155.9

(5) Summary of Force at Bottom of Footing

		Longitudinal Direction			Transverse Direction		
		V(kN)	H(kN)	M(kNm)	V(kN)	H(kN)	M(kNm)
Service Load Design	Group-I	28488.8	369.8	3742.5	27547.2	312.4	8124.8
	Group-II	27799.0	12.3	162.2	27799.0	0.0	0.0
	Group-III	28489.2	413.9	5210.7	28488.8	312.4	8124.8
	Group-IV	29618.1	375.7	3810.9	28488.8	312.4	8124.8
	Group-V	28928.3	18.3	230.6	27799.0	0.0	0.0
	Group-VI	29242.2	407.8	5141.4	28488.8	312.4	8124.8
Load Factor Design	Group-I	37636.2	792.1	7983.7	37035.4	406.1	10562.2
	Group-II	36138.7	16.0	210.9	36138.7	0.0	0.0
	Group-III	37035.9	538.0	6773.9	37035.4	406.1	10562.2
	Group-IV	37111.6	488.5	4954.2	37035.4	406.1	10562.2
	Group-V	35690.0	22.9	289.3	34748.8	0.0	0.0
	Group-VI	36552.7	509.8	6426.8	35610.9	390.5	10155.9
Seismic Design		30100.0	408.0	74700.9	30090.0	8890.9	127730.9

*) Sectional Force for Seismic Design is Calculated from Dynamic Analysis

(6) Calculation of Stability on Service Load Design

Stability of Footing is checked as follows.

*1) Eccentric Distance from Center of Footing to Vertical Force

$$e = M / V - B/2$$

e : Eccentric Distance
M : Moment at Bottom of Footing
V : Vertical Force at Bottom of Footing
B : Width of Footing on Checking Direction

*2) Safety Factor for Horizontal Force

$$S.F = V \cdot \tan\theta / H$$

S.F : Safety Factor
V : Vertical Force at Bottom of Footing
 $\tan\theta$: 0.6
H : Horizontal Force at Bottom of Footing

*3) Ground Reaction

$$q = V/DB \pm 6M/DB^2 \quad (e < B/6)$$

$$q = 2V / D_x \quad (e = B/6)$$

q : Ground Reaction
V : Vertical Force at Bottom of Footing
M : Moment at Bottom of Footing
D : Length of Footing
B : Width of Footing on Checking Direction
x : 3(B/2 - e)

Calculation Result of Stability

1) Longitudinal Direction

Dimension of Footing B= 9.000 m
 D= 14.000 m

Eccentric Distance from Center of Footing to Vertical Force

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	28488.8	369.8	3742.5	0.131
Group-II	27799.0	12.3	162.2	0.006
Group-III	28489.2	413.9	5210.7	0.183
Group-IV	29618.1	375.7	3810.9	0.129
Group-V	28928.3	18.3	230.6	0.008
Group-VI	29242.2	407.8	5141.4	0.176
Seismic Design	30100.0	408.0	74700.9	2.482

Eccentric Distance for Load Factor Design

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	37636.2	792.1	7983.7	0.212
Group-II	36138.7	16.0	210.9	0.006
Group-III	37035.9	538.0	6773.9	0.183
Group-IV	37111.6	488.5	4954.2	0.133
Group-V	35690.0	22.9	289.3	0.008
Group-VI	36552.7	509.8	6426.8	0.176

Safety Factor for Horizontal Force

	V (kN)	H (kN)	M (kN)	S.F	Limit of S.F	
Group-I	28488.8	369.8	3742.5	46.223	1.500	OK
Group-II	27799.0	12.3	162.2	1354.838	1.500	OK
Group-III	28489.2	413.9	5210.7	41.303	1.500	OK
Group-IV	29618.1	375.7	3810.9	47.295	1.500	OK
Group-V	28928.3	18.3	230.6	950.704	1.500	OK
Group-VI	29242.2	407.8	5141.4	43.021	1.500	OK
Seismic Design	30100.0	408.0	74700.9	44.265	1.200	OK

Ground Reaction

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)	qa (kN/m ²)	
Group-I	28488.8	369.8	3742.5	9.000	245.90	206.30	700	OK
Group-II	27799.0	12.3	162.2	9.000	221.49	219.77	700	OK
Group-III	28489.2	413.9	5210.7	9.000	253.67	198.53	700	OK
Group-IV	29618.1	375.7	3810.9	9.000	255.23	214.90	700	OK
Group-V	28928.3	18.3	230.6	9.000	230.81	228.37	700	OK
Group-VI	29242.2	407.8	5141.4	9.000	259.28	204.88	700	OK
Seismic Design	30100.0	408.0	74700.9	6.055	710.19	0.00	1050	OK

Ground Reaction for Load Factor Design

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)
Group-I	37636.2	792.1	7983.7	9.000	340.94	256.46
Group-II	36138.7	16.0	210.9	9.000	287.93	285.70
Group-III	37035.9	538.0	6773.9	9.000	329.78	258.10
Group-IV	37111.6	488.5	4954.2	9.000	320.75	268.32
Group-V	35690.0	22.9	289.3	9.000	284.78	281.72
Group-VI	36552.7	509.8	6426.8	9.000	324.10	256.10

2) Transverse Direction

Dimension of Footing B= 14.000 m

D= 9.000 m

Eccentric Distance from Center of Footing to Vertical Force

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	27547.2	312.4	8124.8	0.295
Group-II	27799.0	0.0	0.0	0.000
Group-III	28488.8	312.4	8124.8	0.285
Group-IV	28488.8	312.4	8124.8	0.285
Group-V	27799.0	0.0	0.0	0.000
Group-VI	28488.8	312.4	8124.8	0.285
Seismic Design	30090.0	8890.9	127730.9	4.245

Eccentric Distance for Load Factor Design

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	37035.4	406.1	10562.2	0.285
Group-II	36138.7	0.0	0.0	0.000
Group-III	37035.4	406.1	10562.2	0.285
Group-IV	37035.4	406.1	10562.2	0.285
Group-V	34748.8	0.0	0.0	0.000
Group-VI	35610.9	390.5	10155.9	0.285

Safety Factor for Horizontal Force

	V (kN)	H (kN)	M (kN)	S.F	Limit of S.F	
Group-I	27547.2	312.4	8124.8	52.913	1.500	OK
Group-II	27799.0	0.0	0.0	-	1.500	OK
Group-III	28488.8	312.4	8124.8	54.721	1.500	OK
Group-IV	28488.8	312.4	8124.8	54.721	1.500	OK
Group-V	27799.0	0.0	0.0	-	1.500	OK
Group-VI	28488.8	312.4	8124.8	54.721	1.500	OK
Seismic Design	30090.0	8890.9	127730.9	2.031	1.200	OK

Ground Reaction

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)	qa (kN/m ²)	
Group-I	27547.2	312.4	8124.8	14.000	246.26	190.99	700	OK
Group-II	27799.0	0.0	0.0	14.000	220.63	220.63	700	OK
Group-III	28488.8	312.4	8124.8	14.000	253.74	198.47	700	OK
Group-IV	28488.8	312.4	8124.8	14.000	253.74	198.47	700	OK
Group-V	27799.0	0.0	0.0	14.000	220.63	220.63	700	OK
Group-VI	28488.8	312.4	8124.8	14.000	253.74	198.47	700	OK
Seismic Design	30090.0	8890.9	127730.9	8.265	809.02	0.00	1050	OK

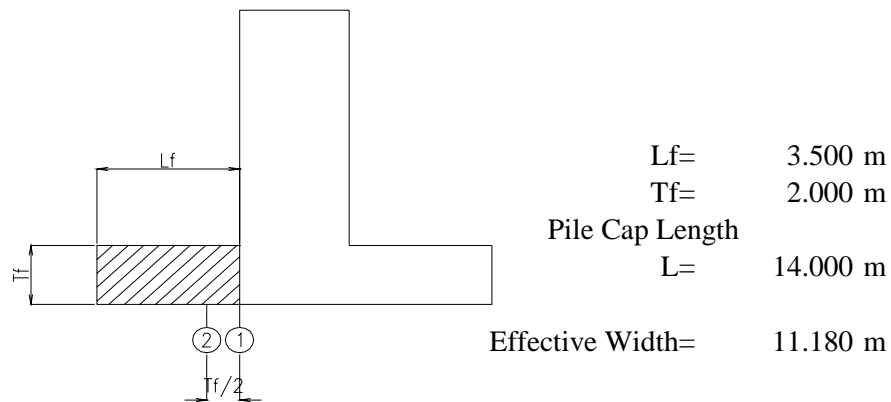
Ground Reaction for Load Factor Design

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)
Group-I	37035.4	406.1	10562.2	14.000	329.86	258.01
Group-II	36138.7	0.0	0.0	14.000	286.82	286.82
Group-III	37035.4	406.1	10562.2	14.000	329.86	258.01
Group-IV	37035.4	406.1	10562.2	14.000	329.86	258.01
Group-V	34748.8	0.0	0.0	14.000	275.78	275.78
Group-VI	35610.9	390.5	10155.9	14.000	317.17	248.08

3.5.2 Design of Spread Footing

(1) Block data that doesn't consider water level for Longitudinal Direction

1) Self Weight for Section-



Division	Calculation formula Width × Height × Length	Volume V1 $V_i(\text{m}^3)$	Barycentric Position $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.5 \times 2 \times 14$	98.0	1.750	171.500
Σ		98.0	---	171.500

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 98 = 2401.00 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 $V_i(\text{m}^3)$	Barycentric Position $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.5 \times 0 \times 14$	0.0	1.750	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 $V_i(\text{m}^3)$	Barycentric Position $X_i(\text{m})$	$V_i \cdot X_i$
1	$3.5 \times 2.2 \times 14$	107.8	1.750	188.650
Σ		107.8	---	188.650

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 107.8 = 2048.20 \text{ kN}$

1) Self Weight for Section-

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	2.5 x 2 x 14	70.0	1.250	87.500
Σ		70.0	---	87.500

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 70 = 1715.00 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	2.5 x 0 x 14	0.0	1.250	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

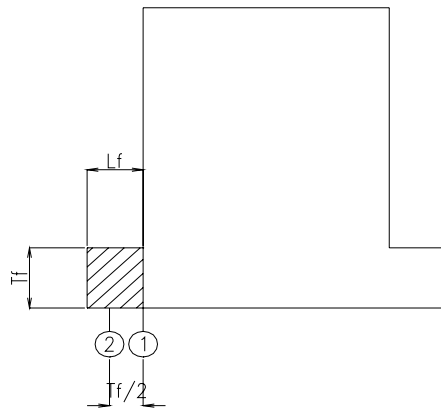
Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	2.5 x 2.2 x 14	77.0	1.250	96.250
Σ		77.0	---	96.250

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 77 = 1463.00 \text{ kN}$

(2) Block data that doesn't consider water level for Transverse Direction

1) Self Weight for Section-



$L_f = 3.250 \text{ m}$
 $T_f = 2.000 \text{ m}$
 Pile Cap Length
 $L = 9.000 \text{ m}$
 Effective Width = 5.777 m

Division	Calculation formula Width × Height × Length	Volume V1 $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	$3.25 \times 2 \times 9$	58.5	1.625	95.063
Σ		58.5	---	95.063

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 58.5 = 1433.25 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	$3.25 \times 0 \times 9$	0.0	1.625	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	$3.25 \times 2.2 \times 9$	64.4	1.625	104.569
Σ		64.4	---	104.569

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 64.4 = 1222.65 \text{ kN}$

1) Self Weight for Section-

Division	Calculation formula Width × Height × Length	Volume V1 $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	$2.25 \times 2 \times 9$	40.5	1.125	45.563
Σ		40.5	---	45.563

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 40.5 = 992.25 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00$ m (equally Top of Footing)

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	2.25 x 0 x 9	0.0	1.125	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00$ kN

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200$ m

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V1 $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	2.25 x 2.2 x 9	44.6	1.125	50.119
Σ		44.6	---	50.119

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 44.6 = 846.45$ kN

(3) Summary of Sectional Force for Service Load Design

Longitudinal Direction at Section-

Group-I	D+SD+L+CF+E+B			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-11671.91	1.76885819	-20646.0
Total		-7222.71		-12859.8
Per 1 meter		-515.91		-1150.3

Group-II	D+SD+E+B+W			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-10836.43	1.75088038	-18973.3
Total		-6387.23		-11187.1
Per 1 meter		-456.23		-1000.6

Group-III	D+SD+L+CF+E+B+0.3W+WL+LF			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-11904.67	1.776	-21139.6
Total		-7455.47		-13353.4
Per 1 meter		-532.53		-1194.4

Group-IV		D+SD+L+CF+E+B+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-12121.92	1.768	-21437.5
Total		-7672.72		-13651.3
Per 1 meter		-548.05		-1221.0

Group-V		D+SD+E+B+W+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-11286.44	1.751	-19764.8
Total		-6837.24		-11978.6
Per 1 meter		-488.37		-1071.4

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-12186.54	1.775	-21628.8
Total		-7737.34		-13842.6
Per 1 meter		-552.67		-1238.2

Transverse Direction at Section-

Group-I		D+SD+L+CF+E+B		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-7015.57	1.63948816	-11501.9
Total		-4359.67		-7186.1
Per 1 meter		-484.41		-1243.9

Group-II		D+SD+E+B+W		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-6453.34	1.625	-10486.7
Total		-3797.44		-6170.9
Per 1 meter		-421.94		-1068.2

Group-III		D+SD+L+CF+E+B+0.3W+WL+LF		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-7234.14	1.639	-11857.1
Total		-4578.24		-7541.3
Per 1 meter		-508.69		-1305.4

Group-IV		D+SD+L+CF+E+B+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-7234.14	1.639	-11857.1
Total		-4578.24		-7541.3
Per 1 meter		-508.69		-1305.4

Group-V		D+SD+E+B+W+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-6453.34	1.625	-10486.7
Total		-3797.44		-6170.9
Per 1 meter		-421.94		-1068.2

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-7234.14	1.639	-11857.1
Total		-4578.24		-7541.3
Per 1 meter		-508.69		-1305.4

(4) Summary of Sectional Force for Load Factor Design

Longitudinal Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-15901.20	1.77952934	-28296.7
Total			-10117.24		-18174.7
Per 1 meter			-722.66		-1625.6

Group-II		$\gamma(D+SD+E+B+W)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-14087.35	1.75088038	-24665.3
Total			-8303.39		-14543.3
Per 1 meter			-593.10		-1300.8

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-15476.08	1.776	-27481.5
Total			-9692.12		-17359.5
Per 1 meter			-692.29		-1552.7

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	3121.30	1.750	5462.3
Backfill Soil Covering on Footing	D	1.300	2662.66	1.750	4659.7
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-15217.19	1.769	-26921.5
Total			-9433.23		-16799.5
Per 1 meter			-673.80		-1502.6

Group-V		$\gamma(D+SD+E+B+W+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	3001.25	1.750	5252.2
Backfill Soil Covering on Footing	D	1.250	2560.25	1.750	4480.4
Buoyancy	B	1.250	0.00	1.750	0.0
Ground Reaction	-	-	-13925.28	1.751	-24386.3
Total			-8363.78		-14653.7
Per 1 meter			-597.41		-1310.7

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	3001.25	1.750	5252.2
Backfill Soil Covering on Footing	D	1.250	2560.25	1.750	4480.4
Buoyancy	B	1.250	0.00	1.750	0.0
Ground Reaction	-	-	-15233.17	1.775	-27036.0
Total			-9671.67		-17303.4
Per 1 meter			-690.83		-1547.7

Longitudinal Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-11522.27
Total			-7390.87
Per 1 meter			-527.92

Group-II		$\gamma(D+SD+E+B+W)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-10066.73
Total			-5935.33
Per 1 meter			-423.95

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-11193.72
Total			-7062.32
Per 1 meter			-504.45

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	2229.50
Backfill Soil Covering on Footing	D	1.300	1901.90
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-10971.36
Total			-6839.96
Per 1 meter			-488.57

Group-V		$\gamma(D+SD+E+B+W+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	2143.75
Backfill Soil Covering on Footing	D	1.250	1828.75
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-9952.58
Total			-5980.08
Per 1 meter			-427.15

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	2143.75
Backfill Soil Covering on Footing	D	1.250	1828.75
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-11013.08
Total			-7040.58
Per 1 meter			-502.90

Transverse Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-9404.39	1.63905041	-15414.3
Total			-5951.72		-9803.8
Per 1 meter			-661.30		-1697.0

Group-II		$\gamma(D+SD+E+B+W)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-8389.34	1.625	-13632.7
Total			-4936.67		-8022.2
Per 1 meter			-548.52		-1388.6

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-9404.39	1.639	-15414.3
Total			-5951.72		-9803.8
Per 1 meter			-661.30		-1697.0

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	1863.23	1.625	3027.7
Backfill Soil Covering on Footing	D	1.300	1589.45	1.625	2582.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-9404.39	1.639	-15414.3
Total			-5951.72		-9803.8
Per 1 meter			-661.30		-1697.0

Group-V		$\gamma(D+SD+E+B+W+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	1791.56	1.625	2911.3
Backfill Soil Covering on Footing	D	1.250	1528.31	1.625	2483.5
Buoyancy	B	1.250	0.00	1.625	0.0
Ground Reaction	-	-	-8066.68	1.625	-13108.4
Total			-4746.81		-7713.6
Per 1 meter			-527.42		-1335.2

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	1791.56	1.625	2911.3
Backfill Soil Covering on Footing	D	1.250	1528.31	1.625	2483.5
Buoyancy	B	1.250	0.00	1.625	0.0
Ground Reaction	-	-	-9042.68	1.639	-14821.4
Total			-5722.81		-9426.6
Per 1 meter			-635.87		-1631.7

Transverse Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-6562.69
Total			-4172.38
Per 1 meter			-463.60

Group-II		$\gamma(D+SD+E+B+W)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-5808.01
Total			-3417.70
Per 1 meter			-379.74

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-6562.69
Total			-4172.38
Per 1 meter			-463.60

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1289.93
Backfill Soil Covering on Footing	D	1.300	1100.39
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-6562.69
Total			-4172.38
Per 1 meter			-463.60

Group-V		$\gamma(D+SD+E+B+W+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1240.31
Backfill Soil Covering on Footing	D	1.250	1058.06
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-5584.62
Total			-3286.25
Per 1 meter			-365.14

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1240.31
Backfill Soil Covering on Footing	D	1.250	1058.06
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-6310.28
Total			-4011.91
Per 1 meter			-445.77

(5) Summary of Sectional Force for Seismic Design

Section- Longitudinal Direction				
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	2401.00	1.750	4201.8
Backfill Soil Covering on Footing	D	2048.20	1.750	3584.4
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-24741.21	1.987	-49164.3
Total		-20292.01		-41378.1
Per 1 meter		-1449.43		-3701.1

Section- Transverse Direction				
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1433.25	1.625	2329.0
Backfill Soil Covering on Footing	D	1222.65	1.625	1986.8
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-19011.37	1.758	-33413.6
Total		-16355.47		-29097.8
Per 1 meter		-1817.27		-5036.8

Section- Longitudinal Direction		
		Vi(kN)
Self Weight of Footing	D	1715.00
Backfill Soil Covering on Footing	D	1463.00
Buoyancy	B	0.00
Ground Reaction	-	-19724.96
Total		-16546.96
Per 1 meter		-1181.93

Section- Transverse Direction		
		Vi(kN)
Self Weight of Footing	D	1433.25
Backfill Soil Covering on Footing	D	1222.65
Buoyancy	B	0.00
Ground Reaction	-	-14152.79
Total		-11496.89
Per 1 meter		-1277.43

(6) Calculation of Stress for Service Load Design and Seismic Design

Stress Equation

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^2 + \frac{2 \cdot n}{b} \{A_{s'} \cdot (x-d') + A_s \cdot (x-d)\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm), h = 2000mm

b : Width in section (mm), b = 1000mm

d : Effective height (mm)

d' : Concrete Cover (mm)

As : Sectional area of reinforcing bar arranged on tension side (mm²)

As': Sectional area of reinforcing bar arranged on compression side (mm²)

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

σc: Compressive Stress of Concrete (N/mm²)

σs: Tensile Stress of Reinforcing (N/mm²)

M: Bending Moment (kN.m)

Bar Arrangement

		Longitudinal Direction		Transverse Direction	
Dimension	b(mm)	1000		1000	
	h(mm)	2000		2000	
	d1(mm)	1890		1920	
	d2(mm)	1790		1820	
Bar Arrangement	As1(mm ²)	4-D32	3217	8-D32	6434
	As2(mm ²)	4-D32	3217	4-D32	3217

Calculation Result of Bending Stress

	Longitudinal Direction					Remarks
	M (kNm)	σc (N/mm ²)	σs (N/mm ²)	σca (N/mm ²)	σsa (N/mm ²)	
Group-I	1150.3	2.73	111.45	9.60	168.00	OK
Group-II	1000.6	2.38	96.95	12.00	210.00	OK
Group-III	1194.4	2.84	115.73	12.00	210.00	OK
Group-IV	1221.0	2.90	118.31	12.00	210.00	OK
Group-V	1071.4	2.55	103.81	13.44	235.20	OK
Group-VI	1238.2	2.94	119.97	13.44	235.20	OK
Seismic Design	3701.1	8.80	358.60	20.40	378.00	OK

	Transverse Direction					Remarks
	M (kNm)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	1243.9	2.22	77.32	9.60	168.00	OK
Group-II	1068.2	1.91	66.40	12.00	210.00	OK
Group-III	1305.4	2.33	81.15	12.00	210.00	OK
Group-IV	1305.4	2.33	81.15	12.00	210.00	OK
Group-V	1068.2	1.91	66.40	13.44	235.20	OK
Group-VI	1305.4	2.33	81.15	13.44	235.20	OK
Seismic Design	5036.8	9.00	313.10	20.40	378.00	OK

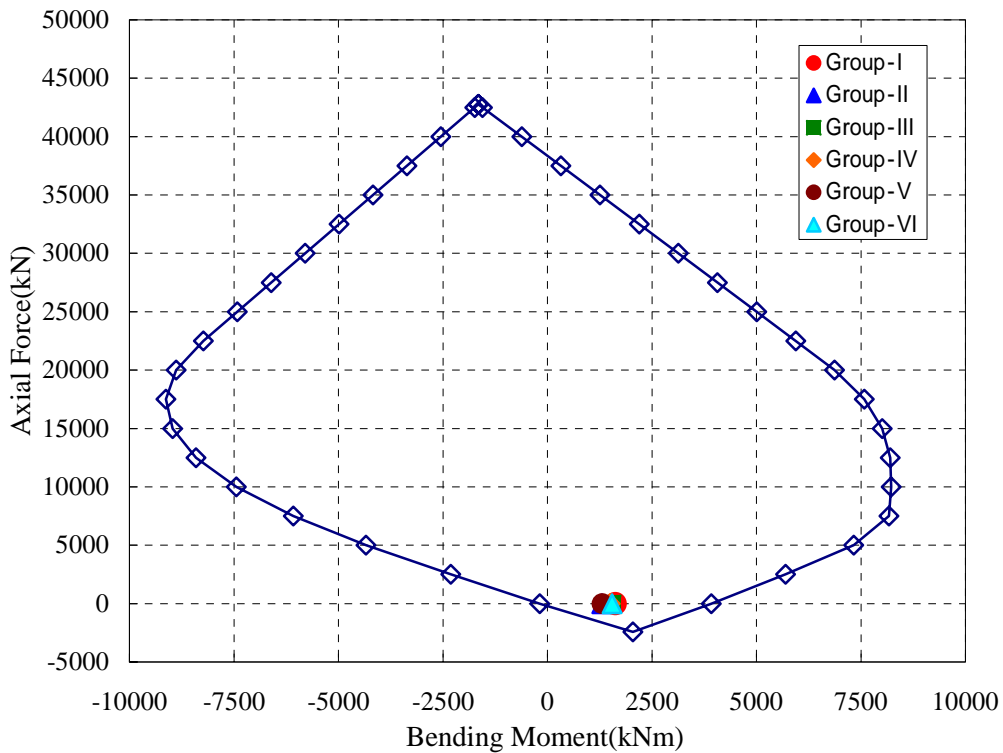
(6) Calculation of Strength for Load Factor Design

*) Flexural Strength

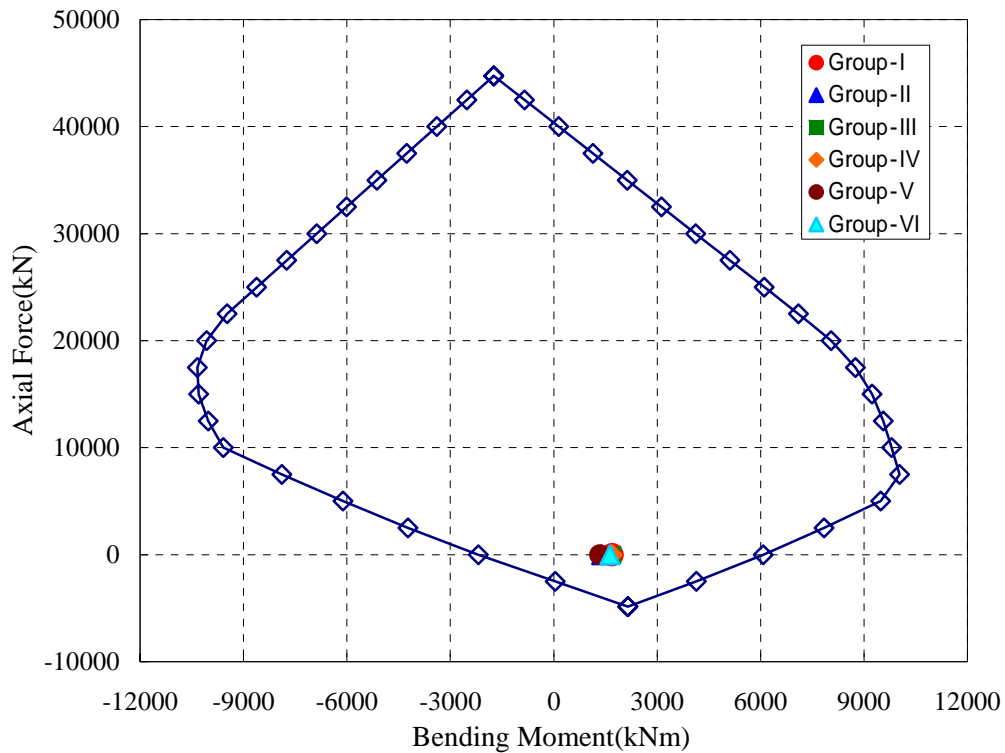
Factored Bending Moment for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	1625.6 kNm	1697.04 kNm
Group-II	1300.8 kNm	1388.64 kNm
Group-III	1552.7 kNm	1697.04 kNm
Group-IV	1502.6 kNm	1697.04 kNm
Group-V	1310.7 kNm	1335.23 kNm
Group-VI	1547.7 kNm	1631.75 kNm

Interaction of Longitudinal Direction



Interaction of Transverse Direction



*) Shear Strength

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 1/6 \times f_c)$$

$$= 1/6 \times f_c \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	527.9 kN	463.60 kN
Group-II	424.0 kN	379.74 kN
Group-III	504.5 kN	463.60 kN
Group-IV	488.6 kN	463.60 kN
Group-V	427.1 kN	365.14 kN
Group-VI	502.9 kN	445.77 kN
Seismic Design	1181.9 kN	1277.43 kN

Calculation of Shear Strength

$$v_c = 1/6x \quad f_c = 1/6x \quad (24) = 0.816\text{N/mm}^2 \rightarrow 816\text{kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 1.000 \text{ m}$$

Longitudinal Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	527.9	1.000	1.790	1241.54	0.00	0.0
Group-II	424.0	1.000	1.790	1241.54	0.00	0.0
Group-III	504.5	1.000	1.790	1241.54	0.00	0.0
Group-IV	488.6	1.000	1.790	1241.54	0.00	0.0
Group-V	427.1	1.000	1.790	1241.54	0.00	0.0
Group-VI	502.9	1.000	1.790	1241.54	0.00	0.0
Seismic Design	1181.9	1.000	1.790	1241.54	0.00	0.0

Arrangement of Stirrup D16 -ctc.500 804.25 mm²/m > 0 mm²/m

Transverse Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	463.6	1.000	1.820	1262.35	0.00	0.0
Group-II	379.7	1.000	1.820	1262.35	0.00	0.0
Group-III	463.6	1.000	1.820	1262.35	0.00	0.0
Group-IV	463.6	1.000	1.820	1262.35	0.00	0.0
Group-V	365.1	1.000	1.820	1262.35	0.00	0.0
Group-VI	445.8	1.000	1.820	1262.35	0.00	0.0
Seismic Design	1277.4	1.000	1.820	1262.35	17.74	23.2

Arrangement of Stirrup D16 -ctc.500 804.25 mm²/m > 23.2 mm²/m

3.6 Design of Wall

3.6.1 Summary of Sectional Force at Base of Wall

		Longitudinal Direction			Transverse Direction		
		N(kN)	S(kN)	M(kNm)	V(kN)	H(kN)	M(kNm)
Service Load Design	Group-I	17675.4	344.7	2723.7	16733.4	312.4	7500.0
	Group-II	16985.2	12.3	137.6	16985.2	0.0	0.0
	Group-III	17675.4	413.9	4382.9	18632.7	312.4	7500.0
	Group-IV	17486.4	18.4	195.1	18632.7	312.4	7500.0
	Group-V	18114.5	18.3	194.1	16985.2	0.0	0.0
	Group-VI	18804.3	306.6	1400.1	18632.7	312.4	7500.0
Load Factor Design	Group-I	23579.1	759.2	6032.9	22977.4	406.1	9750.0
	Group-II	22080.8	16.0	178.9	22080.8	0.0	0.0
	Group-III	22978.0	538.0	5697.8	24222.6	406.1	9750.0
	Group-IV	23956.9	440.3	3466.5	24222.6	406.1	9750.0
	Group-V	22172.8	22.9	243.5	21231.5	0.0	0.0
	Group-VI	23505.3	383.3	1750.2	23290.9	390.5	9375.0
Seismic Design		19921.9	6730.3	59080.8	19916.2	6587.3	112382.0

*) Sectional Force of Seismic Design is Calculated by Dynamic Analysis.

