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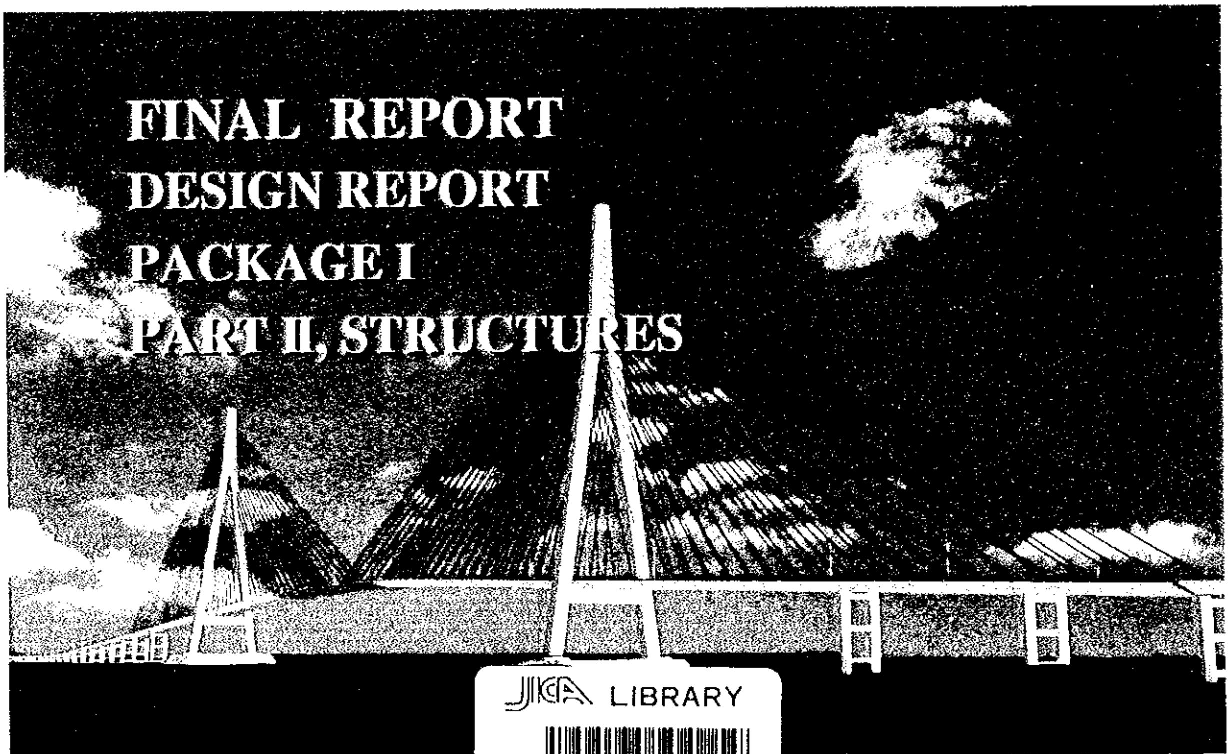
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF TRANSPORT
SOCIALIST REPUBLIC OF VIET NAM

THE DETAILED DESIGN ON THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM



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THE DETAILED DESIGN ON THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM

FINAL REPORT
DESIGN REPORT
PACKAGE I
PART II, STRUCTURES

OCTOBER 2000

NIPPON KOEI CO., LTD.

DESIGN REPORT II

STRUCTURES, PACKAGE-1

CONTENTS

APPENDICES *II - A - 1*

Chapter 1

GENERAL

DESIGN REPORT II

STRUCTURES, PACKAGE-1

CHAPTER 1 GENERAL

1.1 Summary of Categorization

1.1.1 General

The structures of Package -1 and 3 were categorized into the following summary tables with considering the design conditions and dimensions of the structures, and the design analysis was studied for the most severe design condition.

The categorized structures are summarized as follows:

Table 1.1 Summary of Categorized Structures

Structure	Number of Categorized Structures	Remarks	
1) Bridges			
1-1) Superstructures	15 types	PC Box:	2types
		PRC Hollow Slab:	2types
		PC Composite I beam (Connected):	8types
		PC Composite I beam (Simple Span):	3types
1-2) Abutments	11 types	Reversed T type	
1-3) Piers	16 types	3 column type:	8 types
		Solid single column type:	2 types
		Wall type:	6 types
2) Culvert Box			
2-1) Culvert Box	14 types	1 cell type:	10types
		2 cells type:	4types
2-2) Wing Wall	3 types		

1.1.2 Bridges

(1) Superstructures

Table 1.2 Summary of Superstructures for Design

Type for Design		Span Arrangement		Name of Bridges
PC Box Girder	Case 1	42 + 75 + 42	-	Cai Rang Bridge (Package -3)
	Case 2	36.5+57+36.5	-	Tra On Bridge (Package - 1)
PRC Hollow Slab	Case 1	4 @ 25	-	NH. 91B, Over Bridge (Package-3)
	Case 2	2 @ 24.5 + 34.5 + 2 @ 24.5	-	NH. 54, Over Bridge (Pacakge-1)
PC Composite I beam (Connected or Simple Spans)	Case 1	31 (H=1.85) + 31 (H=1.85)	-	Cai Rang Bridge (Package - 3)
	Case 2	37 (H=1.85) + 31 (H=1.65)	-	Cai Rang Bridge (Package - 3)
	Case 3	25(H=1.45) + 37(H=1.85) + 25(H=1.45)	-	Small Tra Va Bridge (Package - 1)
	Case 4	28(H=1.65) + 37(H=1.85) + 28(H=1.65)	-	Cai Da Bridge (Package-3)
			-	Cai Nai Bridge (Package-3)
	Case 6	28(H=1.65) + 25(H=1.65) + 37(H=1.85) + 2@25(H=1.65)	-	Ap My Bridge (Package-3)
	Case 7	5 @ 37(H=1.85)	-	Large Tra Va Bridge (Package-1)
			-	Tra On Bridge (Package-1)
			-	Cai Tac 1 Bridge (Package-3)
	Case 8	28(H=1.65) + 37(H=1.85) + 28(H=1.65), *W=6.5	-	NH No.91, Rampway Bridge (Package-3)
PC Composite I beam (Simple Span)	Case 1	25(H=1.45)	-	Ba Mang Bridge (Package-3)
	Case 2	31(H=1.85)	-	Cai Rang Bridge (Package-3)
	Case 3	37(H=1.85)	-	Cai Rang Bridge (Package-3)
			-	Cai Tac 2 Bridge (Package-3)

Remarks: (H=1.65) indicates the height of PC I beam.
*W=6.5 indicates the Carriageway width of the Bridge Case 8.

(2) Abutments

Table 1.3 Summary of Abutments for Design

Type for Design	Height of abutment	Type & Diameter of Piles
A1	9.2m	Cast in Place Concrete Pile 1.5m
A2	9.2m	Cast in Place Concrete Pile 1.5m
A3	8.2m	Cast in Place Concrete Pile 1.5m
A4	8.8m	Cast in Place Concrete Pile 1.5m
A5	8.0m	Cast in Place Concrete Pile 1.5m
A6	7.52, 7.6, 7.8m	Cast in Place Concrete Pile 1.5m
A8	8.0m	Cast in Place Concrete Pile 1.5m
A2-DP	9.2m	Driving Square Pile 0.45m x 0.45m
A3-DP	8.2m	Driving Square Pile 0.45m x 0.45m
A7-DP	7.6m	Driving Square Pile 0.45m x 0.45m
A9-DP	7.8m	Driving Square Pile 0.45m x 0.45m

Notes: In the Design of "Type A6", the highest Abutment (7.8m) was studied.

(3) Piers

Table 1.4 Summary of Piers for Design

Type for Design	Height of Piers	Type & Diameter of Piles	Type of Pier
P2	8.6m, 9.1m	Cast in Place Concrete Pile 1.5m	Solid Single Column Type
P4	12.6m, 13.6m,14.4m	Cast in Place Concrete Pile 1.5m	Wall Type
P5	11.2m	Cast in Place Concrete Pile 1.5m	Wall Type
P6	9.5m	Cast in Place Concrete Pile 1.5m	3 Column Type
P7	7.4m	Cast in Place Concrete Pile 1.5m	3 Column Type
P8	8.0m, 8.7m, 9.0m	Cast in Place Concrete Pile 1.5m	3 Column Type
P9	9.1m, 10.8m	Cast in Place Concrete Pile 1.5m	3 Column Type
P11	8.4m, 9.0m	Cast in Place Concrete Pile 1.5m	3 Column Type
P13	8.1m	Cast in Place Concrete Pile 1.5m	Wall Type
P14	8.5m	Cast in Place Concrete Pile 1.5m	Wall Type
P15	9.0m	Cast in Place Concrete Pile 1.5m	Wall Type
P16	9.1m	Cast in Place Concrete Pile 1.5m	Wall Type
P3-DP	9.2m	Driving Square Pile 0.45m x 0.45m	Solid Single Column Type
P6-DP	8.7m	Driving Square Pile 0.45m x 0.45m	3 Column Type
P9-DP	11.5m	Driving Square Pile 0.45m x 0.45m	3 Column Type
P12-DP	7.7m	Driving Square Pile 0.45m x 0.45m	3 Column Type

Notes: In the Design, the highest Pier was studied for the types of piers with some heights.

1.1.3 Culverts

(1) Culverts

Table 1.5 Summary of Culverts for Design

Type for Design	Size & Number of Cell Width x Height x Number	Facilities in the Cell
B1	2.5m x 1.5m x 1	Waterway
B2	2.5m x 2.0m x 1	Waterway
B3	3.0m x 3.2m x 1	Waterway
B4	3.0m x 3.5m x 1	Waterway
B5	3.0m x 3.8m x 1	Waterway
B6	5.0m x 3.8m x 1	Waterway & Foot Path
B7	5.0m x 4.0m x 1	Waterway & Foot Path
B8	5.0m x 4.0m x 1	Waterway
B9	5.0m x 4.5m x 1	Waterway & Foot Path
B10	6.5m x 4.5m x 1	Waterway & Foot Path
B11	2.5m x 1.5m x 2	Waterway
B12	2.5m x 2.0m x 2	Waterway
B13	2.5m x 2.0m x 2	Waterway
B14	5.0m x 4.5m x 2	Waterway

(2) Wing Wall

Table 1.6 Summary of Wing Wall for Design

Type for Design	Dimension Length of Footing x Width of Footing x Maximum Height
W1	8.7m x 4.1m x 5.9m
W2	7.2m x 3.5m x 5.1m
W3	3.5m x 1.9m x 3.0m

1.1.4 Types of Structures in Package-1

Table 1.7 Summary of Types of Structures in Package-1

<1> Bridges

Superstructures		Substructures		
Large Tra Va (STA: 0+578.55 ~ 0+860.15)				
- PC Composite I beam (Connected):	Case 7	Abutments:	A1: Type A1	A2: Type A1
		Piers:	P1: Type P6	P2: Type P6
			P3: Type P6	P4: Type P6
			P5: Type P6	P6: Type P6
			P7: Type P6	
Small Tra Va (STA: 1+866.25 ~ 1+953.75)				
- PC Composite I beam (Connected):	Case 3	Abutments:	A1: Type A3	A2: Type A3
		Piers:	P1: Type P7	P2: Type P7
Tra On (STA: 3+582.00 ~ 3+842.00)				
- PC Box Girder:	Case 2	Abutments:	A1: Type A1	A2: Type A1
- PC Composite I beam (Connected):	Case 7	Piers:	P1: Type P2	P2: Type P2
			P3: Type P4	P4: Type P4
			P5: Type P2	P6: Type P2
NH No.54 Interchange Over Bridge (STA: 3+129.68)				
- PRC Hollow Slab:	Case 2	Abutments:	A1: Type A4	A2: Type A4
		Piers:	P1: Type P14	P2: Type P13
			P3: Type P13	P4: Type P14

<2> Culverts

STA	Type of Culvert	Type of Wing Wall	STA	Type of Culvert	Type of Wing Wall
(MAIN ROUTE)			(INTERCHANGE 2)		
Km 0+51.8	-	Type W1	Ramp "A" - Km 0+300	Type B1	Type W1
Km 0+183.7	Type B3	Type W2	Ramp "B" - Km 0+220	Type B1	Type W1
Km 0+369.5	Type B3	Type W2	Ramp "C" - Km 0+240	Type B1	Type W1
Km 1+063.2 (Path)	Type B9	Type W3	Ramp "D" - Km 0+300	Type B1	Type W1
Km 1+300	Type B11	Type W1			
Km 1+560	Type B4	Type W2			
Km 2+150	Type B12	Type W1			
Km 2+620 (Path)	Type B6	Type W2			
Km 2+835	Type B12	Type W1			
Km 3+170	Type B11	Type W1			
Km 4+125	Type B11	Type W1			
Km 4+318	Type B14	Type W3			
Km 4+640 (Path)	Type B10	Type W3			

1.1.5 Types of Structures in Package-3

Table 1.8 Types of Structures in Package-3 (1/2)

<1> Bridges

Superstructures		Substructures		
Cai Tac 1 (STA: 8+456.85 ~ 8+642.75)				
- PC Composite I beam (Connected):	Case 7	Abutments:	A1: Type A6	A2: Type A1
		Piers:	P1: Type P11	P2: Type P8
			P3: Type P8	P4: Type P11
Cai Tac 2 (STA: 9+431.45 ~ 9+468.55)				
- PC Composite I beam (Simple Span):	Case 3	Abutments:	A1: Type A8	A2: Type A5
Cai Da (STA: 10+416.25 ~ 10+509.75)				
- PC Composite I beam (Connected):	Case 4	Abutments:	A1: Type A6	A2: Type A6
		Piers:	P1: Type P9	P2: Type P9
Ba Mang (STA: 11+202.45 ~ 11+227.55)				
- PC Composite I beam (Simple Span):	Case 1	Abutments:	A1: Type A9-DP	
			A2: Type A9-DP	
Cai Nai (STA: 12+336.25 ~ 12+429.75)				
- PC Composite I beam (Connected):	Case 4	Abutments:	A1: Type A3-DP	
			A2: Type A3-DP	
		Piers:	P1: Type P9-DP	
			P2: Type P9-DP	
Ap My (STA: 13+109.55 ~ 13+250.45)				
- PC Composite I beam (Connected):	Case 6	Abutments:	A1: Type A2-DP	
			A2: Type A2-DP	
		Piers:	P1: Type P12-DP	
			P2: Type P9-DP	
			P3: Type P9-DP	
			P4: Type P12-DP	
Cai Rang (STA: 13+806.40 ~ 14+064.90)				
- PC Box Girder:	Case 1	Abutments:	A1: Type A2-DP	
- PC Composite I beam (Connected):	Case 1		A2: Type A2-DP	
- PC Composite I beam (Connected):	Case 2	Piers:	P1: Type P2	P2: Type P5
- PC Composite I beam (Simple Span):	Case 2		P3: Type P5	P4: Type P2
- PC Composite I beam (Simple Span):	Case 3		P5: Type P6-DP	
NH No.91B Interchange Over Bridge (STA: 10+000.00)				
- PRC Hollow Slab:	Case 1	Abutments:	A1: Type A2	A2: Type A2
		Piers:	P1: Type P15	P2: Type P16
			P3: Type P15	
NH No.91B Interchange Ramp Way Bridge				
- PC Composite I beam (Connected):	Case 8	Abutments:	A1: Type A7-DP	A2: Type A7-DP
		Piers:	P1: Type P3-DP	P2: Type P3-DP

Table 1.8 Types of Structures in Package-3 (2/2)

<2> Culverts

STA	Type of Culvert	Type of Wing Wall	STA	Type of Culvert	Type of Wing Wall
(MAIN ROUTE)			(MAIN ROUTE)		
Km 7+820	Type B5	Type W2	Km 13+600	Type B11	Type W1
Km 7+950	Type B12	Type W1	Km 14+247	Type B7	Type W3
Km 8+820	Type B12	Type W1	Km 14+450	Type B11	Type W1
Km 9+326	Type B12	Type W1	Km 14+625	Type B11	Type W1
Km 9+760	Type B11	Type W1	Km 14+890	Type B11	Type W1
Km 10+310	Type B12	Type W1	(INTERCHANGE 3)		
Km 10+690	Type B11	Type W1	Ramp "A" - Km 0+154	Type B11	Type W1
Km 10+950	Type B11	Type W1	Ramp "B" - Km 0+286.5	Type B11	Type W1
Km 11+451	Type B11	Type W1	Ramp "C" - Km 0+300	Type B8	Type W3
Km 11+690	Type B12	Type W1	Ramp "D" - Km 0+300	Type B2	Type W1
Km 11+976.50 (Path)	Type B7	Type W3	Ramp "F" - Km 0+300	Type B8	Type W3
Km 12+180	Type B13	Type W1			
Km 12+592.50 (Path)	Type B7	Type W3	(INTERSECTION 4)		
Km 12+756	Type B5	Type W2	Ramp "B" - Km0+223	Type B11	Type W1

1.2 Design Condition

1.2.1 General

Generally, the design method, the design theory, and the design philosophies were based on the "Design Criteria on the Detailed Design of the Can Tho Bridge Construction in Socialist Republic of Viet Nam", September , 1999.

1.2.2 References and Software

(1) References

- Design Criteria on the Detailed Design of the Can Tho Bridge Construction in Socialist Republic of Viet Nam, September , 1999
- The AASHTO LRFD 1998 Bridge Design Specification shall be applied for design excepting the live loads.
- The Standard Specifications for Highway Bridges (Japanese Road Association - 1996)
- The Design Specifications for Highway Bridges and Culverts (22TCN18-79)

(2) Software

- UC - Dos	Japanese Software, applied for Substructure and Foundation Design
- UC - Bridge	Japanese Software, applied for the Superstructure Design of PRC Hollow Slab
- APPLLO Grid	Japanese Software, applied for the frame analysis of PC Composite I beam
- SAP 2000	U.S. Software, applied for the Frame Analysis of Superstructures & Substructures
- LEAP-5	British Software, applied for the Superstructure Design of PC Box Girder, and the Frame Analysis of Culvert Box & Multicolumn or Rigid Frame Piers
- Microsoft Excel	Applied for the Sectional Analysis of RC Concrete Sections

1.2.3 Load and Load Combinations

Generally, Loads and Load Combinations were based on the "Design Criteria". Addition were described as follows:

Table 1.9 Addition of Loads

Live Load	Refer to "Design Criteria" Japanese Live Load B for Bridges Vietnamese HK-80 Load for Culvert Box
Creep & Shrinkage	(PC Box Girder & PRC Hollow Slab) - "CEP-PIF" was applied to define the Creep & Shrinkage. (PC Composite I beam) - Creep Coefficient t = infinity 2.2 - Creep Coefficient of slab at t = 1.2 - Different Shrinkage between Girder & Slab at t = 140days: 0.00004
Settlement of Piers (Displacement)	(PC Box Girder) - 15mm in the vertical direction (PRC Hollow Slab & PC Composite I beam) - 10mm in the vertical direction
Vessel Collision Force	Loading Elevation: Water level with 5% frequency Force: The formula defined in Clause 3.14, AASHTO LRFD was applied. In this formula, vessel impact velocity was defined as the velocity of water flow, and Dead weight tonnage of vessel was defined based on the Vietnamese Classification of Streams.