3.6.2 Calculation of Stress for Service Load Design and Seismic Design

Stress Equation

$$\sigma_c = \frac{N}{\frac{b \cdot x}{2} - n \cdot A_s \cdot \frac{d-x}{x} + n \cdot A_s' \cdot \frac{x-d'}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^3 - 3 \cdot \left(\frac{h}{2} - e\right) \cdot x^2 - \frac{6n}{b} \left\{ A_s' \cdot \left(\frac{h}{2} - d' - e\right) + A_s \cdot \left(\frac{h}{2} - d - e\right) \right\} \cdot x + \frac{6n}{b} \left\{ A_s' \cdot d' \cdot \left(\frac{h}{2} - d' - e\right) + A_s \cdot d \cdot \left(\frac{h}{2} - d - e\right) \right\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm)

b : Width in section (mm)

d : Effective height (mm)

d' : Concrete Cover (mm)

As : Sectional area of reinforcing bar arranged on tension side (mm²)

As' : Sectional area of reinforcing bar arranged on compression side (mm²)

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

e : Axis force eccentric distance (mm)

σc: Compressive Stress of Concrete (N/mm²)

σs: Tensile Stress of Reinforcing (N/mm²)

N: Axial Force (kN)

M: Bending Moment (kN.m)

Bar Arrangement

		Vertical Direction	Longitudinal Direction
Dimension	b(mm)	7500	2000
	h(mm)	2000	7500
	d1(mm)	1900	7400
	d2(mm)	1800	-
Bar Arrangement	As1(mm ²)	59-D32 47451	11-D32 8847
	As2(mm ²)	59-D32 47451	-

Calculation Result of Bending Stress

	Longitudinal Direction						Remarks
	M (kNm)	N (kN)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	2723.7	17675.4	1.80	-7.75	9.60	168.00	OK
Group-II	137.6	16985.2	1.29	-12.62	12.00	210.00	OK
Group-III	4382.9	17675.4	2.10	-4.29	12.00	210.00	OK
Group-IV	195.1	17486.4	1.33	-12.88	12.00	210.00	OK
Group-V	194.1	18114.5	1.38	-13.36	13.44	235.20	OK
Group-VI	1400.1	18804.3	1.65	-11.37	13.44	235.20	OK
Seismic Design	59080.8	19921.9	15.70	311.80	20.40	378.00	OK

	Transverse Direction						Remarks
	M (kNm)	N (kN)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	7500.0	16733.4	1.25	-9.11	9.60	168.00	OK
Group-II	0.0	16985.2	0.94	0.00	12.00	210.00	OK
Group-III	7500.0	18632.7	1.35	-10.68	12.00	210.00	OK
Group-IV	7500.0	18632.7	1.35	-10.68	12.00	210.00	OK
Group-V	0.0	16985.2	0.94	0.00	13.44	235.20	OK
Group-VI	7500.0	18632.7	1.35	-10.68	13.44	235.20	OK
Seismic Design	112382.0	19916.2	8.24	172.71	20.40	378.00	OK

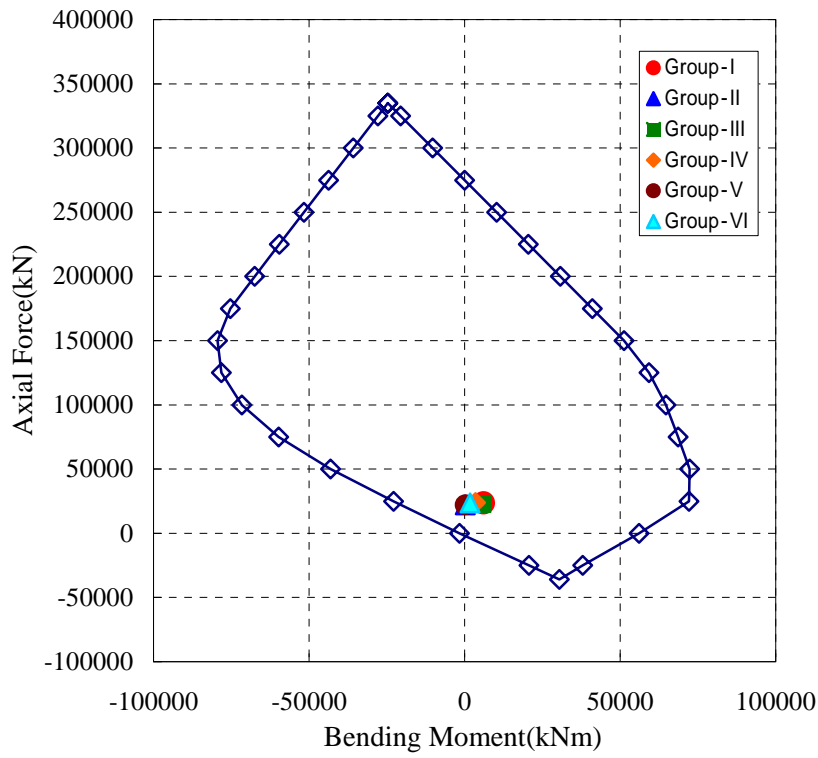
(6) Calculation of Strength for Load Factor Design

*) Flexural Strength

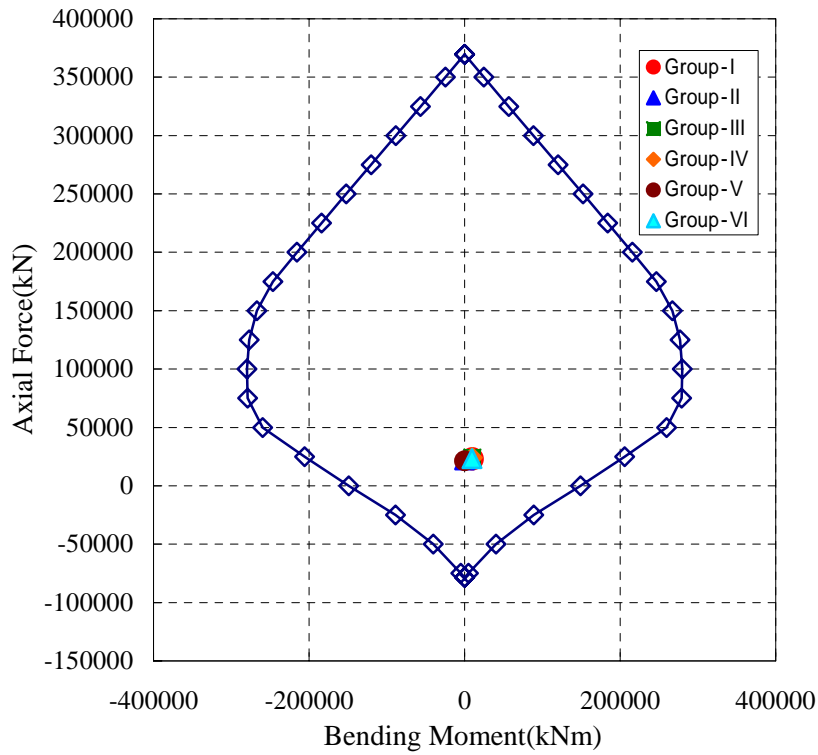
Factored Bending Moment for Load Factor Design

	Vertical Direction		Longitudinal Direction	
	M(kNm)	N(kN)	M(kNm)	N(kN)
Group-I	6032.9	23579.1	9750.0	22977.4
Group-II	178.9	22080.8	0.0	22080.8
Group-III	5697.8	22978.0	9750.0	24222.6
Group-IV	3466.5	23956.9	9750.0	24222.6
Group-V	243.5	22172.8	0.0	21231.5
Group-VI	1750.2	23505.3	9375.0	23290.9

Interaction of Longitudinal Direction



Interaction of Transverse Direction



*) Shear Strength

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 1/6 \times f_c)$$

$$= 1/6 \times f_c \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	759.2 kN	406.1 kN
Group-II	16.0 kN	0.0 kN
Group-III	538.0 kN	406.1 kN
Group-IV	440.3 kN	406.1 kN
Group-V	22.9 kN	0.0 kN
Group-VI	383.3 kN	390.5 kN
Seismic Design	6730.3 kN	6587.3 kN

Calculation of Shear Strength

$$v_c = 1/6 \times f_c = 1/6 \times (24) = 0.816 \text{ N/mm}^2 \rightarrow 816 \text{ kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 1.000 \text{ m}$$

Longitudinal Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	759.2	7.400	1.900	9752.0	0.0	0.0
Group-II	16.0	7.400	1.900	9752.0	0.0	0.0
Group-III	538.0	7.400	1.900	9752.0	0.0	0.0
Group-IV	440.3	7.400	1.900	9752.0	0.0	0.0
Group-V	22.9	7.400	1.900	9752.0	0.0	0.0
Group-VI	383.3	7.400	1.900	9752.0	0.0	0.0
Seismic Design	6730.3	7.400	1.900	9752.0	0.0	0.0

Arrangement of Stirr D16 -ctc.150 12064 mm²/m > 0 mm²/m

Transverse Direction

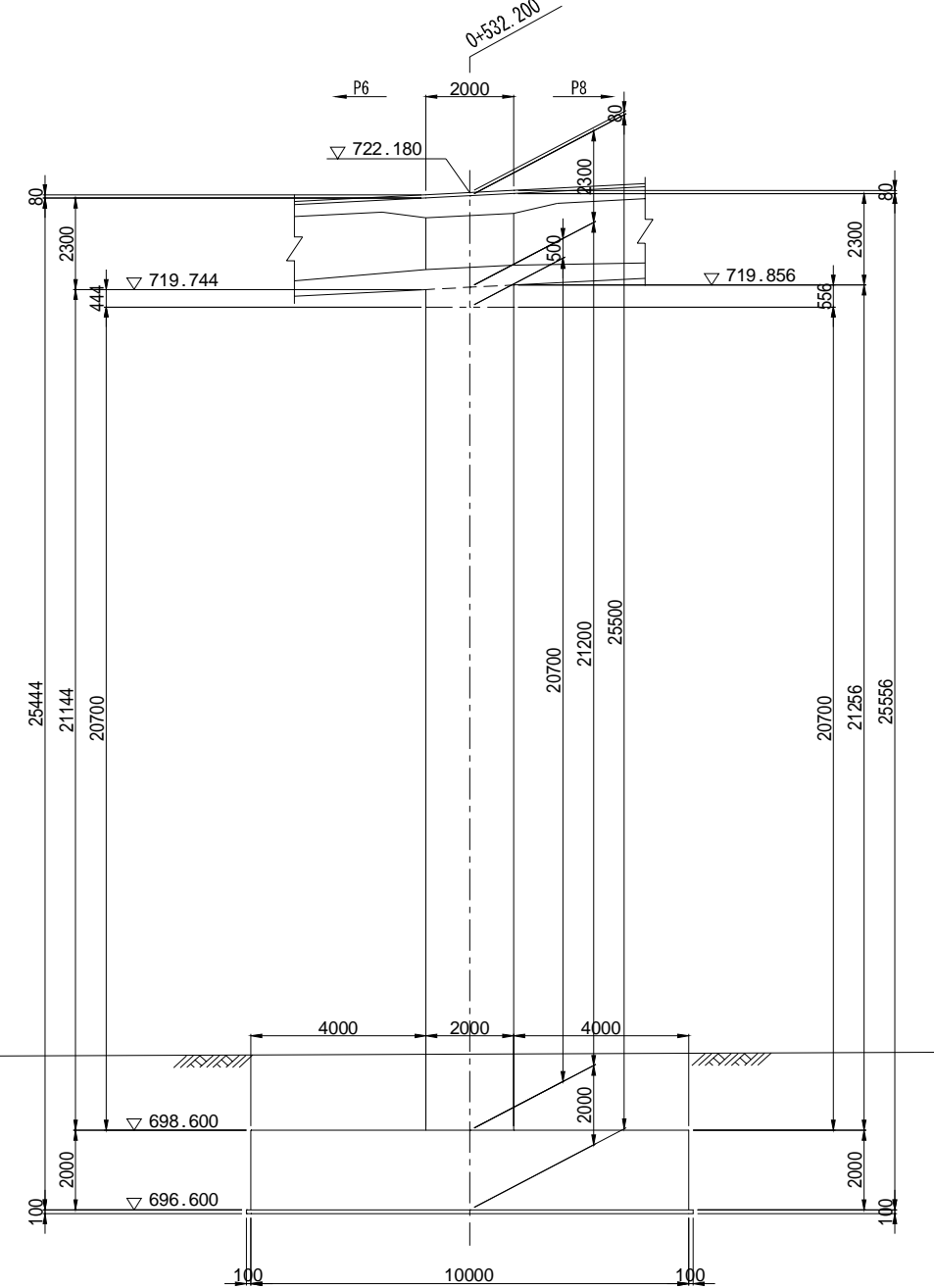
	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	406.1	2.000	7.400	10265.3	0.0	0.0
Group-II	0.0	2.000	7.400	10265.3	0.0	0.0
Group-III	406.1	2.000	7.400	10265.3	0.0	0.0
Group-IV	406.1	2.000	7.400	10265.3	0.0	0.0
Group-V	0.0	2.000	7.400	10265.3	0.0	0.0
Group-VI	390.5	2.000	7.400	10265.3	0.0	0.0
Seismic Design	6587.3	2.000	7.400	10265.3	0.0	0.0

Arrangement of Stirrups D16 -c/c.250 2413 mm²/m > 0 mm²/m

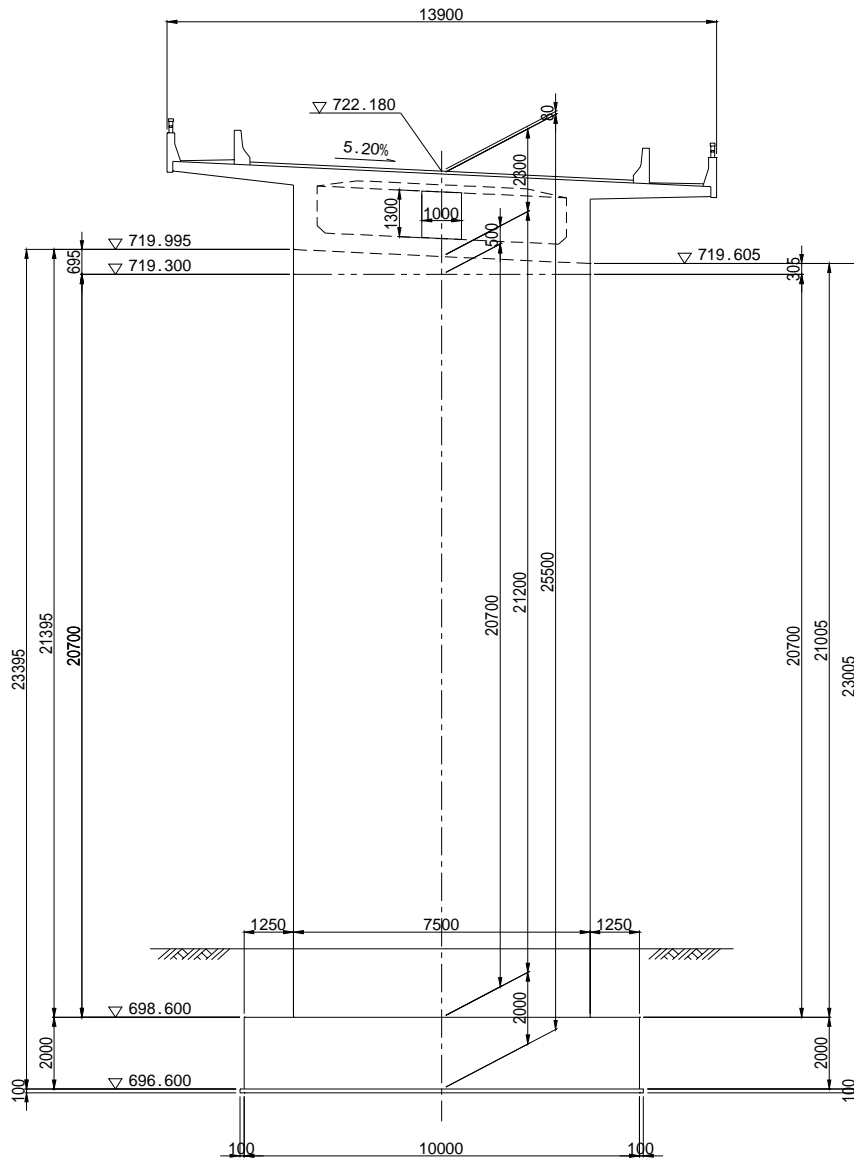
4. Design of P7 Pier

4.1 General Arrangement

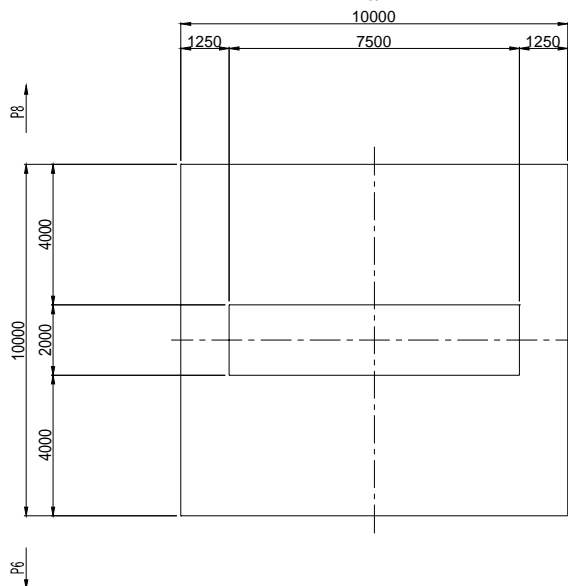
Side Elevation



Front Elevation

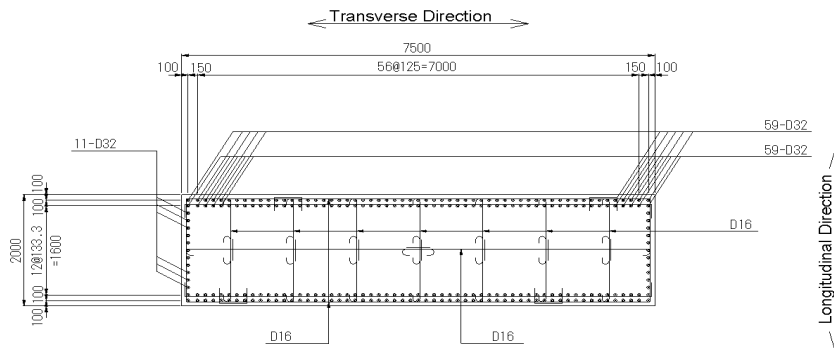


Plan

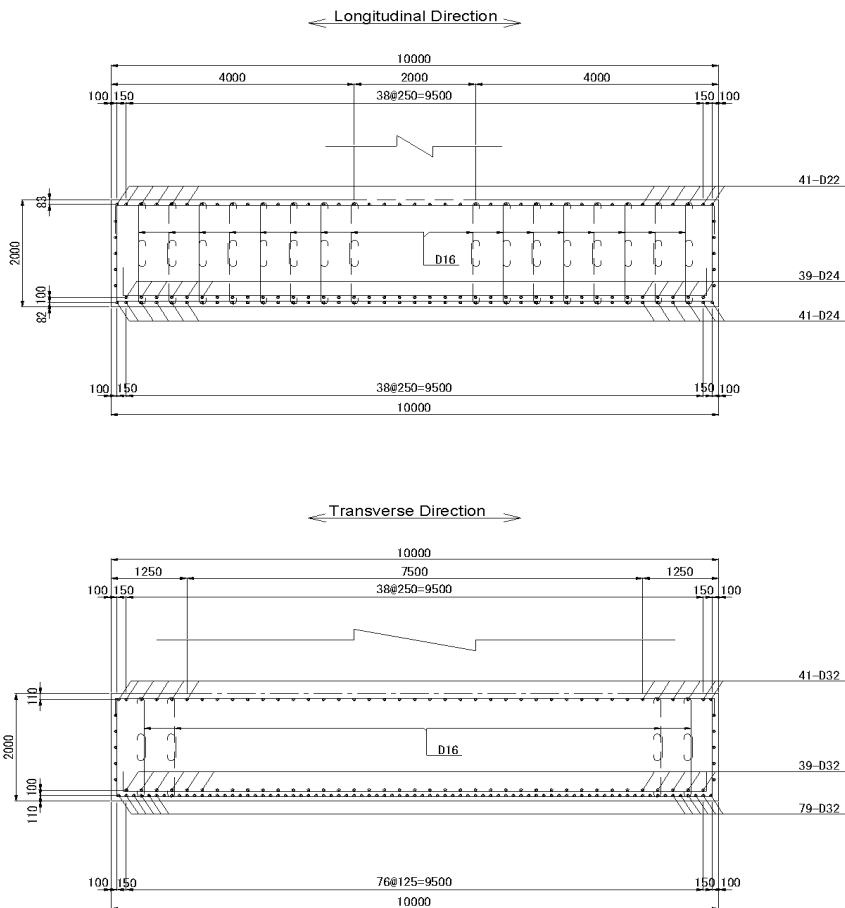


4.2 Bar Arrangement

P7 Wall



P7 Footing



4.3 Summary of Sectional Force at Bottom of Wall from Static Analysis Model

4.3.1 List of Sectional Force

Category	Description	Sectional Force					
		Longitudinal Direction			Transverse Direction		
		M(kNm)	S(kN)	N(kN)	M(kNm)	S(kN)	N(kN)
D	Self Weight	-5605	-717	17051	0	0	17051
D	Surfacing	-1507	-199	2713	0	0	2713
D	Prestress	-4089	26	-818	0	0	-818
D	Creep Effect	229	7	71	0	0	71
L	CLASS-A Live Load (Mmax)	1461	193	691	0	0	691
L	CLASS-A Live Load (Mmin)	-2194	-289	948	0	0	948
L	CLASS-A Live Load (Nmax)	-331	-40	1804	0	0	1804
L	CLASS-A Live Load (Nmin)	-370	-45	-92	0	0	-92
CF	Centrifugal Force	0	0	0	8691	342	0
E	Earth Pressure	0	0	0	0	0	0
LF	Longitudinal Force	1923	76	0	0	0	0
S	Shrinkage	-20393	-1605	-395	0	0	0
T	Temperature Rise	5258	429	48	0	0	0
T	Temperature Down	-5258	-429	-48	0	0	0

4.3.2 Combination Force for Service Load Design

Group		Longitudinal Direction				Transverse Direction			
		M(kNm)	S(kN)	N(kN)	Calc.Stress	M(kNm)	S(kN)	N(kN)	Calc.Stress
I	Mmax	9511	689	19708	Calc.	8691	342	19708	-
	Mmin	13165	1171	19965	-	8691	342	19965	-
	Nmin	11342	927	18925	-	8691	342	18925	Calc
II		10972	882	19017	Calc	0	0	19017	Calc
III	Mmax	7588	614	19708	Calc	8691	342	19708	-
	Mmin	11243	1095	19965	-	8691	342	19965	-
	Nmin	9419	851	18925	-	8691	342	20821	Calc
IV	Mmax	24646	1865	19361	-	8691	342	19708	-
	Mmin	38816	3204	19521	-	8691	342	19965	-
	Nmin	36993	2960	18482	Calc	8691	342	20821	Calc
V		36622	2916	18574	Calc	0	0	19017	Calc
VI	Mmax	22723	1790	19361	-	8691	342	19708	-
	Mmin	36894	3128	19521	Calc	8691	342	19965	-
	Nmin	35070	2884	18482	-	8691	342	20821	Calc

4.3.3 Combination Force for Load Factor Design

Group		Longitudinal Direction				Transverse Direction			
		M(kNm)	S(kN)	N(kN)	Check	M(kNm)	S(kN)	N(kN)	Check
I	Mmax	11092	728	26223	Check	11298	445	25621	-
	Mmin	19026	1774	26780	-	11298	445	25954	Check
	Nmin	15067	1244	24522	-	11298	445	27067	-
II		14263	1147	24722	Check	0	0	24722	Check
III	Mmax	9865	798	25621	Check	11298	445	25621	-
	Mmin	14616	1424	25954	-	11298	445	25954	-
	Nmin	12245	1107	24602	-	11298	445	27067	Check
IV	Mmax	32039	2425	25169	Check	11298	445	25621	-
	Mmin	50461	4165	25378	-	11298	445	25954	-
	Nmin	48091	3848	24026	-	11298	445	27067	Check
V		32633	2573	23337	Check	0	0	23771	Check
VI	Mmax	28404	2237	24201		10863	428	24635	-
	Mmin	46117	3911	24402	Check	10863	428	24956	-
	Nmin	43838	3605	23102		10863	428	26026	Check

4.4 Sectional Force for Seismic Design

	Longitudinal Direction				Transverse Direction			
	M(kNm)	S(kN)	N(kN)	Calc.Stress	M(kNm)	S(kN)	N(kN)	Calc.Stress
Seismic Design	66558	6380	22198	Calc.	70922	4464	20366	Calc.

*) Sectional Force for Seismic Design is Calculated from Dynamic Analysis

4.5 Design of Spread Footing

4.5.1 Calculation of Stability

(1) Concrete Volume and Self Weight of Spread Footing

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)	Gravity y(m)	Vi x y
1	10.000 x 10.000 x 2.000	200.00	1.000	200.000
Σ		200.00	1.000	200.000

Self Weight of Substructure $24.5 \times \Sigma V = 4900.00$ kN

(2) Backfill Soil Covering on Footing

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)
1	(10.000 x 10.000 - 7.500 x 2.000) x 2.20	187.00
Σ		187.00

Weight of Soil on Spread Footing $19 \times \Sigma V = 3553.00$ kN

(3) Buoyancy

Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)
1	10.000 x 10.000 x 0.0	0.00
Σ		0.00

Buoyancy $-10 \times \Sigma V = 0.00$ kN

(4) Summary of Force at Bottom of Footing for Service Load Design

1) Longitudinal Direction

Group-I	D+SD+L+CF+E+B				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi · Yi	
Force at Bottom of Wall	19708.3	689.4	15.797	10889.5	
Self Weight of Footing D	4900.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	3553.0	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	28161.3	689.4	-	10889.5	

Group-II	D+SD+E+B+W				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi · Yi	
Force at Bottom of Wall	19017.0	882.3	14.435	12736.2	
Self Weight of Footing D	4900.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	3553.0	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	27470.0	882.3	-	12736.2	

Group-III	D+SD+L+CF+E+B+0.3W+WL+LF				
Loadings	Vi (kN)	Hi (kN)	Yi(m)	M _{vi} = Hi · Yi	
Force at Bottom of Wall	19708.3	613.7	14.365	8815.5	
Self Weight of Footing D	4900.0	0.0	1.000	0.0	
Backfill Soil Covering on Footing D	3553.0	0.0	3.100	0.0	
Buoyancy B	0.0	0.0	1.000	0.0	
Total	28161.3	613.7	-	8815.5	

Group-IV		D+SD+L+CF+E+B+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18481.5	2960.1	14.497	42913.0
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		26934.5	2960.1	-	42913.0

Group-V		D+SD+E+B+W+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18573.5	2915.5	14.561	42453.5
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27026.5	2915.5	-	42453.5

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		19521.4	3128.5	13.793	43150.7
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27974.4	3128.5	-	43150.7

2) Transvers Direction

Group-I		D+SD+L+CF+E+B			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		18925.0	342.0	27.410	9374.6
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27378.0	342.0	-	9374.6

Group-II		D+SD+E+B+W			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		19017.0	0.0	0.000	0.0
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27470.0	0.0	-	0.0

Group-III		D+SD+L+CF+E+B+0.3W+WL+LF			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		20820.9	342.0	27.410	9374.6
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29273.9	342.0	-	9374.6

Group-IV		D+SD+L+CF+E+B+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		20820.9	342.0	27.410	9374.6
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29273.9	342.0	-	9374.6

Group-V		D+SD+E+B+W+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		19017.0	0.0	0.000	0.0
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	2.750	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		27470.0	0.0	-	0.0

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T			
Loadings		V _i (kN)	H _i (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		20820.9	342.0	27.410	9374.6
Self Weight of Footing	D	4900.0	0.0	1.000	0.0
Backfill Soil Covering on Footing	D	3553.0	0.0	3.100	0.0
Buoyancy	B	0.0	0.0	1.000	0.0
Total		29273.9	342.0	-	9374.6

(5) Summary of Force at Bottom of Footing for Load Factor Design

1) Longitudinal Direction

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	26222.8	728.1	17.234	12547.9
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	4618.9	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			37211.7	728.1	-	12547.9

Group-II		$\gamma(D+SD+E+B+W)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	24722.1	1147.0	14.435	16557.1
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	4618.9	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			35711.0	1147.0	-	16557.1

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$				
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Y _i (m)	M _{vi} = H _i • Y _i
Force at Bottom of Wall		-	25620.7	797.8	14.365	11460.2
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	4618.9	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			36609.6	797.8	-	11460.2

Group-IV $\gamma(D+SD+L+CF+E+B+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	25169.4	2425.0	15.212	36889.4
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	3553.0	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			35092.4	2425.0	-	36889.4

Group-V $\gamma(D+SD+E+B+W+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	23337.3	2572.9	14.683	37779.0
Self Weight of Footing	D	1.250	6125.0	0.0	1.000	0.0
Backfill Soil	D	1.250	4441.3	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			33903.5	2572.9	-	37779.0

Group-VI $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	24401.7	3910.6	13.793	53938.4
Self Weight of Footing	D	1.250	6125.0	0.0	1.000	0.0
Backfill Soil	D	1.250	4441.3	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			34968.0	3910.6	-	53938.4

2) Transvers Direction

Group-I $\gamma(D+SD+1.67L+CF+E+B)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	25954.3	444.6	27.410	12187.0
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	4618.9	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			36943.2	444.6	-	12187.0

Group-II $\gamma(D+SD+E+B+W)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	24722.1	0.0	0.000	0.0
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	4618.9	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			35711.0	0.0	-	0.0

Group-III $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{vi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	27067.1	444.6	27.410	12187.0
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	4618.9	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			38056.0	444.6	-	12187.0

Group-IV $\gamma(D+SD+L+CF+E+B+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	27067.1	444.6	27.410	12187.0
Self Weight of Footing	D	1.300	6370.0	0.0	1.000	0.0
Backfill Soil	D	1.300	4618.9	0.0	3.100	0.0
Buoyancy	B	1.300	0.0	0.0	1.000	0.0
Total			38056.0	444.6	-	12187.0

Group-V $\gamma(D+SD+E+B+W+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	23771.2	0.0	0.000	0.0
Self Weight of Footing	D	1.250	6125.0	0.0	1.000	0.0
Backfill Soil	D	1.250	4441.3	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			34337.5	0.0	-	0.0

Group-VI $\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$						
Loadings		$\gamma \times \beta$	$\gamma \cdot \beta \cdot V_i$ (kN)	$\gamma \cdot \beta \cdot H_i$ (kN)	Yi(m)	$M_{yi} = H_i \cdot Y_i$
Force at Bottom of Wall		-	26026.1	427.5	27.410	11718.3
Self Weight of Footing	D	1.250	6125.0	0.0	1.000	0.0
Backfill Soil	D	1.250	4441.3	0.0	3.100	0.0
Buoyancy	B	1.250	0.0	0.0	1.000	0.0
Total			36592.3	427.5	-	11718.3

(5) Summary of Force at Bottom of Footing

		Longitudinal Direction			Transverse Direction		
		V(kN)	H(kN)	M(kNm)	V(kN)	H(kN)	M(kNm)
Service Load Design	Group-I	28161.3	689.4	10889.5	27378.0	342.0	9374.6
	Group-II	27470.0	882.3	12736.2	27470.0	0.0	0.0
	Group-III	28161.3	613.7	8815.5	29273.9	342.0	9374.6
	Group-IV	26934.5	2960.1	42913.0	29273.9	342.0	9374.6
	Group-V	27026.5	2915.5	42453.5	27470.0	0.0	0.0
	Group-VI	27974.4	3128.5	43150.7	29273.9	342.0	9374.6
Load Factor Design	Group-I	37211.7	728.1	12547.9	36943.2	444.6	12187.0
	Group-II	35711.0	1147.0	16557.1	35711.0	0.0	0.0
	Group-III	36609.6	797.8	11460.2	38056.0	444.6	12187.0
	Group-IV	35092.4	2425.0	36889.4	38056.0	444.6	12187.0
	Group-V	33903.5	2572.9	37779.0	34337.5	0.0	0.0
	Group-VI	34968.0	3910.6	53938.4	36592.3	427.5	11718.3
Seismic Design		30160.0	8095.0	81035.0	26330.0	6185.0	81585.0

*) Sectional Force for Seismic Design is Calculated from Dynamic Analysis

(6) Calculation of Stability on Service Load Design

Stability of Footing is checked as follows.

*1) Eccentric Distance from Center of Footing to Vertical Force

$$e = M / V - B/2$$

e : Eccentric Distance

M : Moment at Bottom of Footing

V : Vertical Force at Bottom of Footing

B : Width of Footing on Checking Direction

*2) Safety Factor for Horizontal Force

$$S.F = V \cdot \tan\theta / H$$

S.F : Safety Factor

V : Vertical Force at Bottom of Footing

$\tan\theta$: 0.6

H : Horizontal Force at Bottom of Footing

*3) Ground Reaction

$$q = V/DB \pm 6M/DB^2 \quad (e < B/6)$$

$$q = 2V / Dx \quad (e \geq B/6)$$

q : Ground Reaction

V : Vertical Force at Bottom of Footing

M : Moment at Bottom of Footing

D : Length of Footing

B : Width of Footing on Checking Direction

x : $3(B/2 - e)$

Calculation Result of Stability

1) Longitudinal Direction

Dimension of Footing B= 10.000 m
 D= 10.000 m

Eccentric Distance from Center of Footing to Vertical Force

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	28161.3	689.4	10889.5	0.387
Group-II	27470.0	882.3	12736.2	0.464
Group-III	28161.3	613.7	8815.5	0.313
Group-IV	26934.5	2960.1	42913.0	1.593
Group-V	27026.5	2915.5	42453.5	1.571
Group-VI	27974.4	3128.5	43150.7	1.543
Seismic Design	30160.0	8095.0	81035.0	2.687

Eccentric Distance for Load Factor Design

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	37211.7	728.1	12547.9	0.337
Group-II	35711.0	1147.0	16557.1	0.464
Group-III	36609.6	797.8	11460.2	0.313
Group-IV	35092.4	2425.0	36889.4	1.051
Group-V	33903.5	2572.9	37779.0	1.114
Group-VI	34968.0	3910.6	53938.4	1.543

Safety Factor for Horizontal Force

	V (kN)	H (kN)	M (kN)	S.F	Limit of S.F	
Group-I	28161.3	689.4	10889.5	24.511	1.500	OK
Group-II	27470.0	882.3	12736.2	18.680	1.500	OK
Group-III	28161.3	613.7	8815.5	27.533	1.500	OK
Group-IV	26934.5	2960.1	42913.0	5.460	1.500	OK
Group-V	27026.5	2915.5	42453.5	5.562	1.500	OK
Group-VI	27974.4	3128.5	43150.7	5.365	1.500	OK
Seismic Design	30160.0	8095.0	81035.0	2.235	1.200	OK

Ground Reaction

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)	qa (kN/m ²)	
Group-I	28161.3	689.4	10889.5	10.000	346.95	216.28	700	OK
Group-II	27470.0	882.3	12736.2	10.000	351.12	198.28	700	OK
Group-III	28161.3	613.7	8815.5	10.000	334.51	228.72	700	OK
Group-IV	26934.5	2960.1	42913.0	10.000	526.82	11.87	700	OK
Group-V	27026.5	2915.5	42453.5	10.000	524.99	15.54	700	OK
Group-VI	27974.4	3128.5	43150.7	10.000	538.65	20.84	700	OK
Seismic Design	30160.0	8095.0	81035.0	6.939	869.23	0.00	1050	OK

Ground Reaction for Load Factor Design

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)
Group-I	37211.7	728.1	12547.9	10.000	447.40	296.83
Group-II	35711.0	1147.0	16557.1	10.000	456.45	257.77
Group-III	36609.6	797.8	11460.2	10.000	434.86	297.34
Group-IV	35092.4	2425.0	36889.4	10.000	572.26	129.59
Group-V	33903.5	2572.9	37779.0	10.000	565.71	112.36
Group-VI	34968.0	3910.6	53938.4	10.000	673.31	26.05

2) Transverse Direction

Dimension of Footing B= 10.000 m

D= 10.000 m

Eccentric Distance from Center of Footing to Vertical Force

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	27378.0	342.0	9374.6	0.342
Group-II	27470.0	0.0	0.0	0.000
Group-III	29273.9	342.0	9374.6	0.320
Group-IV	29273.9	342.0	9374.6	0.320
Group-V	27470.0	0.0	0.0	0.000
Group-VI	29273.9	342.0	9374.6	0.320
Seismic Design	26330.0	6185.0	81585.0	3.099

Eccentric Distance for Load Factor Design

	V (kN)	H (kN)	M (kN)	e (m)
Group-I	36943.2	444.6	12187.0	0.330
Group-II	35711.0	0.0	0.0	0.000
Group-III	38056.0	444.6	12187.0	0.320
Group-IV	38056.0	444.6	12187.0	0.320
Group-V	34337.5	0.0	0.0	0.000
Group-VI	36592.3	427.5	11718.3	0.320

Safety Factor for Horizontal Force

	V (kN)	H (kN)	M (kN)	S.F	Limit of S.F	
Group-I	27378.0	342.0	9374.6	48.029	1.500	OK
Group-II	27470.0	0.0	0.0	-	1.500	OK
Group-III	29273.9	342.0	9374.6	51.355	1.500	OK
Group-IV	29273.9	342.0	9374.6	51.355	1.500	OK
Group-V	27470.0	0.0	0.0	-	1.500	OK
Group-VI	29273.9	342.0	9374.6	51.355	1.500	OK
Seismic Design	26330.0	6185.0	81585.0	2.554	1.200	OK

Ground Reaction

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)	qa (kN/m ²)	
Group-I	27378.0	342.0	9374.6	10.000	330.03	217.53	700	OK
Group-II	27470.0	0.0	0.0	10.000	274.70	274.70	700	OK
Group-III	29273.9	342.0	9374.6	10.000	348.99	236.49	700	OK
Group-IV	29273.9	342.0	9374.6	10.000	348.99	236.49	700	OK
Group-V	27470.0	0.0	0.0	10.000	274.70	274.70	700	OK
Group-VI	29273.9	342.0	9374.6	10.000	348.99	236.49	700	OK
Seismic Design	26330.0	6185.0	81585.0	5.704	923.16	0.00	1050	OK

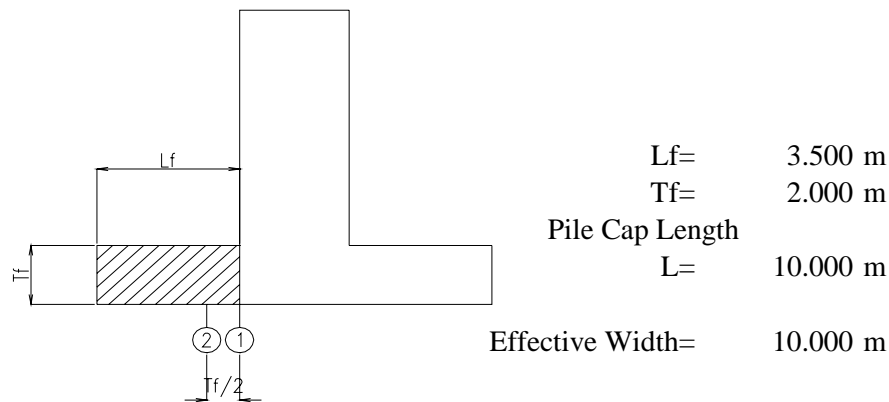
Ground Reaction for Load Factor Design

	V (kN)	H (kN)	M (kN)	x (m)	qmax (kN/m ²)	qmin (kN/m ²)
Group-I	36943.2	444.6	12187.0	10.000	442.55	296.31
Group-II	35711.0	0.0	0.0	10.000	357.11	357.11
Group-III	38056.0	444.6	12187.0	10.000	453.68	307.44
Group-IV	38056.0	444.6	12187.0	10.000	453.68	307.44
Group-V	34337.5	0.0	0.0	10.000	343.37	343.37
Group-VI	36592.3	427.5	11718.3	10.000	436.23	295.61

4.5.2 Design of Spread Footing

(1) Block data that doesn't consider water level for Longitudinal Direction

1) Self Weight for Section-



Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	3.5 x 2 x 10	70.0	1.750	122.500
Σ		70.0	---	122.500

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 70 = 1715.00 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	3.5 x 0 x 10	0.0	1.750	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Position Xi(m)	Vi · Xi
1	3.5 x 2.2 x 10	77.0	1.750	134.750
Σ		77.0	---	134.750

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 77 = 1463.00 \text{ kN}$

1) Self Weight for Section-

Division	Calculation formula	Volume V1	Barycentric Position	$V_i \cdot X_i$
	Width \times Height \times Length	$V_i(m^3)$	$X_i(m)$	
1	2.5 x 2 x 10	50.0	1.250	62.500
Σ		50.0	---	62.500

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 50 = 1225.00 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula	Volume V1	Barycentric Position	$V_i \cdot X_i$
	Width \times Height \times Length	$V_i(m^3)$	$X_i(m)$	
1	2.5 x 0 x 10	0.0	1.250	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

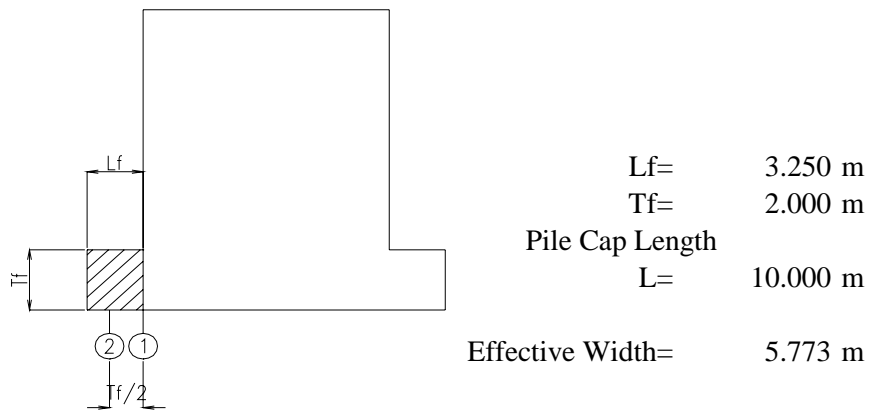
Division	Calculation formula	Volume V1	Barycentric Position	$V_i \cdot X_i$
	Width \times Height \times Length	$V_i(m^3)$	$X_i(m)$	
1	2.5 x 2.2 x 10	55.0	1.250	68.750
Σ		55.0	---	68.750

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 55 = 1045.00 \text{ kN}$

(2) Block data that doesn't consider water level for Transverse Direction

1) Self Weight for Section-



Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Xi(m)	Vi · Xi
1	3.25 x 2 x 10	65.0	1.625	105.625
Σ		65.0	---	105.625

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 65 = 1592.50 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00 \text{ m}$ (equally Top of Footing)

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Xi(m)	Vi · Xi
1	3.25 x 0 x 10	0.0	1.625	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00 \text{ kN}$

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200 \text{ m}$

Buoyancy

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Xi(m)	Vi · Xi
1	3.25 x 2.2 x 10	71.5	1.625	116.188
Σ		71.5	---	116.188

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 71.5 = 1358.50 \text{ kN}$

1) Self Weight for Section-

Division	Calculation formula Width × Height × Length	Volume V1 Vi(m ³)	Barycentric Xi(m)	Vi · Xi
1	2.25 x 2 x 10	45.0	1.125	50.625
Σ		45.0	---	50.625

Self Weight

Vertical Force $W = \gamma \times V = 24.5 \times 45 = 1102.50 \text{ kN}$

2) Backfill soil and buoyancy for Section-

*) Buoyancy

Water level $H_w = 0.00$ m (equally Top of Footing)

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V_i $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	2.25 \times 0 \times 10	0.0	1.125	0.000
Σ		0.0	---	0.000

Buoyancy

Vertical Force $W = \gamma_w \times V = -10 \times 0 = 0.00$ kN

*) Backfill Soil

Backfill Soil Covering on Footing $H = 2.200$ m

Buoyancy

Division	Calculation formula Width \times Height \times Length	Volume V_i $V_i(m^3)$	Barycentric $X_i(m)$	$V_i \cdot X_i$
1	2.25 \times 2.2 \times 10	49.5	1.125	55.688
Σ		49.5	---	55.688

Backfill Soil

Vertical Force $W = \gamma_s \times V = 19 \times 49.5 = 940.50$ kN

(3) Summary of Sectional Force for Service Load Design

Longitudinal Direction at Section-

Group-I	D+SD+L+CF+E+B			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	1715.00	1.750	3001.3
Backfill Soil Covering on Footing	D	1463.00	1.750	2560.3
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-11342.86	1.7911614	-20316.9
Total		-8164.86		-14755.3
Per 1 meter		-816.49		-1475.5

Group-II	D+SD+E+B+W			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	1715.00	1.750	3001.3
Backfill Soil Covering on Footing	D	1463.00	1.750	2560.3
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-11352.99	1.79809886	-20413.8
Total		-8174.99		-14852.2
Per 1 meter		-817.50		-1485.2

Group-III	D+SD+L+CF+E+B+0.3W+WL+LF			
		$V_i(kN)$	$X_i(m)$	$M_i(kNm)$
Self Weight of Footing	D	1715.00	1.750	3001.3
Backfill Soil Covering on Footing	D	1463.00	1.750	2560.3
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-11059.76	1.784	-19732.5
Total		-7881.76		-14170.9
Per 1 meter		-788.18		-1417.1

Group-IV		D+SD+L+CF+E+B+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1715.00	1.750	3001.3
Backfill Soil Covering on Footing	D	1463.00	1.750	2560.3
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-15284.70	1.870	-28588.1
Total		-12106.70		-23026.5
Per 1 meter		-1210.67		-2302.7

Group-V		D+SD+E+B+W+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1715.00	1.750	3001.3
Backfill Soil Covering on Footing	D	1463.00	1.750	2560.3
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-15254.18	1.869	-28515.0
Total		-12076.18		-22953.4
Per 1 meter		-1207.62		-2295.3

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1715.00	1.750	3001.3
Backfill Soil Covering on Footing	D	1463.00	1.750	2560.3
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-15681.09	1.868	-29292.0
Total		-12503.09		-23730.4
Per 1 meter		-1250.31		-2373.0

Transverse Direction at Section-

Group-I		D+SD+L+CF+E+B		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1592.50	1.625	2587.8
Backfill Soil Covering on Footing	D	1358.50	1.625	2207.6
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-10131.78	1.65676275	-16786.0
Total		-7180.78		-11990.6
Per 1 meter		-718.08		-2077.0

Group-II		D+SD+E+B+W		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1592.50	1.625	2587.8
Backfill Soil Covering on Footing	D	1358.50	1.625	2207.6
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-8927.74	1.625	-14507.6
Total		-5976.74		-9712.2
Per 1 meter		-597.67		-1682.3

Group-III		D+SD+L+CF+E+B+0.3W+WL+LF		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1592.50	1.625	2587.8
Backfill Soil Covering on Footing	D	1358.50	1.625	2207.6
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-10747.94	1.655	-17787.2
Total		-7796.94		-12991.8
Per 1 meter		-779.69		-2250.4

Group-IV		D+SD+L+CF+E+B+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1592.50	1.625	2587.8
Backfill Soil Covering on Footing	D	1358.50	1.625	2207.6
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-10747.94	1.655	-17787.2
Total		-7796.94		-12991.8
Per 1 meter		-779.69		-2250.4

Group-V		D+SD+E+B+W+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1592.50	1.625	2587.8
Backfill Soil Covering on Footing	D	1358.50	1.625	2207.6
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-8927.74	1.625	-14507.6
Total		-5976.74		-9712.2
Per 1 meter		-597.67		-1682.3

Group-VI		D+SD+L+CF+E+B+0.3W+WL+LF+S+T		
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1592.50	1.625	2587.8
Backfill Soil Covering on Footing	D	1358.50	1.625	2207.6
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-10747.94	1.655	-17787.2
Total		-7796.94		-12991.8
Per 1 meter		-779.69		-2250.4

(4) Summary of Sectional Force for Load Factor Design

Longitudinal Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2229.50	1.750	3901.6
Backfill Soil Covering on Footing	D	1.300	1901.90	1.750	3328.3
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-14736.90	1.78650636	-26327.6
Total			-10605.50		-19097.7
Per 1 meter			-1060.55		-1909.8

Group-II		$\gamma(D+SD+E+B+W)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2229.50	1.750	3901.6
Backfill Soil Covering on Footing	D	1.300	1901.90	1.750	3328.3
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-14758.88	1.79809886	-26537.9
Total			-10627.48		-19308.0
Per 1 meter			-1062.75		-1930.8

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2229.50	1.750	3901.6
Backfill Soil Covering on Footing	D	1.300	1901.90	1.750	3328.3
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-14377.69	1.784	-25652.3
Total			-10246.29		-18422.4
Per 1 meter			-1024.63		-1842.2

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2229.50	1.750	3901.6
Backfill Soil Covering on Footing	D	1.300	1901.90	1.750	3328.3
Buoyancy	B	1.300	0.00	1.750	0.0
Ground Reaction	-	-	-17317.75	1.841	-31887.7
Total			-13186.35		-24657.8
Per 1 meter			-1318.64		-2465.8

Group-V		$\gamma(D+SD+E+B+W+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	2143.75	1.750	3751.6
Backfill Soil Covering on Footing	D	1.250	1828.75	1.750	3200.3
Buoyancy	B	1.250	0.00	1.750	0.0
Ground Reaction	-	-	-17023.06	1.845	-31410.1
Total			-13050.56		-24458.2
Per 1 meter			-1305.06		-2445.8

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	2143.75	1.750	3751.6
Backfill Soil Covering on Footing	D	1.250	1828.75	1.750	3200.3
Buoyancy	B	1.250	0.00	1.750	0.0
Ground Reaction	-	-	-19601.37	1.868	-36615.0
Total			-15628.87		-29663.1
Per 1 meter			-1562.89		-2966.3

Longitudinal Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1592.50
Backfill Soil Covering on Footing	D	1.300	1358.50
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-10714.57
Total			-7763.57
Per 1 meter			-776.36

Group-II		$\gamma(D+SD+E+B+W)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1592.50
Backfill Soil Covering on Footing	D	1.300	1358.50
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-10790.42
Total			-7839.42
Per 1 meter			-783.94

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1592.50
Backfill Soil Covering on Footing	D	1.300	1358.50
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-10441.68
Total			-7490.68
Per 1 meter			-749.07

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1592.50
Backfill Soil Covering on Footing	D	1.300	1358.50
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-12923.16
Total			-9972.16
Per 1 meter			-997.22

Group-V		$\gamma(D+SD+E+B+W+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1531.25
Backfill Soil Covering on Footing	D	1.250	1306.25
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-12726.01
Total			-9888.51
Per 1 meter			-988.85

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1531.25
Backfill Soil Covering on Footing	D	1.250	1306.25
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-14810.05
Total			-11972.55
Per 1 meter			-1197.26

Transverse Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2070.25	1.625	3364.2
Backfill Soil Covering on Footing	D	1.300	1766.05	1.625	2869.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-13610.65	1.65573749	-22535.7
Total			-9774.35		-16301.7
Per 1 meter			-977.44		-2823.8

Group-II		$\gamma(D+SD+E+B+W)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2070.25	1.625	3364.2
Backfill Soil Covering on Footing	D	1.300	1766.05	1.625	2869.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-11606.06	1.625	-18859.8
Total			-7769.76		-12625.8
Per 1 meter			-776.98		-2187.0

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2070.25	1.625	3364.2
Backfill Soil Covering on Footing	D	1.300	1766.05	1.625	2869.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-13972.32	1.655	-23123.4
Total			-10136.02		-16889.4
Per 1 meter			-1013.60		-2925.6

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.300	2070.25	1.625	3364.2
Backfill Soil Covering on Footing	D	1.300	1766.05	1.625	2869.8
Buoyancy	B	1.300	0.00	1.625	0.0
Ground Reaction	-	-	-13972.32	1.655	-23123.4
Total			-10136.02		-16889.4
Per 1 meter			-1013.60		-2925.6

Group-V		$\gamma(D+SD+E+B+W+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	1990.63	1.625	3234.8
Backfill Soil Covering on Footing	D	1.250	1698.13	1.625	2759.5
Buoyancy	B	1.250	0.00	1.625	0.0
Ground Reaction	-	-	-11159.68	1.625	-18134.5
Total			-7470.93		-12140.2
Per 1 meter			-747.09		-2102.9

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$			
		$\gamma \times \beta$	Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1.250	1990.63	1.625	3234.8
Backfill Soil Covering on Footing	D	1.250	1698.13	1.625	2759.5
Buoyancy	B	1.250	0.00	1.625	0.0
Ground Reaction	-	-	-13434.92	1.655	-22234.0
Total			-9746.17		-16239.7
Per 1 meter			-974.62		-2813.0

Transverse Direction at Section-

Group-I		$\gamma(D+SD+1.67L+CF+E+B)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1433.25
Backfill Soil Covering on Footing	D	1.300	1222.65
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-9587.28
Total			-6931.38
Per 1 meter			-693.14

Group-II		$\gamma(D+SD+E+B+W)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1433.25
Backfill Soil Covering on Footing	D	1.300	1222.65
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-8034.97
Total			-5379.07
Per 1 meter			-537.91

Group-III		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1433.25
Backfill Soil Covering on Footing	D	1.300	1222.65
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-9837.67
Total			-7181.77
Per 1 meter			-718.18

Group-IV		$\gamma(D+SD+L+CF+E+B+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.300	1433.25
Backfill Soil Covering on Footing	D	1.300	1222.65
Buoyancy	B	1.300	0.00
Ground Reaction	-	-	-9837.67
Total			-7181.77
Per 1 meter			-718.18

Group-V		$\gamma(D+SD+E+B+W+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1378.13
Backfill Soil Covering on Footing	D	1.250	1175.63
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-7725.93
Total			-5172.18
Per 1 meter			-517.22

Group-VI		$\gamma(D+SD+L+CF+E+B+0.3W+WL+LF+S+T)$	
		$\gamma \times \beta$	Vi(kN)
Self Weight of Footing	D	1.250	1378.13
Backfill Soil Covering on Footing	D	1.250	1175.63
Buoyancy	B	1.250	0.00
Ground Reaction	-	-	-9459.30
Total			-6905.55
Per 1 meter			-690.56

(5) Summary of Sectional Force for Seismic Design

Section- Longitudinal Direction				
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1715.00	1.750	3001.3
Backfill Soil Covering on Footing	D	1463.00	1.750	2560.3
Buoyancy	B	0.00	1.750	0.0
Ground Reaction	-	-22750.92	1.947	-44289.5
Total		-19572.92		-38727.9
Per 1 meter		-1957.29		-3872.8

Section- Transverse Direction				
		Vi(kN)	Xi(m)	Mi(kNm)
Self Weight of Footing	D	1592.50	1.625	2587.8
Backfill Soil Covering on Footing	D	1358.50	1.625	2207.6
Buoyancy	B	0.00	1.625	0.0
Ground Reaction	-	-21455.75	1.841	-39495.2
Total		-18504.75		-34699.8
Per 1 meter		-1850.48		-6010.7

Section- Longitudinal Direction		
		Vi(kN)
Self Weight of Footing	D	1225.00
Backfill Soil Covering on Footing	D	1045.00
Buoyancy	B	0.00
Ground Reaction	-	-17816.39
Total		-15546.39
Per 1 meter		-1554.64

Section- Transverse Direction		
		Vi(kN)
Self Weight of Footing	D	1592.50
Backfill Soil Covering on Footing	D	1358.50
Buoyancy	B	0.00
Ground Reaction	-	-16674.62
Total		-13723.62
Per 1 meter		-1372.36

(6) Calculation of Stress for Service Load Design and Seismic Design

Stress Equation

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h-x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^2 + \frac{2 \cdot n}{b} \{A_{s'} \cdot (x-d') + A_s \cdot (x-d)\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm), h = 2000mm

b : Width in section (mm), b = 1000mm

d : Effective height (mm)

d' : Concrete Cover (mm)

As : Sectional area of reinforcing bar arranged on tension side (mm²)

As' : Sectional area of reinforcing bar arranged on compression side (mm²)

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

σc: Compressive Stress of Concrete (N/mm²)

σs: Tensile Stress of Reinforcing (N/mm²)

M: Bending Moment (kN.m)

Bar Arrangement

		Longitudinal Direction		Transverse Direction	
Dimension	b(mm)	1000		1000	
	h(mm)	2000		2000	
	d1(mm)	1890		1920	
	d2(mm)	1790		1820	
Bar Arrangement	As1(mm ²)	8-D28	4926	8-D32	6434
	As2(mm ²)	4-D28	2463	4-D32	3217

Calculation Result of Bending Stress

	Longitudinal Direction					Remarks
	M (kNm)	σc (N/mm ²)	σs (N/mm ²)	σca (N/mm ²)	σsa (N/mm ²)	
Group-I	1686.2	3.59	131.50	9.60	168.00	OK
Group-II	1696.0	3.61	132.27	12.00	210.00	OK
Group-III	1620.6	3.45	126.38	12.00	210.00	OK
Group-IV	2613.2	5.56	203.79	12.00	210.00	OK
Group-V	2605.1	5.55	203.16	13.44	235.20	OK
Group-VI	2693.8	5.74	210.08	13.44	235.20	OK
Seismic Design	4372.4	9.31	340.99	20.40	378.00	OK

	Transverse Direction					Remarks
	M (kNm)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	2077.0	3.70	129.10	9.60	168.00	OK
Group-II	1682.3	3.00	104.57	12.00	210.00	OK
Group-III	2250.4	4.01	139.88	12.00	210.00	OK
Group-IV	2250.4	4.01	139.88	12.00	210.00	OK
Group-V	1682.3	3.00	104.57	13.44	235.20	OK
Group-VI	2250.4	4.01	139.88	13.44	235.20	OK
Seismic Design	6010.7	10.71	373.60	20.40	378.00	OK

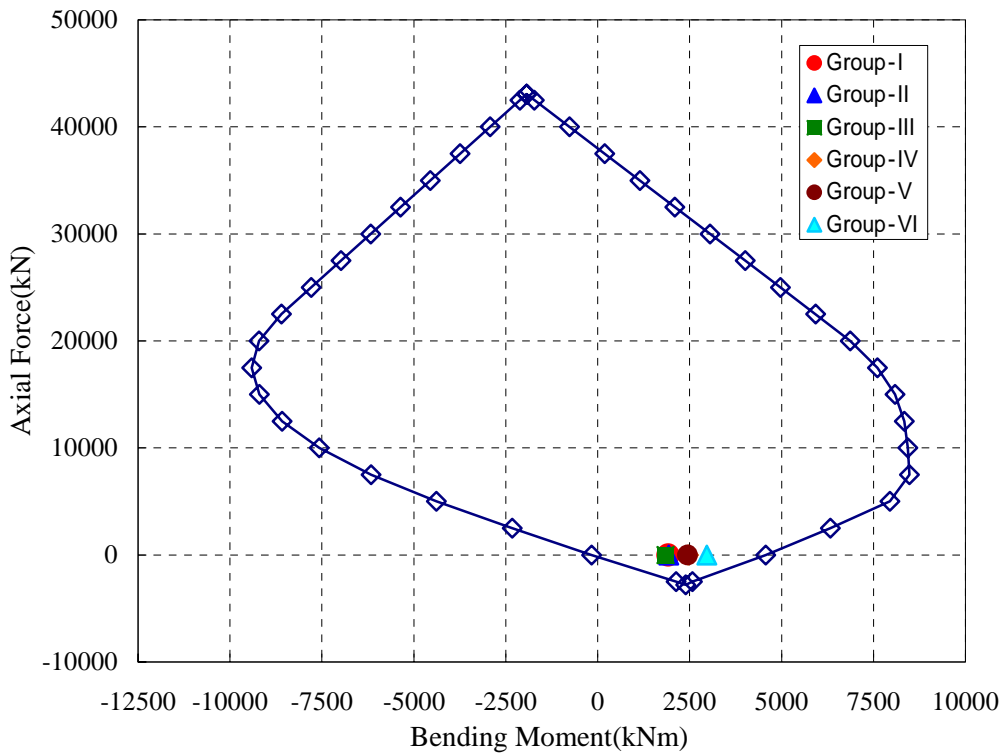
(6) Calculation of Strength for Load Factor Design

*) Flexural Strength

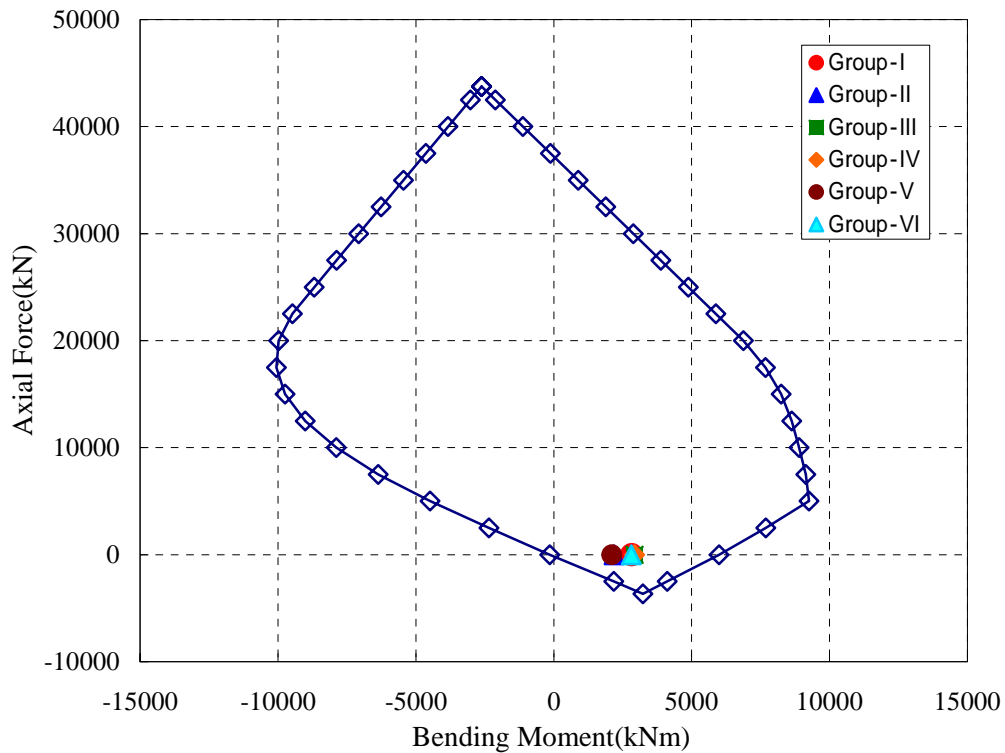
Factored Bending Moment for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	1909.8 kNm	2823.78 kNm
Group-II	1930.8 kNm	2187.04 kNm
Group-III	1842.2 kNm	2925.58 kNm
Group-IV	2465.8 kNm	2925.58 kNm
Group-V	2445.8 kNm	2102.93 kNm
Group-VI	2966.3 kNm	2813.04 kNm

Interaction of Longitudinal Direction



Interaction of Transverse Direction



*) Shear Strength

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 1/6 \times f_c)$$

$$= 1/6 \times f_c \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	776.4 kN	693.14 kN
Group-II	783.9 kN	537.91 kN
Group-III	749.1 kN	718.18 kN
Group-IV	997.2 kN	718.18 kN
Group-V	988.9 kN	517.22 kN
Group-VI	1197.3 kN	690.56 kN
Seismic Design	1554.6 kN	1372.36 kN

Calculation of Shear Strength

$$v_c = 1/6x \quad f_c = 1/6x \quad (24) = 0.816\text{N/mm}^2 \rightarrow 816\text{kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 1.000 \text{ m}$$

Longitudinal Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	776.4	1.000	1.790	1241.54	0.00	0.0
Group-II	783.9	1.000	1.790	1241.54	0.00	0.0
Group-III	749.1	1.000	1.790	1241.54	0.00	0.0
Group-IV	997.2	1.000	1.790	1241.54	0.00	0.0
Group-V	988.9	1.000	1.790	1241.54	0.00	0.0
Group-VI	1197.3	1.000	1.790	1241.54	0.00	0.0
Seismic Design	1554.6	1.000	1.790	1241.54	368.35	490.0

Arrangement of Stirrup D16 -ctc.500 804.25 mm²/m > 490 mm²/m

Transverse Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	693.1	1.000	1.820	1262.35	0.00	0.0
Group-II	537.9	1.000	1.820	1262.35	0.00	0.0
Group-III	718.2	1.000	1.820	1262.35	0.00	0.0
Group-IV	718.2	1.000	1.820	1262.35	0.00	0.0
Group-V	517.2	1.000	1.820	1262.35	0.00	0.0
Group-VI	690.6	1.000	1.820	1262.35	0.00	0.0
Seismic Design	1372.4	1.000	1.820	1262.35	129.42	169.3

Arrangement of Stirrup D16 -ctc.500 804.25 mm²/m > 169.3 mm²/m

4.6 Design of Wall

4.6.1 Summary of Sectional Force at Base of Wall

		Longitudinal Direction			Transverse Direction		
		N(kN)	S(kN)	M(kNm)	V(kN)	H(kN)	M(kNm)
Service Load Design	Group-I	19708.3	689.4	9510.8	18925.0	342.0	8690.6
	Group-II	19017.0	882.3	10971.5	19017.0	0.0	0.0
	Group-III	19708.3	613.7	7588.1	20820.9	342.0	8690.6
	Group-IV	18481.5	2960.1	36992.9	20820.9	342.0	8690.6
	Group-V	18573.5	2915.5	36622.4	19017.0	0.0	0.0
	Group-VI	19521.4	3128.5	36893.7	20820.9	342.0	8690.6
Load Factor Design	Group-I	26222.8	728.1	11091.7	25954.3	444.6	11297.8
	Group-II	24722.1	1147.0	14263.0	24722.1	0.0	0.0
	Group-III	25620.7	797.8	9864.6	27067.1	444.6	11297.8
	Group-IV	25169.4	2425.0	32039.5	27067.1	444.6	11297.8
	Group-V	23337.3	2572.9	32633.1	23771.2	0.0	0.0
	Group-VI	24401.7	3910.6	46117.1	26026.1	427.5	10863.2
Seismic Design		22198.3	6379.9	66557.7	20365.6	4464.2	70921.9

*) Sectional Force of Seismic Design is Calculated by Dynamic Analysis.