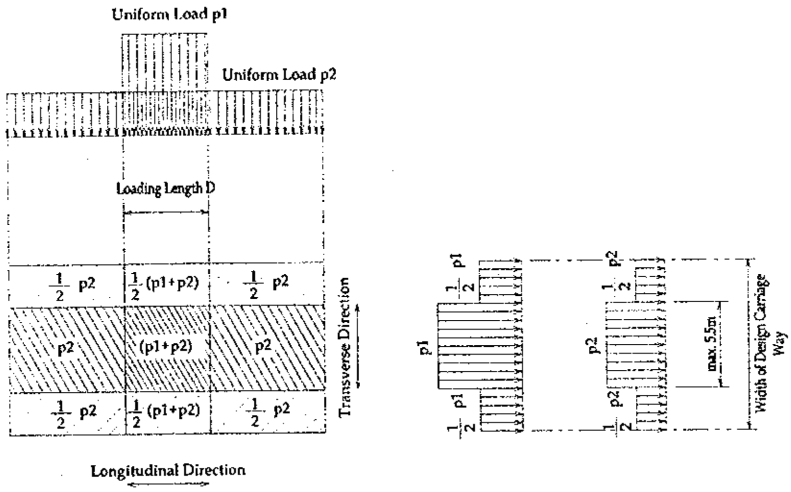


Figure 1.1 Japanese Live Load B (L Load) for Bridge Design

Table 1.10 Japanese Live Load B (L Load) for Bridges

L: Span Length (m)

Main loading (max. loading width 5.5m)						Sub-Loading
p1-Loading			p2-Loading			
Loading length D (m)	Weight (kgf/m^2)		Weight (kgf/m^2)			
	For M	For V	L<=80	80<L<=130	L>130	
10	1 000	1 200	350	430 - L	300	50% of main loading

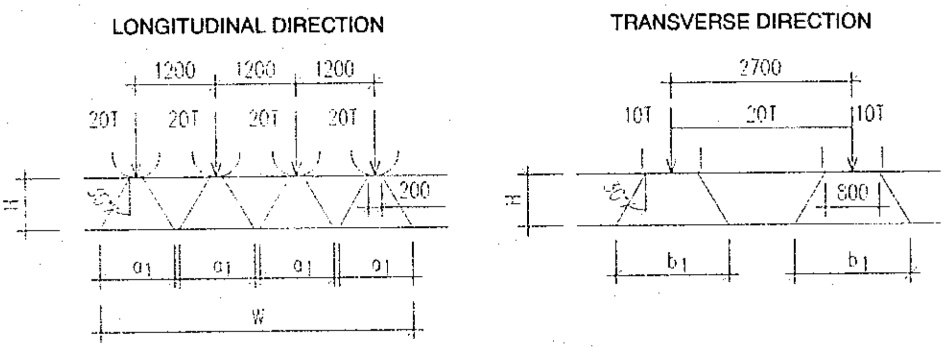


Figure 1.2 Vietnamese HK-80 loading for Culvert Design

Combination of Loads for individual structures are summarized in the following:

Table 1.11 Combination of Loads for Structures

(1) Superstructures	
- Check of tensile stress	SERVICE-III
- Check of resistance	STRENGTH-I, STRENGTH-III & STRENGTH IV
(2) Substructures & Foundations	
- Abutments	STRENGTH I-1, STRENGTH I-2, STRENGTH I-3, EXTREME EVENT I-1, and EXTREME EVENT I-2
- Piers	STRENGTH I-1, STRENGTH I-2, STRENGTH III, EXTREME EVENT I-1, EXTREME EVENT I-2, and SERVICE I
(3) Culvert Box	
- Culvert Box	STRENGTH I, STRENGTH IV, and SERVICE I
- Wing Wall	STRENGTH I & STRENGTH II

1.2.4 Soil Properties for Design

Table 1.12 Summary of Soil Properties for Design (1/2)

STA		B.P. ~ 4+500 (Package-1)	4+500 ~ 7+600	7+600 ~ 11+000 (Package-3)	11+000 ~ E.P (Package-3)
Bridge		- Large Tra Va - Small Tra Va - Tra On - Interchange No.54 Over bridge	-	- Cai Tac 1 - Cai Tac 2 - Cai Da - Interchange No.91B Over bridge - Rampway Bridge of Interchange No.91B	- Ba Mang - Cai Nai - Ap My - Cai Rang
No. of Bowling Point		D-1 ~ D-9	-	D-18 ~ D-21	D-22 ~ D-28
Layer C1	N	1	1	1	1
	ϕ	5	5	4	4
	γ	16	16	16	16
	γ'	7	7	7	7
	C	10	10	10	10
	E0	2000	2000	2000	2000
	qu	30	30	35	20
Layer C2	N	8	12	18	20
	ϕ	14	14	14	14
	γ	19	19	19	19
	γ'	10	10	10	10
	C	20	20	50	50
	E0	5000	8000	12000	3500
	qu	60	150	220	150
Layer S/St	N	-	20	-	-
	ϕ	-	10	-	-
	γ	-	18	-	-
	γ'	-	9	-	-
	C	-	10	-	-
	E0	-	13000	-	-
	qu	-	300	-	-

* Notes:
- N: N value (Blows/300mm)
- ϕ: Friction Angle of Soil (Degree)
- γ: Unit Weight of Soil (kN/m3)
- γ': Dry Unit Weight of Soil (kN/m3)
- C: Cohesion (kN/m2)
- E0: Modulus of Deformation (kN/m2)
- qu: Unconfined Compression Strength (kN/m2)

* Friction of C1 Layer was ignored.

Table 1.12 Summary of Soil Properties for Design (2/2)

STA		B.P. ~ 4+500 (Package-1)	4+500 ~ 7+600 (Package-?)	7+600 ~ 11+000 (Package-3)	11+000 ~ E.P (Package-3)
Bridge		- Large Tra Va - Small Tra Va - Tra On - Interchange No.54 Over bridge	-	- Cai Tac 1 - Cai Tac 2 - Cai Da - Interchange No.91B Over bridge - Rampway Bridge of Interchange No.91B	- Ba Mang - Cai Nai - Ap My - Cai Rang
No. of Bowling Point		D-1 ~ D-9	-	D-18 ~ D-21	D-22 ~ D-28
Layer St/C1	N	28	25	29	28
	ϕ	15	15	15	15
	γ	19.5	19.5	19.5	19.5
	γ'	10	10	10	10
	C	170	170	170	170
	E0	19000	17500	20000	19000
	qu	450	450	450	450
Layer S1	N	60	60	60	60
	ϕ	40	40	40	40
	γ	21	21	21	21
	γ'	12	12	12	12
	C	50	50	50	50
	E0	27000	27000	27000	27000
	qu	1000	1000	1000	1000

* Notes:
- N: N value (Blows/300mm)
- ϕ: Friction Angle of Soil (Degree)
- γ: Unit Weight of Soil (kN/m3)
- γ': Dry Unit Weight of Soil (kN/m3)
- C: Cohesion (kN/m2)
- E0: Modulus of Deformation (kN/m2)
- qu: Unconfined Compression Strength (kN/m2)

* Friction of C1 Layer was ignored.

1.2.5 Design of the Connecting Portion of Pile Top and Footing

The following analyses were studied for the connecting portion of pile top and footing, based on the "Japanese Manual for the Design of Pile Foundation":

(1) Checking of Push out Force

1) Vertical Bearing Pressure of the Pile Cap caused by the Pile

The following formula should be applied for the checking:

$$\sigma_{cv} = P / (\pi D^2/4) <= \sigma_{ca}$$

where, P: Axial Force of Pile

D: Diameter of Pile

σ_{cv}: Vertical Bearing Pressure of Pile Cap

σ_{ca}: Allowable Vertical Bearing Pressure of Pile Cap

($0.5 \times \sigma_{ck} = 0.5 \times 240$ kgf/cm^2 = 120 kgf/cm^2 = 11.8 Mpa)

2) Vertical Punching Shear of the Pile Cap caused by the Pile

$\tau_c = P / \{\pi \times (D + h) \times h\} <= \tau_a$

where, P: Axial Force of Pile

D: Diameter of Pile

h: depth from the pile head to the upper surface of Pile cap

τ_c: Punching Shear of Pile Cap

τ_a: Allowable Punching Shear of Pile Cap

(9.0 kgf/cm^2 = 0.88 Mpa)

(2) Checking of Horizontal Force

1) Horizontal Bearing Pressure of the Pile Cap caused by the Pile

$\sigma_{ch} = H / (Dl) <= \sigma_{ca}$

where, H: Horizontal Force at the top of Pile

D: Diameter of Pile

l: 100mm (Embedded length of Pile into Pile cap)

σ_{ch}: Horizontal Bearing Pressure of Pile Cap

σ_{ca}: Allowable Horizontal Bearing Pressure of Pile Cap

($0.3 \times \sigma_{ck} = 0.3 \times 240$ kgf/cm^2 = 72 kgf/cm^2 = 7.0 Mpa)

2) Horizontal Punching Shear of the Pile Cap caused by the Pile

$\tau_c = H / \{h' \times (2l + D + 2h')\} <= \tau_a$

where, H: Horizontal Force at the top of Pile

D: Diameter of Pile

h': Nearest Length from the side surface of Pile to the side surface of Pile cap

l: 100mm (Embedded length of Pile into Pile cap)

τ_c : Horizontal Punching Shear of Pile Cap

τ_a : Allowable Horizontal Punching Shear of Pile Cap
(9.0 kgf/cm^2 = 0.88 Mpa)

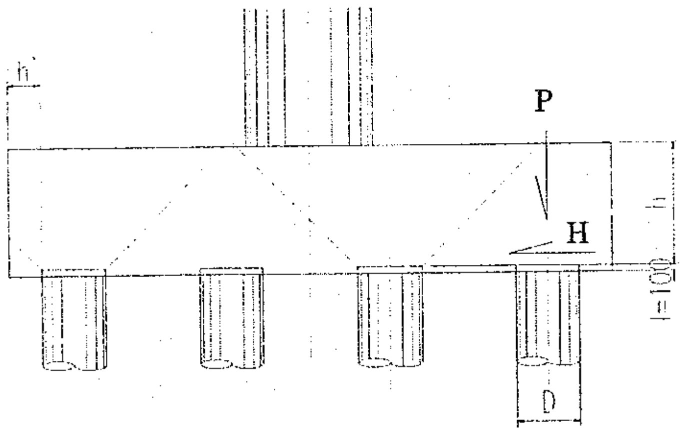


Figure 1.3 Design Condition of Connecting Portion

1.2.6 Materials

(1) Concrete

Table 1.13 Concrete for Design (1/2)

Grade	fc′	Typical use
B	40 Mpa	PC box girder, PC I-Girder
C	35 Mpa	Hollow Slab
D	30 Mpa	In situ concrete : Bored pile, Deck Slab
E	24 Mpa	In situ concrete : Pier, Abut, Pile cap, Wing wall , retaining wall, Culverts
F	20 Mpa	In situ concrete : Base concrete, Apron
G	15 Mpa	In situ concrete : Lean Concrete, Plain Concrete

* fc′: Compressive strength of concrete at 28 days

Table 1.13 Concrete for Design (2/2)

Grade	fc′	Ec (Mpa)	EXP
B	40Mpa	33 990	10.8 x 1.0E-6 (/°C)
D	30Mpa	29 440	
E	24Mpa	26 330	

* Ec: Young's Modulus (AASHTO LRFD, 5.4.2.4) $Ec = 0.043\gamma_c^{1.5} \times \sqrt{fc'}$

γ_c: Density of concrete (kg/m^3)

EXP: Coefficient of thermal expansion and contraction

<Allowable Stress of Concrete>

- For checking of tensile stress in Serviceability limit state (SERVICE-III): $0.25 \times \sqrt{f'c}$
  ~ for PC Box Girder & PC Composite I beam
- For checking of tensile stress in stages during construction, and serviceability limit state: $0.50 \times \sqrt{f'c}$
  ~ for PRC Hollow slab
- Stress at interface between pre-casting segments: No tension allowed.

(2) Reinforcement Steel

- Specified Yield Strength: Plain Round: 240Mpa
  High Yield deformed: 390MPa
- Modulus of elasticity of reinforcement steel:
  Es = 200,000 Mpa

Table 1.14 Summary of Reinforcement Steel

Dia. (mm)	Area (mm2)	Mass kg/m	Dia. (mm)	Area (mm2)	Mass kg/m
10	78.5	0.617	20	314.2	2.466
12	113.1	0.888	22	380.1	2.984
14	153.9	1.208	24	490.9	3.85
16	201.1	1.578	28	615.8	4.83
18	254.5	1.998	32	804.2	6.31

Table 1.15 Summary of Development of Reinforcement Steel (1/2)

Strength of Concrete	Diameter (mm)	Unit weight (kg/m)	Hook (mm)	Lap Splice (mm) Grade A	Grade B	Grade C
24Mpa	Plain Round					
	6	0.222	129	300	300	300
	8	0.395	151	300	300	318
	10	0.617	173	300	304	398
	Deformed					
	10	0.617	175	300	304	398
	12	0.888	210	300	365	477
	14	1.208	245	328	426	557
	16	1.578	280	374	487	636
	18	1.998	315	421	548	716
	20	2.466	350	500	650	850
	22	2.984	385	605	787	1029
	25	3.853	437	782	1016	1329
	28	4.834	534	980	1274	1667
	32	6.313	610	1280	1665	2177
30Mpa	Plain Round					
	6	0.222	129	300	300	300
	8	0.395	151	300	300	318
	10	0.617	173	300	304	398
	Deformed					
	10	0.617	175	300	304	398
	12	0.888	210	300	365	477
	14	1.208	245	328	426	557
	16	1.578	280	374	487	636
	18	1.998	315	421	548	716
	20	2.466	350	468	608	796
	22	2.984	385	541	704	920
	25	3.853	437	699	909	1188
	28	4.834	534	877	1140	1491
	32	6.313	610	1145	1489	1947
35Mpa	Plain Round					
	6	0.222	129	300	300	300
	8	0.395	151	300	300	318
	10	0.617	173	300	304	398
	Deformed					
	10	0.617	175	300	304	398
	12	0.888	210	300	365	477
	14	1.208	245	328	426	557
	16	1.578	280	374	487	636
	18	1.998	315	421	548	716
	20	2.466	350	468	608	796
	22	2.984	385	515	669	875
	25	3.853	437	647	841	1100
	28	4.834	534	812	1055	1380
	32	6.313	610	1060	1378	1803

Table 1.15 Summary of Development of Reinforcement Steel (2/2)

Strength of Concrete	Diameter (mm)	Unit weight (kg/m)	Hook (mm)	Lap Splice (mm) Grade A	Grade B	Grade C
40Mpa	Plain Round					
	6	0.222	129	300	300	300
	8	0.395	151	300	300	318
	10	0.617	173	300	304	398
	Deformed					
	10	0.617	175	300	304	398
	12	0.888	210	300	365	477
	14	1.208	245	328	426	557
	16	1.578	280	374	487	636
	18	1.998	315	421	548	716
	20	2.466	350	468	608	796
	22	2.984	385	515	669	875
	25	3.853	437	605	787	1029
	28	4.834	534	759	987	1291
	32	6.313	610	992	1289	1686

Reference: AASHTO 98 - Article 5.11.2 - Page 5-138

- Hook and Bends (For Standard Hooks)

<Longitudinal Reinforcement>

- 180°-bend, plus a 4.0 d_b extension, but not less than 65mm at the free end of the bar, or
- 90°-bend, plus a 12.0 d_b extension at the free end of the bar

<Transverse Reinforcement>

- No.16 bar (Dia. 15.9mm) and smaller – 90°-bend, plus a 6.0 d_b extension at the free end of the bar,
- No.19, No.22 and No.25 bar (Dia. 19.1mm, 22.2mm, and 25.4mm, respectively) – 90°-bend, plus a 12.0 d_b extension at the free end of the bar, and
- No.25 bar (Dia. 25.4mm) and smaller – 135°-bend, plus a 6.0 d_b extension at the free end of the bar.

where,
d_b: nominal diameter of reinforcing bar (mm)

Reference: AASHTO 98 - Article 5.10.2.1 - Page 5-90

- Minimum Bend Diameters (For Standard Hooks)

Bar Size and Use	Minimum Diameter
No.10 (Dia. 9.5mm) through No.16 (Dia. 15.9mm) – General	$6.0d_b$
No.10 (Dia. 9.5mm) through No.16 (Dia. 15.9mm) – Stirrups and Ties	$4.0d_b$
No.19 (Dia. 19.1mm) through No.25 (Dia. 25.4mm) – General	$6.0d_b$
No.29 (Dia. 28.7mm), No.32 (Dia. 32.3mm), and No.36 (Dia. 35.8mm)	$8.0d_b$
No.43 (Dia. 43.0mm) and No.57 (Dia. 57.3mm)	$10.0d_b$

Reference: AASHTO 98 - Article 5.10.2.3 - Page 5-91

(3) PC Strand

Table 1.16 Summary of PC Strands

	Internal	External	Transverse
Type of PC Steel	12S12.7	12S15.2	3S12.7
Sectional Area (mm2)	1,184.5	1,664.5	296.1
Nominal Strength (N/mm2)	1,860	1,860	1,860
Yield Strength (N/mm2)	1,395	1,395	1,395
Young's Modules (MPa)	196,000	196,000	196,000
Friction Loss Coefficient (/m)	0.004	0.004	0.004
Angle Coefficient (/Deg.)	0.25	0.25	0.25
Set Losses (mm)			
One side Tensioning	5	5	5
Both side Tensioning	10	10	10

1.2.7 Span Length Arrangement and Foundation Pile for the Minor Bridges in the Approach Roads

(1) General

After the discussion about the Draft Final Report on 7 August 2000, the Vietnamese side requested the review of the types of the minor bridges in the approach roads, namely, Package-1 and Package-3. The item number in the "Minutes of Meeting on the Draft Final Report" is "3.2".

Accordingly, the Study Team reviewed the minor bridges, and some of them were revised as shown in the following.

(2) Summary of Revision

The following table shows the summary of modifications for the bridges in the approach roads (Package-1 & 3).