4.6.2 Calculation of Stress for Service Load Design and Seismic Design

Stress Equation

$$\sigma_c = \frac{N}{\frac{b \cdot x}{2} - n \cdot A_s \cdot \frac{d-x}{x} + n \cdot A_s' \cdot \frac{x-d'}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^3 - 3 \cdot \left(\frac{h}{2} - e \right) \cdot x^2 - \frac{6n}{b} \left\{ A_s' \cdot \left(\frac{h}{2} - d' - e \right) + A_s \cdot \left(\frac{h}{2} - d - e \right) \right\} \cdot x + \frac{6n}{b} \left\{ A_s' \cdot d' \cdot \left(\frac{h}{2} - d' - e \right) + A_s \cdot d \cdot \left(\frac{h}{2} - d - e \right) \right\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm)

b : Width in section (mm)

d : Effective height (mm)

d' : Concrete Cover (mm)

A_s : Sectional area of reinforcing bar arranged on tension side (mm²)

A_s' : Sectional area of reinforcing bar arranged on compression side (mm²)

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

e : Axis force eccentric distance (mm)

σ_c: Compressive Stress of Concrete (N/mm²)

σ_s: Tensile Stress of Reinforcing (N/mm²)

N: Axial Force (kN)

M: Bending Moment (kN.m)

Bar Arrangement

		Vertical Direction	Longitudinal Direction
Dimension	b(mm)	7500	2000
	h(mm)	2000	7500
	d1(mm)	1900	7400
	d2(mm)	1800	-
Bar Arrangement	As1(mm ²)	59-D32 47451	11-D32 8847
	As2(mm ²)	59-D32 47451	-

Calculation Result of Bending Stress

	Longitudinal Direction						Remarks
	M (kNm)	N (kN)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	9510.8	19708.3	3.25	7.10	9.60	168.00	OK
Group-II	10971.5	19017.0	3.56	13.71	12.00	210.00	OK
Group-III	7588.1	19708.3	2.85	1.23	12.00	210.00	OK
Group-IV	36992.9	18481.5	10.13	171.25	12.00	210.00	OK
Group-V	36622.4	18573.5	10.04	168.46	13.44	235.20	OK
Group-VI	36893.7	19521.4	10.15	166.60	13.44	235.20	OK
Seismic Design	66557.7	22198.3	17.68	352.26	20.40	378.00	OK

	Transverse Direction						Remarks
	M (kNm)	N (kN)	σ_c (N/mm ²)	σ_s (N/mm ²)	σ_{ca} (N/mm ²)	σ_{sa} (N/mm ²)	
Group-I	8690.6	18925.0	1.42	-10.17	9.60	168.00	OK
Group-II	0.0	19017.0	1.05	0.00	12.00	210.00	OK
Group-III	8690.6	20820.9	1.53	-11.74	12.00	210.00	OK
Group-IV	8690.6	20820.9	1.53	-11.74	12.00	210.00	OK
Group-V	0.0	19017.0	1.05	0.00	13.44	235.20	OK
Group-VI	8690.6	20820.9	1.53	-11.74	13.44	235.20	OK
Seismic Design	70921.9	20365.6	5.18	71.54	20.40	378.00	OK

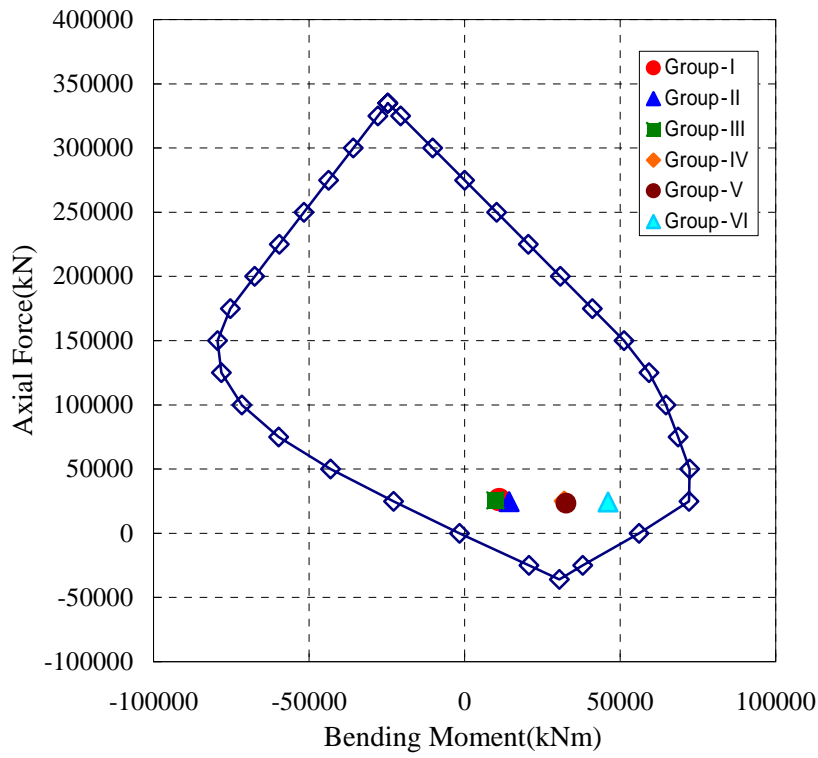
(6) Calculation of Strength for Load Factor Design

*) Flexural Strength

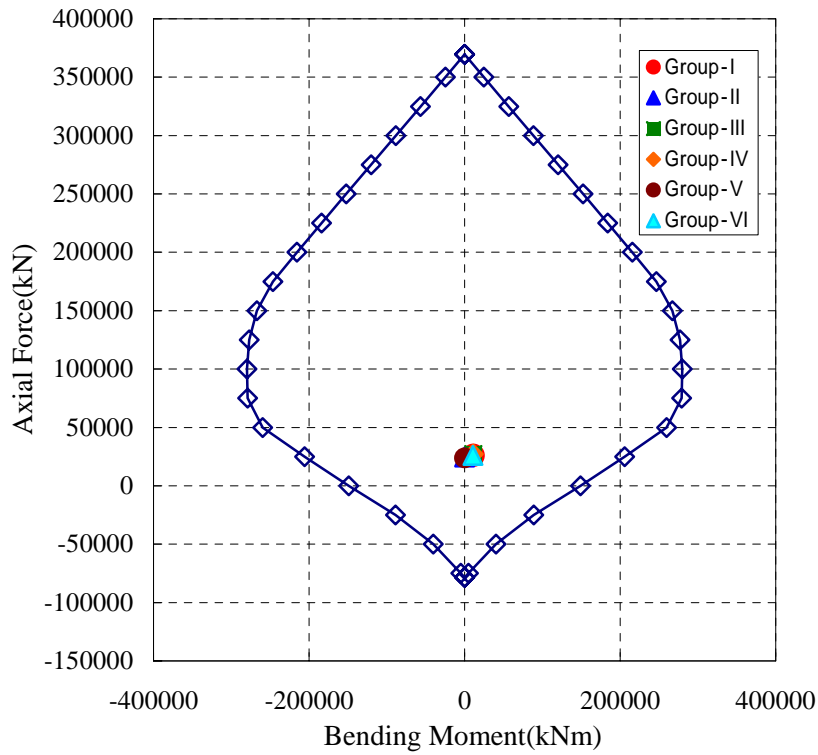
Factored Bending Moment for Load Factor Design

	Vertical Direction		Longitudinal Direction	
	M(kNm)	N(kN)	M(kNm)	N(kN)
Group-I	11091.7	26222.8	11297.8	25954.3
Group-II	14263.0	24722.1	0.0	24722.1
Group-III	9864.6	25620.7	11297.8	27067.1
Group-IV	32039.5	25169.4	11297.8	27067.1
Group-V	32633.1	23337.3	0.0	23771.2
Group-VI	46117.1	24401.7	10863.2	26026.1

Interaction of Longitudinal Direction



Interaction of Transverse Direction



*) Shear Strength

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 1/6 \times f_c)$$

$$= 1/6 \times f_c \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

	Longitudinal Direction	Transverse Direction
Group-I	728.1 kN	444.6 kN
Group-II	1147.0 kN	0.0 kN
Group-III	797.8 kN	444.6 kN
Group-IV	2425.0 kN	444.6 kN
Group-V	2572.9 kN	0.0 kN
Group-VI	3910.6 kN	427.5 kN
Seismic Design	6379.9 kN	4464.2 kN

Calculation of Shear Strength

$$v_c = 1/6 \times f_c = 1/6 \times (24) = 0.816 \text{ N/mm}^2 \rightarrow 816 \text{ kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 1.000 \text{ m}$$

Longitudinal Direction

	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	728.1	7.400	1.900	9752.0	0.0	0.0
Group-II	1147.0	7.400	1.900	9752.0	0.0	0.0
Group-III	797.8	7.400	1.900	9752.0	0.0	0.0
Group-IV	2425.0	7.400	1.900	9752.0	0.0	0.0
Group-V	2572.9	7.400	1.900	9752.0	0.0	0.0
Group-VI	3910.6	7.400	1.900	9752.0	0.0	0.0
Seismic Design	6379.9	7.400	1.900	9752.0	0.0	0.0

Arrangement of Stirr D16 -ctc.150 12064 mm²/m > 0 mm²/m

Transverse Direction

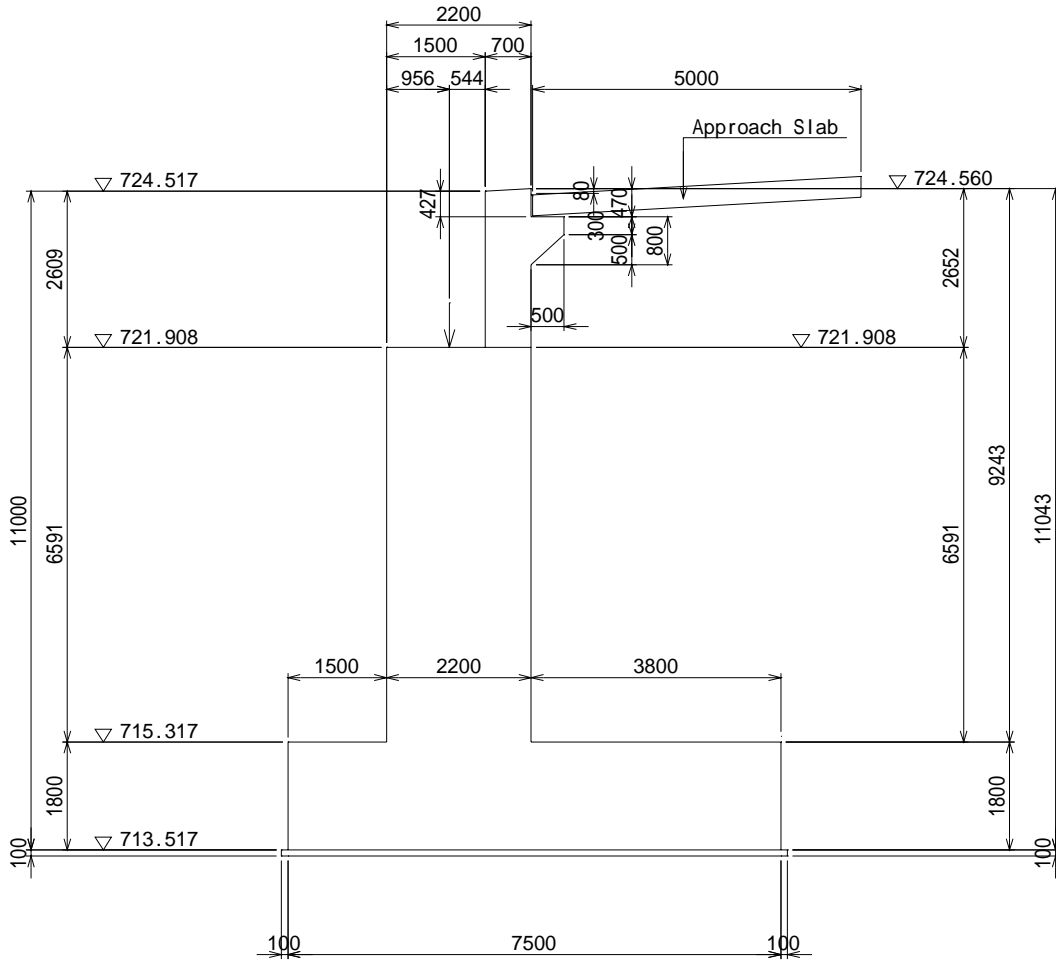
	Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Group-I	444.6	2.000	7.400	10265.3	0.0	0.0
Group-II	0.0	2.000	7.400	10265.3	0.0	0.0
Group-III	444.6	2.000	7.400	10265.3	0.0	0.0
Group-IV	444.6	2.000	7.400	10265.3	0.0	0.0
Group-V	0.0	2.000	7.400	10265.3	0.0	0.0
Group-VI	427.5	2.000	7.400	10265.3	0.0	0.0
Seismic Design	4464.2	2.000	7.400	10265.3	0.0	0.0

Arrangement of Stirrups D16 -c/c.250 2413 mm²/m > 0 mm²/m

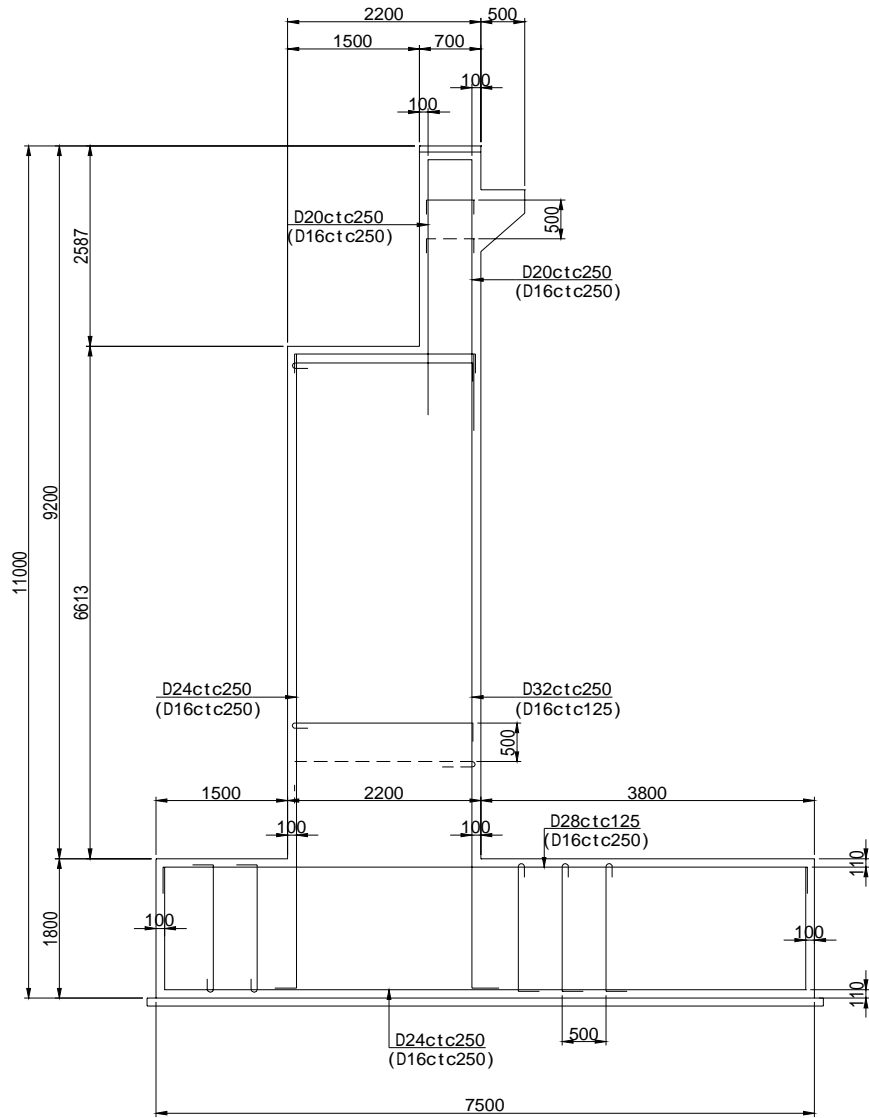
5 Design of A2 Abutment

5.1 General Arrangement

Side Elevation



5.1.1 Reinforcement Bar Arrangement



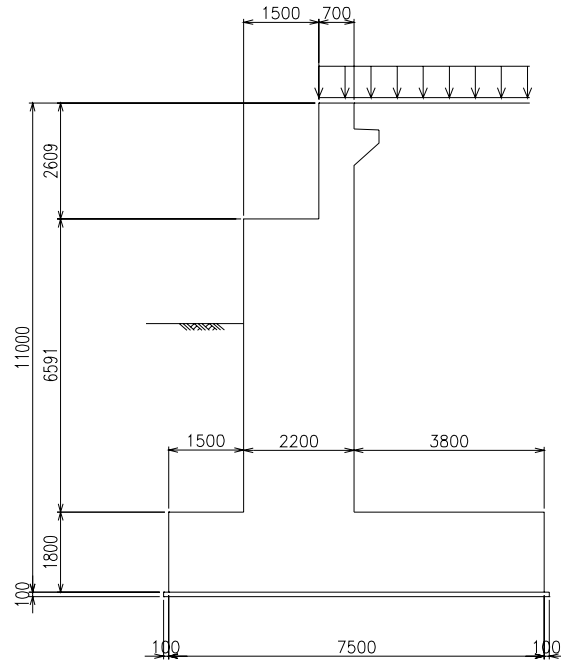
() Inside the reinforced concrete arrangement indicates of distribution direction

5.2 Loading Data

5.2.1 Type of Structure

- Reversed T Type Abutment

5.2.2 Configuration of Abutment



Transverse Width B (mm)	Left Projection length	Right Projection length
15.390	0.805	0.805

5.2.3 Material

【Concrete】 Parapet: $\sigma_{ck} = 24 \text{ (N/mm}^2\text{)}$
 Wall : $\sigma_{ck} = 24 \text{ (N/mm}^2\text{)}$
 Footing : $\sigma_{ck} = 24 \text{ (N/mm}^2\text{)}$
 Wing Wall: $\sigma_{ck} = 24 \text{ (N/mm}^2\text{)}$

【Reinforcement】 : Yield=420N/mm²

【Back Fill】 Internal Friction Angle $\phi = 30.00^\circ$

5.2.4 Loadings

(1) Unit Weight

【 Unit Weight 】

(kN/m³)

Concrete	24.5	
Water	10	
Soil	Wet Density	Saturated Density
Backfill(Front)	18.00	19.00
Backfill(Side)	19.00	20.00

(2) Superstructure Reaction

1. Vertical Reaction

Loadings		A2 Rz(kN)
Self Weight of Girder	D	4220.000
Superimposed Dead Load	SD	850.000
A Loading Maximum	L	780.000
Shrinkage	S	-110.000
Temperature	T	240.000

2. Horizontal Reaction for Longitudinal Direction

Loadings		A2 Rz(kN)
Shrinkage	S	0.000
Temperature	T	0.000
Longitudanal Force	LF	50.000
Centrifugal Force	CF	0.000
Earthquake	EQ	770.000

3. Horizontal Reaction for Transverse Direction

Loadings		A2 Rz(kN)
Centrifugal Force	CF	0.000

Combination Load Group			Reaction from Superstructure (kN)				
			Rd	Rex	RD=Rd+Rex	RL	RH
S.L.D		1.0D+1.0SD+1.0L	5070.000	0.000	5070.000	780.000	0.000
		1.0D+1.0SD	5070.000	0.000	5070.000	0.000	0.000
		1.0D+1.0SD+1.0L+1.0LF	5070.000	0.000	5070.000	780.000	50.000
		1.0D+1.0SD+1.0L+1.0CF+1.0S+1.0T	5070.000	0.000	5070.000	780.000	0.000
		1.0D+1.0SD+1.0S+1.0T	5070.000	0.000	5070.000	0.000	0.000
		1.0D+1.0SD+1.0L+1.0CF+1.0LF+1.0S+1.0T	5070.000	0.000	5070.000	780.000	50.000
		1.0D+1.0SD+EQ	5070.000	0.000	5070.000	0.000	770.000
L.F.D		(1.0D+1.0SD+1.67L)*1.3	6600.000	0.000	6600.000	1700.000	0.000
		(1.0D+1.0SD)*1.3	6600.000	0.000	6600.000	0.000	0.000
		(1.0D+1.0SD+1.0L+1.0CF+1.0LF)*1.3	6600.000	0.000	6600.000	1020.000	65.000
		(1.0D+1.0SD+1.0L+1.0CF+1.0S+1.0T)*1.3	6600.000	0.000	6600.000	1020.000	0.000
		(1.0D+1.0SD+1.0S+1.0T)*1.25	6340.000	0.000	6340.000	0.000	0.000
		(1.0D+1.0SD+1.0L+1.0CF+1.0LF+1.0S+1.0T)*1.25	6340.000	0.000	6340.000	975.000	62.500
		(1.0D+1.0SD+1.0EQ)*1.3	6600.000	0.000	6600.000	0.000	990.000

Rd : Dead Load

Rex : Other Dead Load

RD : Rd+Rex

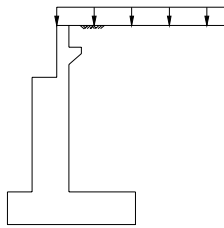
RL : Reaction of Live Load

RH : Horizontal Reaction

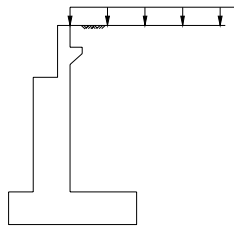
The stability check and the calculation of the stress are done by combining the load about the coloring part.

(3) Surcharge Load

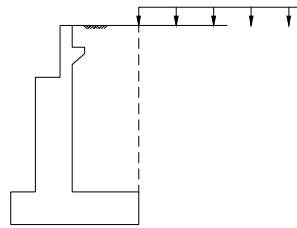
Combination Load Case		Surcharge Load (N/m ²)		Live Load Type		
		Dead Load Qd	Live Load Ql	a	b	c
S.L.D	Group	0.00	10			
	Group	0.00	10			
	Group	0.00	10			
	Group	0.00	10			
	Group	0.00	10			
	Group	0.00	10			
	Group	0.00	0.0	-		
L.F.D	Group	0.00	21.7			
	Group	0.00	13			
	Group	0.00	13			
	Group	0.00	13			
	Group	0.00	12.5			
	Group	0.00	12.5			
	Group	0.00	0.0	-		



TYPE A



TYPE B



TYPE C

5.2.5 Earth Pressure

(1) Coulomb's Formula

$$\delta=0.8\Phi=24.0^\circ$$

$$K_a = \frac{\cos^2(\phi - \theta)}{\cos^2 \theta \cos(\theta + \delta) \left\{ 1 + \sqrt{\frac{\sin(\phi + \delta) \sin(\phi - \alpha)}{\cos(\theta + \delta) \cos(\theta - \alpha)}} \right\}^2}$$

$$= \frac{\cos^2(30.000 - 0.000)}{\cos^2 0.000 \cos(0.000 + 30.000) \left\{ 1 + \sqrt{\frac{\sin(30.000 + 30.000) \sin(30.000 - (0.000))}{\cos(0.000 + 30.000) \cos(0.000 - (0.000))}} \right\}^2}$$

$$= 0.297$$

$$\delta=0.0^\circ$$

$$K_a = \frac{\cos^2(\phi - \theta)}{\cos^2 \theta \cos(\theta + \delta) \left\{ 1 + \sqrt{\frac{\sin(\phi + \delta) \sin(\phi - \alpha)}{\cos(\theta + \delta) \cos(\theta - \alpha)}} \right\}^2}$$

$$= \frac{\cos^2(30.000 - 0.000)}{\cos^2 0.000 \cos(0.000 + 0.000) \left\{ 1 + \sqrt{\frac{\sin(30.000 + 0.000) \sin(30.000 - (0.000))}{\cos(0.000 + 0.000) \cos(0.000 - (0.000))}} \right\}^2}$$

$$= 0.333$$

5.2.6 Water Pressure

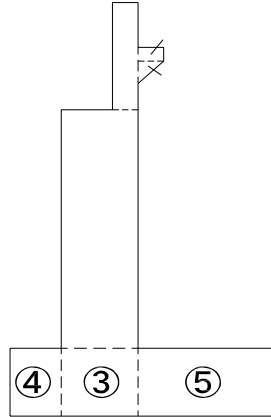
- The direction in the back hydraulic pressure where hydraulic pressure acts is made horizontal direction.

5.3 Calculation of acting force at footing bottom

(1) Block data that doesn't consider water level

1) Self Weight

a) Block dividing



b) Volum · Center of Gravity

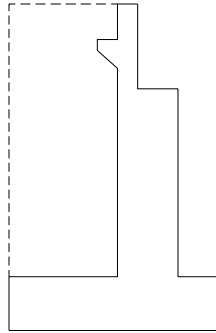
Division	Calculation formula Width × Height × Dept	Volume Vi(m ³)	Barycentric Position (m)		Vi · Xi	Vi · Yi
			Xi	Yi		
1	0.700 × 2.609 × 15.390	28.107	3.350	9.695	94.158	272.495
2	2.200 × 6.591 × 15.390	223.158	2.600	5.095	580.211	1136.990
3	2.200 × 1.800 × 17.000	67.320	2.600	0.900	175.032	60.588
4	1.500 × 1.800 × 17.000	45.900	0.750	0.900	34.425	41.310
5	3.800 × 1.800 × 17.000	116.280	5.600	0.900	651.168	104.652
6	0.500 × 0.300 × 12.728	1.909	3.950	10.423	7.541	19.898
7	1/2 × 0.500 × 0.500 × 12.728	1.591	3.867	10.106	6.152	16.079
Σ		484.265			1548.686	1652.011

Barycentric Position

$$XG = \frac{\sum(V_i \cdot X_i)}{\sum V_i} = \frac{1548.69}{484.27} = 3.198 \text{ (m)}$$

$$YG = \frac{\sum(V_i \cdot Y_i)}{\sum V_i} = \frac{1652.01}{484.47} = 3.412 \text{ (m)}$$

2) Rear Backfill Soil
a) Block dividing



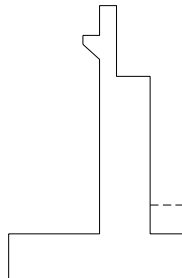
b) Volum • Center of Gravity

Division	Calculation Formula Width × Height × Dept	Volume Vi(m ³)	Barycentric Position (m)		Vi • Xi	Vi • Yi
			Xi	Yi		
1	3.800 × 9.200 × 15.390	538.034	5.600	6.400	3012.993	3443.420
2	- 0.500 × 0.300 × 12.728	-1.909	3.950	10.423	-7.541	-19.898
3	-1/2 × 0.500 × 0.500 × 12.728	-1.591	3.867	10.106	-6.152	-16.079
Σ		534.534			2999.300	3407.444

Barycentric Position $XG = \frac{\sum(V_i \cdot X_i)}{\sum V_i} = 5.611$ (m)
 $YG = \frac{\sum(V_i \cdot Y_i)}{\sum V_i} = 6.375$ (m)

3) Flont Backfill Soil

a) Block dividing



b) Volum • Center of Gravity

Division	Calculation Formula Width × Height × Dept	Volume Vi(m ³)	Barycentric Position (m)		Vi • Xi	Vi • Yi
			Xi	Yi		
1	1.500 × 4.200 × 15.390	96.957	0.750	3.900	72.7178	378.132
Σ		96.957			72.7178	378.132

Barycentric Position $XG = \frac{\sum(V_i \cdot X_i)}{\sum V_i} = 0.750$ (m)
 $YG = \frac{\sum(V_i \cdot Y_i)}{\sum V_i} = 3.900$ (m)

3) Side Backfill Soil

b) Volum • Center of Gravity

Division	Calculation Formula Width × Height × Dept	Volume Vi(m ³)	Barycentric Position (m)		Vi • Xi	Vi • Yi
			Xi	Yi		
1	6.000 × 4.200 × 1.610	40.572	4.500	3.900	182.574	158.231
2	0.500 × 2.500 × 5.000 × 1.610	10.063	3.867	7.667	38.912	77.149
3	2.800 × 5.000 × 1.610	22.540	6.100	8.500	137.494	191.590
4	1.500 × 4.200 × 1.610	10.143	0.750	3.900	7.607	39.558
Σ		83.318			366.587	466.528

Barycentric Position $XG = \frac{\sum(V_i \cdot X_i)}{\sum V_i} = 4.400$ (m)
 $YG = \frac{\sum(V_i \cdot Y_i)}{\sum V_i} = 5.599$ (m)

(2) Vertical Force and Horizontal Force of Self-Weight, Buoyancy

1) Acting force by self-weight

Vertical Force = $\gamma \cdot V = 24.50 \times 484.265 = 11864.493$ (kN)
 Point of application X = 3.198 (m)

2) Acting force by buoyancy of backfill soil

Vertical Force $W = W_u + W_l$ (kN)
 $W_u = V_u$ (Volum of Above water of Above water) • γ (Wet density) (kN)
 $W_l = V_l$ (Volum of below water.) • γ_{sat} (Saturation density) (kN)
 Point of application X = $(W_u \cdot X_u + W_l \cdot X_l) / W$ (m)

Horizontal force $H = W \cdot K_h$ (kN)
 Point of application Y = $(W_u \cdot Y_u + W_l \cdot Y_l) / W$ (m)

Position	Total Volum, Barycentric Position			Volum of below water		
	Volume	Barycentric Position (m)		Volume	Barycentric Position (m)	
	V(m ³)	X	Y	V(m ³)	X	Y
Backfill(Rear)	534.534	5.611	6.375	0.000	0.000	0.000
Backfill(Flont)	96.957	0.750	3.900	0.000	0.000	0.000
Backfill(Side)	83.318	4.373	5.599	0.000	0.000	0.000

Position	Volum of Above water		
	Volume	Barycentric Position (m)	
	V(m ³)	X	Y
Backfill(Rear)	534.534	5.611	6.375
Backfill(Flont)	96.957	0.750	3.900
Backfill(Side)	83.318	4.400	5.599

Position	Weight of above water level $W_u = V_u \times \gamma$ (kN)	Weight of below waterlevel $W_l = V_l \times \gamma_{sat}$ (kN)
	Backfill(Rear)	$534.534 \times 19.000 = 10156.150$
Backfill(Flont)	$103.882 \times 18.000 = 1745.226$	$0.000 \times 20.000 = 0.000$
Backfill(Side)	$86.940 \times 18.000 = 1499.715$	$0.000 \times 20.000 = 0.000$

Position	Vertical Force:W W _u +W _l (kN)	Point of application X(m)
Backfill(Rear)	$10156.150 + 0.000 = 10156.150$	5.611
Backfill(Flont)	$1745.226 + 0.000 = 1745.226$	0.750
Backfill(Side)	$1499.715 + 0.000 = 1499.715$	4.400

Position	Horizontal Force:W W*kh(kN)	Point of apprication X(m)
Backfill(Rear)	$10156.150 \times 0.160 = 1624.984$	6.375
Backfill(Flont)	$1745.226 \times 0.000 = 0.000$	3.900
Backfill(Side)	$1499.715 \times 0.000 = 0.000$	5.599

(3) Surcharge load

Vertical Force

$$N = q \cdot L \cdot B$$

Point of application

$$X = Ls + \frac{L}{2.0}$$

in which,

q: Ground level surcharge load

qd : Ground level surcharge load(dead load)

ql : Ground level surcharge load(live load)

B: Surcharge load length at transvers direction, B = 24.800 (m)

Ls: Distance from design section to load action position

L: Length on which load acts(m)

Surcharge	q (kN/m ²)	Ls (m)	L (m)	Vertical Force N (kN)	Point of application X (m)
ql(a)	10.000	3.000	4.500	692.550	5.250
ql(b)	10.000	3.700	3.800	54.820	5.600

(4) Earth pressure and hydraulic pressure

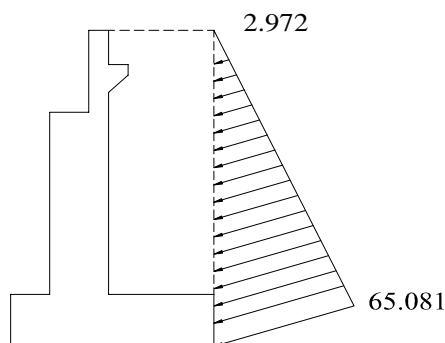
[1] S.L.D Group ,

1) Common data

Unit weight of water	γ_w (kN/m ³)	10.000
Width of soil pressure action	Bc (m)	17.000
Height in which soil pressure is not considered	hr (m)	0.000
Cohesion of soil	C (kN/m ²)	0.000

2) Earth pressure

a) Bouyancy is not taken into consideration.



Data for Earth pressure calculation- bouyancy not considered

Surcharge load	q (kN/m ²)	10.000
Height from rear water level to top of abutment	H1 (m)	11.000
Height from rear water level to bottom of Footing	H2 (m)	0.000
Height of rear water level	Hs (m)	0.000

Calculation Result of Earth Pressure

Item			
Parameter	HU(m)	HU(m)	11.000
	HL(m)	HL(m)	0.000
	Height from water level of the back to the top	h1(m)	11.000
	Height from Water level of the back to the lower side of Footing	h2(m)	0.000
	Height of water level of the back	hs(m)	0.000
	Height in which soil pressure is not considered	hr(m)	0.000
	Intersection angle of abutment wall and vertical	θ (deg.)	0.000
	Friction angle of soil and wall	δ (deg.)	30.000
	Wet density of backfill soil (kN/m ³)	γt	19.000
	Saturation density of backfill soil (kN/m ³)	γsat	20.000
Action starting point of earth pressure (X-Coordinates)	Xp(m)	7.500	
Coefficient of Earth Pressure	Coefficient of earth pressure above water level (upper)	Ku1	0.29717
	(lower)	Kl1	0.29717
	Coefficient of earth pressure below water level (upper)	Ku2	0.29717
	(lower)	Kl2	0.29717
Earth Pressure Strength	[1] Earth pressure strength above water level (upper)		2.972
	[2] Earth pressure strength above water level (lower)		65.081
	[3] Earth pressure strength below water level (upper)		0.000
	[4] Earth pressure strength below water level (lower)		0.000
Earth Pressure Force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc		6362.92
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc		0.00
	Pe = Pe1+Pe2		6362.92
	Peh = Pe · cos(δ+θ) (Horizontal element of earth pressure)		5510.45
	Pev = Pe · sin(δ+θ) (Vertical element of earth pressure)		3181.46
Point of application	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr		3.827
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr		0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe		3.827
	X = Xp - Y tanθ		7.500

• Point of application

$$X = \frac{\sum(P_{ev} \cdot X)}{\sum P_{ev}} = 7.500 \quad (\text{m})$$

$$Y = \frac{\sum(P_{eh} \cdot Y)}{\sum P_{eh}} = 3.827 \quad (\text{m})$$

• Earth Pressure Force

Vertical Force

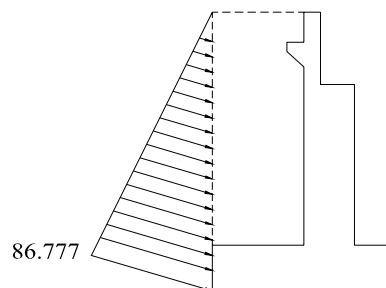
$$P_v = \sum P_{ev} = 3181.45 \quad (\text{kN})$$

Horizontal Force

$$P_h = \sum P_{eh} = 5510.45 \quad (\text{kN})$$

[2] S.L.D Group

During Earthquake-Bouyancy is not taken into consideration.



Data for Earth pressure calculation- buoyancy not considered

Surcharge load	q (kN/m ²)	0.000
Height from rear water level to top of abutment	H1 (m)	11.000
Height from rear water level to bottom of Footing	H2 (m)	0.000
Height of rear water level	Hs (m)	0.000

Calculation Result of Earth Pressure

Item			
Parameter	HU(m)	HU(m)	11.000
	HL(m)	HL(m)	0.000
	Height from water level of the back to the top	h1(m)	11.000
	Height from Water level of the back to the lower side of Footing	h2(m)	0.000
	Height of water level of the back	hs(m)	0.000
	Height in which soil pressure is not considered	hr(m)	0.000
	Intersection angle of abutment wall and vertical	θ (deg.)	0.000
	Friction angle of soil and wall	δ (deg.)	15.000
	Wet density of backfill soil (kN/m ³)	γt	19.000
	Saturation density of backfill soil (kN/m ³)	γsat	20.000
Action starting point of earth pressure (X-Coordinates)	Xp(m)	7.500	
Coefficient of Earth Pressure	Coefficient of earth pressure above water level (upper)	Ku1	0.4152
	(lower)	Kl1	0.4152
	Coefficient of earth pressure below water level (upper)	Ku2	0.4152
	(lower)	Kl2	0.4152
Earth Pressure Strength	[1] Earth pressure strength above water level (upper)		0.000
	[2] Earth pressure strength above water level (lower)		86.777
	[3] Earth pressure strength below water level (upper)		0.000
	[4] Earth pressure strength below water level (lower)		0.000
Earth Pressure Force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc		8113.63
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc		0.00
	Pe = Pe1+Pe2		8113.63
	Peh = Pe · cos(δ+θ) (Horizontal element of earth pressure)		7837.17
	Pev = Pe · sin(δ+θ) (Vertical element of earth pressure)		2099.96
Point of application	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr		3.667
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr		0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe		3.667
	X = Xp - Y tanθ		7.500

- Point of application

$$X = \frac{\Sigma(P_{ev} * X)}{\Sigma P_{ev}} = 7.500 \quad (\text{m})$$

$$Y = \frac{\Sigma(P_{eh} * Y)}{\Sigma P_{eh}} = 3.667 \quad (\text{m})$$

- Earth Pressure Force

Vertical Force

$$P_v = \Sigma P_{ev} = 2099.96 \quad (\text{kN})$$

Horizontal Force

$$P_h = \Sigma P_{eh} = 7837.17 \quad (\text{kN})$$

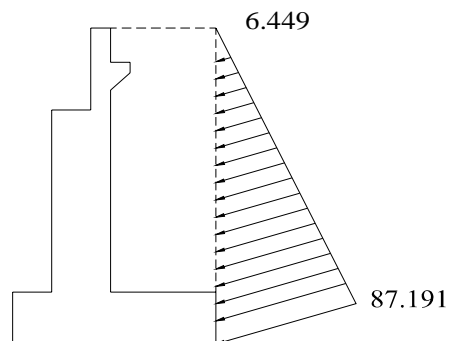
[3] L.F.D Group

Common data

Unit weight of water	$\gamma_w (\text{kN/m}^3)$	10.000
Width of soil pressure action	$B_c \quad (\text{m})$	17.000
Height in which soil pressure is not considered	$h_r \quad (\text{m})$	0.000
Cohesion of soil	$C \quad (\text{kN/m}^2)$	0.000

2) Earth pressure

- a) Bouyancy is not taken into consideration.



Data for Earth pressure calculation- buoyancy not considered

Surcharge load	$q \quad (\text{kN/m}^2)$	21.700
Height from rear water level to top of abutment	$H_1 \quad (\text{m})$	11.000
Height from rear water level to bottom of Footing	$H_2 \quad (\text{m})$	0.000
Height of rear water level	$H_s \quad (\text{m})$	0.000

Calculation Result of Earth Pressure

Item			
Parameter	HU(m)	HU(m)	11.000
	HL(m)	HL(m)	0.000
	Height from water level of the back to the top	h1(m)	11.000
	Height from Water level of the back to the lower side of Footing	h2(m)	0.000
	Height of water level of the back	hs(m)	0.000
	Height in which soil pressure is not considered	hr(m)	0.000
	Intersection angle of abutment wall and vertical	θ (deg.)	0.000
	Friction angle of soil and wall	δ (deg.)	30.000
	Wet density of backfill soil (kN/m ³)	γ_t	24.700
	Saturation density of backfill soil (kN/m ³)	γ_{sat}	26.000
Action starting point of earth pressure (X-Coordinates)	Xp(m)	7.500	
Coefficient of Earth Pressure	Coefficient of earth pressure above water level (upper)	Ku1	0.29717
	(lower)	Kl1	0.29717
	Coefficient of earth pressure below water level (upper)	Ku2	0.29717
	(lower)	Kl2	0.29717
Earth Pressure Strength	[1] Earth pressure strength above water level (upper)		6.449
	[2] Earth pressure strength above water level (lower)		87.191
	[3] Earth pressure strength below water level (upper)		0.000
	[4] Earth pressure strength below water level (lower)		0.000
Earth Pressure Force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc		8755.27
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc		0.00
	Pe = Pe1+Pe2		8755.27
	Peh = Pe · cos(δ + θ) (Horizontal element of earth pressure)		7582.28
	Pev = Pe · sin(δ + θ) (Vertical element of earth pressure)		4377.63
Point of application	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr		3.919
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr		0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe		3.919
	X = Xp - Y tan θ		7.500

• Point of application

$$X = \frac{\sum(P_{ev} \cdot X)}{\sum P_{ev}} = 7.500 \quad (\text{m})$$

$$Y = \frac{\sum(P_{eh} \cdot Y)}{\sum P_{eh}} = 3.919 \quad (\text{m})$$

• Earth Pressure Force

Vertical Force

$$P_v = \sum P_{ev} = 4377.63 \quad (\text{kN})$$

Horizontal Force

$$P_h = \sum P_{eh} = 7582.28 \quad (\text{kN})$$

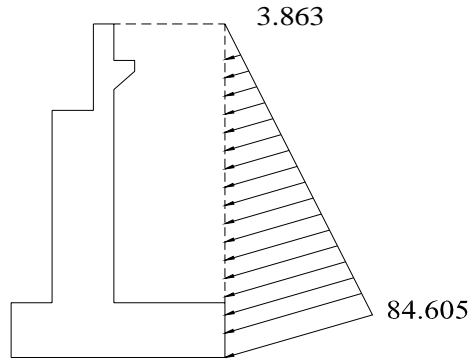
[4] L.F.D Group

Common data

Unit weight of water	γ_w (kN/m ³)	10.000
Width of soil pressure action	Bc (m)	17.000
Height in which soil pressure is not considered	hr (m)	0.000
Cohesion of soil	C (kN/m ²)	0.000

2) Earth pressure

a) Bouyancy is not taken into consideration.



Data for Earth pressure calculation- buoyancy not considered

Surcharge load	q (kN/m ²)	13.000
Height from rear water level to top of abutment	H1 (m)	11.000
Height from rear water level to bottom of Footing	H2 (m)	0.000
Height of rear water level	Hs (m)	0.000

Calculation Result of Earth Pressure

Item			
Parameter	HU(m)	HU(m)	11.000
	HL(m)	HL(m)	0.000
	Height from water level of the back to the top	h1(m)	11.000
	Height from Water level of the back to the lower side of Footing	h2(m)	0.000
	Height of water level of the back	hs(m)	0.000
	Height in which soil pressure is not considered	hr(m)	0.000
	Intersection angle of abutment wall and vertical	θ (deg.)	0.000
	Friction angle of soil and wall	δ (deg.)	30.000
	Wet density of backfill soil (kN/m ³)	γ_t	24.700
	Saturation density of backfill soil (kN/m ³)	γ_{sat}	26.000
Action starting point of earth pressure (X-Coordinates)	Xp(m)	7.500	
Coefficient of Earth Pressure	Coefficient of earth pressure above water level (upper)	Ku1	0.29717
	(lower)	Kl1	0.29717
	Coefficient of earth pressure below water level (upper)	Ku2	0.29717
	(lower)	Kl2	0.29717
Earth Pressure Strength	[1] Earth pressure strength above water level (upper)		3.863
	[2] Earth pressure strength above water level (lower)		84.605
	[3] Earth pressure strength below water level (upper)		0.000
	[4] Earth pressure strength below water level (lower)		0.000
Earth Pressure Force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc		8271.79
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc		0.00
	Pe = Pe1+Pe2		8271.79
	Peh = Pe · cos(δ + θ) (Horizontal element of earth pressure)		7163.58
	Pev = Pe · sin(δ + θ) (Vertical element of earth pressure)		4135.90
Point of application	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr		3.827
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr		0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe		3827.000
	X = Xp - Y tan θ		7.500

• Point of application

$$X = \frac{\sum(P_{ev} \cdot X)}{\sum P_{ev}} = 7.500 \quad (\text{m})$$

$$Y = \frac{\sum(P_{eh} \cdot Y)}{\sum P_{eh}} = 3.827 \quad (\text{m})$$

• Earth Pressure Force

Vertical Force

$$P_v = \sum P_{ev} = 4135.90 \quad (\text{kN})$$

Horizontal Force

$$P_h = \sum P_{eh} = 7163.58 \quad (\text{kN})$$

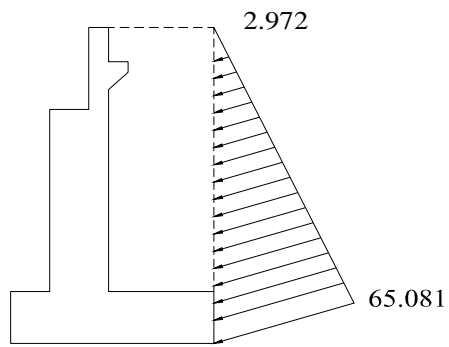
[5] L.F.D Group

Common data

Unit weight of water	γ_w (kN/m ³)	10.000
Width of soil pressure action	Bc (m)	17.000
Height in which soil pressure is not considered	hr (m)	0.000
Cohesion of soil	C (kN/m ²)	0.000

2) Earth pressure

a) Bouyancy is not taken into consideration.



Data for Earth pressure calculation- buoyancy not considered

Surcharge load	q (kN/m ²)	0.000
Height from rear water level to top of abutment	H1 (m)	11.000
Height from rear water level to bottom of Footing	H2 (m)	0.000
Height of rear water level	Hs (m)	0.000

Calculation Result of Earth Pressure

Item			
Parameter	HU(m)	HU(m)	11.000
	HL(m)	HL(m)	0.000
	Height from water level of the back to the top	h1(m)	11.000
	Height from Water level of the back to the lower side of Footing	h2(m)	0.000
	Height of water level of the back	hs(m)	0.000
	Height in which soil pressure is not considered	hr(m)	0.000
	Intersection angle of abutment wall and vertical	θ (deg.)	0.000
	Friction angle of soil and wall	δ (deg.)	30.000
	Wet density of backfill soil (kN/m ³)	γ_t	24.700
	Saturation density of backfill soil (kN/m ³)	γ_{sat}	26.000
Action starting point of earth pressure (X-Coordinates)	Xp(m)	7.500	
Coefficient of Earth Pressure	Coefficient of earth pressure above water level (upper)	Ku1	0.29717
	(lower)	Kl1	0.29717
	Coefficient of earth pressure below water level (upper)	Ku2	0.29717
	(lower)	Kl2	0.29717
Earth Pressure Strength	[1] Earth pressure strength above water level (upper)		0.000
	[2] Earth pressure strength above water level (lower)		112.810
	[3] Earth pressure strength below water level (upper)		0.000
	[4] Earth pressure strength below water level (lower)		0.000
Earth Pressure Force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc		10547.72
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc		0.00
	Pe = Pe1+Pe2		10547.72
	Peh = Pe · cos(δ + θ) (Horizontal element of earth pressure)		10188.32
	Pev = Pe · sin(δ + θ) (Vertical element of earth pressure)		2729.95
Point of application	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr		3.667
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr		0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe		3667.000
	X = Xp - Y tan θ		7.500

• Point of application

$$X = \frac{\sum(P_{ev} \cdot X)}{\sum P_{ev}} = 7.500 \quad (\text{m})$$

$$Y = \frac{\sum(P_{eh} \cdot Y)}{\sum P_{eh}} = 3.667 \quad (\text{m})$$

• Earth Pressure Force

Vertical Force

$$P_v = \sum P_{ev} = 2729.95 \quad (\text{kN})$$

Horizontal Force

$$P_h = \sum P_{eh} = 10188.32 \quad (\text{kN})$$

(5) Summary of Acting Force

1) Total Acting Force at Bottom of Footing

[1] S.L.D Group

Loadings	Vertical Force	Horizontal Force	Arm Length		Rotation Moment(kN.m)	
	V_i (kN)	H_i (kN)	X_i (m)	Y_i (m)	$M_{xi}= V_i \cdot X_i$	$M_{yi}= H_i \cdot Y_i$
Self Weight	11,864.493	0.000	3.198	3.412	37,942.649	0.000
Front Backfill	1,745.226	0.000	0.750	0.000	1,308.920	0.000
Side Backfill	1,499.715	0.000	4.400	0.000	6,598.505	0.000
Rear back Soil	10,156.150	0.000	5.611	0.000	56,986.691	0.000
Backfill Total	13,401.091	0.000	-	-	64,894.115	0.000
Superstructure Reaction	5,850.000	0.000	2.456	9.891	14,367.600	0.000
Surcharge D	0.000	0.000	5.250	11.000	0.000	0.000
Surcharge L	692.550	0.000	5.250	11.000	3,635.888	0.000
Other Load	0.000	0.000	0.000	0.000	0.000	0.000
Earth Pressure	3,181.459	5,510.449	7.500	3.827	23,860.943	21,087.293
Back Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Front Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Buoyancy	0.000	0.000	0.000	0.000	0.000	0.000
Total	34,989.593	5,510.449			144,701.194	21,087.293

[2]S.L.D Group

Loadings	Vertical Force	Horizontal Force	Arm Length		Rotation Moment(kN.m)	
	V_i (kN)	H_i (kN)	X_i (m)	Y_i (m)	$M_{xi}= V_i \cdot X_i$	$M_{yi}= H_i \cdot Y_i$
Self Weight	11,864.493	0.000	3.198	3.412	37,942.649	0.000
Front Backfill	1,745.226	0.000	0.750	0.000	1,308.920	0.000
Side Backfill	1,499.715	0.000	4.400	0.000	6,598.505	0.000
Rear back Soil	10,156.150	0.000	5.611	0.000	56,986.691	0.000
Backfill Total	13,401.091	0.000	-	-	64,894.115	0.000
Superstructure Reaction	5,850.000	50.000	2.456	9.891	14,367.600	494.550
Surcharge D	0.000	0.000	5.250	11.000	0.000	0.000
Surcharge L	692.550	0.000	5.250	11.000	3,635.888	0.000
Other Load	0.000	0.000	0.000	0.000	0.000	0.000
Earth Pressure	3,181.459	5,510.449	7.500	3.827	23,860.943	21,087.293
Back Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Flont Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Buoyancy	0.000	0.000	0.000	0.000	0.000	0.000
Total	34,989.593	5,560.449			144,701.194	21,581.843

[3]S.L.D Group

Loadings	Vertical Force	Horizontal Force	Arm Length		Rotation Moment(kN.m)	
	V_i (kN)	H_i (kN)	X_i (m)	Y_i (m)	$M_{xi}= V_i \cdot X_i$	$M_{yi}= H_i \cdot Y_i$
Self Weight	11,864.493	2,372.899	3.198	3.412	37,942.649	8,096.330
Front Backfill	1,745.226	0.000	0.750	0.000	1,308.920	0.000
Side Backfill	1,499.715	0.000	4.400	0.000	6,598.505	0.000
Rear back Soil	10,156.150	1,624.984	5.611	6.375	56,986.691	10,359.273
Backfill Total	13,401.091	1,624.984	-	-	64,894.115	10,359.273
Superstructure Reaction	5,070.000	770.000	2.456	9.891	12,451.920	7,616.070
Surcharge D	0.000	0.000	0.000	11.000	0.000	0.000
Surcharge L	0.000	0.000	0.000	11.000	0.000	0.000
Other Load	0.000	0.000	0.000	0.000	0.000	0.000
Earth Pressure	2,099.962	7,837.166	7.500	3.667	15,749.715	28,736.275
Back Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Flont Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Buoyancy	0.000	0.000	0.000	0.000	0.000	0.000
Total	32,435.546	12,605.049			131,038.399	54,807.948

[4]L.F.D Group

Loadings	Vertical Force	Horizontal Force	Arm Length		Rotation Moment(kN.m)	
	V_i (kN)	H_i (kN)	X_i (m)	Y_i (m)	$M_{xi}= V_i \cdot X_i$	$M_{yi}= H_i \cdot Y_i$
Self Weight	15,423.841	0.000	3.198	3.412	49,325.443	0.000
Front Backfill	2,268.794	0.000	0.750	0.000	1,701.595	0.000
Side Backfill	1,949.630	0.000	4.400	0.000	8,578.056	0.000
Rear back Soil	13,202.995	0.000	5.611	6.375	74,082.698	0.000
Backfill Total	17,421.418	0.000	-	-	84,362.349	0.000
Superstructure Reaction	8,300.000	0.000	2.456	9.891	20,384.800	0.000
Surcharge D	0.000	0.000	0.000	11.000	0.000	0.000
Surcharge L	900.315	0.000	5.250	11.000	4,726.654	0.000
Other Load	0.000	0.000	0.000	0.000	0.000	0.000
Earth Pressure	4,377.632	7,582.282	7.500	3.919	32,832.240	29,714.963
Back Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Flont Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Buoyancy	0.000	0.000	0.000	0.000	0.000	0.000
Total	46,423.206	7,582.282			191,631.486	29,714.963

[5]L.F.D Group

Loadings	Vertical Force	Horizontal Force	Arm Length		Rotation Moment(kN.m)	
	V_i (kN)	H_i (kN)	X_i (m)	Y_i (m)	$M_{xi}= V_i \cdot X_i$	$M_{yi}= H_i \cdot Y_i$
Self Weight	15,423.841	0.000	3.198	3.412	49325.443	0.000
Front Backfill	2,268.794	0.000	0.750	0.000	1701.595	0.000
Side Backfill	1,949.630	0.000	4.400	0.000	8578.056	0.000
Rear back Soil	13,202.995	0.000	5.611	6.375	74082.698	0.000
Backfill Total	17,421.418	0.000	-	0.000	84362.349	0.000
Superstructure Reaction	7,620.000	65.000	2.456	9.891	18714.720	642.915
Surcharge D	0.000	0.000	0.000	11.000	0.000	0.000
Surcharge L	900.315	0.000	5.250	11.000	4726.654	0.000
Other Load	0.000	0.000	0.000	0.000	0.000	0.000
Earth Pressure	4,135.897	7,163.584	7.500	3.827	31019.225	27415.035
Back Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Flont Hydraulic Pressure	0.000	0.000	0.000	0.000	0.000	0.000
Buoyancy	0.000	0.000	0.000	0.000	0.000	0.000
Total	45,501.471	7,228.584			188148.392	28057.950

[6]L.F.D Group

Loadings	Vertical Force	Horizontal Force	Arm Length		Rotation Moment(kN.m)	
	V_i (kN)	H_i (kN)	X_i (m)	Y_i (m)	$M_{xi}= V_i \cdot X_i$	$M_{yi}= H_i \cdot Y_i$
Self Weight	15,423.841	3,084.768	3.198	3.412	49,325.443	10,525.229
Front Backfill	2,268.794	0.000	0.750	0.000	1,701.595	0.000
Side Backfill	1,949.630	0.000	0.000	0.000	0.000	0.000
Rear back Soil	13,202.995	2,112.479	5.611	6.375	74,082.005	13,466.210
Backfill Total	17,421.418	2,112.479	-	-	75,783.600	13,466.210
Superstruture Reaction	6,600.000	990.000	2.456	9.891	16,209.600	9,792.090
Surcharge D	0.000	0.000	0.000	0.000	0.000	0.000
Surcharge L	900.315	0.000	0.000	0.000	0.000	0.000
Other Load	0.000	0.000	0.000	0.000	0.000	0.000
Earth Pressure	2,729.951	10,188.316	7.500	3.667	20,474.630	37,360.554
Back Hydraulic Pressure	0.000	0.000	0.000	0.400	0.000	0.000
Flont Hydraulic Pressure	0.000	0.000	0.000	0.400	0.000	0.000
Buoyancy	0.000	0.000	2.250	0.000	0.000	0.000
Total	43,075.525	16,375.563			161,793.273	71,144.083

2) Total Force at Footing center

Vertical Force : $V_B = V_o$ (kN)
 Horizontal Force : $H_B = H_o$ (kN)
 Rotation Moment : $M_B = V_o \cdot B_j/2.0 + M_o$ (kN.m)

Footing Length at Longitudanal Direction : $B_j = 7.500$ (m)

Load Case		VB (kN)	HB (kN)	MB (kN.m)
S.L.D	Group	34989.59	5510.45	7597.07
	Group	34989.59	5560.45	8091.62
	Group	32435.55	12605.05	45402.85
L.F.D	Group	46423.21	7582.28	12170.50
	Group	45501.47	7228.58	10540.07
	Group	43075.52	16375.56	70884.03

5.4 Stability checking

1) Checking of the safety to fall

Load Case		Displacement Distance	
		$e_B = M_B / V_B$	Allowable Displacement distance
S.L.D	Group	0.217	1.250
	Group	0.231	1.250
	Group	1.400	2.500
L.F.D	Group	0.262	3.750
	Group	0.232	3.750
	Group	1.646	3.750

2) Checking of the safety to Slide

$$f_s = H_U / H_B$$

Load Case		Shear Resistance (kN)	Action horizontal force(kN)	Safety Factor	Required Safety
S.L.D	Group	17,564.8	5,510.4	3.188	1.50
	Group	17,564.8	5,560.4	3.159	1.50
	Group	16,282.6	12,605.0	1.292	1.20
L.F.D	Group	23,304.4	7,582.3	3.074	1.10
	Group	22,841.7	7,228.6	3.160	1.10
	Group	21,623.9	16,375.6	1.320	1.10

$$\tan \beta = 0.502 \quad [\tan 26.667^\circ (2/3\Phi)]$$

3) Checking of subgrade reaction

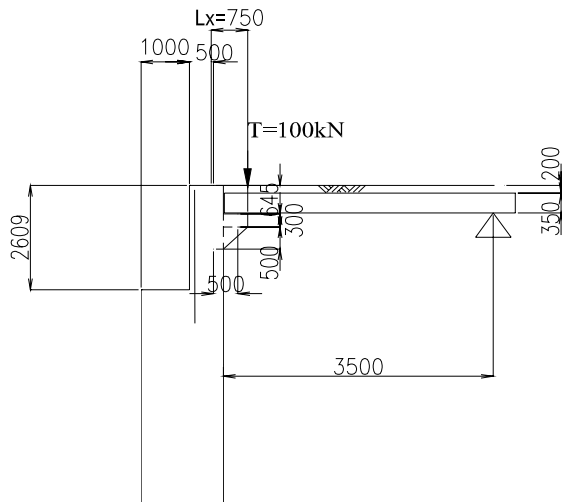
Load Case		Type of subgrade reaction	Subgrade Reaction		Allowable Reaction (kN)
			qmin(kN)	qmax(kN)	
S.L.D	Group	Trapezoid	226.8	322.1	700.0
	Group	Trapezoid	223.7	325.2	1050.0
	Group	Triangle	-	541.2	1050.0
L.F.D	Group	Trapezoid	287.7	440.5	-
	Group	Trapezoid	290.7	423.0	-
	Group	Triangle	-	782.6	-

$$L = 17.000 \text{ m}$$

$$B = 7.500 \text{ m}$$

5.5 Design of Parapet Wall

5.5.1 Calculation of Sectional Force



[unit:mm]

$$M_f = R_u \cdot L_x = 77.920 \text{ (kN.m)}$$

$$R_u = R_f + T = 91.671 \text{ (kN)}$$

$$R_f = \frac{1}{2} \cdot (W_1 + W_2 + q) \cdot L = 18.944 \text{ (kN)}$$

in which,

M_f : Sectinal Force at Base of Parapet (kN.m)

R_u : Total reaction on support (kN)

L_x : Distance from center of Parapet to reaction force action position (m), $L_x = 0.750$

T : Load of wheel (kN), $T = 222/2.44 = 91.0 \quad 100.0$

R_f : Reaction force that acts on approach-slab base (kN)

W_1 : Pavement weight on approach-slab (kN/m^2), $W_1 = 4.432$

W_2 : Self Weight of Approach-slab (kN/m^2), $W_2 = 8.575$

q : Surcharge Load (kN/m^2), $q = 0.0$

L : Design Span Length $L = \alpha L_0 = 3.500$

L_0 : Approach Slab Length (m), $L_0 = 5.000$

α : , Design span length coefficient $\alpha = 0.700$

5.5.2 Calculation of Stress

(1) Calculation of Bending Stress

Calculation Formura

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^2 + \frac{2 \cdot n}{b} \{A_{s'} \cdot (x-d') + A_s \cdot (x-d)\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm), h = 500.000

b : Width in section (mm), b = 1000.000

d : Effective height (mm) = 415

d' : Concrete Cover (mm) = 85

As : Sectional area of reinforcing bar arranged on tension side (mm²) D20@250=1256.8

As': Sectional area of reinforcing bar arranged on compression side (mm²) = D16@250=804.25

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

e : Axis force eccentric distance (mm)

σc: Compressive Stress of Concrete (N/mm²)

σs: Tensile Stress of Reinforcing (N/mm²)

M: Bending Moment (N.mm) =96.656

Calculation Result

x = 127.5mm

σc = 2.19 N/mm² < σca=0.4fcu = 9.6 N/mm² OK

σs = 121.9 N/mm² < σsa=0.4fy = 168 N/mm² OK

5.6 Calculation of Calculation of Approach Slab Support

5.6.1 Calculation of Sectional Force

$$M_u = R_u \cdot b_u = 45.836 \quad (\text{kN.m})$$

$$R_u = R_f + T/3.00 = 91.671 \quad (\text{kN})$$

$$R_f = 1/2 \cdot (W_1 + W_2 + q) \cdot L = 18.944 \quad (\text{kN})$$

Sectional Force by Self Weight

	Calculation	Area A _i (m ²)	Distance to center of gravity X (m)	A _i · X _i
	0.500 × 0.300	0.150	0.250	0.038
	1/2 × 0.500 × 0.500	0.125	0.167	0.021
Total		0.275		0.058

$$\text{Self Weight} \quad R_g = \Sigma A_i \cdot \gamma = 0.275 \cdot 24.500 = 6.738 \quad (\text{kN})$$

$$\text{Point of application} \quad X_g = \Sigma(A_i \cdot Y_i) / \Sigma A_i = 0.058 / 0.275 = 0.212 \quad (\text{m})$$

$$\text{Bending Moment} \quad M_g = R_g \cdot X_g = 6.875 \cdot 0.212 = 1.429 \quad (\text{kN.m})$$

$$\text{Total Bending Moment } M = M_u + M_g = 45.836 + 1.429 = 47.265 \quad (\text{kN.m})$$

$$\text{Shear Force} \quad S = R_u + R_g = 91.671 + 6.738 = 98.409 \quad (\text{kN})$$

5.6.2 Calculation of Stress

(1) Calculation of Bending Stress

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h-x}{2} - \frac{x}{3}\right) + n \cdot A_s' \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^2 + \frac{2 \cdot n}{b} \{A_s' \cdot (x-d') + A_s \cdot (x-d)\} = 0.0$$

Calculation Result

Reinforcement Bar: D16@250

$$x = 117.8 \text{ mm}$$

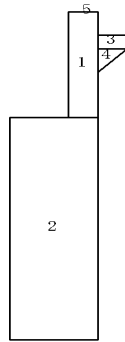
$$\sigma_c = 1.21 \text{ N/mm}^2 < \sigma_{ca} = 0.4 f_{cu} = 9.6 \text{ N/mm}^2 \quad \text{OK}$$

$$\sigma_s = 90.05 \text{ N/mm}^2 < \sigma_{sa} = 0.4 f_y = 168 \text{ N/mm}^2 \quad \text{OK}$$

5.7 Design of Abutment Wall

5.7.1 Block data that doesn't consider water level

(1)Block dividing



Division	Calculation formula Width × Height × Depth	Volume Vi(m ³)	Barycentric Position		Vi · Xi	Vi · Yi
			Xi	Yi		
1	0.700 × 2.609 × 15.39	28.107	1.850	7.895	51.998	221.905
2	2.2 × 6.591 × 15.390	223.158	1.100	3.296	245.474	735.529
3	0.500 × 0.300 × 12.728	1.909	2.450	8.623	4.677	16.461
4	1/2 × 0.500 × 0.500 × 12.728	1.591	2.367	8.306	3.766	13.215
Σ		254.765			305.915	987.110

Center of gravity $XG = \frac{\sum(V_i \cdot X_i)}{\sum V_i} = 1.201 \text{ (m)}$

$YG = \frac{\sum(V_i \cdot Y_i)}{\sum V_i} = 3.875 \text{ (m)}$

5.7.2 Sectional force from self weight,superstructure

(1) Self Weight

Vertical Force $W = \gamma \cdot V = 24.5 \times 254.765 = 6241.744 \text{ (kN)}$

Point of application $X = 1.201 \text{ (m)}$

(2) Superstructure Reaction

[1]S.L.D Group

Vertical Force $R_v = 5850 \text{ (kN)}$

Point of application $X = 0.144 \text{ (m)}$

Horizontal Force $R_H = 0.000 \text{ (kN)}$.