1) Package-1 (Approach Road on Vinh Long side)

Bridge	Modification
- Large Tra Va	Span Length Arrangement (Original) PC I beam: 4@31 = 124m PC Box Girder: 56+80+56 = 192m Total Length: 316m (Modified) PC I beam: 4@35+4@35 = 280m
- Tra On	Span Length Arrangement (Original) PC I beam: 1@31 = 31m PC Box Girder: 56+80+56= 192m PC I beam: 1@31 = 31m Total Length: 254m (Modified) PC I beam: 2@36=72m PC Box Girder: 36.5+57.0+36.5=130m PC I beam: 2@29=58m Total Length: 260m

2) Package-3 (Approach Road on Can Tho side)

Bridge	Modification
- Ba Mang	Pile Foundation The types of piles are changed from bore-hole pile to driven pile, and the penetration depths were shortened with considering the geotechnical conditions. Type of Superstructure * The connection between spans were removed, and changed to the simple spans.
- Cai Nai	Pile Foundation The types of piles are changed from bore-hole pile to driven pile, and the penetration depths were shortened with considering the geotechnical conditions. Type of Superstructure * The connection between spans were removed, and changed to the simple spans.
- Ap My	Pile Foundation The types of piles are changed from bore-hole pile to driven pile, and the penetration depths were shortened with considering the geotechnical conditions. Type of Superstructure * The connection between spans were removed, and changed to the simple spans.
- Cai Rang	Pile Foundation The types of piles of the substructures supporting PC I beams (A1, A2, P5) are changed from bore-hole pile to driven pile, and the penetration depth were shortened with considering the geotechnical conditions. Type of Superstructure * The connection between spans were removed, and changed to the simple spans.
- NH No.91B Interchange Ramp Way Bridge	Pile Foundation The types of piles are changed from bore-hole pile to driven pile, and the penetration depths were shortened with considering the geotechnical conditions. Type of Superstructure * The connection between spans were removed, and changed to the simple spans.

(3) Policy of Revision

1) Span Length Arrangement for the Approach Roads

The navigational clearances were reviewed, and the span lengths for two bridges were reduced with considering the requirement. The comparison tables for these bridges are shown in Figure 1.4 and Figure 1.5, respectively.

2) Foundation Pile for the Approach Span and Approach Road Bridges

The geotechnical conditions were reviewed. The summary of soil properties is shown in Table 1.12.

In the Draft Final Report, the Layer and the Layers, "St/C1" or "S1" were regarded as the bearing stratum, and in the revision, the Clay Layer "C2" was regarded as the bearing stratum for some types of Minor Bridges at some locations.

The types of pile foundations were selected with considering the following items:

- Location & Soil Properties of C2 Layer

  At the each location of minor bridge, the depth and soil properties of C2 Layer were reviewed. With considering the available construction depth of driven pile (40m), the bridges with the following design conditions were reviewed;

  - The depth of the C2 Layer is less than 35m from the existing ground level.

  - The design N value of C2 Layer is more than "20". (Based on the Standard Specification of Highway Bridge, Japan Road Association)

  - Type of Superstructure

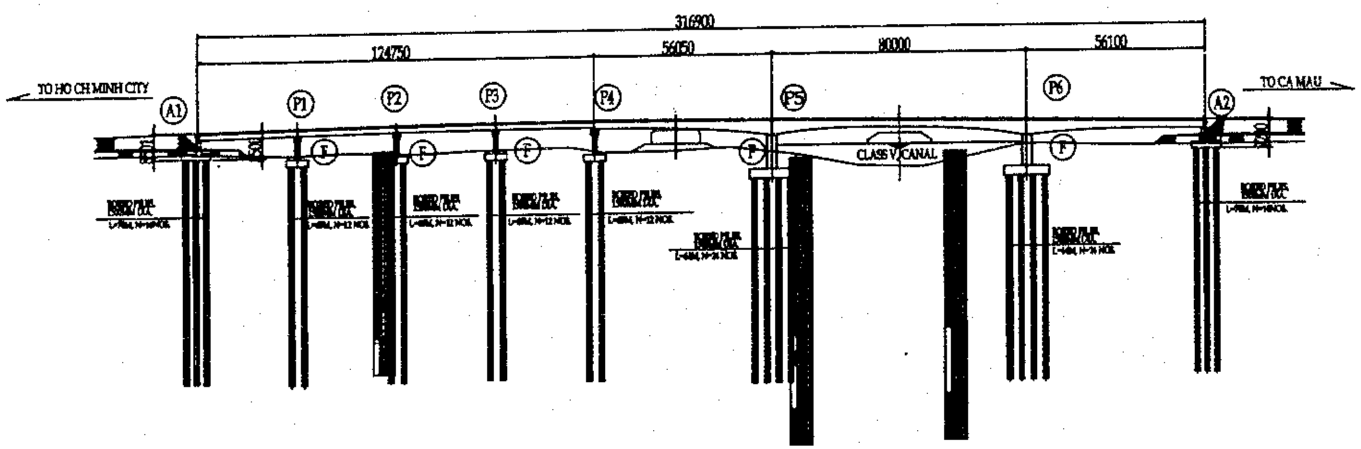
The driven piles were only applied for the substructures supporting the simple span portions of PC I beam.

In case that the C2 Layer is regarded as the bearing stratum, the differential settlements of substructures will be happened. To prevent the effects caused by these settlements for the superstructures, the continuous spans of superstructures will not be adopted.

The PC I beam can be the simple span, however the PC Box Girder and PRC Hollow Slab can not be the simple span because of their design and construction features.

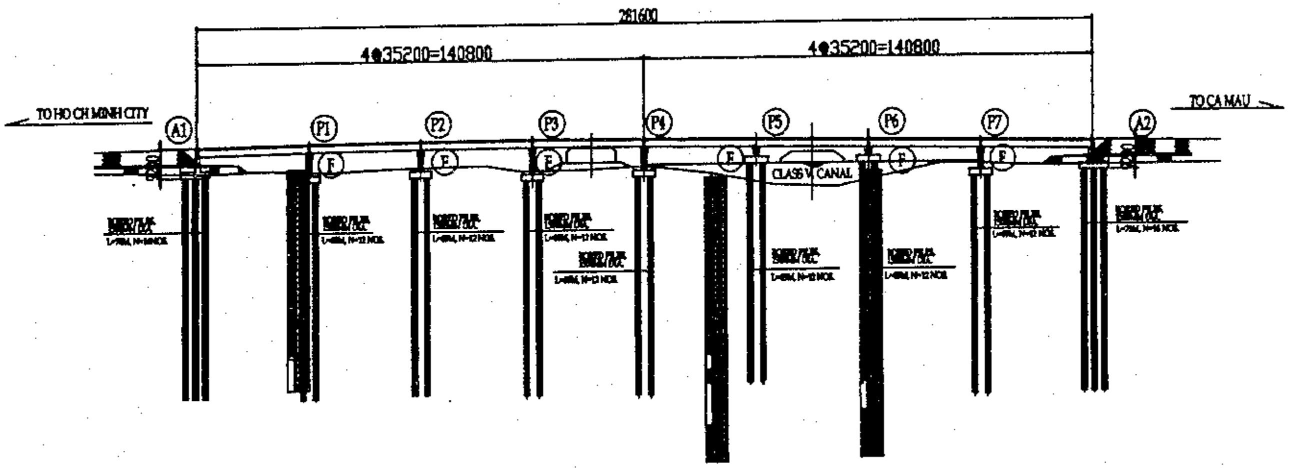
Figure 1.4 Comparison of the Span Arrangement, Large Tra Va Bridge

LARGE TRA VA BRIDGE- Alternative 1



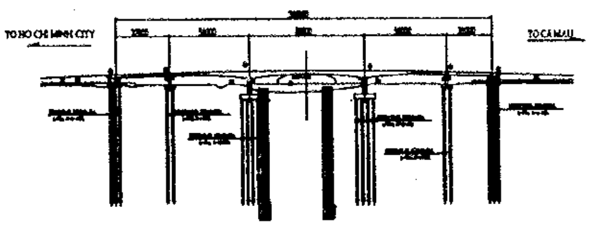
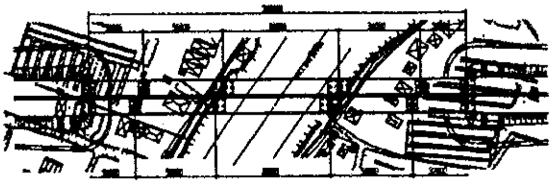
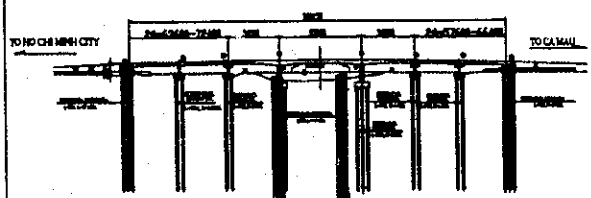
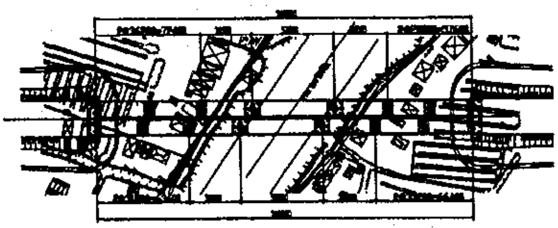
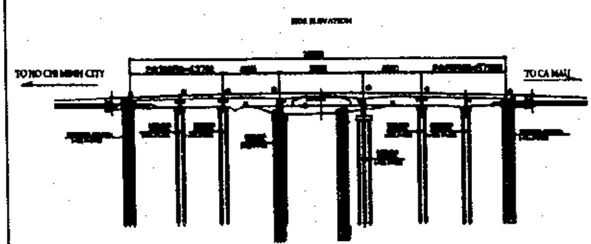
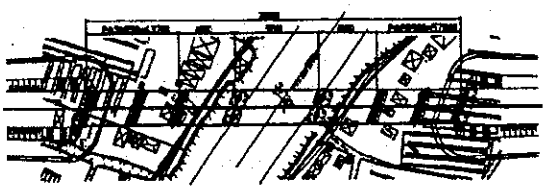
CONST.-COST (RATIO)	
SUPERSTRUCTURE	1.000
SUB-STRUCTURE	1.000
FOUNDATION	1.000
TOTAL	1.000

LARGE TRA VA BRIDGE- Alternative 2



CONST.-COST (RATIO)	
SUPERSTRUCTURE	0.703
SUB-STRUCTURE	1.045
FOUNDATION	1.045
TOTAL	0.850

Figure 1.5 Comparison of the Span Arrangement, Tra On Bridge

	GENERAL VIEW	STRUCTURAL FEATURE		
Tra On Bridge ALTERNATIVE-1	SIDE ELEVATION  PLAN 	TECHNICAL	TOTAL BRIDGE LENGTH L=260m NUMBER OF TOTAL SPAN : 5 SPANS 3-SPANS CONTINUOUS BOX GIRDER (56m+80m+56m) + COMPOSITE I-GIRDER(37m+31m) SKEW ANGLE OF BRIDGE =90 MIDDLE SPAN LENGTH =80m	
		CONSTRUCTION COST	ITEM	COST RATIO
			SUPERSTRUCTURE	1.000
			SUB STRUCTURE	1.000
			FOUNDATION	1.000
			TOTAL	1.000
Tra On Bridge ALTERNATIVE-2	SIDE ELEVATION  PLAN 	TECHNICAL	TOTAL BRIDGE LENGTH L=260m NUMBER OF TOTAL SPAN :7 SPANS 3-SPANS CONTINUOUS BOX GIRDER (36.5m+57.0m+36.5m) + COMPOSITE I-GIRDER (2@=63.8m 72.4m+2@=57.8m 68.4m) SKEW ANGLE OF BRIDGE =90 MIDDLE SPAN LENGTH =57m	
		CONSTRUCTION COST	ITEM	COST RATIO
			SUPERSTRUCTURE	0.867
			SUB STRUCTURE	1.098
			FOUNDATION	1.150
			TOTAL	0.968
Tra On Bridge ALTERNATIVE-3	 PLAN 	TECHNICAL	TOTAL BRIDGE LENGTH L=260 m NUMBER OF TOTAL SPAN : 7 SPANS 3-SPANS CONTINUOUS BOX GIRDER(40m+58.5m+40m) +COMPOSITE I-GIRDER (2@=63.7m+2@=57.8m) SKEW ANGLE OF BRIDGE =70 MIDDLE SPAN LENGTH =58.5m	
		CONSTRUCTION COST	ITEM	COST RATIO
			SUPERSTRUCTURE	0.873
			SUB STRUCTURE	1.098
			FOUNDATION	1.209
			TOTAL	0.982

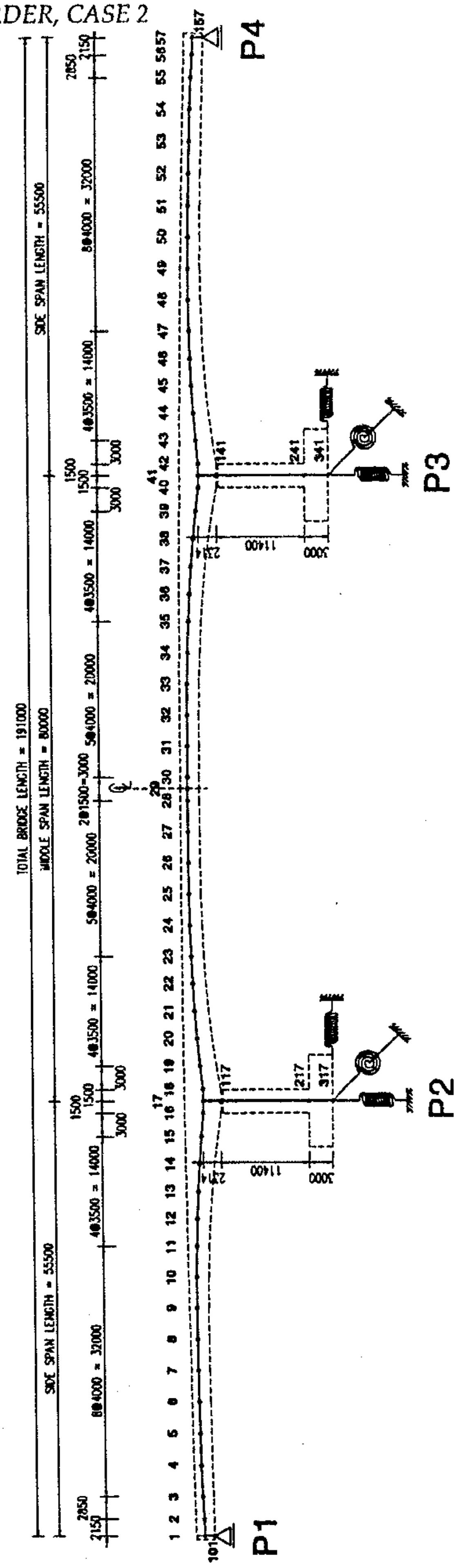
Chapter 2

DESIGN SUMMARY OF SUPERSTRUCTURES

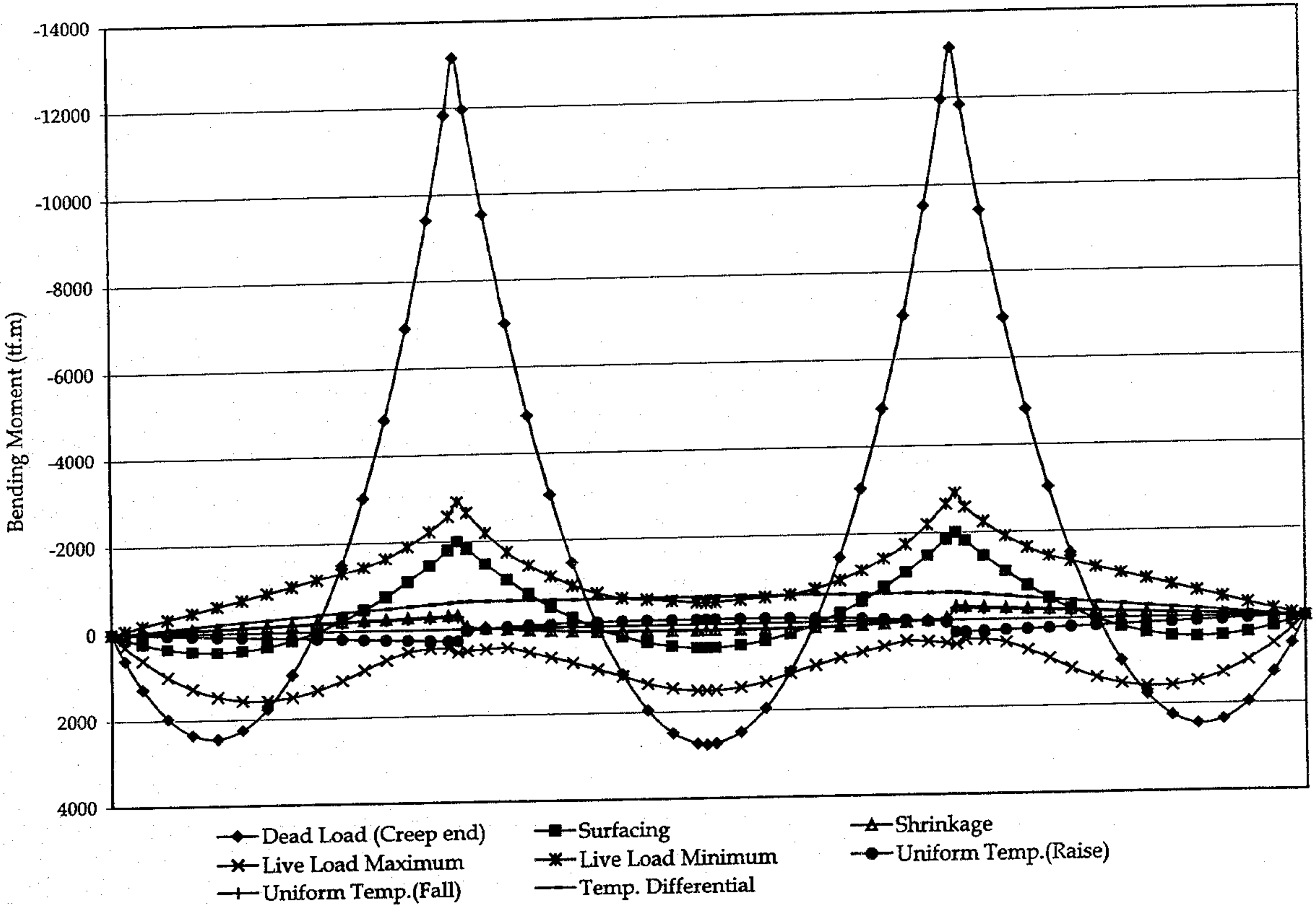
2.1 *PC BOX GIRDER*

(1) *PC BOX GIRDER, CASE 2*

CALCULATION MODEL OF PC BOX GIRDER - TRA ON BRIDGE



Bending Moment Diagram after Construction
PC Box girder of Tra On Bridge



Summary of Bending Stress at Service Load Design - PC Box girder of Tra On Bridge