Point of application $Y = 8.091 \text{ (m)}$

$$X = \frac{B}{2} - (BR - XR) = 1.100 - 0.956 = 0.144 \text{ m}$$

where

B : Thickness of wall

BR: Distance from the front side of wall to the front side of parapet

XR: Distance from the front side of parapet to action position

Action position horizontal force

$$Y = YZ + YR = 6.591 + 1.500 = 8.091 \quad (\text{m})$$

where

YZ: Height of wall

YR: Height of horizontal force acting position

[2]S.L.D Group

$$R_v = 5850.000 \quad (\text{kN})$$

$$X = 0.144 \quad (\text{m})$$

$$R_H = 50.000 \quad (\text{kN})$$

$$Y = 8.091 \quad (\text{m})$$

[3]S.L.D Group

$$R_v = 5070.000 \quad (\text{kN})$$

$$X = 0.144 \quad (\text{m})$$

$$R_H = 770.000 \quad (\text{kN})$$

$$Y = 8.091 \quad (\text{m})$$

[4]L.F.D Group

$$R_v = 8300 \quad (\text{kN})$$

$$X = 0.144 \quad (\text{m})$$

$$R_H = 0.000 \quad (\text{kN})$$

$$Y = 8.091 \quad (\text{m})$$

[5]L.F.D Group

$$R_v = 7620 \quad (\text{kN})$$

$$X = 0.144 \quad (\text{m})$$

$$R_H = 50.000 \quad (\text{kN})$$

$$Y = 8.091 \quad (\text{m})$$

[6]L.F.D Group

$$R_v = 6600 \quad (\text{kN})$$

$$X = 0.144 \quad (\text{m})$$

$$R_H = 990.00 \quad (\text{kN})$$

$$Y = 8.091 \quad (\text{m})$$

5.7.3 Earth pressure and hydraulic pressure

(1) General data

Unit Weight of Water : γ_w (kN/m ³)	10.000
Width of soil pressure action : Bc (m)	15.390
Height in which soil pressure is not considered : hr (m)	0.000
cohesion of soil : C (kN/m ²)	0.000

(2) Earth pressure

[1] S.L.D Group

1) Data for earthl pressure calculation

Surcharge : q (kN/m ²)	10.00
Height from back water level to top : H1 (m)	9.20
Height of back water level to bottom : H2 (m)	0.000
Height in which hydraulic pressure is calculated : Hs (m)	0.000

2) Calculation result of earthl pressure

	Item	Value
Parameter	Acting height (Upper section) HU(m)	9.200
	Acting height (Lower section) HL(m)	0.000
	Height from water level of the back to the top h1	9.200
	Height from water level of the back to the lower side of Footing h2	0.000
	Height of water level of the back hs(m)	0.000
	Height in which soil pressure is not considered hr(m)	0.000
	Intersection angle of abutment wall and vertical (deg.) θ	0.000
	Friction angle of soil and wall (deg.)	10.000
	Wet density of backfill soil (kN/m ³)	19.000
	Saturation density of backfill soil	20.000
	Action starting point of earthl pressure (Xcoordinates) (m)	3.700
Coefficient of earth pressure	Coefficient of earth pressure from water level of the back above(upper) Ku1	0.3085
	Coefficient of earth pressure from water level of the back above(lower) Ku11	0.3085
	Coefficient of earth pressure below from water level of the back (upper) Ku2	0.3085
	Coefficient of earth pressure below from water level of the back (lower) Ku22	0.3085
Earth pressure	[1] Earth pressure strength above water level (upper)	3.085
	[2] Earth pressure strength above water level (lower)	58.763
	[3] Earth pressure strength below water level (upper)	0.000
	[4] Earth pressure strength below water level (lower)	0.000
Earth pressure force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc	4521.199
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc	0.000
	Pe = Pe1+Pe2	4521.199
	Peh = Pe · cos(δ + θ) (Horizontal element of earth pressure)	4452.512
Point of application	Y1 = (2 · [1]+[2]) · h1 / {3 · ([1]+[2])} + h2 + HL + hr	3.325
	Y2 = (2 · [3]+[4]) · h2 / {3 · ([3]+[4])} + HL + hr	0.000
	Y = (Pe1 · Y1 + Pe2 · Y2) / Pe	3.325

• Point of application

$$Y = \frac{\sum (Peh \cdot Y)}{\sum Peh} = 3.224 \text{ m}$$

• Earth pressure force

Horizontal Force

$$Ph = \sum Peh = 4189.32 \text{ kN}$$

[2]S.L.D Group

1)Data for earthl pressure calculation

Surcharge : q (kN/m ²)	0.00
Height from back water level to top : H1 (m)	9.20
Height of back water level to bottom : H2 (m)	0.000
Height in which hydraulic pressure is calculated : Hs (m)	0.000

2) Calculation result of earthl pressure

	Item	Value
Parameter	Acting height (Upper section) HU(m)	9.200
	Acting height (Lower section) HL(m)	0.000
	rom water level of the back to the top h1	9.500
	Height from water level of the back to the lower side of Fo	0.000
	Height of water level of the back hs(m)	0.000
	Height in which soil pressure is not considered hr(m)	0.000
	Intersection angle of abutment wall and vertical (deg.) θ	0.000
	Friction angle of soil and wall (deg.)	10.000
	Wet density of backfill soil (kN/m ³)	19.000
	Saturation density of backfill soil	20.000
	Action starting point of earthl pressure (Xoordinates) (m)	3.700
Coefficient of earth pressure	Coefficient of earth pressure from water level of the back above(upper) Ku1	0.4128
	Coefficient of earth pressure from water level of the back above(lower) Ku11	0.4128
	Coefficient of earth pressure below from water level of the back (upper) Ku2	0.4128
	Coefficient of earth pressure below from water level of the back (lower) Ku22	0.4128
Earth pressure	[1] Earth pressure strength abobe water level (uppert)	0.000
	[2] Earth pressure strength abobe water level (lower)	74.510
	[3] Earth pressure strength below water level (upper)	0.000
	[4] Earth pressure strength below water level (lower)	0.000
Earth pressure force	Pe1 = (1/2) • ([1]+[2]) • h1 • Bc	5446.896
	Pe2 = (1/2) • ([3]+[4]) • h2 • Bc	0.000
	Pe = Pe1+Pe2	5446.896
	Peh = Pe • cos(δ+θ) (Horizontal element of earth pressure)	5446.896
Point of apprication	Y1 = (2 • [1]+[2]) • h1/{ 3 • ([1]+[2]) }+h2+HL+hr	3.167
	Y2 = (2 • [3]+[4]) • h2/{ 3 • ([3]+[4]) }+HL+hr	0.000
	Y = (Pe1 • Y1+Pe2 • Y2)/Pe	3.167

• Point of apprication

$$Y = \frac{\sum (Peh \cdot Y)}{\sum Peh} = 3.067 \text{ m}$$

• Earth pressur force

Horizontal Force

$$Ph = \sum Peh = 5108.31 \text{ kN}$$

[3]L.F.D Group

1)Data for earthl pressure calculation

Surcharge : q (kN/m ²)	21.70
Height from back water level to top : H1 (m)	9.20
Height of back water level to bottom : H2 (m)	0.000
Height in which hydraulic pressure is calculated : Hs (m)	0.000

2) Calculation result of earthl pressure

	Item	Value
Parameter	Acting height (Upper section) HU(m)	9.200
	Acting height (Lower section) HL(m)	0.000
	Height from water level of the back to the top h1	9.200
	Height from water level of the back to the lower side of Footing h2	0.000
	Height of water level of the back hs(m)	0.000
	Height in which soil pressure is not considered hr(m)	0.000
	Intersection angle of abutment wall and vertical (deg.) θ	0.000
	Friction angle of soil and wall (deg.)	10.000
	Wet density of backfill soil (kN/m ³)	24.700
	Saturation density of backfill soil	26.000
	Action starting point of earthl pressure (Xoordinates) (m)	3.700
Coefficient of earth pressure	Coefficient of earth pressure from water level of the back above(upper) Ku1	0.3085
	Coefficient of earth pressure from water level of the back above(lower) Ku11	0.3085
	Coefficient of earth pressure below from water level of the back (upper) Ku2	0.3085
	Coefficient of earth pressure below from water level of the back (lower) Ku22	0.3085
Earth pressure	[1] Earth pressure strength abobe water level (upper)	6.694
	[2] Earth pressure strength abobe water level (lower)	76.789
	[3] Earth pressure strength below water level (upper)	0.000
	[4] Earth pressure strength below water level (lower)	0.000
Earth pressure force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc	5910.108
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc	0.000
	Pe = Pe1+Pe2	5910.108
	Peh = Pe · cos(δ+θ) (Horizontal element of earth pressure)	5820.320
Point of application	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr	3.313
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr	0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe	3.313

• Point of application

$$Y = \frac{\sum(Peh \cdot Y)}{\sum Peh} = 3.313 \text{ m}$$

• Earth pressur force

Horizontal Force

$$Ph = \sum Peh = 5820.32 \text{ kN}$$

[4]L.F.D Group

1)Data for earthl pressure calculation

Surcharge : q (kN/m ²)	13.00
Height from back water level to top : H1 (m)	9.20
Height of back water level to bottom : H2 (m)	0.000
Height in which hydraulic pressure is calculated : Hs (m)	0.000

2) Calculation result of earthl pressure

	Item	Value
Parameter	Acting height (Upper section) HU(m)	9.200
	Acting height (Lower section) HL(m)	0.000
	Height from water level of the back to the top h1	9.200
	Height from water level of the back to the lower side of Footing h2	0.000
	Height of water level of the back hs(m)	0.000
	Height in which soil pressure is not considered hr(m)	0.000
	Intersection angle of abutment wall and vertical (deg.) θ	0.000
	Friction angle of soil and wall (deg.)	10.000
	Wet density of backfill soil (kN/m ³)	24.700
	Saturation density of backfill soil	26.000
	Action starting point of earthl pressure (Xoordinates) (m)	3.700
Coefficient of earth pressure	Coefficient of earth pressure from water level of the back above(upper) Ku1	0.3085
	Coefficient of earth pressure from water level of the back above(lower) Ku11	0.3085
	Coefficient of earth pressure below from water level of the back (upper) Ku2	0.3085
	Coefficient of earth pressure below from water level of the back (lower) Ku22	0.3085
Earth pressure	[1] Earth pressure strength abobe water level (uppert)	4.010
	[2] Earth pressure strength abobe water level (lower)	74.106
	[3] Earth pressure strength below water level (upper)	0.000
	[4] Earth pressure strength below water level (lower)	0.000
Earth pressure force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc	5530.135
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc	0.000
	Pe = Pe1+Pe2	5530.135
	Peh = Pe · cos(δ+θ) (Horizontal element of earth pressure)	5446.120
Point of apprication	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr	3.224
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr	0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe	3.224

• Point of apprication

$$Y = \frac{\sum(Peh \cdot Y)}{\sum Peh} = 3.224 \text{ m}$$

• Earth pressur force

Horizontal Force

$$Ph = \sum Peh = 5446.12 \text{ kN}$$

[5]L.F.D Group

1)Data for earthl pressure calculation

Surcharge :q (kN/m ²)	0.00
Height from back water level to top : H1 (m)	9.20
Height of back water level to bottom : H2 (m)	0.000
Height in which hydraulic pressure is calculated : Hs (m)	0.000

2) Calculation result of earthl pressure

	Item	Value
Parameter	Acting height (Upper section) HU(m)	9.200
	Acting height (Lower section) HL(m)	0.000
	Height from water level of the back to the top h1	9.200
	Height from water level of the back to the lower side of Footing hr(m)	0.000
	Height of water level of the back hs(m)	0.000
	Height in which soil pressure is not considered hr(m)	0.000
	Intersection angle of abutment wall and vertical (deg.) θ	0.000
	Friction angle of soil and wall (deg.)	0.000
	Wet density of backfill soil (kN/m ³)	24.700
	Saturation density of backfill soil	26.000
	Action starting point of earthl pressure (Xcoordinates) (m)	3.700
Coefficient of earth pressure	Coefficient of earth pressure from water level of the back above(upper) Ku1	0.4128
	Coefficient of earth pressure from water level of the back above(lower) Ku11	0.4128
	Coefficient of earth pressure below from water level of the back (upper) Ku2	0.4128
	Coefficient of earth pressure below from water level of the back (lower) Ku22	0.4128
Earth pressure	[1] Earth pressure strength abobe water level (upper)	0.000
	[2] Earth pressure strength abobe water level (lower)	93.805
	[3] Earth pressure strength below water level (upper)	0.000
	[4] Earth pressure strength below water level (lower)	0.000
Earth pressure force	Pe1 = (1/2) · ([1]+[2]) · h1 · Bc	6640.808
	Pe2 = (1/2) · ([3]+[4]) · h2 · Bc	0.000
	Pe = Pe1+Pe2	6640.808
	Peh = Pe · cos(δ+θ) (Horizontal element of earth pressure)	6640.808
Point of application	Y1 = (2 · [1]+[2]) · h1/{3 · ([1]+[2])}+h2+HL+hr	3.067
	Y2 = (2 · [3]+[4]) · h2/{3 · ([3]+[4])}+HL+hr	0.000
	Y = (Pe1 · Y1+Pe2 · Y2)/Pe	3.067

• Point of application

$$Y = \frac{\sum (Peh \cdot Y)}{\sum Peh} = 3.067 \text{ m}$$

• Earth pressur force

Horizontal Force

$$Ph = \sum Peh = 6640.81 \text{ kN}$$

5.7.4 Summary of Sectional Force

(1) Service Load Design

[1]S.L.D Group

Loadings	N _i (kN)	H _i (kN)	X _i (m)	Y _i (m)	M =M _{xi} +M _{yi} (kN.m)
Self Weight	6241.744	0.000	-0.101	0.000	-628.981
Superstruture Reaction	5850.000	0.000	0.144	8.091	842.400
Other Load	0.000	0.000	0.000	0.000	0.000
Earth Pressure	0.000	4189.323	0.000	3.224	13506.377
Back Hydraulic Pressure(back)	0.000	0.000	0.000	0.000	0.000
Back Hydraulic Pressure(flont)	0.000	0.000	0.000	0.000	0.000
Total	12091.744	4189.323	-	-	13719.797
unit width	785.688	272.211	-	-	891.475

[2]S.L.D Group

Loadings	N _i (kN)	H _i (kN)	X _i (m)	Y _i (m)	M =M _{xi} +M _{yi} (kN.m)
Self Weight	6241.744	0.000	-0.101	0.000	-628.981
Superstruture Reaction	5850.000	50.000	0.144	8.091	1246.950
Other Load	0.000	0.000	0.000	0.000	0.000
Earth Pressure	0.000	4189.323	0.000	3.224	13506.377
Back Hydraulic Pressure(back)	0.000	0.000	0.000	0.000	0.000
Back Hydraulic Pressure(flont)	0.000	0.000	0.000	0.000	0.000
Total	12091.744	4239.323	-	-	14124.347
unit width	785.688	275.460	-	-	917.761

[3]S.L.D Group

Loadings	N _i (kN)	H _i (kN)	X _i (m)	Y _i (m)	M =M _{xi} +M _{yi} (kN.m)
Self Weight	6241.744	1248.349	-0.101	3.874	4207.123
Superstruture Reaction	5070.000	770.000	0.144	8.091	6960.150
Other Load	0.000	0.000	0.000	0.000	0.000
Earth Pressure	0.000	5108.313	0.000	3.067	15665.510
Back Hydraulic Pressure(back)	0.000	0.000	0.000	0.000	0.000
Back Hydraulic Pressure(flont)	0.000	0.000	0.000	0.000	0.000
Total	11311.744	7126.662	-	-	26832.783
unit width	735.006	463.071	-	-	1743.521

(2) Load Factor Design

[4]L.F.D Group

Loadings	N _i (kN)	H _i (kN)	X _i (m)	Y _i (m)	M =M _{xi} +M _{yi} (kN.m)
Self Weight	8114.267	0.000	-0.101	0.000	-817.675
Superstruture Reaction	8300.000	0.000	0.144	8.091	1195.200
Other Load	0.000	0.000	0.000	0.000	0.000
Earth Pressure	0.000	5820.321	0.000	3.313	19282.723
Back Hydraulic Pressure(back)	0.000	0.000	0.000	0.000	0.000
Back Hydraulic Pressure(flont)	0.000	0.000	0.000	0.000	0.000
Total	16414.267	5820.321	-	-	19660.249
unit width	1066.554	378.188	-	-	1277.469

[5]L.F.D Group

Loadings	N _i (kN)	H _i (kN)	X _i (m)	Y _i (m)	M =M _{xi} +M _{yi} (kN.m)
Self Weight	8114.267	0.000	-0.101	0.000	-817.675
Superstruture Reaction	7620.000	65.000	0.144	8.091	1623.195
Other Load	0.000	0.000	0.000	0.000	0.000
Earth Pressure	0.000	5446.120	0.000	3.224	17558.291
Back Hydraulic Pressure(back)	0.000	0.000	0.000	0.000	0.000
Back Hydraulic Pressure(flont)	0.000	0.000	0.000	0.000	0.000
Total	15734.267	5511.120	-	-	18363.811
unit width	1022.370	358.097	-	-	1193.230

[6]L.F.D Group

Loadings	N _i (kN)	H _i (kN)	X _i (m)	Y _i (m)	M =M _{xi} +M _{yi} (kN.m)
Self Weight	8114.267	1622.853	-0.101	3.874	5469.260
Superstruture Reaction	6600.000	990.000	0.144	8.091	8960.490
Other Load	0.000	0.000	0.000	0.000	0.000
Earth Pressure	0.000	7080.965	0.000	3.067	21714.983
Back Hydraulic Pressure(back)	0.000	0.000	0.000	0.000	0.000
Back Hydraulic Pressure(flont)	0.000	0.000	0.000	0.000	0.000
Total	14714.267	9693.818	-	-	36144.732
unit width	956.093	629.878	-	-	2348.586

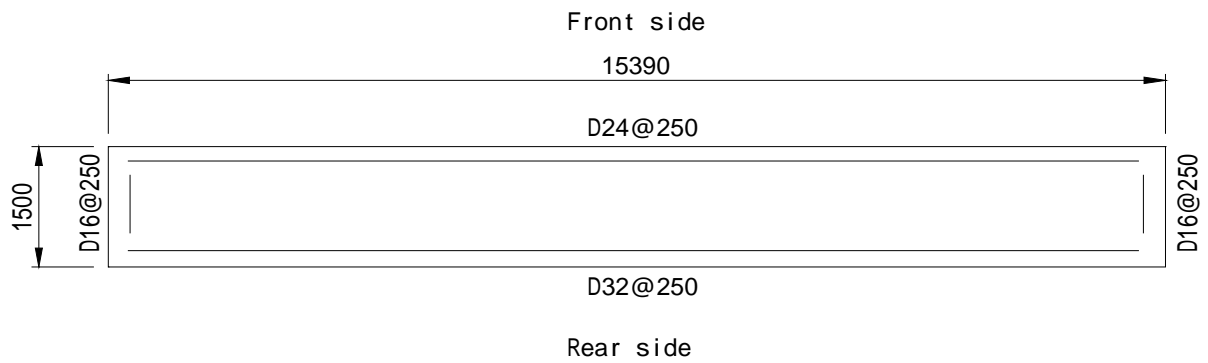
5.7.5 Calculation of Stress

(1) Reinforcement Arrangement

Nos. of Reinforcement Bars 4 Nos (Rear: @250, Front@250, Side: @250)

Total area of bars

Rear:	4-D20 (@250)	$314.2 \times 4 =$	1256.8 mm ²
Front:	4-D16 (@250)	$201.1 \times 4 =$	804.4 mm ²
Side:	10-D16 (@250)	$201.1 \times 10 =$	2011.0 mm ²



(2) Calculation of Stress

$$\sigma_c = \frac{N}{\frac{b \cdot x}{2} - n \cdot A_s \cdot \frac{d-x}{x} + n \cdot A_s' \cdot \frac{x-d'}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^3 - 3 \cdot \left(\frac{h}{2} - e\right) \cdot x^2 - \frac{6n}{b} \left\{ A_s' \cdot \left(\frac{h}{2} - d' - e\right) + A_s \cdot \left(\frac{h}{2} - d - e\right) \right\} \cdot x + \frac{6n}{b} \left\{ A_s' \cdot d' \cdot \left(\frac{h}{2} - d' - e\right) + A_s \cdot d \cdot \left(\frac{h}{2} - d - e\right) \right\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm), h = 500.000

b : Width in section (mm), b = 1000.000

d : Effective height (mm) = 415

d' : Concrete Cover (mm) = 85

A_s : Sectional area of reinforcing bar arranged on tension side (mm²) = D32@250

A_s' : Sectional area of reinforcing bar arranged on compression side (mm²) = D24@250

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

e : Axis force eccentric distance (mm)

σ_c: Compressive Stress of Concrete (N/mm²)

σ_s: Tensile Stress of Reinforcing (N/mm²)

N: Axial Force (kN)

M :Bending Moment (kNm)

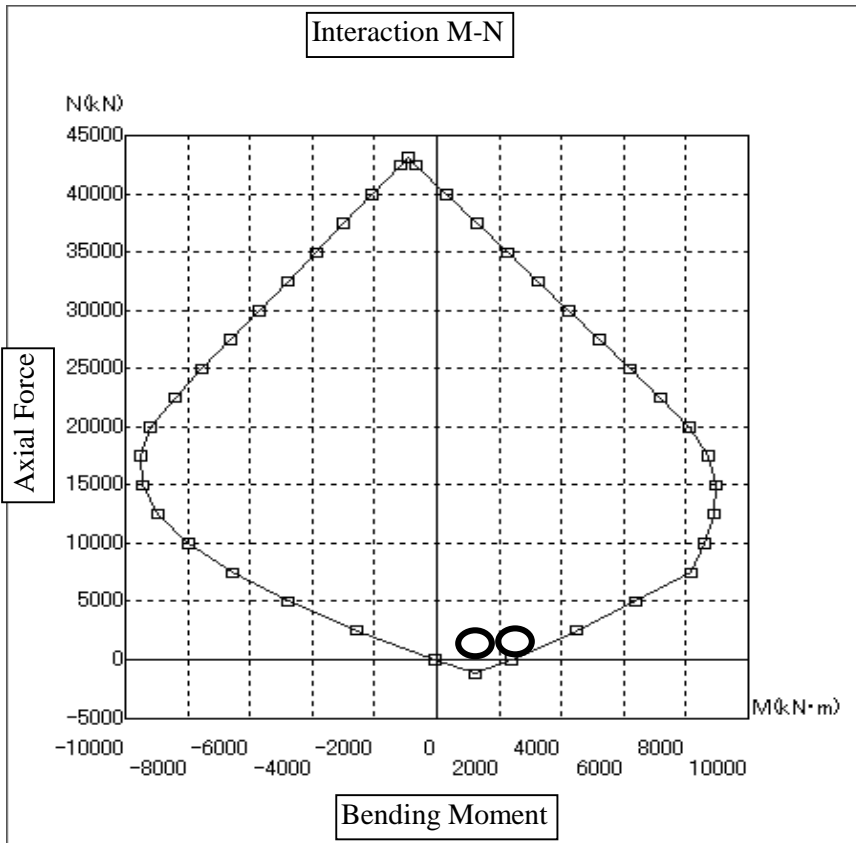
Calculation Result

Load Case	M	N	x	σ _c	σ _s	σ _{ca}	σ _{sa}
S.L.D GRoup	891.5	785.7	505.400	2.10	44.2	9.6	168.0
S.L.D GRoup	917.8	785.7	725.700	2.20	47.6	12.0	210.0
S.L.D GRoup	1743.5	735.0	382.400	4.50	175.7	12.8	223.4

(3) Checking of Flexural Strength

List of Sectinal Force at Base of Wall

Load Case	M (kN.m)	N (kN.)	S (kN.)
L.F.D GRoup	1277.5	1066.6	378.2
L.F.D GRoup	1193.2	1022.4	358.1
L.F.L GRoup	2348.6	956.093	629.9



N(kN)	Mr(kN·m)
43166.434	-926.435
42500	-664.734
40000	316.204
37500	1295.716
35000	2274.657
32500	3256.883
30000	4237.209
27500	5216.717
25000	6197.728
22500	7176.631
20000	8116.424
17500	8732.888
15000	8996.432
12500	8942.995
10000	8633.358
7500	8165.609
5000	6394.511
2500	4494.205
0	2389.542

*) Shear Strength

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 1/6 \times \sqrt{f_c})$$

$$= 1/6 \times \sqrt{f_c} \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

		Longitudinal Direction
Load Factor Design	Group-I	378.2 kN
	Group-	358.1 kN
	Group-	629.9 kN

Calculation of Shear Strength

$$v_c = 1/6 \times \sqrt{f_c} = 1/6 \times \sqrt{24} = 0.816 \text{ N/mm}^2 \rightarrow 816 \text{ kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 1.000 \text{ m}$$

Longitudinal Direction

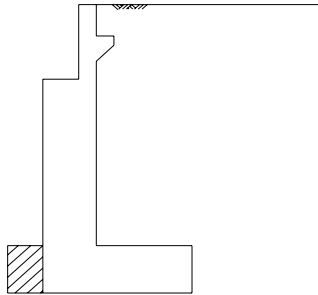
		Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Load Factor Design	Group-I	378.2	1.000	2.100	1456.56	0.00	0.0
	Group-III	358.1	1.000	2.100	1456.56	0.00	0.0
	Group-	629.9	1.000	2.100	1456.56	0.00	0.0

5.8 Design of Flont Footing

5.8.1 Block data that doesn't consider water level

(1) Self Weight

1) Block dividing



2) Self-respect and center of gravity

Division	Calculation formula Width × Height × Depth	Volume V1	Barycentric Position	Vi · Xi
		Vi(m ³)	Xi(m)	
1	1.500 × 1.800 × 17.00	45.900	0.750	34.425
Σ		45.900		34.425

Barycentric Position $XG = \frac{\Sigma(Vi \cdot Xi)}{\Sigma Vi} = 0.750 \text{ (m)}$

5.8.2 Vertical force by self-weight , backfill soil, buoyancy and other load

(1) Self Weight

$$\begin{aligned} \text{Vertical Force } W &= \gamma \cdot V = 24.50 \times 45.900 = 1124.55 \text{ (kN)} \\ \text{Point of application } X &= 0.750 \text{ (m)} \end{aligned}$$

(2) Backfill soil and buoyancy

1) Backfill

$$\begin{aligned} \text{Weight of Backfill } & 1.500 \times 4.200 \times 17.00 \times 18 & W_b = & 1927.800 \text{ (kN)} \\ \text{Point of application } & & X_i = & 0.750 \text{ (m)} \end{aligned}$$

2) buoyancy

$$\begin{aligned} \text{Front water level } H_f &= 0.00 \text{ (m)} \\ \text{Water level of the back } H_r &= 0.000 \text{ (m)} \\ \text{Hydraulic pressure in front of footing } P_f &= 0.000 \text{ (kN/m}^2\text{)} \\ \text{Hydraulic pressure in front of footing } P_r &= 0.000 \text{ (kN/m}^2\text{)} \\ \text{Uplift pressure} & \end{aligned}$$

$$P_u = \frac{P_f + P_r}{2} \cdot B_j \cdot B_c = 0.000 \text{ (kN)}$$

Point of application

$$X_u = \frac{P_f + 2 \cdot P_r}{3 \cdot (P_f + P_r)} \cdot B_j = 0.750 \text{ (kN)}$$

where,

B_j : Footing Width at longitudinal direction $B_j = 1.500 \text{ (m)}$

B_c : Footing Width at transverse direction $B_c = 17.000 \text{ (m)}$

5.8.3 Subgrade Reaction

Vertical Force

$$V = (q_1+q_2)/2 \times L$$

Point of application: X_i

$$X = \frac{(2q_1+q_2)}{(q_1+q_2)} \times L/3$$

in which

q_1, q_2 : Subgrade Reaction (kN/m²)

X : Arm Length (m)

L : Front footing Length (m) 1.500 m

B : Footing Width (m) 17.000 m

Load Case		Subgrade Reaction		Vertical Force (kN)	X (m)	$\Sigma V X_i$ (kN · m)
		q_1 (kN/m ²)	q_2 (kN/m ²)			
S.L.S	Group	322.1	303.0	7970.3	0.758	6038.5
	Group	325.2	304.9	8033.6	0.758	6090.0
	Group	541.2	426.1	12333.0	0.780	9616.8
L.F.D	Group	440.5	409.9	10842.5	0.759	8229.2
	Group	423.0	338.4	9708.0	0.778	7550.7
	Group	782.6	596.7	17585.8	0.784	13782.0

5.8.4 Summary of Secsinal Force

[1] S.L.D Group-

Loadings	V (kN)	X (m)	$M = N_i \cdot X_i$ (kN.m)
Self Weight	-1124.550	0.750	-843.413
Flont Backfill Soil	-1927.800	0.750	-1445.850
Total of backfill Soil	-1927.800		-1445.850
Buoyancy	0.000	0.750	0.000
Subgrade Reaction	7970.344	0.758	6038.535
Total	4917.994		3749.272
unit width	319.558		243.617

[2] S.L.D Group-

Loadings	V (kN)	X (m)	$M = N_i \cdot X_i$ (kN.m)
Self Weight	-1124.550	0.750	-843.413
Flont Backfill Soil	-1927.800	0.750	-1445.850
Total of backfill Soil	-1927.800		-1445.850
Buoyancy	0.000	0.750	0.000
Subgrade Reaction	8033.646	0.758	6089.968
Total	4981.296		3800.705
unit width	323.671		246.959

[3] S.L.D Group-

Loadings	V (kN)	X (m)	$M = N_i \cdot X_i$ (kN.m)
Self Weight	-1124.550	0.750	-843.413
Flont Backfill Soil	-1927.800	0.750	-1445.850
Total of backfill Soil	-1927.800		-1445.850
Buoyancy	0.000	0.750	0.000
Subgrade Reaction	12333.038	0.780	9616.796
Total	9280.688		7327.533
unit width	603.034		476.123

[4] L.F.D Group-

Loadings	V (kN)	X (m)	$M = N_i \cdot X_i$ (kN.m)
Self Weight	-1461.915	0.750	-1096.436
Flont Backfill Soil	-2506.140	0.750	-1879.605
Total of backfill Soil	-2506.140		-1879.605
Buoyancy	0.000	0.750	0.000
Subgrade Reaction	10842.465	0.759	8229.213
Total	6874.410		5253.172
unit width	446.680		341.337

[5] L.F.D Group-

Loadings	V (kN)	X (m)	$M = N_i \cdot X_i$ (kN.m)
Self Weight	-1461.915	0.750	-1096.436
Flont Backfill Soil	-2506.140	0.750	-1879.605
Total of backfill Soil	-2506.140		-1879.605
Buoyancy	0.000	0.750	0.000
Subgrade Reaction	9708.035	0.778	7550.694
Total	5739.980		4574.653
unit width	372.968		297.248

[6] L.F.D Group-

Loadings	V (kN)	X (m)	$M = N_i \cdot X_i$ (kN.m)
Self Weight	-1461.915	0.750	-1096.436
Flont Backfill Soil	-2506.140	0.750	-1879.605
Total of backfill Soil	-2506.140		-1879.605
Buoyancy	0.000	0.750	0.000
Subgrade Reaction	17585.765	0.784	13782.020
Total	13617.710		10805.978
unit width	884.841		702.143

5.8.5 Calculation of Stress

(1) Serviceability Limit State

Stress and Crack Width checked with the Load Case S-Lc.4-2

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^2 + \frac{2 \cdot n}{b} \{A_{s'} \cdot (x-d') + A_s \cdot (x-d)\} = 0.0$$

in which,

x : Distance from edge on compression side to neutral axis (mm)

h : Height of Member (mm), h = 1200

b : Width in section (mm), b = 1000

d : Effective height (mm) = 1090

d' : Concrete Cover (mm) = 110

A_s : Sectional area of reinforcing bar arranged on tension side (mm²) D24@250

A_{s'} : Sectional area of reinforcing bar arranged on compression side (mm²) = D28@250

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

σ_c: Compressive Stress of Concrete (N/mm²)

σ_s: Tensile Stress of Reinforcing (N/mm²)

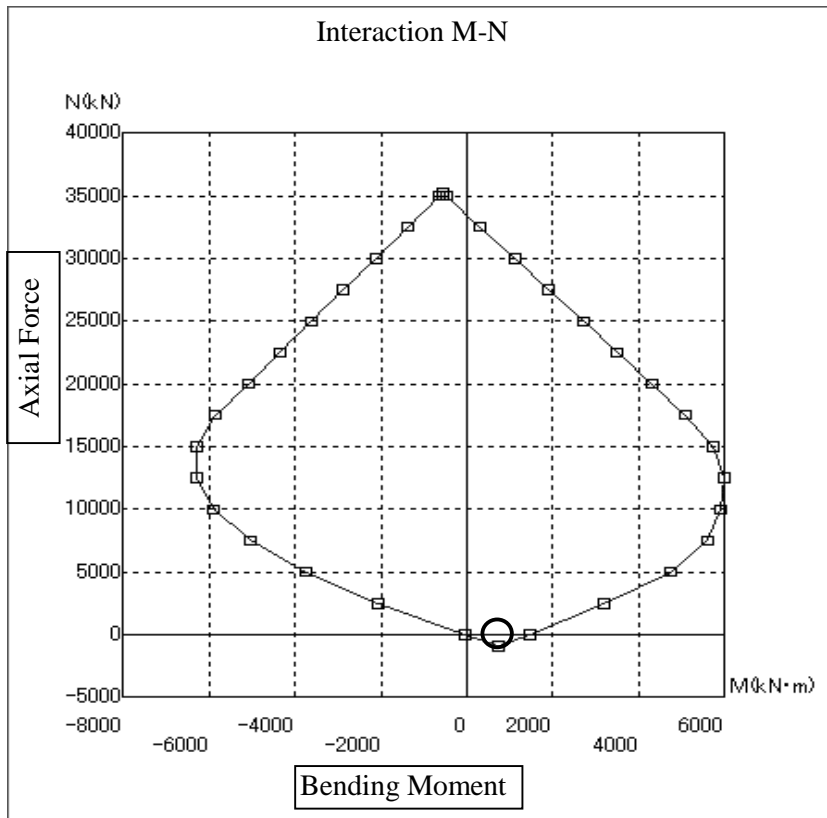
M: Bending Moment (kN.m)

Calculation Result

Load Case	M (kNm/m)	S (kN)	σ _c (N/mm ²)	σ _s (N/mm ²)	σ _{ca} (N/mm ²)	σ _{sa} (N/mm ²)
S.L.D-Group	243.6	319.56	1.00	62.4	9.6	168.0
S.L.D-Group	247.0	323.67	1.00	63.3	12.0	210.0
S.L.D-Group	476.1	603.03	1.90	122.0	12.8	223.4

(2) Load Factor Design

Load Case	M (kN.m)	N (kN.)	S (kN.)
L.F.D GRoup	341.3	-	446.7
L.F.D GRoup	297.2	-	373.0
L.F.L GRoup	702.1	-	884.8

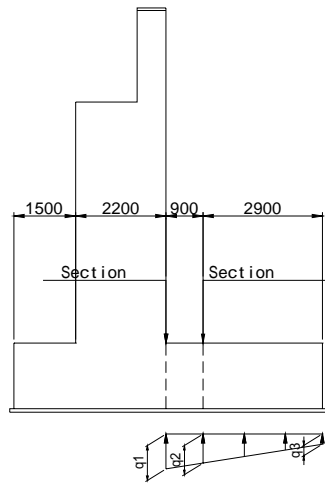


N(kN)	Mr(kN.m)
30000	1116.12
27500	1912.555
25000	2706.929
20000	4298.184
17500	5093.077
12500	5985.301
10000	5918.013
7500	5592.684
5000	4715.088
2500	3187.803
0	1474.709

5.9 Design of Rear Footing

5.9.1 Block data

(1) Self Weight, Backfill, Buoyancy and Subgrade Reaction



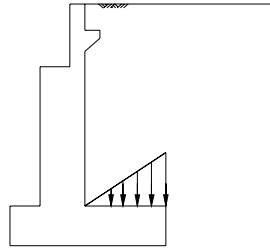
1) Section-

Load Comb.	Self Weight (kN)	Backfill (kN)	Buoyancy (kN)	ΣW (kN)	Subgrade Reaction			
					q_1 (kN/m ²)	q_3 (kN/m ²)	q (kN)	x (m)
S.L.S Group	-2848.860	-11292.080	0.000	-14140.940	275.1	226.8	16208.916	1.839
S.L.S Group	-2848.860	-11292.080	0.000	-14140.940	275.1	223.7	16110.024	1.835
S.L.S Group	-2848.860	-11292.080	0.000	-14140.940	257.2	0.0	7325.203	1.117
L.F.D Group	-3703.518	-14679.704	0.000	-18383.222	365.1	287.7	11098.644	1.825
L.F.D Group	-3703.518	-14679.704	0.000	-18383.222	416.5	290.7	22843.315	1.787
L.F.D Group	-3703.518	-14679.704	0.000	-18383.222	323.9	0.0	7195.804	1.307

2) Section-

Load Comb.	Self Weight (kN)	Backfill (kN)	Buoyancy (kN)	ΣW (kN)	Subgrade Reaction			
					q_2 (kN/m ²)	q_3 (kN/m ²)	q (kN)	x (m)
S.L.S Group	-2174.130	-8617.640	0.000	-10791.770	262.3	225.2	12015.693	1.413
S.L.S Group	-1811.775	-8617.640	0.000	-10429.415	261.6	222.1	11921.865	1.411
S.L.S Group	-1811.775	-8617.640	0.000	-10429.415	186.9	0.0	3872.480	1.113
L.F.D Group	-2826.369	-11202.932	0.000	-14029.301	342.6	256.0	14755.738	1.380
L.F.D Group	-2355.308	-11202.932	0.000	-13558.240	439.5	259.0	17220.218	1.325
L.F.D Group	-2355.308	-11202.932	0.000	-13558.240	0.0	0.0	0.000	0.000

(2) Earth Pressure



Vertical element of earth pressure

$$E_w = \frac{P_{ev}}{L \cdot B}$$

$$N = (q_r + q_f) \cdot L \cdot \frac{B}{2.0}$$

Point of application

$$X = \frac{2.0 \cdot q_r + q_f}{3 \cdot (q_r + q_f)}$$

in which

P_{ev} : Vertical element of earth pressure

q_f : Distribution load strength of rear end earth pressure vertical element

q_r : Distribution load of earth pressure vertical element of design position

L : Rear footing length. $L=3.800$ (m)

B : Width of earth pressure action $B = 17.00$ (m)

Section	Load Case	E_w (kN/m)	q_f (kN/m ²)	q_r (kN/m ²)	N (kN)	X (m)	$M=N \cdot x$ (kN · m)
	S.L.S Group ,	-98.497	0.000	-98.497	-3181.453	2.533	-8059.681
	S.L.S Group	-65.014	0.000	-65.014	-2099.952	2.533	-5319.879
	L.F.D Group	-135.530	0.000	-135.530	-4377.619	2.533	-11089.968
	L.F.D Group	-128.046	0.000	-128.046	-4135.886	2.533	-10477.577
	L.F.D Group	-84.519	0.000	-84.519	-2729.964	2.533	-6915.908
	S.L.S Group ,	-98.497	-19.440	-98.497	-2907.152	1.774	-5157.266
	S.L.S Group	-65.014	-15.398	-65.014	-1982.157	1.748	-3465.260
	L.F.D Group	-135.530	-32.099	-135.530	-4132.060	1.748	-7223.779
	L.F.D Group	-128.046	-30.327	-128.046	-3903.887	1.748	-6824.880
	L.F.D Group	-84.519	-20.018	-84.519	-2576.829	1.748	-4504.881

(3) Surcharge

Point of application

where

q: Surcharge load

qd : Surcharge load strength (dead load)

ql : Surcharge load strength (live load)

B: Surcharge load length at transvers direction, B = 17.00 (m)

Ls: Distance from design section to load action position

L: Length on which load acts(m)

Section	Load Case	q (kN/m ²)	Ls (m)	L (m)	Vertical N (kN)	Point of X (m)	M=N·x (kN·m)
	S.L.S Group	-10.000	0.000	3.800	-646.00	1.900	-1227.400
	L.F.D Group	-16.700	0.000	3.800	-1,078.82	1.900	-2049.758
	L.F.D Group	-13.000	0.000	3.800	-839.80	1.900	-1595.620
	S.L.S Group	-10.000	0.000	3.050	-518.50	1.525	-790.713
	L.F.D Group	-16.700	0.000	3.050	-865.90	1.525	-1320.490
	L.F.D Group	-13.000	0.000	3.050	-674.05	1.525	-1027.926

(4) Summary of Sectional Force for Service Limit State

a) Section

Bending Moment

(unit:kN·m)

Load Case	Self Weight,Backfill	Earth pressurer	Surcharge	Subgrade Reaction	Total Moment	unit width
S.L.S Group	-26867.786	-8059.681	-1227.400	29808.812	-6346.055	-399.123
S.L.S Group	-26867.786	-8059.681	-1227.400	29556.592	-6598.275	-414.986
S.L.S Group	-26867.786	-5319.879	0.000	8181.372	-24006.293	-1509.830
L.F.D Group	-34928.122	-11089.968	-2049.758	20254.276	-27813.571	-1749.281
L.F.D Group	-34928.122	-10477.577	-1595.620	40830.027	-6171.292	-388.132
L.F.D Group	-34928.122	-6915.908	0.000	9402.302	-32441.728	-2040.360

B) Section

Bending Moment

(unit:kN·m)

Load Case	Self Weight,Backfill,B uoyancy	Earth pressurer	Surcharge	Subgrade Reaction	Total Moment	unit width
S.L.S Group	-15648.067	-5157.266	-790.713	16980.988	-4615.057	-290.255
S.L.S Group	-15122.652	-5157.266	-790.713	16816.346	-4254.284	-267.565
S.L.S Group	-15122.652	-3465.260	0.000	4308.861	-14279.052	-898.054
L.F.D Group	-20342.486	-7223.779	-1320.490	20365.030	-8521.725	-535.958
L.F.D Group	-19659.447	-6824.880	-1027.926	22818.865	-4693.388	-295.182
L.F.D Group	-19659.447	-4504.881	0.000	0.000	-24164.329	-1519.769

Shearing Force

(unit:kN)

Load Case	Self Weight,Backfill,B uoyancy	Earth pressurer	Surcharge	Subgrade Reaction	Total Shearing Force	unit width
S.L.S Group	-2174.130	-2907.152	-518.500	12015.693	6415.911	416.888
S.L.S Group	-1811.775	-2907.152	-518.500	11921.865	6684.438	434.336
S.L.S Group	-1811.775	-1982.157	0.000	3872.480	78.547	5.104
L.F.D Group	-2826.369	-4132.060	-865.895	14755.738	6931.414	450.384
L.F.D Group	-2355.308	-3903.887	-674.050	17220.218	10286.974	668.419
L.F.D Group	-2355.308	-2576.829	0.000	0.000	-4932.136	-320.477

5.9.2 Calculation of Stress
 (1) Service Load Design

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h-x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

- b : Width in section (mm), b = 1000
- d : Effective height (mm) = 1426
- d' : Concrete Cover (mm) = 74
- A_s : Sectional area of reinforcing bar arranged on tension side (mm²) D28@125
- A_{s'} : Sectional area of reinforcing bar arranged on compression side (mm²) = D24@250
- n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00
- σ_c: Compressive Stress of Concrete (N/mm²)
- σ_s: Tensile Stress of Reinforcing (N/mm²)
- M: Bending Moment (kN.m)

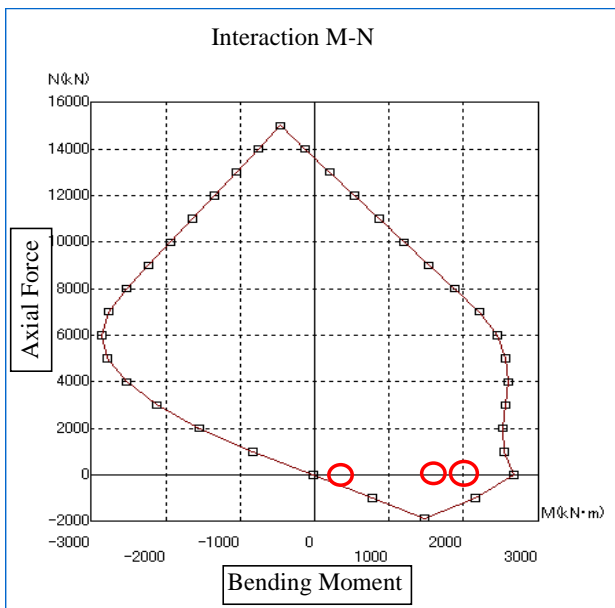
Calculation Result
 Section

Load Case	M (kNm/m)	X (m)	σ _c (N/mm ²)	σ _s (N/mm ²)	σ _{ca} (N/mm ²)	σ _{sa} (N/mm ²)
S.L.D-Group	399.1	0.431	1.20	52.4	9.6	168.0
S.L.D-Group	415.0	0.431	1.20	54.5	12.0	210.0
S.L.D-Group	1509.8	0.431	4.50	198.2	12.8	223.4

(2) Load Factor Design

Load Case	M (kNm/m)
L.F.D Group	1749.3
L.F.D Group	388.1
L.F.D Group	2040.4

N(kN)	Mr(kN.m)
14991.119	-466.984
14000	-135.114
13000	200.606
12000	534.885
11000	870.378
10000	1205.527
9000	1540.666
8000	1875.433
7000	2206.87
6000	2446.076
5000	2568.384
4000	2596.676
3000	2566.357
2000	2527.885
1000	2542.992
0	2667.516
-1000	2158.433
-1862.028	1471.085
-1862.028	1470.922
-1000	775.32



(3) Calculation of Shearing Stress

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 0.08 \sqrt{f_c}) \\ = 0.08 \sqrt{f_c} \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

		Longitudinal Direction
Load Factor Design	Group-I	450.4 kN
	Group-	668.4 kN
	Group-	-320.5 kN

Calculation of Shear Strength

$$v_c = 0.08 \sqrt{f_c} = 0.08 \sqrt{24} = 0.39 \text{ N/mm}^2 \rightarrow 390 \text{ kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 0.500 \text{ m}$$

		Su(kN)	bw(m)	d(m)	Vc(kN)	Vsreq(kN)	Asreq(mm ² /m)
Load Factor Design	Group-I	450.4	1.000	1.690	659.10	0.00	0.0
	Group-III	668.4	1.000	1.690	659.10	9.32	13.1
	Group-VI	-320.5	1.000	1.690	659.10	0.00	0.0

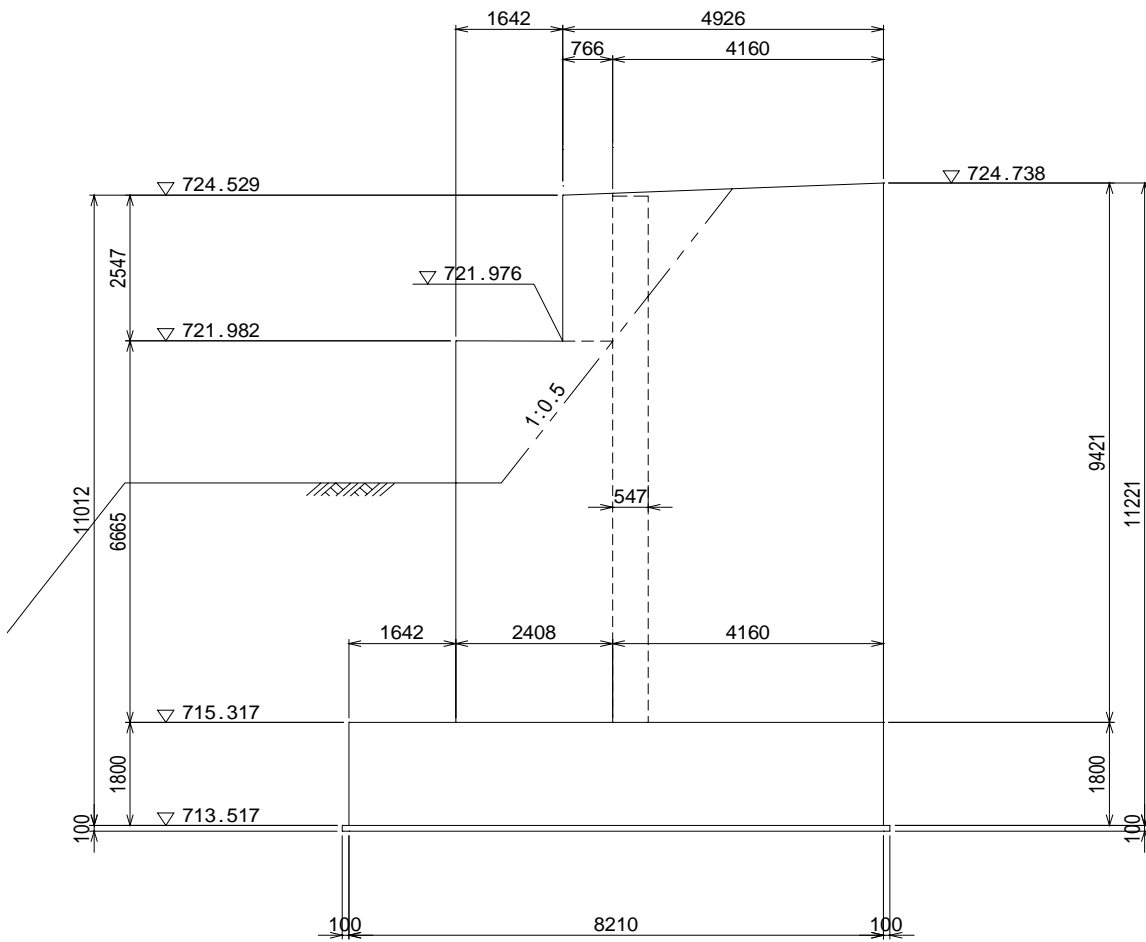
Arrangement of Stirrup

D16 -ctc.500

804.2 mm²/m

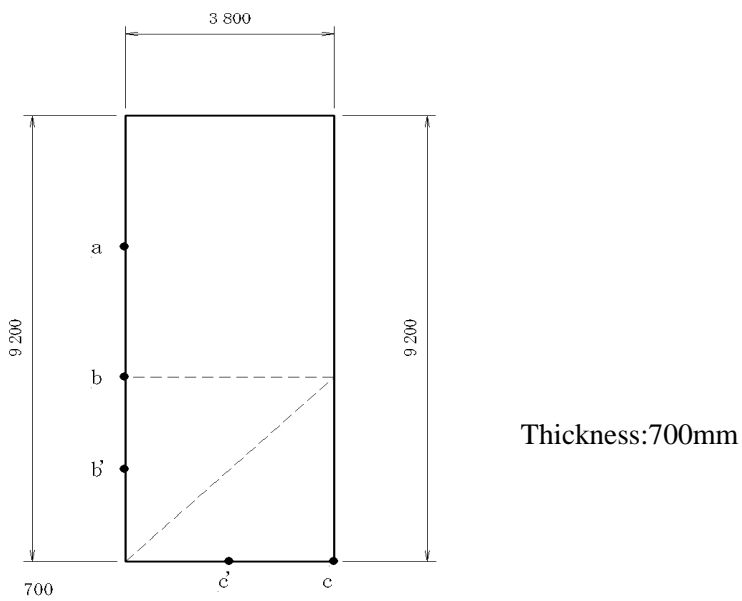
> 13.1 mm²/m

5.10 Design of Wing Wall
 5.10.1 Configuration of Wing



Side Elevation of Wing Wall(Right,Left)

5.10.2 Calculation of Sectinal Force



(1) Service Load Design: Group

1) Sectional Force at Section "a"

Shear and Bending Moment due to Earth Pressure

Shear Force

$$S_a = \frac{SA}{h_1} = 70.762 \quad (\text{kN/m})$$

$$SA = \frac{1}{2} \cdot (P_a + P_b) \cdot h_1 \cdot 11 = 382.117 \quad (\text{kN})$$

$$P_a = q \cdot K_a \cdot \cos \delta = 3.038 \quad (\text{kN/m}^2)$$

Bending Moment

$$M_a = \frac{MA}{h_1} = 134.449 \quad (\text{kN} \cdot \text{m/m})$$

$$MA = SA \cdot \frac{11}{2} = 726.022 \quad (\text{kN} \cdot \text{m})$$

2) Sectional Force at Section "b"

Shear and Bending Moment due to Earthpressure

$$S_b = P_b \cdot 11 = 129.981 \quad (\text{kN/m})$$

$$M_b = S_b \cdot \frac{11}{2} = 246.964 \quad (\text{kN} \cdot \text{m/m})$$

$$P_b = (q + \gamma_s \cdot h_1) \cdot K_a \cdot \cos \delta = 34.206 \quad (\text{kN/m}^2)$$

3) Sectional Force at Section "b"

Shear and Bending Moment due to Earthpressure

$$S_b' = P_b' \cdot \frac{11}{2} = 85.827 \quad (\text{kN/m})$$

$$M_b' = S_b' \cdot \frac{11}{4} = 81.535 \quad (\text{kN} \cdot \text{m/m})$$

$$P_b' = \left\{ q + \gamma_s \cdot \left(h_1 + \frac{h_2}{2} \right) \right\} \cdot K_a \cdot \cos \delta = 45.172 \quad (\text{kN/m}^2)$$

4) Sectional Force at Section "c"

Shear and Bending Moment due to Earth Pressure

$$S_c = \frac{1}{2} \cdot (P_b + P_c) \cdot 11 = 171.654 \quad (\text{kN/m})$$

$$\begin{aligned} M_c &= S_c \cdot \frac{2 \cdot (P_b + P_c)}{3 \cdot (P_b + P_c)} \cdot 11 = \frac{1}{6} \cdot (2 \cdot (P_b + P_c)) \cdot 11^2 \\ &= 299.749 \quad (\text{kN} \cdot \text{m/m}) \end{aligned}$$

$$P_c = \left\{ q + \gamma_s \cdot (h_1 + h_2) \right\} \cdot K_a \cdot \cos \delta = 56.138 \quad (\text{kN/m}^2)$$

5) Sectional Force at Section “ c ’ ’

Shear and Bending Moment due to Earth Pressure

$$S_{c'} = \frac{1}{2} \cdot (P_{b'} + P_{c'}) \cdot \frac{11}{2} = 96.245 \quad (\text{kN/m})$$

$$M_{c'} = S_{c'} \cdot \frac{2 \cdot P_{b'} + P_{c'}}{3 \cdot (P_{b'} + P_{c'})} \cdot \frac{11}{2} = \frac{1}{6} \cdot (2 \cdot P_{b'} + P_{c'}) \cdot \left(\frac{11}{2}\right)^2$$

$$= 88.134 \quad (\text{kN.m/m})$$

$$P_{c'} = \{q + \gamma_s \cdot (h_1 + h_2)\} \cdot K_a \cdot \cos \delta = 56.138 \quad (\text{kN/m}^2)$$

Section	Load Type	M (kN.m)	S (kN)
a	Earth Pressure	134.45	70.76
b	Earth Pressure	246.96	129.98
b'	Earth Pressure	81.54	85.83
c	Earth Pressure	299.75	171.65
c'	Earth Pressure	88.13	96.25

(2) Service Load Design: Group

1) Sectional Force at Section "a"

Shear and Bending Moment due to Earth Pressure

Earth pressure

$$S_a = 80.471 \quad (\text{kN/m})$$

$$M_a = 152.895 \quad (\text{kN. m/m})$$

Seismic inertia force

$$S_a = \frac{SA}{h_1} = 13.034 \quad (\text{kN})$$

$$M_a = \frac{MA}{h_1} = 24.765 \quad (\text{kN. m})$$

$$SA = h_1 \cdot 11 \cdot t_d \cdot \gamma_c \cdot Kh = 70.384 \quad (\text{kN})$$

$$MA = SA \cdot \frac{11}{2} = 133.729 \quad (\text{kN. m})$$

2) Sectional Force at Section "b"

Earth pressure

$$S_b = 160.942 \quad (\text{kN/m})$$

$$M_b = 305.791 \quad (\text{kN. m/m})$$

Seismic inertia force

$$S_b = 11 \cdot t_d \cdot \gamma_c \cdot Kh = 13.034 \quad (\text{kN/m})$$

$$M_b = S_b \cdot \frac{11}{2} = 24.765 \quad (\text{kN. m/m})$$

3) Sectional Force at Section "b'"

Earth pressure

$$S_b' = 108.785 \quad (\text{kN/m})$$

$$M_b' = 103.346 \quad (\text{kN. m/m})$$

Seismic inertia force

$$S_b' = \frac{11}{2} \cdot t_d \cdot \gamma_c \cdot Kh = 6.517 \quad (\text{kN/m})$$

$$M_b' = S_b' \cdot \frac{11}{4} = 6.191 \quad (\text{kN. m/m})$$

4) Sectional Force at Section “ c ”

Earth pressure

$$S_c' = 122.942 \quad (\text{kN/m})$$

$$M_c' = 112.312 \quad (\text{kN. m/m})$$

Seismic inertia force

$$S_c = 11 \cdot t_d \cdot \gamma_c \cdot K_h = 13.034 \quad (\text{kN/m})$$

$$M_c = S_c \cdot \frac{11}{2} = 24.765 \quad (\text{kN. m/m})$$

5) Sectional Force at Section “ c ’ ’

Earth pressure

$$S_c' = 122.942 \quad (\text{kN/m})$$

$$M_c' = 112.312 \quad (\text{kN. m/m})$$

Seismic inertia force

$$S_c' = \frac{11}{2} \cdot t_d \cdot \gamma_c \cdot K_h = 6.517 \quad (\text{kN/m})$$

$$M_c' = S_c' \cdot \frac{11}{4} = 6.191 \quad (\text{kN. m/m})$$

Section	Load Type	M (kN.m)	S (kN)
a	Earth Pressure + Seismic inertia force	177.66	93.51
b	Earth Pressure + Seismic inertia force	330.56	173.98
b'	Earth Pressure + Seismic inertia force	109.54	115.30
c	Earth Pressure + Seismic inertia force	402.28	230.60
c'	Earth Pressure + Seismic inertia force	118.50	129.46

(3) Load Factor Design: Group

Section	Load Type	M (kN.m)	S (kN)
a	Earth Pressure	174.78	91.99
b	Earth Pressure	321.05	168.97
b'	Earth Pressure	106.00	111.58
c	Earth Pressure	389.67	223.15
c'	Earth Pressure	114.57	125.12

(4) Load Factor Design: Group

Section	Load Type	M (kN.m)	S (kN)
a	Earth Pressure + Seismic inertia force	230.96	121.56
b	Earth Pressure + Seismic inertia force	429.72	226.17
b'	Earth Pressure + Seismic inertia force	142.40	149.89
c	Earth Pressure + Seismic inertia force	522.97	299.79
c'	Earth Pressure + Seismic inertia force	154.05	168.30

5.10.3 Calculation of Stress and Strength

(1) Service Load Design

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

b : Width in section (mm), b = 1000

d : Effective height (mm) = 1426

d' : Concrete Cover (mm) = 74

A_s : Sectional area of reinforcing bar arranged on tension side (mm²)

A_{s'}: Sectional area of reinforcing bar arranged on compression side (mm²)

n : Elastic Modulus Ratio of Reinforce and Concrete , n = 15.00

σ_c: Compressive Stress of Concrete (N/mm²)

σ_s: Tensile Stress of Reinforcing (N/mm²)

M: Bending Moment (kN.m)

Section	A _s	A _{s'}
a	D28@250	D20@250
b	D32@250	D20@250
b'	D32@250	D20@250
c	D28@125	D28@250
c'	D28@250	D20@250

Calculation Result

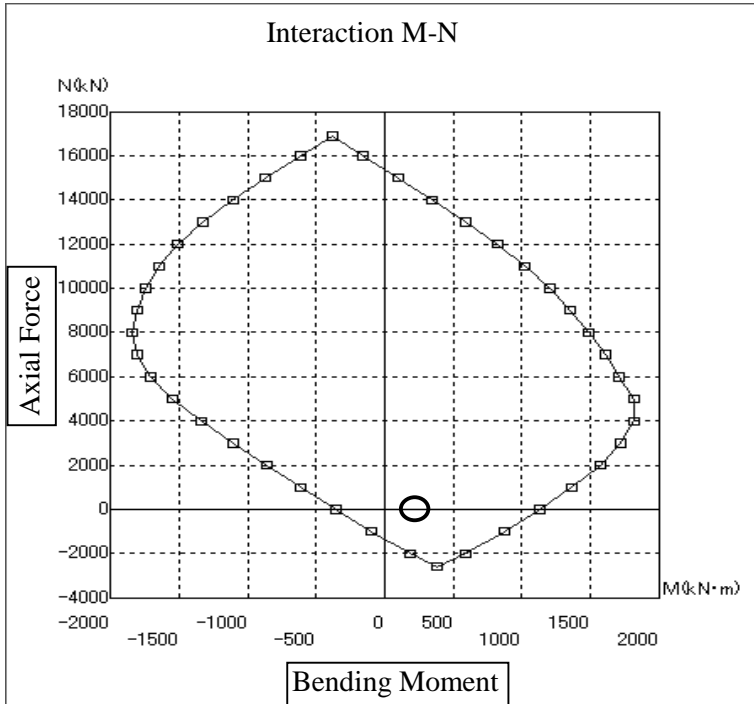
Section	Load Case	M (kNm/m)	X (m)	σ _c (N/mm ²)	σ _s (N/mm ²)	σ _{ca} (N/mm ²)	σ _{sa} (N/mm ²)
a	S.L.D-Group	134.4	0.171	2.7	101.1	9.6	168.0
	S.L.D-Group	177.7		3.5	133.7	12.8	223.4
b	S.L.D-Group	247.0	0.190	4.5	143.9	9.6	168.0
	S.L.D-Group	330.6		6.0	192.6	12.8	223.4
b'	S.L.D-Group	81.5	0.190	1.5	47.5	9.6	168.0
	S.L.D-Group	109.5		2.0	63.8	12.8	223.4
c	S.L.D-Group	299.7	0.214	5.0	123.7	9.6	168.0
	S.L.D-Group	402.3		6.7	166.0	12.8	223.4
c'	S.L.D-Group	88.1	0.164	1.9	70.4	9.6	168.0
	S.L.D-Group	118.5		2.5	94.6	12.8	223.4

(2) Checking of Flexural Strength

1) Section "a"

Load Case	M (kNm/m)
L.F.D Group	174.8
L.F.D Group	231.0

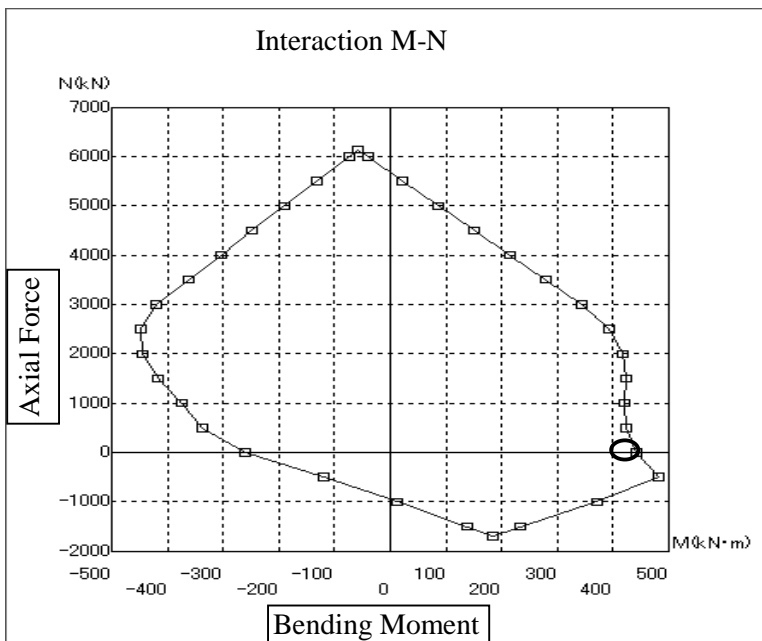
N(kN)	Mr(kN·m)
16876.69	-385.287
16000	-155.186
15000	101.332
14000	348.704
13000	589.354
12000	820.526
11000	1024.169
10000	1201.092
9000	1354.787
8000	1489.067
7000	1608.019
6000	1715.775
5000	1816.509
4000	1815.186
3000	1719.143
2000	1568.542
1000	1370.01
0	1133.665
-1000	872.019
-2000	585.156



2) Section "b"

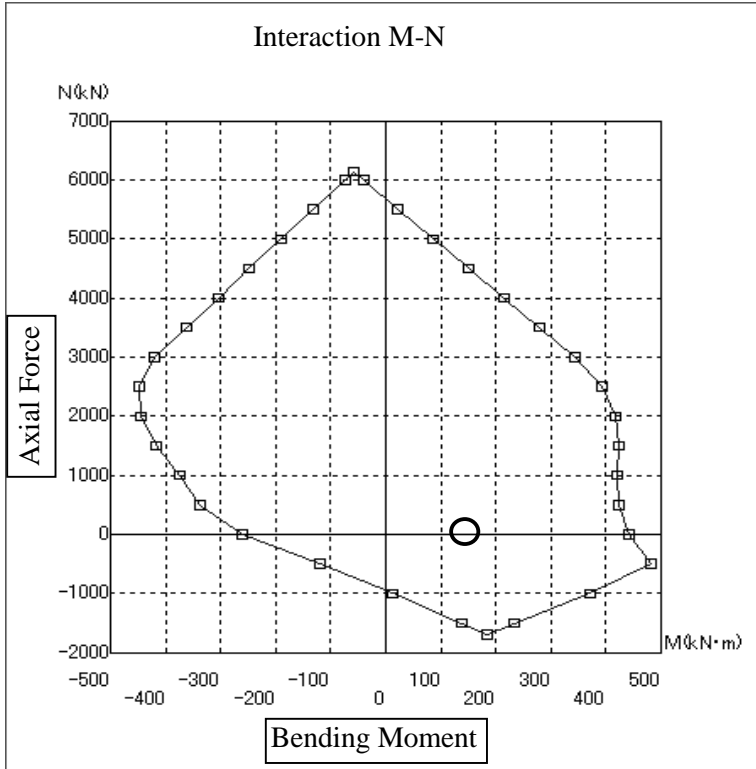
Load Case	M (kNm/m)
L.F.D Group	321.0
L.F.D Group	429.7

N(kN)	Mr(kN·m)
6136.832	-58.812
6000	-41.352
5500	22.781
5000	86.889
4500	150.915
4000	215.048
3500	279.15
3000	343.186
2500	393.291
2000	417.359
1500	423.207
1000	421.721
500	425.311
0	443.892
-500	481.356
-1000	373.201



3) Section "b"

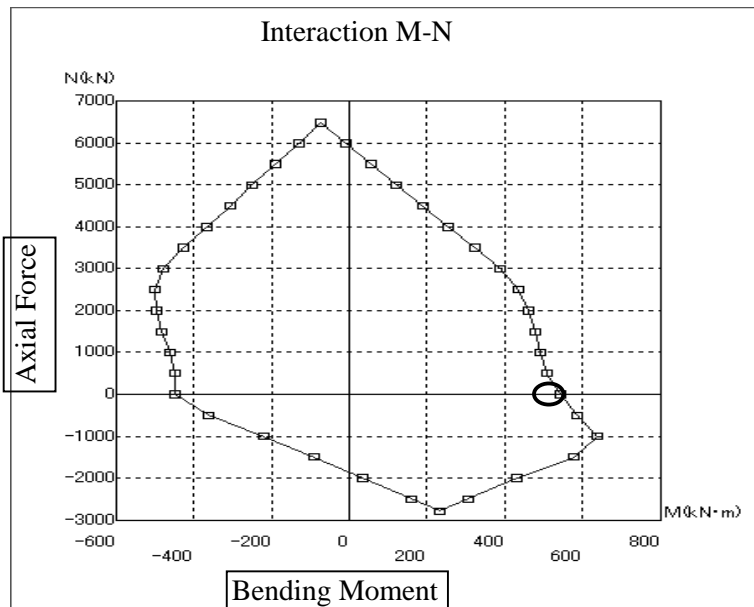
Load Case	M (kNm/m)
L.F.D Group	106.0
L.F.D Group	142.4



N(kN)	Mr(kN·m)
6136.832	-58.812
6000	-41.352
5500	22.781
5000	86.889
4500	150.915
4000	215.048
3500	279.15
3000	343.186
2500	393.291
2000	417.359
1500	423.207
1000	421.721
500	425.311
0	443.892
-500	481.356
-1000	373.201

4) Section "c"

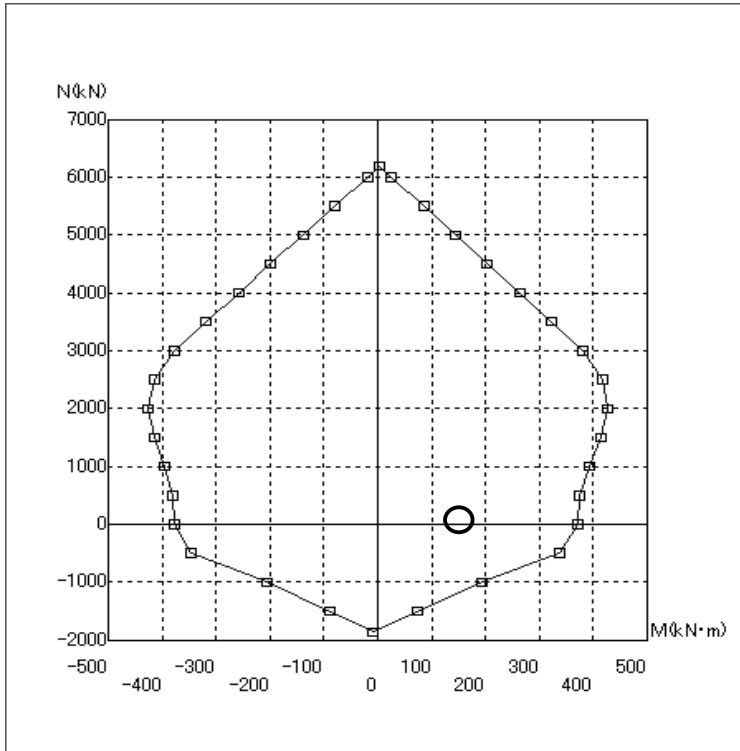
Load Case	M (kNm/m)
L.F.D Group	389.7
L.F.D Group	523.0



N(kN)	Mr(kN·m)
6486.68	-73.89
6000	-9.538
5500	56.538
5000	122.7
4500	188.728
4000	254.886
3500	320.954
3000	386.057
2500	432.985
2000	460.497
1500	476.684
1000	490.506
500	510.032
0	540.499
-1000	638.813

5) Section "c"

Load Case	M (kNm/m)
L.F.D Group	114.6
L.F.D Group	154.1



N(kN)	Mr(kN·m)
6191.12	2.956
6000	25.641
5500	85.227
5000	144.758
4500	204.224
3500	323.243
3000	382.14
2500	419.058
2000	427.745
1000	394.404
500	376.706
0	372.984
-500	337.572
-1000	194.973

(3) Calculation of Shearing Stress

Shear Strength "Vn" is Calculated as follows.

$$V_n = V_c + V_s$$

In Which

V_c : Normal Shear Strength provided by the Concrete

$$V_c = v_c \times b_w \times d \quad (v_c = 0.08 \sqrt{f_c})$$

$$= 0.08 \sqrt{f_c} \times b_w \times d$$

f_c : 28days Cylinder Strength

b_w : Width of Section

d : Effective Height of Section

V_s : Normal Shear Strength provided by the Shear Reinforcement

$$V_s = A_v \times f_y \times d / s$$

A_v : Area of Shear Reinforcement within a distances.

f_y : Yeild Strength of Shear Reinforcement

d : Effective Height of Section

s : Calculated Distance.