(Unit : tf/m2)

			P1~P2 [Section 6]		P2 [Section 17]		P2~P3 [Section 29]		P3 [Section 41]		P3~P4 [Section 52]	
			Top Slab	Bottom Slab	Top Slab	Bottom Slab	Top Slab	Bottom Slab	Top Slab	Bottom Slab	Top Slab	Bottom Slab
Bending Stress due to Each Loadings (tf/m2)	Self Weight of Girder (Include Creep)	DC	371.48	-623.99	-712.29	690.75	431.26	-699.11	-712.29	690.75	371.48	-623.99
	Dead Load of Surface Load	DW	64.43	-111.84	-111.08	104.35	78.01	-132.24	-111.08	104.35	64.43	-111.84
	Shrinkage	SH	-13.99	24.23	-17.44	16.38	3.71	-48.82	-17.44	16.38	-13.99	24.23
	Pre-stress	PS	-48.15	1163.91	1375.26	-352.65	176.18	1042.49	1375.26	-352.65	-48.15	1163.91
	Live Load with Impact Factor											
	Maximum	LL_MAX	215.13	-372.68	37.10	-21.64	232.58	-372.49	37.10	-21.64	215.13	-372.68
	Minimum	LL_MIN	-87.95	152.20	-166.10	146.81	-79.65	114.92	-166.10	146.81	-87.95	152.20
	Thermal Rise and Fall											
	In Case of Rising (+10Deg)	TUR	12.27	-21.26	15.30	-14.37	-3.23	42.25	15.30	-14.37	12.27	-21.26
	In Case of Falling (-20Deg)	TUF	-12.27	21.26	-15.30	14.37	3.23	-42.25	-15.30	14.37	-12.27	21.26
	Differential Temperature (5Deg)	TG	-27.87	48.27	-34.74	32.64	-90.26	158.88	-34.74	32.64	-27.87	48.27
	Wind load on Structure											
	Maximum	WL_MAX	11.10	-19.22	19.75	-18.56	11.49	-16.91	20.66	-18.20	11.09	-19.23
	Minimum	WL-MIN	-22.56	39.11	5.92	-5.56	-25.36	40.42	4.03	-5.30	-22.55	39.12
	Support Setlement											
	Maximum	SE_MAX	27.02	-46.81	33.69	-31.65	11.46	-16.87	33.20	-29.98	27.01	-46.82
	Minimum	SE_MIN	-17.55	30.39	-21.87	20.55	-11.46	16.87	-23.60	20.97	-17.54	30.40
Combination of Bending Stress (tf/m2)	Combination SERVICE III											
	SERVICE III-1		545.88	154.17	564.13	441.53	875.22	-135.67	564.13	441.53	545.88	154.17
	SERVICE III-2		303.41	574.07	401.57	576.29	625.44	254.26	401.57	576.29	303.41	574.07
	SERVICE III-3		574.57	104.48	601.67	406.26	841.77	-35.92	601.45	408.03	574.56	104.47
	SERVICE III-4		550.03	146.99	571.07	435.00	848.23	-120.42	570.86	436.77	550.01	146.98
	SERVICE III-5		277.44	619.08	379.40	597.12	558.01	404.95	377.11	597.62	277.45	619.09
	SERVICE III-6		252.89	661.59	348.81	625.86	564.47	320.45	346.51	626.36	252.90	661.60
	Checking: 1835.5 > σc > -161.2		OK		OK		OK		OK		OK	

Notes: Load Factors of Combinations:

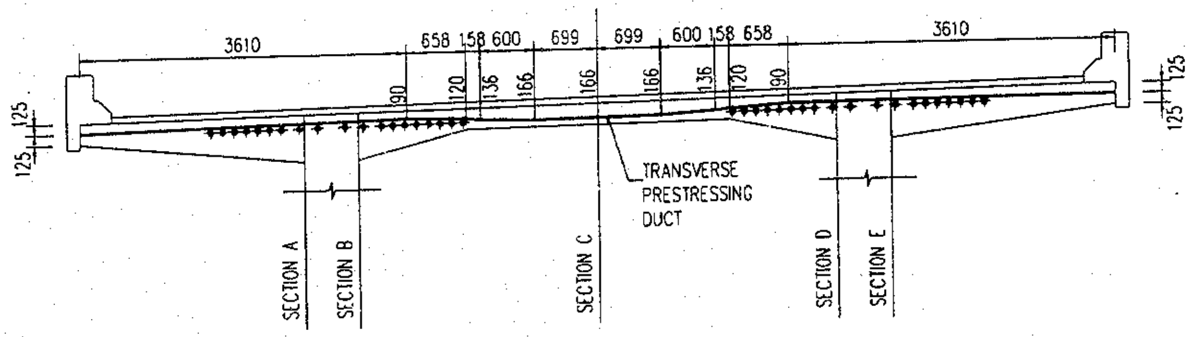
COMBINATION	LOAD FACTORS												
	DC	DW	SH	PS	LL_MAX	LL_MIN	TUR	TUF	TG	WL_MAX	WL_MIN	SE_MAX	SE_MIN
SERVICE III-1	1.00	1.00	1.00	1.00	0.80								
SERVICE III-2	1.00	1.00	1.00	1.00		0.80							
SERVICE III-3	1.00	1.00	1.00	1.00	0.80		1.00		0.50	0.30		1.00	
SERVICE III-4	1.00	1.00	1.00	1.00	0.80			1.00	0.50	0.30		1.00	
SERVICE III-5	1.00	1.00	1.00	1.00		0.80	1.00		0.50		0.30		1.00
SERVICE III-6	1.00	1.00	1.00	1.00		0.80		1.00	0.50		0.30		1.00

Summary of Bending Stress for Slab in Transverse Direction - PC Box Girder of Tra On bridge

Unit : tf/m^2

		After prestressing		SERVICE I		SERVICE III	
		Top Fiber	Bottom Fiber	Top Fiber	Bottom Fiber	Top Fiber	Bottom Fiber
Cantilever Slab	Section-A	110.23	3.72	-40.38	154.34	-12.23	126.18
Continuous Slab	Section-B	136.45	-22.53	-47.03	160.95	-12.73	126.65
	Section-C	48.61	207.31	562.09	-306.17	461.35	-205.42
	Section-D	136.45	-22.53	-47.03	160.95	-12.73	126.65
Cantilever Slab	Section-E	110.23	3.72	-40.38	154.34	-12.23	126.18
Allowable Stress		$2447 > \sigma c > -374$		$1631.6 > \sigma c$		$\sigma c > -322.5$	
Check		OK		OK		OK	

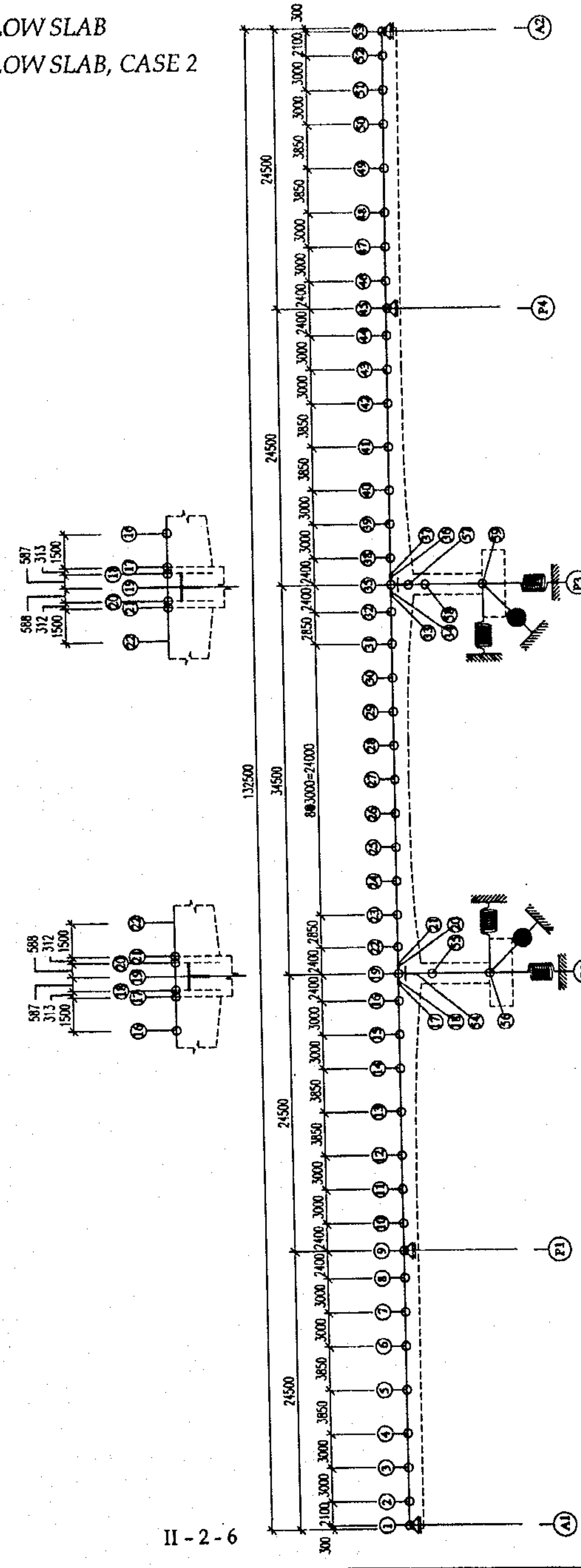
<u>*Notes:*</u> * SERVICE I : Checking compressive stress
* SERVICE III : Checking tensile stress

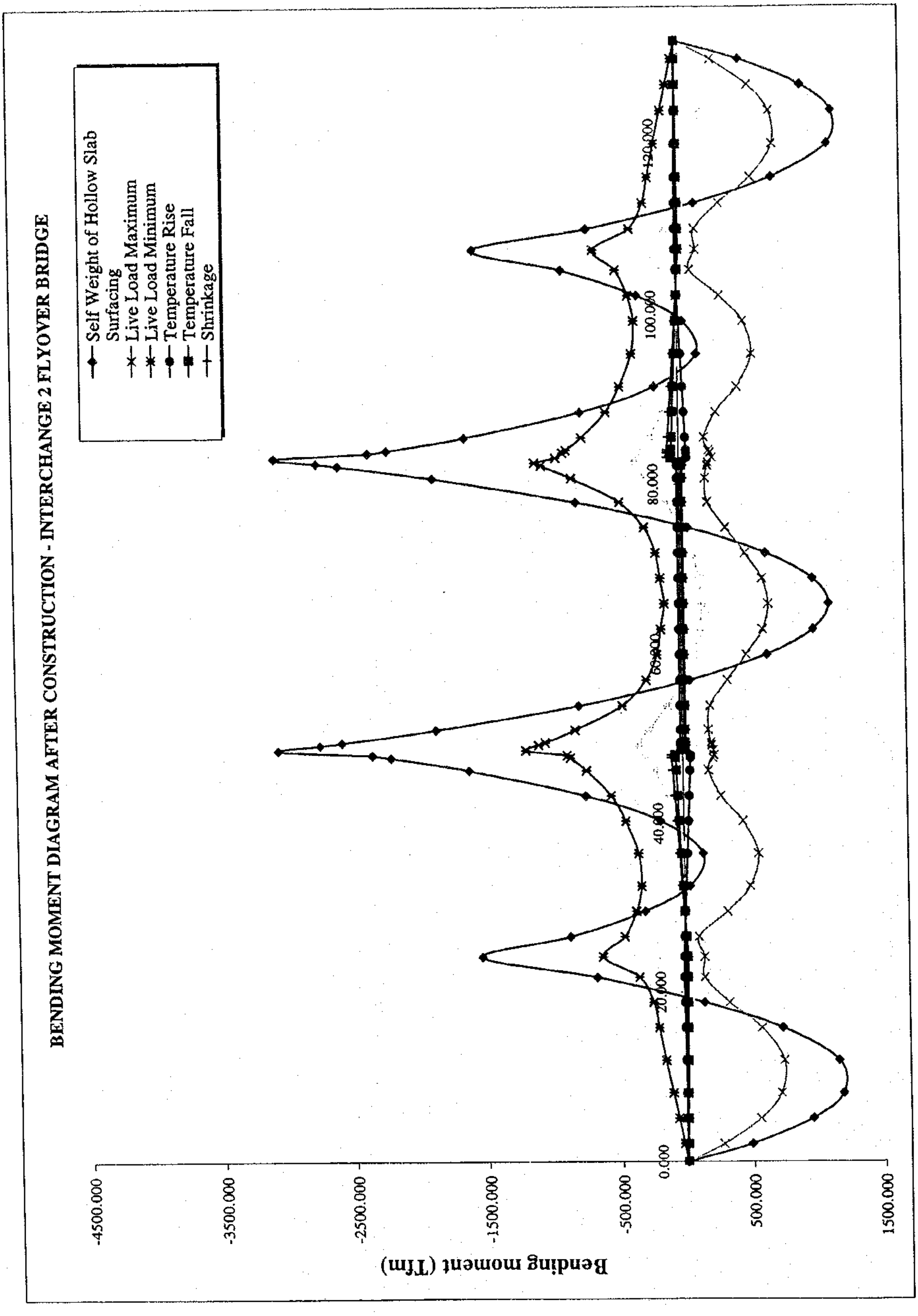


2.2 *PRC HOLLOW SLAB*

(1) PRC HOLLOW SLAB, CASE 2

MODEL FOR ANALYSIS
INTERCHANGE 2 FLYOVER BRIDGGE





BENDING MOMENT DIAGRAM AFTER CONSTRUCTION - INTERCHANGE 2 FLYOVER BRIDGE
Self Weight of Hollow Slab
Surfacing
Live Load Maximum
Live Load Minimum
Temperature Rise
Temperature Fall
Shrinkage
Bending moment (Tfm)
-4500.000
-3500.000
-2500.000
-1500.000
-500.000
500.000
1500.000
0.000
20.000
40.000
60.000
80.000
100.000
120.000

SUMMARY OF FLEXURAL STRESS AT SERVICE LIMIT STATE - INTERCHANGE 2 FLYOVER BRIDGE

			A1 ~ P1 [Section 6]		P1 [Section 9]		P1 ~ P2 [Section 12]		P2 [Section 19]	
			Top fiber	Bottom fiber	Top fiber	Bottom fiber	Top fiber	Bottom fiber	Top fiber	Bottom fiber
Bending Stress due to Each Loading (Mpa)	Self Weight of Hollow Slab	DC	2.456	-2.835	-4.548	4.967	0.124	-0.138	-3.683	4.086
	Dead Load due to Surfacing	DW	0.376	-0.435	-0.624	0.682	0.001	-0.001	-0.479	0.532
	Shrinkage	SH	0.041	-0.047	0.054	-0.059	-0.061	0.068	0.020	-0.045
	PC Tendon	PS	-2.289	10.695	6.444	-2.482	-0.442	7.249	3.911	-1.737
	Live Load with Impact Factor									
	In case of Maximum Bending Moment	LL_Max	1.930	-2.228	0.422	-0.461	1.595	-1.775	0.275	-0.311
	In case of Minimum Bending Moment	LL_Min	-0.713	0.824	-1.873	2.045	-1.050	1.169	-1.422	1.584
	Thermal Rise and Fall									
	In case of Rasing (+10 Deg)	TUR	-0.027	0.031	-0.036	0.039	0.040	-0.044	-0.013	0.029
	In case of Falling (-10 Deg)	TUF	0.027	-0.031	0.036	-0.039	-0.040	0.044	0.013	-0.029
	Support Settlement									
	Maximum	SE_Max	0.854	-0.986	1.144	-1.250	0.291	-0.324	0.188	-0.215
	Minimum	SE_Min	-0.354	0.409	-0.474	0.518	-0.261	0.290	-0.381	0.411
Combination of Bending Stress (Mpa)	Combination Service III									
	SERVICE III-1		2.128	5.597	1.663	2.738	0.897	5.759	-0.012	2.588
	SERVICE III-2		0.013	8.038	-0.173	4.743	-1.219	8.113	-1.369	4.104
	SERVICE III-3		2.955	4.642	2.772	1.527	1.228	5.390	0.163	2.402
	SERVICE III-4		3.008	4.580	2.844	1.449	1.149	5.479	0.189	2.343
	SERVICE III-5		-0.367	8.477	-0.683	5.300	-1.439	8.359	-1.763	4.544
	SERVICE III-6		-0.314	8.416	-0.611	5.222	-1.519	8.448	-1.737	4.485
	Checking 14.000 > σc >	-2.950	OK		OK		OK		OK	

Notes Load Factors of Combinations

Combination Service III	Load Factors									
	DC	DW	SH	PS	LL_Max	LL_Min	TUR	TUF	SE_Max	SE_Min
SERVICE III-1	1.000	1.000	1.000	1.000	0.800					
SERVICE III-2	1.000	1.000	1.000	1.000		0.800				
SERVICE III-3	1.000	1.000	1.000	1.000	0.800		1.000		1.000	
SERVICE III-4	1.000	1.000	1.000	1.000	0.800			1.000	1.000	
SERVICE III-5	1.000	1.000	1.000	1.000		0.800	1.000			1.000
SERVICE III-6	1.000	1.000	1.000	1.000		0.800		1.000		1.000