Factored Shear Force for Load Factor Design

		Factored Shear Force
Load Factor Design	Group-I	223.2 kN
	Group-	299.8 kN

Calculation of Shear Strength

$$v_c = 0.08 \sqrt{f_c} = 0.08 \sqrt{24} = 0.39 \text{ N/mm}^2 \rightarrow 390 \text{ kN/m}^2$$

$$f_y = 420 \text{ N/mm}^2 \rightarrow 420000 \text{ kN/m}^2$$

$$s = 0.500 \text{ m}$$

		Su(kN)	b _w (m)	d(m)	V _c (kN)	V _{sreq} (kN)	A _{sreq} (mm ² /m)
Load Factor Design	Group-I	223.2	1.000	0.600	234.00	0.00	0.0
	Group-VI	299.8	1.000	0.600	234.00	65.79	261.1

Arrangement of Stirruj D16 -ctc.500 804.2 mm²/m > 261.1 mm²/m

5.11 Design of Approach Slab

5.11.1 Calculation of Sectional Force

$$M = MD + ML = 16.576 + 78.000 = 94.576 \quad (\text{kN. m/m})$$

$$MD = \frac{1}{8} (W1 + W2 + q) \cdot L^2 = 16.576 \quad (\text{kN. m/m})$$

$$ML = \left\{ \frac{1}{4} wL \cdot L \cdot (0.2 + 2d) - \frac{1}{8} wL \cdot (0.2 + 2d)^2 \right\} \alpha$$

$$= 78.000 \quad (\text{kN. m/m})$$

in which,

MD: Bending Moment at middle of span for Dead Load

ML: Bending Moment at middle of span for Live Load

W1: Self-weight of pavement

W2: Self-weight of approach slab

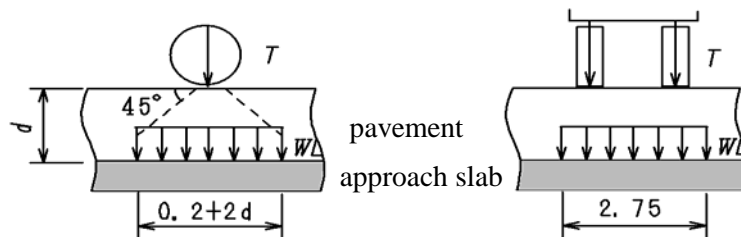
q: Surcharge load

d: Thickness of pavement

h: Thickness of approach slab

L: Design span length of approach slab = $0.70 \times 5.00 = 3.50\text{m}$

wL: Live load (Uniform load)



$$wL = \frac{2 \cdot T \cdot (1+i)}{2.75 \cdot (0.2 + 2d)} = 236.364$$

T: Wheel load = 100 kN

i: Impact Coefficient

5.11.2 Calculation of Stress

$$\sigma_c = \frac{M}{\frac{b \cdot x}{2} \cdot \left(\frac{h}{2} - \frac{x}{3}\right) + n \cdot A_{s'} \cdot \frac{(x-d') \cdot (h/2-d')}{x} + n \cdot A_s \cdot \frac{(x-d) \cdot (h/2-d)}{x}}$$

$$\sigma_s = n \cdot \sigma_c \cdot \frac{d-x}{x}$$

$$x^2 + \frac{2 \cdot n}{b} \{A_{s'} \cdot (x-d') + A_s \cdot (x-d)\} = 0.0$$

As: D24@150

As': D20@300

Calculation Result

x = 113.6mm

$\sigma_c = 5.6 \text{ N/mm}^2$ < $\sigma_{ca} = 0.4f_{cu} = 9.6 \text{ N/mm}^2$ OK

$\sigma_s = 114.0 \text{ N/mm}^2$ < $\sigma_{sa} = 0.4f_y = 168 \text{ N/mm}^2$ OK

Seismic Analysis

1. SEISMIC ANALYSIS

1.1 Summary of Analysis

1.1.1 Analysis Model

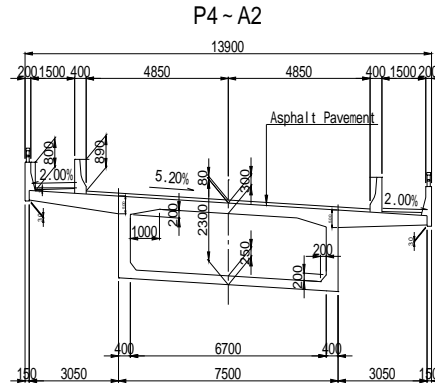
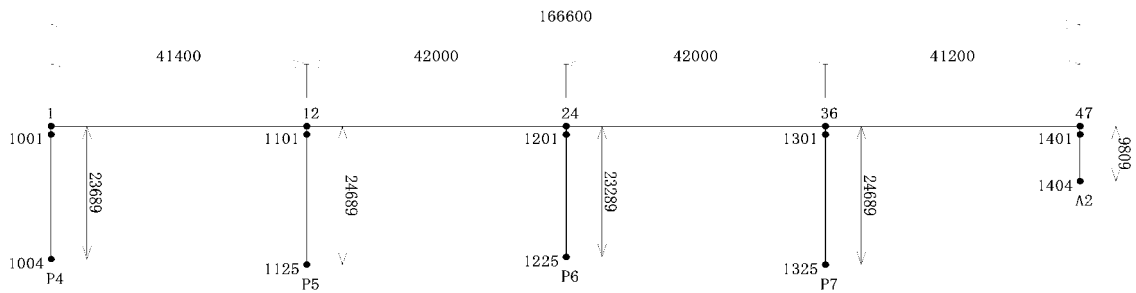


Figure 1.1 Typical Section of Girder



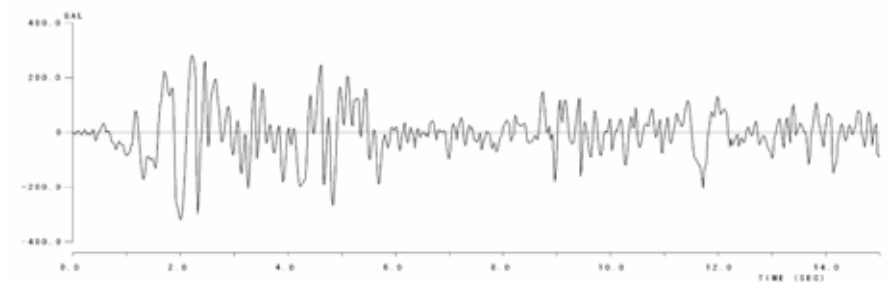
Support Condition

	P4	P5	P6	P7	A2	Remarks
Longitudinal Direction	Mov.	Rigid	Rigid	Rigid	Mov.	
Transverse Direction	Fix.	Rigid	Rigid	Rigid	Fix.	

Figure 1.2 Analysis Frame Model

1.1.2 Input Waveforme

In the time-history response analysis, the El Centro seismic waveform are utilized as an input earthquake ground motion. Although it is desirable to use observed seismic record at an actual bridge construction point for seismic wave input, it is normally difficult to obtain survey data. Therefore, the EL Centro seismic wave in accordance with AASHTO which has almost equal maximum acceleration to the earthquake arisen on 8th Oct, 2005.



1.1.3 Eigenvalue Analysis

(1) Purpos of Eigenvalue Analysis

From the Eigenvalue analysis outputs, it is calculated selected vibration mode and viscosity damping characteristics for further dynamic analysis. The dynamic analysis take bridge damping effect calculated by viscosity damping matrix into consideration.

(2) Determination of Parameter for Viscosity Damping Matrix

Determination of parameter for viscosity damping matrix, which clculate from two predominant mode, the parameter should calculate as following formula.

$$[C] = \alpha \cdot [K_0] + \beta \cdot [M]$$

$$\alpha = (f_i \cdot h_i - f_j \cdot h_j) / \{\pi \cdot (f_i^2 - f_j^2)\}$$

$$\beta = 4\pi \cdot f_i \cdot (h_i - \alpha \cdot \pi \cdot f_i)$$

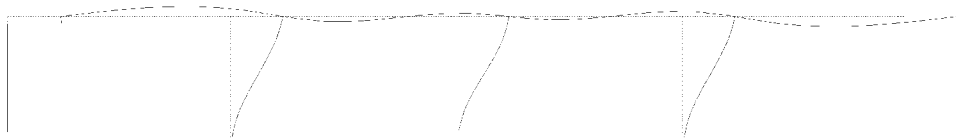
- [C] : Damping Matrix
- [K₀] : Elasticity Stiffness Matrix
- [M] : Mass Matrix
- a : Coefficient of Stiffness Matrix for Structural Syste
- b : Coefficient of Mass Matrix for Structural System
- f_i : Freqency at "i"th Mode
- f_j : Freqency at "j"th Mode
- h_i : Damping Coefficient at "i"th Mode
- h_j : Damping Coefficient at "j"th Mode

1.2 Result of Eigenvalue Analysis

1.2.1 Mode Shape

(1) Longitudinal Direction

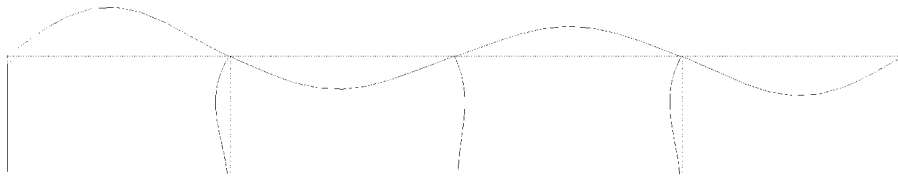
Mode < 1 > T = 0.905 sec



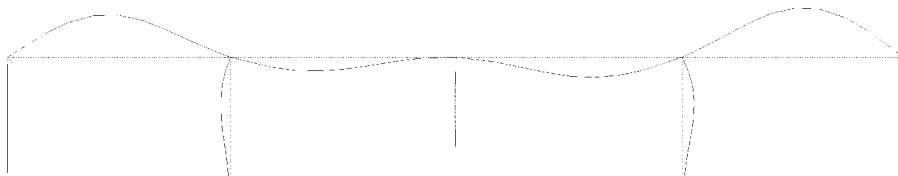
Mode < 2 > T = 0.581 sec



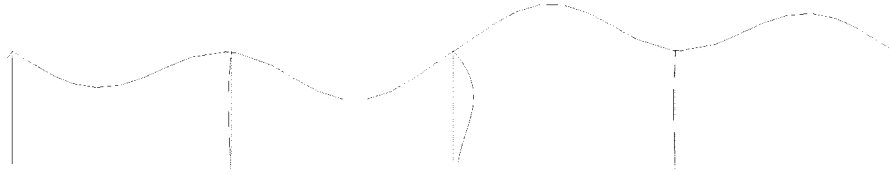
Mode < 3 > T = 0.335 sec



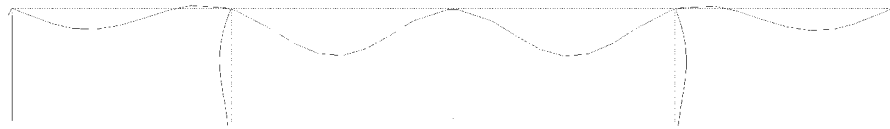
Mode < 4 > T = 0.314 sec



Mode < 5 > T = 0.241 sec



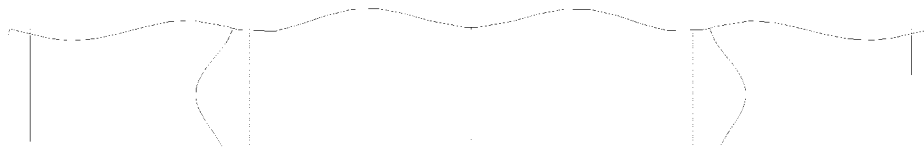
Mode < 6 > T = 0.193 sec



Mode < 7 > T = 0.176 sec



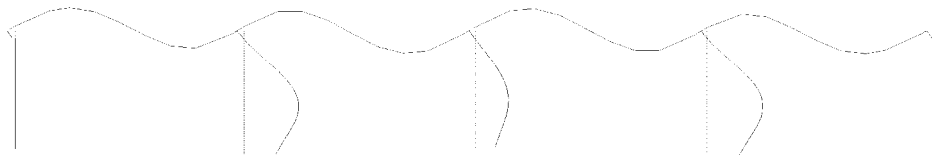
Mode < 8 > T = 0.135 sec



Mode < 9 > T = 0.131 sec

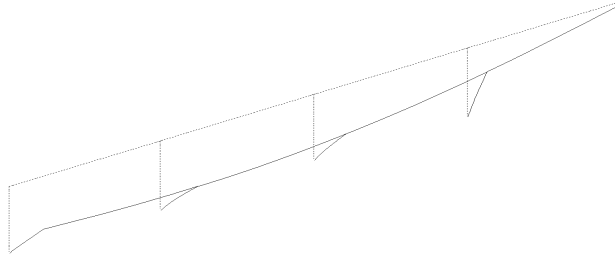


Mode < 10 > T = 0.130 sec

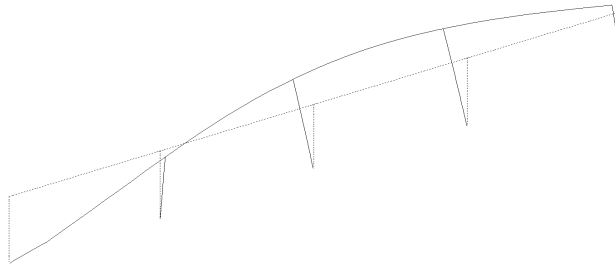


(2) Transverse Direction

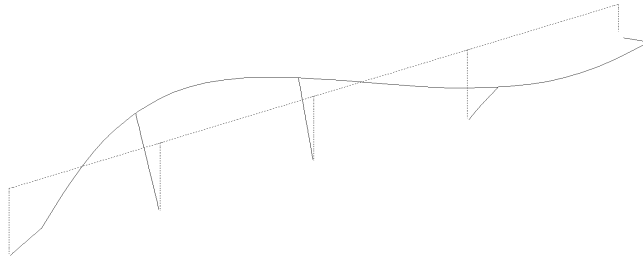
Mode < 1 > T = 0.968 sec



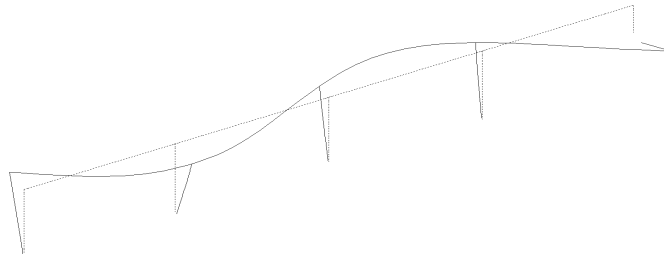
Mode < 2 > T = 0.730 sec



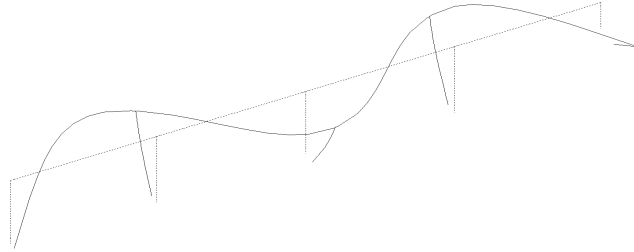
Mode < 3 > T = 0.401 sec



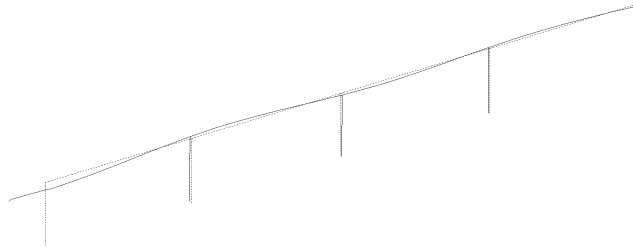
Mode < 4 > T = 0.254 sec



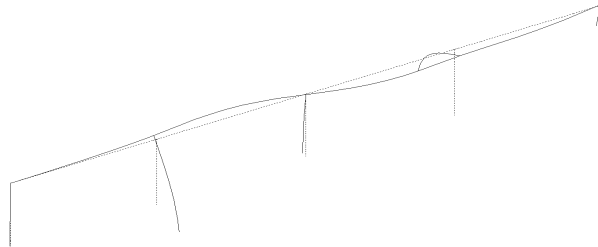
Mode < 5 > T = 0.166 sec



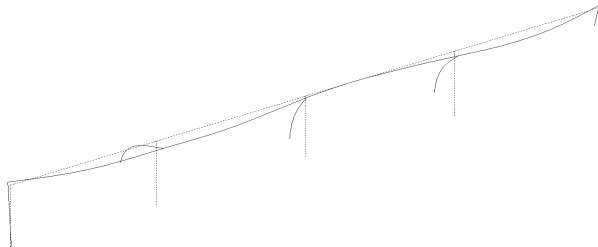
Mode < 6 > T = 0.127 sec



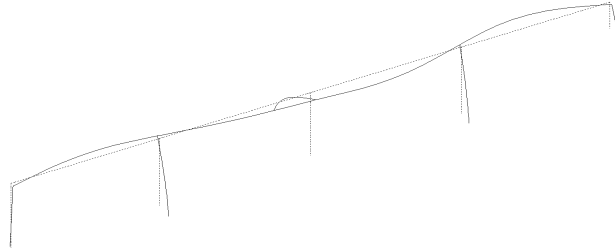
Mode < 7 > T = 0.106 sec



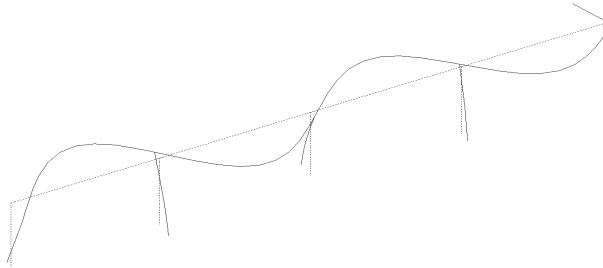
Mode < 8 > T = 0.106 sec



Mode < 9 > T = 0.103 sec



Mode < 10 > T = 0.098 sec



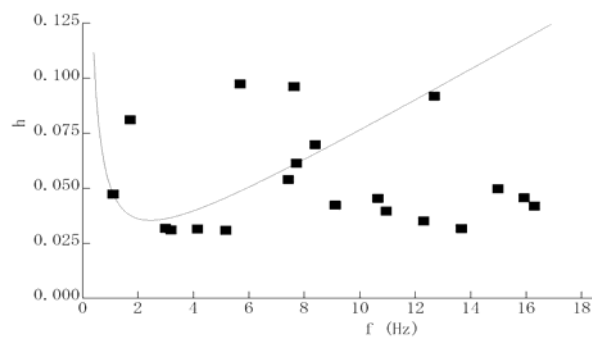
1.2.2 Natural Frequency

	Mode	Frequency f_i (Hz)	Period T (sec)	Remarks
Longitudinal Direction	1	1.105	0.91	
Transverse Direction	1	1.033	0.97	

1.2.3 Determination of Parameter for Viscosity Damping Matrix

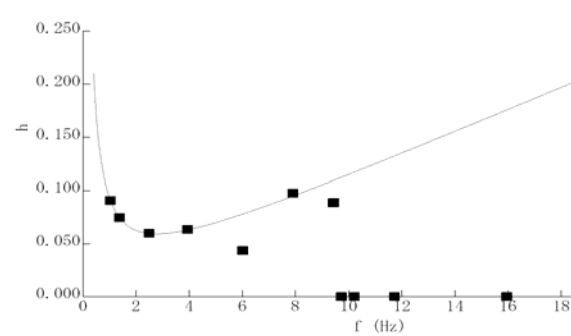
(1) Longitudinal Direction

Mode	Frequency f_i (Hz)	Modal Damping h	α	β
1	1.105	0.047	0.0023	0.5469
10	7.711	0.061		



(2) Transverse Direction

Mode	Frequency f_i (Hz)	Modal Damping h	α	β
1	1.033	0.091	0.00341	1.03636
3	2.493	0.060		

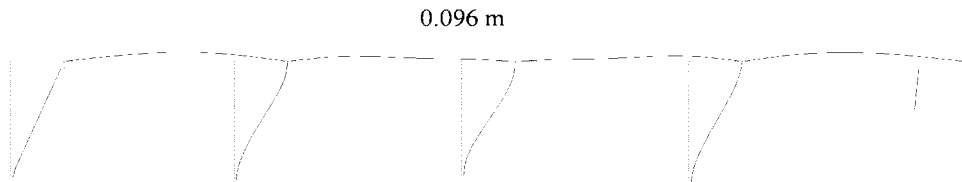


1.3 Calculation Result of Dynamic Analysis

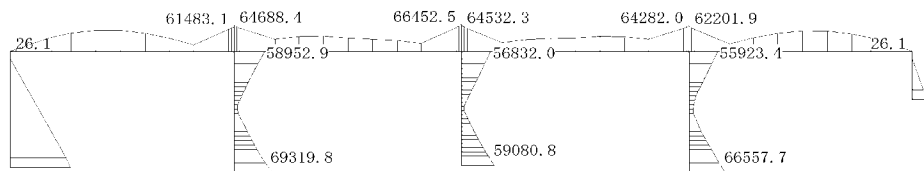
1.3.1 Longitudinal Seismic Motion

(1) Response Displacement and Sectional Force

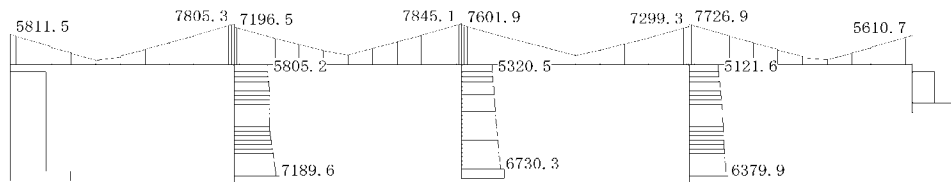
Maximum Displacement



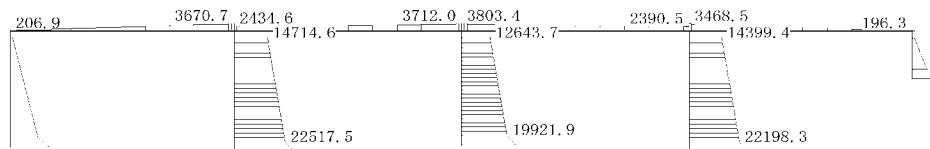
Maximum Bending Moment



Maximum Shear Force



Maximum Axial Force

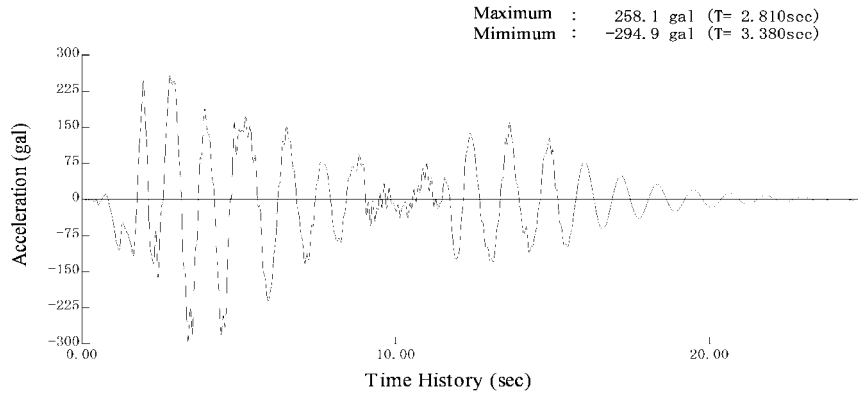


Note: include Initial Force

Longitudinal Direction

(2) Response Acceleration

Superstructure



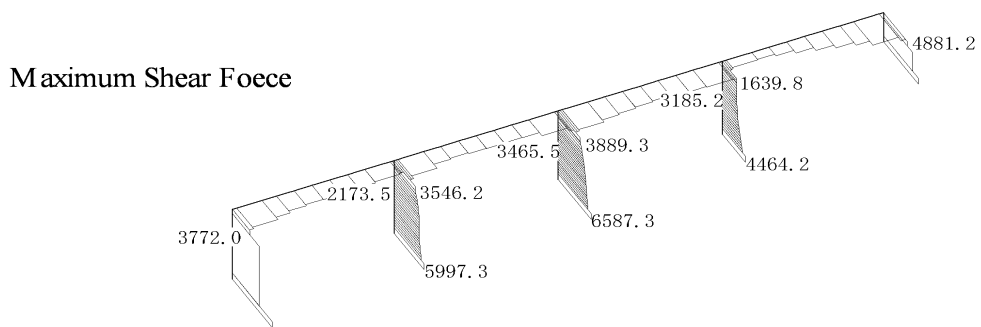
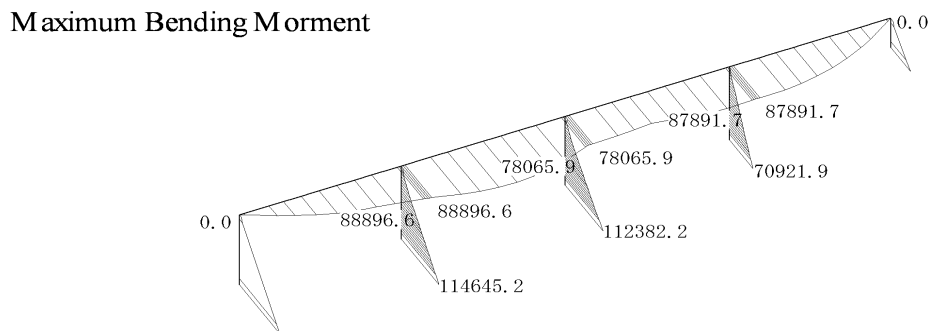
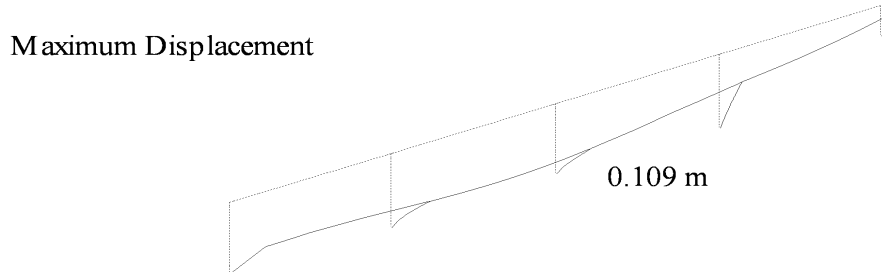
(3) Sectional Force on Base of Wall

	unit	P5 Pier	P6 Pier	P7 Pier
Bending Morment	kNm	69319.8	59080.8	66557.7
Shear Force	kN	7189.6	6730.3	6379.9
Axial Force	kN	22517.5	19921.9	22198.3

Note: include Initial Force

1.3.2 Transverse Seismic Motion

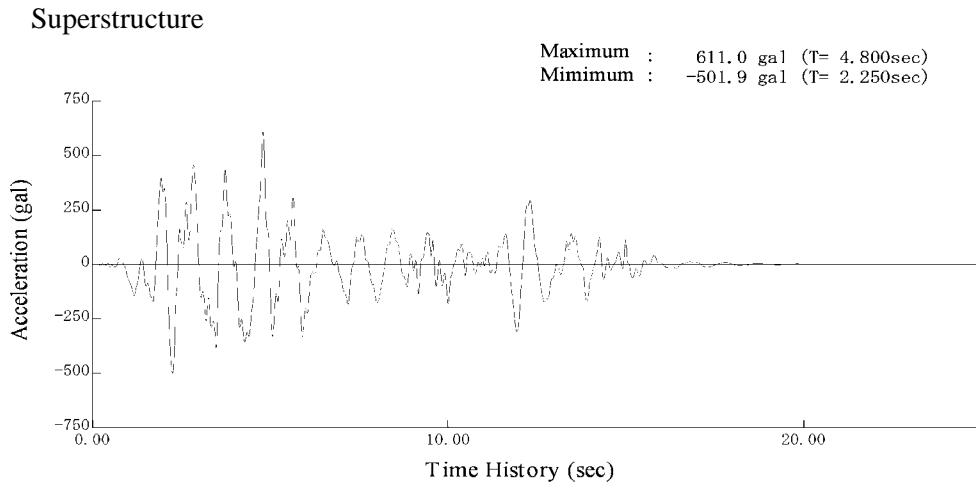
(1) Response Displacement and Sectional Force



Note: include Initial Force

Transverse Direction

(2) Response Acceleration



(3) Sectional Force on Base of Wall

	unit	P5 Pier	P6 Pier	P7 Pier
Bending Morment	kNm	114645.2	112382.2	70921.9
Shear Force	kN	5997.3	6587.3	4464.2
Axial Force	kN	20485.7	19916.2	20365.6

Note: include Initial Force