SUMMARY OF FLEXURAL STRESS AT SERVICE LIMIT STATE - INTERCHANGE 2 FLYOVER BRIDGE

			P2 ~ P3 [Section 27]		P3 [Section 35]		P3 ~ P4 [Section 42]		P4 [Section 45]		P4 ~ A2 [Section 49]	
			Top fiber	Bottom fiber	Top fiber	Bottom fiber	Top fiber	Bottom fiber	Top fiber	Bottom fiber	Top fiber	Bottom fiber
Bending Stress due to Each Loading (Mpa)	Self Weight of Hollow Slab	DC	3.806	-4.304	-3.683	4.086	0.124	-0.138	-4.548	4.967	3.889	-4.490
	Dead Load due to Surfacing	DW	0.542	-0.612	-0.402	0.447	0.001	-0.001	-0.624	0.682	0.577	-0.666
	Shrinkage	SH	0.058	-0.127	-0.120	0.109	-0.061	0.068	0.054	-0.059	0.031	-0.035
	PC Tendon	PS	-1.903	8.152	3.911	-1.737	-0.442	7.249	6.444	-2.482	-2.518	10.791
	Live Load with Impact Factor											
	In case of Maximum Bending Moment	LL_Max	2.269	-2.550	0.302	-0.341	1.595	-1.775	0.422	-0.461	2.482	-2.865
	In case of Minimum Bending Moment	LL_Min	-0.428	0.459	-1.116	1.247	-1.050	1.169	-1.873	2.045	-0.540	0.623
	Thermal Rise and Fall											
	In case of Rasing (+10 Deg)	TUR	-0.038	0.083	0.079	-0.071	0.040	-0.044	-0.036	0.039	-0.020	0.023
	In case of Falling (-10 Deg)	TUF	0.038	-0.083	-0.079	0.071	-0.040	0.044	0.036	-0.039	0.020	-0.023
	Support Settlement											
	Maximum	SE_Max	0.039	-0.042	0.104	-0.115	0.291	-0.324	1.145	-1.250	0.646	-0.746
	Minimum	SE_Min	-0.270	0.289	-0.572	0.630	-0.261	0.290	-0.474	0.518	-0.268	0.309
Combination of Bending Stress (Mpa)	Combination Service III											
	SERVICE III-1		4.319	1.068	-0.052	2.632	0.897	5.759	1.663	2.738	3.963	3.308
	SERVICE III-2		2.161	3.476	-1.186	3.903	-1.219	8.113	-0.173	4.743	1.546	6.099
	SERVICE III-3		4.320	1.109	0.131	2.446	1.228	5.390	2.772	1.527	4.589	2.586
	SERVICE III-4		4.396	0.943	-0.027	2.589	1.149	5.479	2.844	1.449	4.629	2.539
	SERVICE III-5		1.853	3.848	-1.680	4.461	-1.439	8.359	-0.683	5.300	1.259	6.431
	SERVICE III-6		1.929	3.682	-1.837	4.604	-1.519	8.448	-0.611	5.222	1.299	6.384
	Checking 14.000 > σc > -2.950		OK		OK		OK		OK		OK	

Notes Load Factors of Combinations

Combination Service III	Load Factors									
	DC	DW	SH	PS	LL_Max	LL_Min	TUR	TUF	SE_Max	SE_Min
SERVICE III-1	1.000	1.000	1.000	1.000	0.800					
SERVICE III-2	1.000	1.000	1.000	1.000		0.800				
SERVICE III-3	1.000	1.000	1.000	1.000	0.800		1.000		1.000	
SERVICE III-4	1.000	1.000	1.000	1.000	0.800			1.000	1.000	
SERVICE III-5	1.000	1.000	1.000	1.000		0.800	1.000			1.000
SERVICE III-6	1.000	1.000	1.000	1.000		0.800		1.000		1.000

2.3 *PC COMPOSITE I BEAM (CONNECTED)*

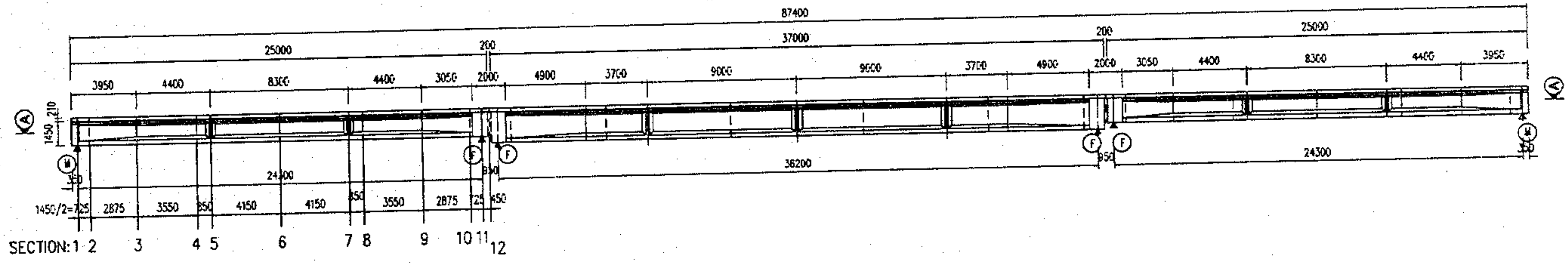
(1) *PC COMPOSITE I BEAM (CONNECTED), CASE 3*

Structural Views, Design Sections

3 CONTINUOUS SPANS L = 25.0m + 37.0m + 25.0m

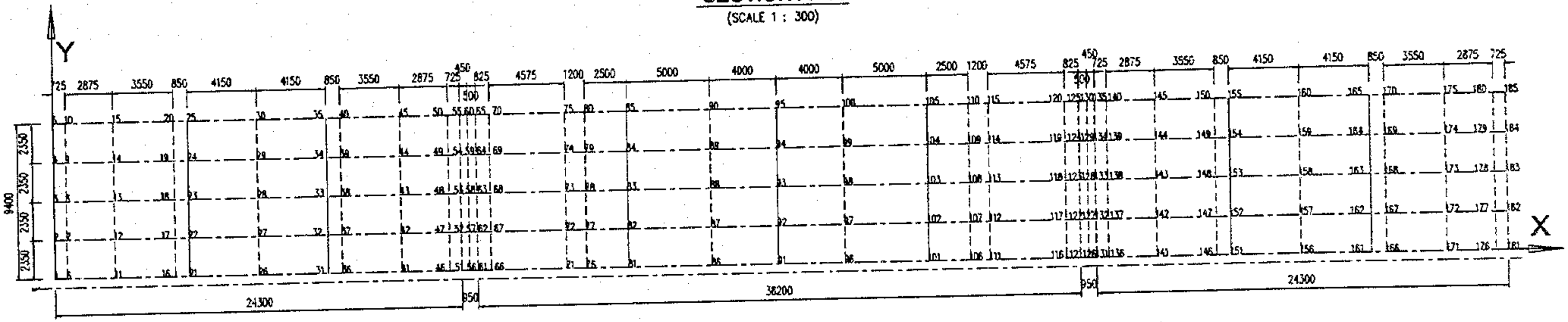
ELEVATION

(SCALE 1 : 300)



SECTION A - A

(SCALE 1 : 300)



Summary of Sectional Forces:

Section	S.W of girder			S.W of Deck Slab+Diaphragms			S.W of Surface		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	0.00	20.76	0.00	0.00	14.99	0.00	0.00	9.33	-1.41
SEC-2	0.00	19.08	14.44	0.00	14.10	10.54	0.00	8.21	4.95
SEC-3	0.00	14.53	62.75	0.00	10.55	45.97	0.00	3.74	22.13
SEC-4	0.00	7.74	102.27	0.00	6.17	75.64	0.00	-1.06	27.86
SEC-5	0.00	6.39	108.28	0.00	5.12	80.44	0.00	-2.38	26.39
SEC-6	0.00	0.00	121.19	0.00	0.00	91.07	0.00	-2.73	28.34
SEC-7	0.00	-6.39	108.28	0.00	-5.12	80.44	0.00	-8.89	4.86
SEC-8	0.00	-7.74	102.27	0.00	-6.17	75.64	0.00	-4.89	1.41
SEC-9	0.00	-14.53	62.75	0.00	-10.55	45.97	0.00	-10.40	-25.74
SEC-10	0.00	-19.08	14.44	0.00	-14.10	10.54	0.00	-14.75	-61.47
SEC-11	0.00	-20.76	0.00	0.00	-14.99	0.00	0.00	-15.88	-72.57

Section	Prestress			LiveLoad max			LiveLoad min		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	376.83	-34.64	0.00	0.00	8.41	1.96	0.00	-1.04	-1.90
SEC-2	376.83	-32.49	-53.02	0.00	7.99	4.70	0.00	-1.04	-0.67
SEC-3	383.09	-26.09	-139.56	0.00	6.40	21.22	0.00	-1.19	-3.10
SEC-4	389.95	-18.93	-217.17	0.00	5.12	35.47	0.00	-2.74	-6.79
SEC-5	395.20	-11.66	-230.19	0.00	4.71	37.73	0.00	-3.16	-7.72
SEC-6	397.67	0.04	-260.13	0.00	2.24	36.61	0.00	-4.67	-11.03
SEC-7	395.20	11.69	-229.84	0.00	1.04	26.05	0.00	-6.69	-14.54
SEC-8	389.95	18.91	-216.80	0.00	2.02	22.16	0.00	-8.29	-15.18
SEC-9	383.09	26.01	-139.26	0.00	1.25	9.29	0.00	-9.97	-21.38
SEC-10	376.83	32.37	-52.99	0.00	1.24	8.99	0.00	-11.12	-39.77
SEC-11	376.83	34.64	0.00	0.00	1.24	9.71	0.00	-11.37	-46.18

Section	Differential Creep			Differential Shrinkage			Differential Temperature		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	77.20	0.00	9.17	5.70	0.00	0.55	7.69	0.00	0.75
SEC-2	55.21	0.00	6.77	5.53	0.00	0.54	7.47	0.00	0.72
SEC-3	-26.02	0.00	-2.07	4.83	0.00	0.46	6.53	0.00	0.63
SEC-4	-83.82	0.00	-8.57	4.87	0.00	0.47	6.57	0.00	0.63
SEC-5	-80.53	0.00	-8.41	5.75	0.00	0.56	7.76	0.00	0.76
SEC-6	-113.44	0.00	-11.89	4.90	0.00	0.47	6.62	0.00	0.64
SEC-7	-80.53	0.00	-8.41	5.75	0.00	0.56	7.76	0.00	0.76
SEC-8	-83.82	0.00	-8.57	4.87	0.00	0.47	6.57	0.00	0.63
SEC-9	-26.02	0.00	-2.07	4.83	0.00	0.46	6.53	0.00	0.63
SEC-10	55.21	0.00	6.77	5.53	0.00	0.54	7.47	0.00	0.72
SEC-11	77.20	0.00	9.17	5.70	0.00	0.55	7.69	0.00	0.75

Section	Secondary force due to Creep			Impact max			Impact min		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	0.00	1.58	0.00	0.00	2.77	0.65	0.00	-0.34	-0.63
SEC-2	0.00	1.58	1.14	0.00	2.64	1.55	0.00	-0.34	-0.22
SEC-3	0.00	1.58	5.68	0.00	2.11	7.00	0.00	-0.39	-1.02
SEC-4	0.00	1.58	11.28	0.00	1.69	11.71	0.00	-0.91	-2.24
SEC-5	0.00	1.58	12.61	0.00	1.55	12.45	0.00	-1.04	-2.55
SEC-6	0.00	1.45	19.16	0.00	0.74	12.08	0.00	-1.54	-3.64
SEC-7	0.00	1.33	24.69	0.00	0.34	8.60	0.00	-2.21	-4.80
SEC-8	0.00	1.33	25.83	0.00	0.67	7.31	0.00	-2.74	-5.01
SEC-9	0.00	2.15	32.01	0.00	0.41	3.07	0.00	-3.29	-7.05
SEC-10	0.00	1.49	37.24	0.00	0.41	2.97	0.00	-3.67	-13.12
SEC-11	0.00	1.41	38.32	0.00	0.41	3.20	0.00	-3.75	-15.24

(1) Nominal Flexural Strength of Girder during Construction Stage (AASHTO LRFD 5.7.3.2.2) - 1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	1,450	1,450	1,450	1,450	1,450	1,450	1,450
Width of Deck Slap	bd	mm	600	600	600	600	600	600	600
Depth of Deck Slap	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	576	200	200	200	200	200
Width of Siffit Slap	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	3,553.6	3,553.6	3,553.6	3,553.6	3,553.6	3,553.6	3,553.6
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dp	mm	778.0	843.0	1,070.0	1,261.0	1,291.0	1,360.0	1,291.0
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calculation of Mr									
Stress block factor	β1		0.76	0.76	0.76	0.76	0.76	0.76	0.76
Distance from extreme compressive fibre Neutral Axis	c	mm	343	385	954	992	997	1,008	997
Depth of equivalent stress block	a	mm	262	294	729	758	762	770	762
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,630	1,622	1,395	1,450	1,458	1,474	1,458
Nominal Resistance	Mn	N.mm	3.74E+09	4.02E+09	4.06E+09	5.14E+09	5.32E+09	5.72E+09	5.32E+09
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0	1.0	1.0	1.0
Factored Resistance	Mr	N.mm	3.74E+09	4.02E+09	4,062,154,	5.14E+09	5.32E+09	5.72E+09	5.32E+09
Checking									
Factored Bending Moment due to External Loads	Mu	N.mm	0.00E+00	3.75E+08	1.63E+09	2.67E+09	2.83E+09	3.18E+09	2.83E+09

(1) Nominal Flexural Strength of Girder during Construction Stage (AASHTO LRFD 5.7.3.2.2) -2/2

		Unit	Section 8	Section 9	Section 10	Section 11
Sectional Properties						
Depth of Girder	H	mm	1,450	1,450	1,450	1,450
Width of Deck Slap	bd	mm	600	600	600	600
Depth of Deck Slap	hd	mm	210	210	210	210
Total width of Webs	bw	mm	200	200	576	650
Width of Siffit Slap	bs	mm	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	3,553.6	3,553.6	3,553.6	3,553.6
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dp	mm	1,261.0	1,070.0	843.0	778.0
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	0.0
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	0.0
Calculation of Mr						
Stress block factor	β1		0.76	0.76	0.76	0.76
Distance from extreme compressive fibre Neutral Axis	c	mm	992	954	385	343
Depth of equivalent stress block	a	mm	758	729	294	262
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,450	1,395	1,622	1,630
Nominal Resistance	Mn	N.mm	5.14E+09	4.06E+09	4.02E+09	3.74E+09
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0
Factored Resistance	Mr	N.mm	5.14E+09	4.06E+09	4.02E+09	3.74E+09
Checking						
Factored Bending Moment due to External Loads	Mu	N.mm	2.67E+09	1.63E+09	3.75E+08	0.00E+00

(2) Checking Nominal Shear Strength of Section during Construction Stage - 1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	1,450	1,450	1,450	1,450	1,450	1,450	1,450
Width of Deck Slap	bd	mm	600	600	600	600	600	600	600
Depth of Deck Slap	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	576	200	200	200	200	200
Width of Soffit Slap	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	3,554	3,554	3,554	3,554	3,554	3,554	3,554
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	778	843	1,070	1,261	1,291	1,360	1,291
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	0	0	0	0	0
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	0	0	0	0	0
Calculation of Mr									
Effective shear Depth	dv	mm	1,044	1,044	1,044	1,044	1,044	1,044	1,044
Effective web width	bv	mm	650	576	200	200	200	200	200
Spacing of stirrups	s	mm2	150	150	150	300	300	300	300
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90	90	90	90
Factor indicating ability of diagonally cracked concrete to transmit tension	β		6.3	6.2	5.4	5.1	5.1	4.9	5.4
Area of shear reinf. within a distances	Av	mm2	616	616	616	308	308	308	308
Strain in the tensile reinforcement	εx		-0.000162	-0.000154	-0.000117	-0.000030	-0.000024	-0.000006	-0.000069
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	23.40	27.00	27.00	27.00	27.00
Component of effective pretressed force in the direction of the applied shear	Vp	N	-3.46E+05	-3.25E+05	-2.61E+05	-1.89E+05	-1.17E+05	4.15E+02	1.17E+05
Nominal Resistance of Concrete	Vc	N	2.25E+06	1.96E+06	5.88E+05	5.60E+05	5.55E+05	5.40E+05	5.92E+05
Nominal Resistance of Reinforcement	Vs	N	3.28E+06	3.28E+06	3.86E+06	8.20E+05	8.20E+05	8.20E+05	8.20E+05
Nominal Resistance	Vn	N	5.19E+06	4.92E+06	1.83E+06	1.19E+06	1.26E+06	1.36E+06	1.53E+06
Resistance factor for shear	φ		0.9	0.9	0.9	0.9	0.9	0.9	0.9
Factored Resistance	Vr	N	4.67E+06	4.42E+06	1.64E+06	1.07E+06	1.13E+06	1.22E+06	1.38E+06
Checking									
Factored Moment due to External Loads	Mu	N.mm	0.00E+00	3.75E+08	1.63E+09	2.67E+09	2.83E+09	3.18E+09	2.83E+09
Factored Axial Force due to External Loads	Nu	N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factored Shear Force due to External Loads	Vu	N	5.36E+05	4.98E+05	3.76E+05	2.09E+05	1.73E+05	0.00E+00	1.73E+05

(2) Checking Nominal Shear Strength of Section during Construction Stage - 2/2

		Unit	Section 8	Section 9	Section 10	Section 11
Sectional Properties						
Depth of Girder	H	mm	1,450	1,450	1,450	1,450
Width of Deck Slap	bd	mm	600	600	600	600
Depth of Deck Slap	hd	mm	210	210	210	210
Total width of Webs	bw	mm	200	200	576	650
Width of Soffit Slap	bs	mm	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	3,554	3,554	3,554	3,554
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,261	1,070	843	778
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	0	0
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	0	0
Calculation of Mr						
Effective shear Depth	dv	mm	1,044	1,044	1,044	1,044
Effective web width	bv	mm	200	200	576	650
Spacing of stirrups	s	mm2	300	150	150	150
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90
Factor indicating ability of diagonally cracked concrete to transmit tension	β		5.5	6.8	6.1	5.7
Area of shear reinf. within a distances	Av	mm2	308	616	616	616
Strain in the tensile reinforcement	εx		-0.000088	-0.000208	-0.000148	-0.000107
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	27.00	27.00
Component of effective pretressed force in the direction of the applied shear	Vp	N	1.89E+05	2.60E+05	3.24E+05	3.46E+05
Nominal Resistance of Concrete	Vc	N	6.07E+05	7.43E+05	1.94E+06	2.03E+06
Nominal Resistance of Reinforcement	Vs	N	8.20E+05	3.28E+06	3.28E+06	3.28E+06
Nominal Resistance	Vn	N	1.62E+06	2.35E+06	5.54E+06	5.66E+06
Resistance factor for shear	φ		0.9	0.9	0.9	0.9
Factored Resistance	Vr	N	1.45E+06	2.11E+06	4.99E+06	5.09E+06
Checking						
Factored Moment due to External Loads	Mu	N.mm	2.67E+09	1.63E+09	3.75E+08	0.00E+00
Factored Axial Force due to External Loads	Nu	N	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factored Shear Force due to External Loads	Vu	N	2.09E+05	3.76E+05	4.98E+05	5.36E+05

(3) Nominal Flexural Strength of Girder at Service Stage (AASHTO LRFD 5.7.3.2.2) -1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	1,660	1,660	1,660	1,660	1,660	1,660	1,660
Width of Deck Slab	bd	mm	2,035	2,035	2,035	2,035	2,035	2,035	2,035
Depth of Deck Slab	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	576	200	200	200	200	200
Width of Soffit Slab	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slab	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	3,553.6	3,553.6	3,553.6	3,553.6	3,553.6	3,553.6	3,553.6
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	988.0	1,053.0	1,280.0	1,471.0	1,501.0	1,570.0	1,501.0
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calculation of Mr									
Stress block factor	β1		0.76	0.76	0.76	0.76	0.76	0.76	0.76
Distance from extreme compressive fibre to the Neutral Axis	c	mm	352	395	995	1,024	1,028	1,037	1,028
Depth of equivalent stress block	a	mm	269	302	760	783	786	792	786
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,674	1,665	1,455	1,497	1,503	1,516	1,503
Nominal Resistance	Mn	N.mm	5.30E+09	5.70E+09	7.41E+09	8.61E+09	8.80E+09	9.24E+09	8.80E+09
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0	1.0	1.0	1.0
Factored Resistance	Mr	N.mm	5.30E+09	5.70E+09	7.41E+09	8.61E+09	8.80E+09	9.24E+09	8.80E+09
Checking									
Factored Bending Moment due to External Loads	Mu	N.mm	7.30E+07	5.38E+08	2.21E+09	3.48E+09	3.66E+09	3.97E+09	3.12E+09

(3) Nominal Flexural Strength of Girder at Service Stage (AASHTO LRFD 5.7.3.2.2) -2/2

		Unit	Section 8	Section 9	Section 10	Section 11			
Sectional Properties									
Depth of Girder	H	mm	1,660	1,660	1,660	1,660			
Width of Deck Slab	bd	mm	2,035	2,035	2,035	2,035			
Depth of Deck Slab	hd	mm	210	210	210	210			
Total width of Webs	bw	mm	200	200	576	650			
Width of Soffit Slab	bs	mm	650	650	650	650			
Depth of Soffit Slab	hs	mm	250	250	250	250			
Total Area of Prestressing Cables	Ap	mm2	3,553.6	3,553.6	3,553.6	3,553.6			
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,471.0	1,280.0	607.0	672.0			
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0			
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	1,660.0			
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0			
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	1,660.0			
Calculation of Mr									
Stress block factor	β1		0.76	0.76	0.76	0.76			
Distance from extreme compressive fibre to the Neutral Axis	c	mm	1,024	995	367	336			
Depth of equivalent stress block	a	mm	783	760	280	257			
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,497	1,455	1,545	1,599			
Nominal Resistance	Mn	N.mm	8.61E+09	7.41E+09	2.57E+09	3.09E+09			
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0			
Factored Resistance	Mr	N.mm	8.61E+09	7.41E+09	2.57E+09	3.09E+09			
Checking									
Factored Bending Moment due to External Loads	Mu	N.mm	2.85E+09	1.40E+09	8.78E+08	1.31E+09			

(4) Checking Nominal Shear Strength of Section at Service Stage - 1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	1,660	1,660	1,660	1,660	1,660	1,660	1,660
Width of Deck Slap	bd	mm	2,035	2,035	2,035	2,035	2,035	2,035	2,035
Depth of Deck Slap	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	576	200	200	200	200	200
Width of Soffit Slap	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	3,554	3,554	3,554	3,554	3,554	3,554	3,554
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	988	1,053	1,280	1,471	1,501	1,570	1,501
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	0	0	0	0	0
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	0	0	0	0	0
Calculation of Mr									
Effective shear Depth	dv	mm	1,195	1,195	1,195	1,195	1,195	1,195	1,195
Effective web width	bv	mm	650	576	200	200	200	200	200
Spacing of stirrups	s	mm2	150	150	150	300	300	300	300
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90	90	90	90
Factor indicating ability of diagonally cracked concrete to transmit tension	β		6.1	6.1	5.9	5.4	5.4	5.3	5.6
Area of shear reinf. within a distances	Av	mm2	616	616	616	308	308	308	308
Strain in the tensile reinforcement	εx		-0.000143	-0.000139	-0.000140	-0.000069	-0.000066	-0.000053	-0.000102
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	25.11	27.00	27.00	27.00	27.00
Component of effective pretressed force in the direction of the applied shear	Vp	N	-3.46E+05	-3.25E+05	-2.61E+05	-1.89E+05	-1.17E+05	4.15E+02	1.17E+05
Nominal Resistance of Concrete	Vc	N	2.49E+06	2.19E+06	7.40E+05	6.78E+05	6.74E+05	6.62E+05	7.09E+05
Nominal Resistance of Reinforcement	Vs	N	3.76E+06	3.76E+06	4.08E+06	9.39E+05	9.39E+05	9.39E+05	9.39E+05
Nominal Resistance	Vn	N	5.89E+06	5.62E+06	2.13E+06	1.43E+06	1.50E+06	1.60E+06	1.76E+06
Resistance factor for shear	φ		0.9	0.9	0.9	0.9	0.9	0.9	0.9
Factored Resistance	Vr	N	5.31E+06	5.06E+06	1.92E+06	1.28E+06	1.35E+06	1.44E+06	1.59E+06
Checking									
Factored Moment due to External Loads	Mu	N.mm	7.30E+07	5.38E+08	2.21E+09	3.48E+09	3.66E+09	3.97E+09	3.12E+09
Factored Axial Force due to External Loads	Nu	N	4.14E+05	3.04E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factored Shear Force due to External Loads	Vu	N	7.90E+05	7.32E+05	5.27E+05	2.85E+05	2.26E+05	1.19E+05	3.10E+05

(4) Checking Nominal Shear Strength of Section at Service Stage - 2/2

		Unit	Section 8	Section 9	Section 10	Section 11			
Sectional Properties									
Depth of Girder	H	mm	1,660	1,660	1,660	1,660			
Width of Deck Slap	bd	mm	2,035	2,035	2,035	2,035			
Depth of Deck Slap	hd	mm	210	210	210	210			
Total width of Webs	bw	mm	200	200	576	650			
Width of Soffit Slap	bs	mm	650	650	650	650			
Depth of Soffit Slap	hs	mm	250	250	250	250			
Total Area of Prestressing Cables	Ap	mm2	3,554	3,554	3,554	3,554			
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,471	1,280	607	672			
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0			
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	1,660	1,660			
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0			
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	1,660	1,660			
Calculation of Mr									
Effective shear Depth	dv	mm	1,195	1,195	1,195	1,195			
Effective web width	bv	mm	200	200	576	650			
Spacing of stirrups	s	mm2	300	150	150	150			
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90			
Factor indicating ability of diagonally cracked concrete to transmit tension	β		5.8	6.8	5.5	5.4			
Area of shear reinf. within a distances	Av	mm2	308	616	616	616			
Strain in the tensile reinforcement	εx		-0.000116	-0.000211	-0.000085	-0.000066			
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	27.00	27.00			
Component of effective pretressed force in the direction of the applied shear	Vp	N	1.89E+05	2.60E+05	3.24E+05	3.46E+05			
Nominal Resistance of Concrete	Vc	N	7.28E+05	8.51E+05	1.99E+06	2.19E+06			
Nominal Resistance of Reinforcement	Vs	N	9.39E+05	3.76E+06	3.76E+06	3.76E+06			
Nominal Resistance	Vn	N	1.86E+06	2.65E+06	6.07E+06	6.29E+06			
Resistance factor for shear	φ		0.9	0.9	0.9	0.9			
Factored Resistance	Vr	N	1.67E+06	2.39E+06	5.47E+06	5.66E+06			
Checking									
Factored Moment due to External Loads	Mu	N.mm	2.85E+09	1.40E+09	8.78E+08	1.31E+09			
Factored Axial Force due to External Loads	Nu	N	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Factored Shear Force due to External Loads	Vu	N	3.43E+05	5.32E+05	7.19E+05	7.74E+05			

Checking Stress during construction

Load Combinations for Checking Stress during construction stage

	COMBINATION 14	
	Load type	**Factor**
	Girder Selfweight G_DC	1.00
	Slab+Dia. Selfweight S_D	1.00
	Prestress PS	1.00

Section	N(T)	V(T)	M(T.m)
SEC-1	376.83	1.12	0.00
SEC-2	376.83	0.68	-28.03
SEC-3	383.09	-1.01	-30.84
SEC-4	389.95	-5.02	-39.26
SEC-5	395.20	-0.14	-41.47
SEC-6	397.67	0.04	-47.87
SEC-7	395.20	0.18	-41.12
SEC-8	389.95	5.00	-38.88
SEC-9	383.09	0.93	-30.54
SEC-10	376.83	-0.80	-28.01
SEC-11	376.83	-1.12	0.00

Stress checking during construction stage (AASHTO 5.9.4.2

Section	COMBINATION 14			
	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking
SEC-1	414.39	OK	414.39	OK
SEC-2	321.53	OK	579.01	OK
SEC-3	507.15	OK	816.68	OK
SEC-4	480.25	OK	865.21	OK
SEC-5	258.55	OK	615.65	OK
SEC-6	454.42	OK	915.97	OK
SEC-7	260.03	OK	614.13	OK
SEC-8	482.08	OK	863.40	OK
SEC-9	508.70	OK	815.14	OK
SEC-10	321.64	OK	578.88	OK
SEC-11	414.39	OK	414.39	OK

Checking Stress at service stage

Load Combinations for Checking Stress at service stage

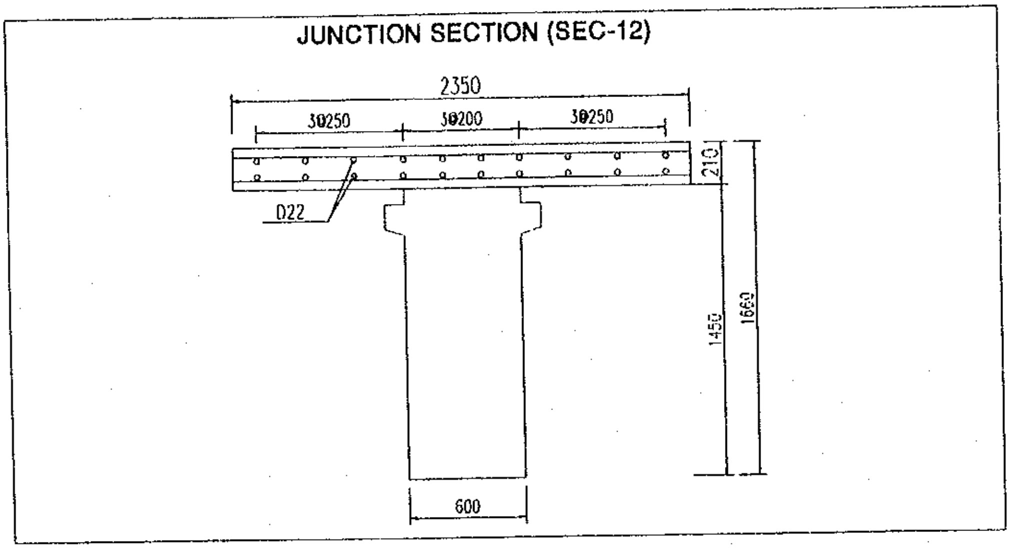
COMBINATION 11 Load type	Factor	COMBINATION 12 Load type	Factor	COMBINATION 13 Load type	Factor
Girder Selfweight G_DC	1.00	Girder Selfweight G_DC	1.00	Girder Selfweight G_DC	1.00
Slab+Dia. Selfweight S_DC	1.00	Slab+Dia. Selfweight S_DC	1.00	Slab+Dia. Selfweight S_D	1.00
Surface + Railings DW	1.00	Surface + Railings DW	1.00	Surface + Railings DW	1.00
Max. Live Load LL_MAX	0.80	Max. Live Load LL_MAX	0.00	Max. Live Load LL_MAX	0.00
Min. Live Load LL_MIN	0.00	Min. Live Load LL_MIN	0.80	Min. Live Load LL_MIN	0.00
Max. Impact IM_MAX	0.80	Max. Impact IM_MAX	0.00	Max. Impact IM_MAX	0.00
Min. Impact IM_MIN	0.00	Min. Impact IM_MIN	0.80	Min. Impact IM_MIN	0.00
Creep Diff. CR_D	1.00	Creep Diff. CR_D	1.00	Creep Diff. CR_D	1.00
Shrinkage Diff. SH_D	1.00	Shrinkage Diff. SH_D	1.00	Shrinkage Diff. SH_D	1.00
Temperature Diff. TG	0.50	Temperature Diff. TG	0.50	Temperature Diff. TG	1.00
Creep CR	1.00	Creep CR	1.00	Creep CR	1.00
Prestress PS	1.00	Prestress PS	1.00	Prestress PS	1.00

Section	COMBINATION 11 N(T)	V(T)	M(T.m)	COMBINATION 12 N(T)	V(T)	M(T.m)	COMBINATION 13 N(T)	V(T)	M(T.m)
SEC-1	463.56	20.97	10.77	463.56	10.92	6.66	467.41	12.03	9.06
SEC-2	441.30	18.97	-9.28	441.30	9.36	-14.99	445.04	10.47	-13.92
SEC-3	365.17	11.12	18.24	365.17	3.05	-7.63	368.43	4.31	-4.02
SEC-4	314.29	0.95	29.83	314.29	-7.42	-15.13	317.58	-4.50	-7.59
SEC-5	324.29	4.07	30.21	324.29	-4.31	-18.15	328.17	-0.95	-9.56
SEC-6	292.44	1.15	27.48	292.44	-6.20	-23.21	295.75	-1.23	-11.16
SEC-7	324.29	-6.27	8.67	324.29	-14.49	-34.51	328.17	-7.38	-18.67
SEC-8	314.29	3.58	4.15	314.29	-7.39	-35.58	317.58	1.44	-19.11
SEC-9	365.17	-6.00	-15.67	365.17	-17.94	-48.31	368.43	-7.32	-25.25
SEC-10	441.30	-12.75	-35.01	441.30	-25.91	-86.88	445.04	-14.07	-44.21
SEC-11	463.56	-14.27	-13.83	463.56	-27.68	-73.30	467.41	-15.58	-23.79

Stress checking at Service stage (AASHTO 5.9.4.2)

Section	COMBINATION 11				COMBINATION 12				COMBINATION 13			
	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking
SEC-1	359.29	OK	318.80	OK	354.51	OK	329.48	OK	360.18	OK	326.12	OK
SEC-2	336.91	OK	372.38	OK	330.36	OK	387.68	OK	334.54	OK	387.74	OK
SEC-3	381.37	OK	309.65	OK	355.23	OK	385.25	OK	362.12	OK	377.93	OK
SEC-4	342.26	OK	226.67	OK	297.22	OK	355.86	OK	308.04	OK	337.46	OK
SEC-5	277.23	OK	166.27	OK	221.78	OK	288.45	OK	234.53	OK	269.64	OK
SEC-6	318.00	OK	212.54	OK	267.56	OK	356.63	OK	282.84	OK	325.66	OK
SEC-7	252.53	OK	220.68	OK	203.01	OK	329.79	OK	224.09	OK	292.66	OK
SEC-8	316.53	OK	300.47	OK	276.75	OK	414.59	OK	296.50	OK	370.56	OK
SEC-9	347.11	OK	408.72	OK	314.14	OK	504.07	OK	340.68	OK	439.94	OK
SEC-10	307.41	OK	441.27	OK	247.94	OK	580.14	OK	299.81	OK	468.84	OK
SEC-11	330.70	OK	382.69	OK	261.59	OK	537.18	OK	322.01	OK	411.44	OK

Stress Check at Junction of the Girders



Moment due to Service Load	M=	73.3 tf.m		
Tensile Reinforcement	As=2xD22(Nos=2x10=20)			
Stress of Concrete	fcj=	199.8 t/m2	<	1835.5 t/m2
Stress of Tensile Reinf.	fs=	-574.5 t/m2	>	-17896.1 t/m2

Design of connectors at the interface between girder and deck slab (AASHTO 5.8.4):

Horizontal Shear per unit length of girder V_h due to Vertical Shear V_u	$V_h = V_u / d_e$		
Distance from the centroid of tensile steel to the midthickness of the deck	d_e		
Required area of reinforcement:	A_{vf}		
$A_{vf} >= \max\{0.35\, b_v / f_y\, ;\, (V_h - c\, b_v - \mu\, P_c) / \mu\, f_y\}$			
Width of the interface between the girder and the deck:	b_v=	600	mm
Yield strength of reinforcement	f_y=	390	MPa
Cohesion factor	c =	0.17	MPa
Friction factor	μ =	0.7	
Permanent net compressive force normal to the shear plan	P_c=	58750	N

Section		SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6	SEC-7	SEC-8	SEC-9	SEC-10	SEC-11
d_e (mm)		883	948	1175	1366	1396	1465	1396	1366	1175	948	883
Interface Shear(N):												
Girder Selfweight G_DC		203618	187087	142459	75906	62712	0	-62712	-75906	-142459	-187087	-203618
Slab+Dia. Selfweight S_D		147002	138230	103446	60495	50211	0	-50211	-60495	-103446	-138230	-147002
Surface + Railings DW		91529	80490	36715	-10400	-23342	-26779	-87157	-47978	-102031	-144687	-155726
Max. Live Load LL_MAX		82445	78333	62808	50241	46187	21980	10205	19789	12244	12161	12135
Min. Live Load LL_MIN		-10184	-10237	-11626	-26899	-30974	-45794	-65601	-81339	-97808	-109096	-111500
Max. Impact IM_MAX		27207	25850	20727	16580	15242	7254	3368	6530	4040	4013	4005
Min. Impact IM_MIN		-3361	-3378	-3837	-8877	-10222	-15112	-21648	-26842	-32277	-36002	-36795
Creep Diff. CR_D		757067	541424	-255193	-821957	-789696	-1112450	-789696	-821957	-255193	541424	757067
Shrinkage Diff. SH_D		55851	54255	47409	47754	56355	48061	56355	47754	47409	54255	55851
Temperature Diff. TG		75399	73244	64002	64468	76079	64882	76079	64468	64002	73244	75399
Creep CR		15466	15468	15467	15464	15464	14266	13077	13079	21078	14598	13855
Total	Max	1455583	1194381	237841	-501449	-490789	-982786	-830694	-854717	-454355	229690	411965
	Min	1332387	1076582	138843	-604045	-593414	-1072926	-931516	-989217	-600724	68418	247530
$A_{vf\ required}$ (mm2)		5181	4224	720	2062	2023	3779	3261	3472	2049	690	1358
Area of Stirrups (mm^2)		3695 (D14@150)	3695 (D14@150)	3695 (D14@150)	924 (D14@300)	924 (D14@300)	924 (D14@300)	924 (D14@300)	924 (D14@300)	3695 (D14@150)	3695 (D14@150)	3695 (D14@150)
Area of Dowel bars (mm^2)		3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)	3770 (D20@150)
Total Connector Area (mm^2)		7464	7464	7464	4694	4694	4694	4694	4694	7464	7464	7464
Checking		OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

Design of Deck Slab

Sumary of Bending Moment:

Bending Moment due to Live Load:

(a) Continuous Slab

1) Effective Span Length	1.700 m		
2) Load	10.000 T		
3) Impact Factor IM	33%		
4) Positive Moment	M=0.8*(1+IM)*(0.12S+0.07)	2.92	T.m/m
5) Negative Moment	M=-(1+IM)*(0.15S+0.125)*	-5.05	T.m/m

(2) Cantilever Slab

1) Effective Span Length	0.100 m < 0.5m --> ignore		
2) Load	10.000 T		
3) Impact Factor IM	33%		
4) Negative Moment		M= 0.00	T.m/m

Bending Moment due to Self-weight of Slab:

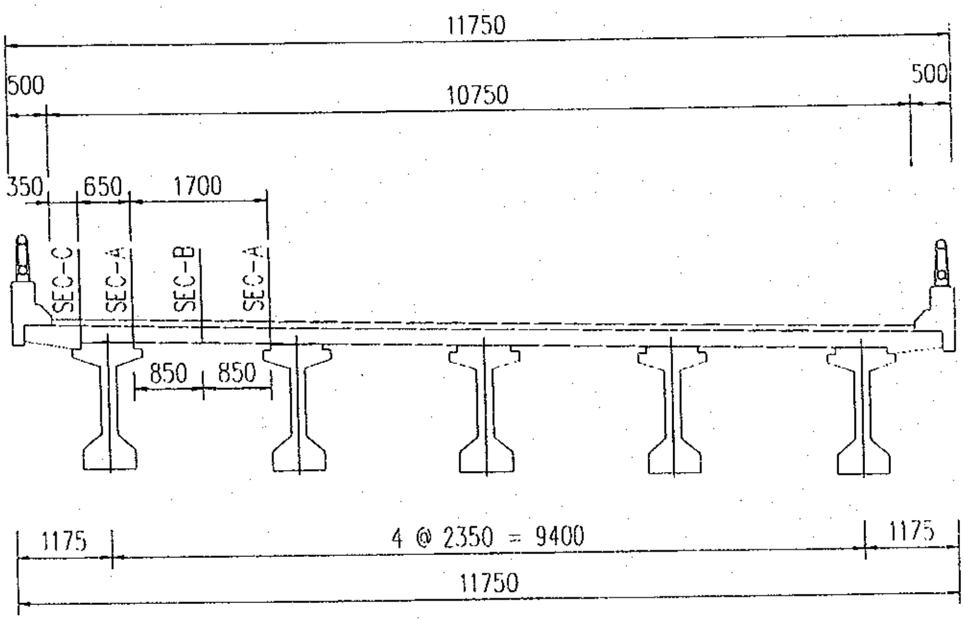
Section	A	B	C
Bending Moment (T.m)	-0.152	0.152	-0.150

Bending Moment due to Asphalt Concrete:

Section	A	B	C
Bending Moment (T.m)	-0.050	0.050	-0.030

Bending Moment due to Parapet & Railings:

Section	A	B	C
Bending Moment (T.m)	0.000	0.000	-0.424



Checking Nominal Flexural Strength of Deck Slab (Article 5.7.3.2.2 AASHTO)

			Section A	Section B	Section C
Sectional Properties					
	Depth of Slab	H	210 mm	210 mm	210 mm
	Width of Slab	ds	1000 mm	1000 mm	1000 mm
	Area of Tensile Reinforcement	A_{st}	1885 mm^2	1885 mm^2	1885 mm^2
	Distance from extreme compressive fibre to centroid of Tensile Reinforcement	d_{st}	162 mm	162 mm	162 mm
	Area of Compressive Reinforcement	A_{sc}	0 mm^2	0 mm^2	0 mm^2
	Distance from extreme compressive fibre to centroid of Compressive Reinforcement	d_{sc}	48 mm	48 mm	48 mm
Calculation of Mr	Stress block factor	β_1	0.76	0.76	0.76
	Distance from extreme compressive fibre to the Neutral Axis	c	28 mm	28 mm	28 mm
	Depth of equivalent stress block	a	22 mm	22 mm	22 mm
	Nominal Resistance	Mn	111,144,141 N.mm	111,144,141 N.mm	111,144,141 N.mm
	Flexural Resistance factor	φ	0.9	0.9	0.9
	Factored Resistance	Mr	100,029,726 N.mm	100,029,726 N.mm	100,029,726 N.mm
Checking	Factored Bending Moment due to External Loads	Mu	91,089,350 N.mm	53,663,150 N.mm	7,617,528 N.mm
			OK	OK	OK

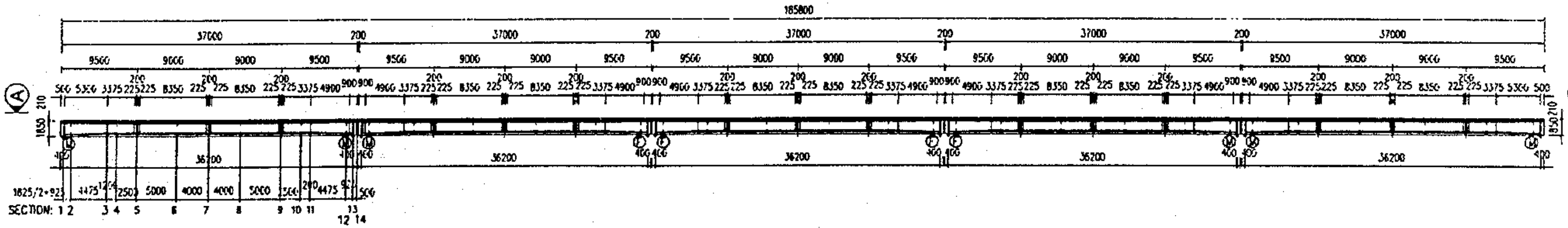
(2) PC COMPOSITE I BEAM (CONNECTED), CASE 7

Structural Views, Design Sections

5 CONTINUOUS SPANS 5@37.0m, W = 11.75m

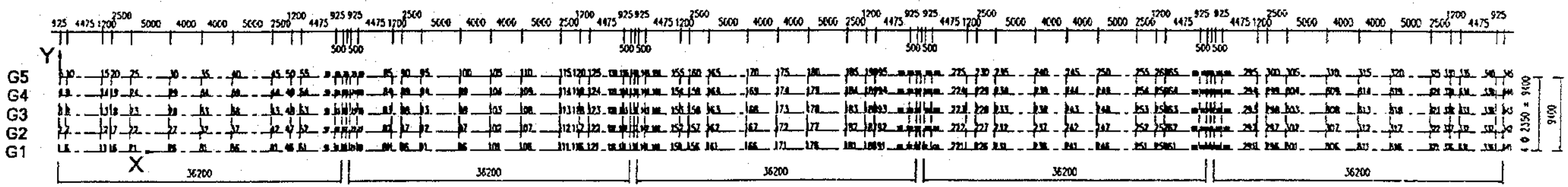
ELEVATION

(SCALE : 1:600)



SECTION A - A

(SCALE : 1:600)



Summary of Sectional Forces:

Section	S.W of girder			S.W of Deck Slab+Diaphragms			S.W of Surface		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	0.00	35.61	0.00	0.00	22.33	0.00	0.00	13.80	-0.99
SEC-2	0.00	32.72	31.60	0.00	21.19	20.13	0.00	12.36	11.11
SEC-3	0.00	24.40	159.40	0.00	15.67	102.60	0.00	5.41	50.89
SEC-4	0.00	21.48	186.93	0.00	14.19	120.51	0.00	4.06	56.77
SEC-5	0.00	16.84	234.83	0.00	11.10	152.13	0.00	0.18	62.06
SEC-6	0.00	7.54	295.78	0.00	4.94	192.23	0.00	-0.54	78.71
SEC-7	0.00	0.00	311.09	0.00	0.00	202.10	0.00	-6.61	64.70
SEC-8	0.00	-7.54	295.78	0.00	-4.94	192.23	0.00	-5.23	56.20
SEC-9	0.00	-16.84	234.83	0.00	-11.10	152.13	0.00	-12.84	11.42
SEC-10	0.00	-21.48	186.93	0.00	-14.19	120.51	0.00	-10.64	-10.27
SEC-11	0.00	-24.40	159.40	0.00	-15.67	102.60	0.00	-12.51	-24.16
SEC-12	0.00	-32.72	31.60	0.00	-21.19	20.13	0.00	-19.15	-94.18
SEC-13	0.00	-35.61	0.00	0.00	-22.33	0.00	0.00	-20.59	-112.56

Section	Prestress			LiveLoad max			LiveLoad min		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	633.99	-54.23	0.00	0.00	9.82	2.72	0.00	-0.80	-2.68
SEC-2	633.99	-50.56	-92.20	0.00	9.44	7.07	0.00	-0.80	-0.63
SEC-3	644.24	-42.51	-300.75	0.00	7.63	37.61	0.00	-1.52	-3.51
SEC-4	653.03	-35.26	-346.23	0.00	8.12	44.51	0.00	-2.37	-4.47
SEC-5	661.26	-24.57	-426.84	0.00	7.14	57.39	0.00	-3.33	-6.80
SEC-6	661.23	-7.94	-510.74	0.00	4.26	66.24	0.00	-3.90	-9.91
SEC-7	656.44	0.00	-508.31	0.00	3.17	65.61	0.00	-5.36	-12.61
SEC-8	661.23	7.94	-510.74	0.00	2.18	53.10	0.00	-7.62	-14.37
SEC-9	661.26	24.57	-426.84	0.00	1.11	32.07	0.00	-9.10	-17.88
SEC-10	653.03	35.26	-346.23	0.00	2.09	21.01	0.00	-11.33	-22.78
SEC-11	644.24	42.51	-300.75	0.00	1.87	17.76	0.00	-11.68	-27.09
SEC-12	633.99	50.56	-92.20	0.00	1.37	17.03	0.00	-12.41	-63.68
SEC-13	633.99	54.23	0.00	0.00	1.36	17.99	0.00	-12.61	-72.77

Section	Differential Creep			Differential Shrinkage			Differential Temperature		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	120.24	0.00	13.76	7.10	0.00	0.71	9.59	0.00	0.96
SEC-2	89.11	0.00	10.39	6.89	0.00	0.69	9.31	0.00	0.93
SEC-3	-56.20	0.00	-5.24	5.70	0.00	0.57	7.70	0.00	0.77
SEC-4	-82.52	0.00	-8.15	5.71	0.00	0.57	7.70	0.00	0.77
SEC-5	-128.48	0.00	-13.22	5.71	0.00	0.57	7.72	0.00	0.77
SEC-6	-181.95	0.00	-19.15	5.73	0.00	0.57	7.74	0.00	0.77
SEC-7	-190.57	0.00	-20.11	5.73	0.00	0.57	7.74	0.00	0.77
SEC-8	-181.95	0.00	-19.15	5.73	0.00	0.57	7.74	0.00	0.77
SEC-9	-128.48	0.00	-13.22	5.71	0.00	0.57	7.72	0.00	0.77
SEC-10	-82.52	0.00	-8.15	5.71	0.00	0.57	7.70	0.00	0.77
SEC-11	-56.20	0.00	-5.24	5.70	0.00	0.57	7.70	0.00	0.77
SEC-12	89.11	0.00	10.39	6.89	0.00	0.69	9.31	1.00	0.93
SEC-13	120.24	0.00	13.76	7.10	0.00	0.71	9.59	2.00	0.96

Section	Secondary force due to Creep			Impact max			Impact min		
	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)	N (tf)	V (tf)	M (tf.m)
SEC-1	0.00	0.71	0.00	0.00	3.24	0.90	0.00	-0.26	-0.89
SEC-2	0.00	0.82	0.76	0.00	3.11	2.33	0.00	-0.27	-0.21
SEC-3	0.00	0.82	4.42	0.00	2.52	12.41	0.00	-0.50	-1.16
SEC-4	0.00	0.82	5.41	0.00	2.68	14.69	0.00	-0.78	-1.47
SEC-5	0.00	0.82	7.45	0.00	2.36	18.94	0.00	-1.10	-2.24
SEC-6	0.00	0.82	11.55	0.00	1.41	21.86	0.00	-1.29	-3.27
SEC-7	0.00	0.94	14.83	0.00	1.05	21.65	0.00	-1.77	-4.16
SEC-8	0.00	1.05	19.05	0.00	0.72	17.52	0.00	-2.51	-4.74
SEC-9	0.00	0.98	24.23	0.00	0.37	10.58	0.00	-3.00	-5.90
SEC-10	0.00	0.93	26.58	0.00	0.69	6.93	0.00	-3.74	-7.52
SEC-11	0.00	1.38	28.01	0.00	0.62	5.86	0.00	-3.85	-8.94
SEC-12	0.00	-0.45	30.02	0.00	0.45	5.62	0.00	-4.09	-21.01
SEC-13	0.00	-0.34	29.66	0.00	0.45	5.94	0.00	-4.16	-24.01

(1) Nominal Flexural Strength of Girder during Construction Stage (AASHTO LRFD 5.7.3.2.2) - 1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	1,850	1,850	1,850	1,850	1,850	1,850	1,850
Width of Deck Slap	bd	mm	650	650	650	650	650	650	650
Depth of Deck Slap	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	580	200	200	200	200	200
Width of Siffit Slap	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dp	mm	971.0	1,050.0	1,370.0	1,437.0	1,552.0	1,677.0	1,688.0
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calculation of Mr									
Stress block factor	β1		0.76	0.76	0.76	0.76	0.76	0.76	0.76
Distance from extreme compressive fibre Neutral Axis	c	mm	549	612	1,479	1,500	1,533	1,566	1,568
Depth of equivalent stress block	a	mm	420	467	1,130	1,147	1,172	1,197	1,199
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,566	1,557	1,298	1,316	1,346	1,374	1,376
Nominal Resistance	Mn	N.mm	7.06E+09	7.57E+09	7.32E+09	7.89E+09	8.88E+09	9.99E+09	1.01E+10
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0	1.0	1.0	1.0
Factored Resistance	Mr	N.mm	7.06E+09	7.57E+09	7.32E+09	7.89E+09	8.88E+09	9.99E+09	1.01E+10
Checking									
Factored Bending Moment due to External Loads	Mu	N.mm	0.00E+00	7.76E+08	3.93E+09	4.61E+09	5.80E+09	7.32E+09	7.70E+09

(1) Nominal Flexural Strength of Girder during Construction Stage (AASHTO LRFD 5.7.3.2.2) -2/2

		Unit	Section 8	Section 9	Section 10	Section 11	Section 12	Section 13	
Sectional Properties									
Depth of Girder	H	mm	1,850	1,850	1,850	1,850	1,850	1,850	
Width of Deck Slap	bd	mm	650	650	650	650	650	650	
Depth of Deck Slap	hd	mm	210	210	210	210	210	210	
Total width of Webs	bw	mm	200	200	200	200	580	650	
Width of Siffit Slap	bs	mm	650	650	650	650	650	650	
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250	
Total Area of Prestressing Cables	Ap	mm2	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dp	mm	1,677.0	1,552.0	1,437.0	1,370.0	1,050.0	970.0	
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0	0.0	0.0	
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	0.0	0.0	0.0	
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0	0.0	0.0	
Distance from extreme compressive fibre of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	0.0	0.0	0.0	
Calculation of Mr									
Stress block factor	β1		0.76	0.76	0.76	0.76	0.76	0.76	
Distance from extreme compressive fibre Neutral Axis	c	mm	1,566	1,533	1,500	1,479	612	549	
Depth of equivalent stress block	a	mm	1,197	1,172	1,147	1,130	467	420	
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,374	1,346	1,316	1,298	1,557	1,566	
Nominal Resistance	Mn	N.mm	9.99E+09	8.88E+09	7.89E+09	7.32E+09	7.57E+09	7.06E+09	
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0	1.0	1.0	
Factored Resistance	Mr	N.mm	9.99E+09	8.88E+09	7.89E+09	7.32E+09	7.57E+09	7.06E+09	
Checking									
Factored Bending Moment due to External Loads	Mu	N.mm	7.32E+09	5.80E+09	4.61E+09	3.93E+09	7.76E+08	0.00E+00	

(2) Checking Nominal Shear Strength of Section during Construction Stage - 1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	1,850	1,850	1,850	1,850	1,850	1,850	1,850
Width of Deck Slap	bd	mm	650	650	650	650	650	650	650
Depth of Deck Slap	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	580	200	200	200	200	200
Width of Soffit Slap	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	5,923	5,923	5,923	5,923	5,923	5,923	5,923
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	971	1,050	1,370	1,437	1,552	1,677	1,688
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	0	0	0	0	0
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	0	0	0	0	0
Calculation of Mr									
Effective shear Depth	dv	mm	1,332	1,332	1,332	1,332	1,332	1,332	1,332
Effective web width	bv	mm	650	580	200	200	200	200	200
Spacing of stirrups	s	mm2	150	150	150	300	300	300	300
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90	90	90	90
Factor indicating ability of diagonally cracked concrete to transmit tension	β		6.8	6.8	6.1	6.6	6.3	5.5	5.4
Area of shear reinf. within a distances	Av	mm2	616	616	616	308	308	308	308
Strain in the tensile reinforcement	εx		-0.000254	-0.000248	-0.000245	-0.000219	-0.000163	-0.000083	-0.000070
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	23.14	25.06	27.00	27.00	27.00
Component of effective pretressed force in the direction of the applied shear	Vp	N	-5.42E+05	-5.06E+05	-4.25E+05	-3.53E+05	-2.46E+05	-7.94E+04	0.00E+00
Nominal Resistance of Concrete	Vc	N	3.08E+06	2.75E+06	8.55E+05	9.26E+05	8.86E+05	7.69E+05	7.55E+05
Nominal Resistance of Reinforcement	Vs	N	4.19E+06	4.19E+06	4.99E+06	1.14E+06	1.05E+06	1.05E+06	1.05E+06
Nominal Resistance	Vn	N	6.72E+06	6.43E+06	2.24E+06	1.71E+06	1.69E+06	1.74E+06	1.80E+06
Resistance factor for shear	φ		0.9	0.9	0.9	0.9	0.9	0.9	0.9
Factored Resistance	Vr	N	6.05E+06	5.79E+06	2.02E+06	1.54E+06	1.52E+06	1.56E+06	1.62E+06
Checking									
Factored Moment due to External Loads	Mu	N.mm	0.00E+00	7.76E+08	3.93E+09	4.61E+09	5.80E+09	7.32E+09	7.70E+09
Factored Axial Force due to External Loads	Nu	N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factored Shear Force due to External Loads	Vu	N	8.69E+05	8.09E+05	6.01E+05	5.35E+05	4.19E+05	1.87E+05	0.00E+00

(2) Checking Nominal Shear Strength of Section during Construction Stage - 2/2

		Unit	Section 8	Section 9	Section 10	Section 11	Section 12	Section 13
Sectional Properties								
Depth of Girder	H	mm	1,850	1,850	1,850	1,850	1,850	1,850
Width of Deck Slap	bd	mm	650	650	650	650	650	650
Depth of Deck Slap	hd	mm	210	210	210	210	210	210
Total width of Webs	bw	mm	200	200	200	200	580	650
Width of Soffit Slap	bs	mm	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	5,923	5,923	5,923	5,923	5,923	5,923
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,677	1,552	1,437	1,370	1,050	971
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	0	0	0	0
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	0	0	0	0
Calculation of Mr								
Effective shear Depth	dv	mm	1,332	1,332	1,332	1,332	1,332	1,332
Effective web width	bv	mm	200	200	200	200	580	650
Spacing of stirrups	s	mm2	300	150	150	150	150	150
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90	90	90
Factor indicating ability of diagonally cracked concrete to transmit tension	β		5.5	6.3	6.8	6.8	6.8	6.8
Area of shear reinf. within a distances	Av	mm2	308	616	616	616	616	616
Strain in the tensile reinforcement	εx		-0.000083	-0.000163	-0.000225	-0.000257	-0.000248	-0.000254
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	27.00	27.00	27.00	27.00
Component of effective pretressed force in the direction of the applied shear	Vp	N	7.94E+04	2.46E+05	3.53E+05	4.25E+05	5.06E+05	5.42E+05
Nominal Resistance of Concrete	Vc	N	7.69E+05	8.86E+05	9.48E+05	9.48E+05	2.75E+06	3.08E+06
Nominal Resistance of Reinforcement	Vs	N	1.05E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06
Nominal Resistance	Vn	N	1.89E+06	2.91E+06	3.02E+06	3.09E+06	7.44E+06	7.81E+06
Resistance factor for shear	φ		0.9	0.9	0.9	0.9	0.9	0.9
Factored Resistance	Vr	N	1.71E+06	2.62E+06	2.71E+06	2.78E+06	6.70E+06	7.03E+06
Checking								
Factored Moment due to External Loads	Mu	N.mm	7.32E+09	5.80E+09	4.61E+09	3.93E+09	7.76E+08	0.00E+00
Factored Axial Force due to External Loads	Nu	N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factored Shear Force due to External Loads	Vu	N	1.87E+05	4.19E+05	5.35E+05	6.01E+05	8.09E+05	8.69E+05

(3) Nominal Flexural Strength of Girder at Service Stage (AASHTO LRFD 5.7.3.2.2) -1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	2,060	2,060	2,060	2,060	2,060	2,060	2,060
Width of Deck Slab	bd	mm	2,035	2,035	2,035	2,035	2,035	2,035	2,035
Depth of Deck Slab	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	580	200	200	200	200	200
Width of Soffit Slab	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slab	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,181.0	1,260.0	1,580.0	1,647.0	1,762.0	1,887.0	1,898.0
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calculation of Mr									
Stress block factor	β1		0.76	0.76	0.76	0.76	0.76	0.76	0.76
Distance from extreme compressive fibre to the Neutral Axis	c	mm	565	629	1,541	1,558	1,586	1,621	1,615
Depth of equivalent stress block	a	mm	432	481	1,178	1,191	1,212	1,232	1,234
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,611	1,600	1,352	1,367	1,391	1,415	1,417
Nominal Resistance	Mn	N.mm	1.00E+10	1.07E+10	1.28E+10	1.34E+10	1.45E+10	1.58E+10	1.59E+10
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0	1.0	1.0	1.0
Factored Resistance	Mr	N.mm	1.00E+10	1.07E+10	1.28E+10	1.34E+10	1.45E+10	1.58E+10	1.59E+10
Checking									
Factored Bending Moment due to External Loads	Mu	N.mm	1.25E+08	1.04E+09	4.95E+09	5.77E+09	7.14E+09	8.85E+09	8.95E+09

(3) Nominal Flexural Strength of Girder at Service Stage (AASHTO LRFD 5.7.3.2.2) -2/2

		Unit	Section 8	Section 9	Section 10	Section 11	Section 12	Section 13	Section 14
Sectional Properties									
Depth of Girder	H	mm	2,060	2,060	2,060	2,060	2,060	2,060	2,060
Width of Deck Slab	bd	mm	2,035	2,035	2,035	2,035	2,035	2,035	2,035
Depth of Deck Slab	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	200	200	200	200	580	650	650
Width of Soffit Slab	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slab	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	5,922.6	0.0
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,887.0	1,762.0	1,647.0	1,580.0	800.0	879.0	2,060.0
Area of Tensile Reinforcement	Ast	mm2	0.0	0.0	0.0	0.0	0.0	0.0	7,603.0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst	mm	0.0	0.0	0.0	0.0	2,060.0	2,060.0	1,955.0
Area of Compressive Reinforcement	Asc	mm2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0.0	0.0	0.0	0.0	2,060.0	2,060.0	2,060.0
Calculation of Mr									
Stress block factor	β1		0.76	0.76	0.76	0.76	0.76	0.76	0.76
Distance from extreme compressive fibre to the Neutral Axis	c	mm	1,612	1,586	1,558	1,541	582	540	176
Depth of equivalent stress block	a	mm	1,232	1,212	1,191	1,178	445	413	134
Average stress in Prestress stell at nominal bending resistance	fps	Mpa	1,415	1,391	1,367	1,352	1,481	1,540	1,816
Nominal Resistance	Mn	N.mm	1.58E+10	1.45E+10	1.34E+10	1.28E+10	5.11E+09	6.14E+09	5.60E+09
Flexural Resistance factor	φ		1.0	1.0	1.0	1.0	1.0	1.0	0.8
Factored Resistance	Mr	N.mm	1.58E+10	1.45E+10	1.34E+10	1.28E+10	5.11E+09	6.14E+09	4.20E+09
Checking									
Factored Bending Moment due to External Loads	Mu	N.mm	8.22E+09	6.02E+09	4.54E+09	3.67E+09	1.50E+09	2.30E+09	2.30E+09

(4) Checking Nominal Shear Strength of Section at Service Stage - 1/2

		Unit	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Sectional Properties									
Depth of Girder	H	mm	2,060	2,060	2,060	2,060	2,060	2,060	2,060
Width of Deck Slap	bd	mm	2,035	2,035	2,035	2,035	2,035	2,035	2,035
Depth of Deck Slap	hd	mm	210	210	210	210	210	210	210
Total width of Webs	bw	mm	650	580	200	200	200	200	200
Width of Soffit Slap	bs	mm	650	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	5,923	5,923	5,923	5,923	5,923	5,923	5,923
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,181	1,260	1,580	1,647	1,762	1,887	1,898
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	0	0	0	0	0
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	0	0	0	0	0
Calculation of Mr									
Effective shear Depth	dv	mm	1,483	1,483	1,483	1,483	1,483	1,483	1,483
Effective web width	bv	mm	650	580	200	200	200	200	200
Spacing of stirrups	s	mm2	150	150	150	300	300	300	300
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90	90	90	90
Factor indicating ability of diagonally cracked concrete to transmit tension	β		6.8	6.7	4.7	6.0	5.7	5.1	5.1
Area of shear reinf. within a distances	Av	mm2	616	616	616	308	308	308	308
Strain in the tensile reinforcement	εx		-0.000200	-0.000196	-0.000178	-0.000155	-0.000107	-0.000033	-0.000029
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	22.17	24.07	27.00	27.00	27.00
Component of effective pretressed force in the direction of the applied shear	Vp	N	-5.42E+05	-5.06E+05	-4.25E+05	-3.53E+05	-2.46E+05	-7.94E+04	0.00E+00
Nominal Resistance of Concrete	Vc	N	3.43E+06	3.04E+06	7.31E+05	9.30E+05	8.88E+05	7.98E+05	7.94E+05
Nominal Resistance of Reinforcement	Vs	N	4.66E+06	4.66E+06	5.83E+06	1.33E+06	1.17E+06	1.17E+06	1.17E+06
Nominal Resistance	Vn	N	7.55E+06	7.19E+06	2.54E+06	1.91E+06	1.81E+06	1.88E+06	1.96E+06
Resistance factor for shear	φ		0.9	0.9	0.9	0.9	0.9	0.9	0.9
Factored Resistance	Vr	N	6.79E+06	6.47E+06	2.29E+06	1.72E+06	1.63E+06	1.70E+06	1.76E+06
Checking									
Factored Moment due to External Loads	Mu	N.mm	1.25E+08	1.04E+09	4.95E+09	5.77E+09	7.14E+09	8.85E+09	8.95E+09
Factored Axial Force due to External Loads	Nu	N	6.37E+05	4.80E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factored Shear Force due to External Loads	Vu	N	1.17E+06	1.09E+06	8.02E+05	7.07E+05	5.29E+05	2.55E+05	1.88E+05

(4) Checking Nominal Shear Strength of Section at Service Stage - 2/2

		Unit	Section 8	Section 9	Section 10	Section 11	Section 12	Section 13
Sectional Properties								
Depth of Girder	H	mm	2,060	2,060	2,060	2,060	2,060	2,060
Width of Deck Slap	bd	mm	2,035	2,035	2,035	2,035	650	650
Depth of Deck Slap	hd	mm	210	210	210	210	210	2,035
Total width of Webs	bw	mm	200	200	200	200	580	650
Width of Soffit Slap	bs	mm	650	650	650	650	650	650
Depth of Soffit Slap	hs	mm	250	250	250	250	250	250
Total Area of Prestressing Cables	Ap	mm2	5,923	5,923	5,923	5,923	5,923	5,923
Distance from extreme compressive fibre to centroid of Prestressing Cables	dp	mm	1,887	1,762	1,647	1,580	800	879
Area of Tensile Reinforcement	Ast	mm2	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Tensile Reinforcement	dst		0	0	0	0	2,060	2,060
Area of Comressive Reinforcement	Asc	mm2	0	0	0	0	0	0
Distance from extreme compressive fibre to centroid of Compressive Reinforcement	dsc	mm	0	0	0	0	2,060	2,060
Calculation of Mr								
Effective shear Depth	dv	mm	1,483	1,483	1,483	1,483	1,483	1,483
Effective web width	bv	mm	200	200	200	200	580	650
Spacing of stirrups	s	mm2	300	150	150	150	150	150
Angle of inclination of transverse reinforcement to longitudinal axis of girder	α	degree	90	90	90	90	90	90
Factor indicating ability of diagonally cracked concrete to transmit tension	β		5.4	6.3	6.8	6.8	6.0	5.7
Area of shear reinf. within a distances	Av	mm2	308	616	616	616	616	616
Strain in the tensile reinforcement	εx		-0.000063	-0.000163	-0.000233	-0.000266	-0.000133	-0.000107
Inclination angle of diagonal compressive stress	θ	degree	27.00	27.00	27.00	27.00	27.00	27.00
Component of effective pretressed force in the direction of the applied shear	Vp	N	7.94E+04	2.46E+05	3.53E+05	4.25E+05	5.06E+05	5.42E+05
Nominal Resistance of Concrete	Vc	N	8.33E+05	9.85E+05	1.06E+06	1.06E+06	2.71E+06	2.89E+06
Nominal Resistance of Reinforcement	Vs	N	1.17E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06
Nominal Resistance	Vn	N	2.08E+06	3.21E+06	3.32E+06	3.39E+06	7.87E+06	8.09E+06
Resistance factor for shear	φ		0.9	0.9	0.9	0.9	0.9	0.9
Factored Resistance	Vr	N	1.87E+06	2.89E+06	2.99E+06	3.05E+06	7.08E+06	7.28E+06
Checking								
Factored Moment due to External Loads	Mu	N.mm	8.22E+09	6.02E+09	4.54E+09	3.67E+09	1.50E+09	2.30E+09
Factored Axial Force due to External Loads	Nu	N	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factored Shear Force due to External Loads	Vu	N	3.26E+05	6.12E+05	6.95E+05	7.89E+05	1.10E+06	1.18E+06

Checking Stress during construction

Load Combinations for Checking Stress during construction stage

	COMBINATION 14	
	Load type	Factor
	Girder Selfweight G_DC	1.00
	Slab+Dia. Selfweight S_D	1.00
	Prestress PS	1.00

Section	N(T)	V(T)	M(T.m)
SEC-1	633.99	3.70	0.00
SEC-2	633.99	3.35	-40.47
SEC-3	644.24	-2.44	-38.74
SEC-4	653.03	0.41	-38.79
SEC-5	661.26	3.37	-39.88
SEC-6	661.23	4.54	-22.73
SEC-7	656.44	0.00	4.87
SEC-8	661.23	-4.54	-22.73
SEC-9	661.26	-3.37	-39.88
SEC-10	653.03	-0.41	-38.79
SEC-11	644.24	2.44	-38.74
SEC-12	633.99	-3.35	-40.47
SEC-13	633.99	-3.70	0.00

Stress checking during construction stage (AASHTO 5.9.4.2)

Section	COMBINATION 14			
	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking
SEC-1	512.28	OK	512.28	OK
SEC-2	448.35	OK	664.46	OK
SEC-3	816.99	OK	1062.95	OK
SEC-4	829.94	OK	1075.49	OK
SEC-5	839.05	OK	1090.00	OK
SEC-6	893.84	OK	1035.68	OK
SEC-7	973.71	OK	943.32	OK
SEC-8	893.84	OK	1035.68	OK
SEC-9	839.05	OK	1090.00	OK
SEC-10	829.94	OK	1075.49	OK
SEC-11	816.99	OK	1062.95	OK
SEC-12	448.35	OK	664.46	OK
SEC-13	512.28	OK	512.28	OK

Checking Stress at service stage

Load Combinations for Checking Stress at service stage

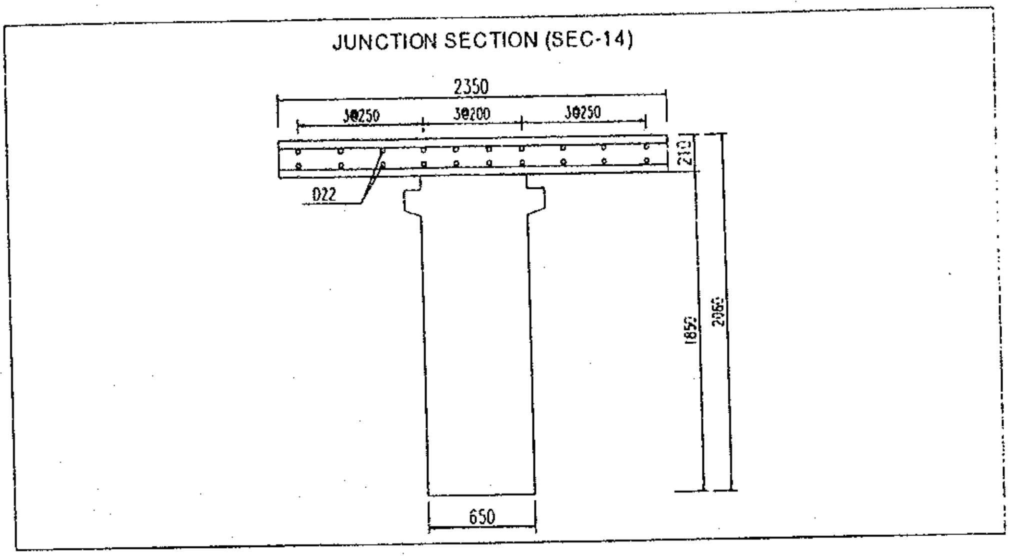
	COMBINATION 11		COMBINATION 12		COMBINATION 13	
	Load type	Factor	Load type	Factor	Load type	Factor
	Girder Selfweight G_DC	1.00	Girder Selfweight G_DC	1.00	Girder Selfweight G_DC	1.00
	Slab+Dia. Selfweight S_D	1.00	Slab+Dia. Selfweight S_D	1.00	Slab+Dia. Selfweight S_D	1.00
	Surface + Railings DW	1.00	Surface + Railings DW	1.00	Surface + Railings DW	1.00
	Max. Live Load LL_MAX	0.80	Max. Live Load LL_MAX	0.00	Max. Live Load LL_MAX	0.00
	Min. Live Load LL_MIN	0.00	Min. Live Load LL_MIN	0.80	Min. Live Load LL_MIN	0.00
	Max. Impact IM_MAX	0.80	Max. Impact IM_MAX	0.00	Max. Impact IM_MAX	0.00
	Min. Impact IM_MIN	0.00	Min. Impact IM_MIN	0.80	Min. Impact IM_MIN	0.00
	Creep Diff. CR_D	1.00	Creep Diff. CR_D	1.00	Creep Diff. CR_D	1.00
	Shrinkage Diff. SH_D	1.00	Shrinkage Diff. SH_D	1.00	Shrinkage Diff. SH_D	1.00
	Temperature Diff. TG	0.50	Temperature Diff. TG	0.50	Temperature Diff. TG	1.00
	Creep CR	1.00	Creep CR	1.00	Creep CR	1.00
	Prestress PS	1.00	Prestress PS	1.00	Prestress PS	1.00

Section	N(T)	V(T)	M(T.m)	N(T)	V(T)	M(T.m)	N(T)	V(T)	M(T.m)
SEC-1	766.13	28.67	16.87	766.13	17.37	11.11	770.93	18.22	14.45
SEC-2	734.64	26.57	-9.54	734.64	15.68	-17.72	739.30	16.53	-16.59
SEC-3	597.59	11.91	52.29	597.59	2.18	8.54	601.44	3.79	12.66
SEC-4	580.08	13.93	63.55	580.08	2.77	11.44	583.93	5.29	16.57
SEC-5	542.35	11.97	78.42	542.35	0.83	10.13	546.21	4.36	17.74
SEC-6	488.87	9.35	119.82	488.87	0.66	38.79	492.74	4.81	49.73
SEC-7	475.48	-2.29	135.06	475.48	-11.37	51.84	479.34	-5.67	65.64
SEC-8	488.87	-6.41	90.83	488.87	-16.83	19.04	492.74	-8.73	34.71
SEC-9	542.35	-14.05	17.62	542.35	-24.91	-35.54	546.21	-15.23	-16.12
SEC-10	580.08	-7.90	-7.32	580.08	-22.18	-53.91	583.93	-10.12	-29.29
SEC-11	597.59	-6.70	-20.29	597.59	-21.11	-68.01	601.44	-8.69	-38.80
SEC-12	734.64	-21.00	-74.96	734.64	-35.65	-160.84	739.30	-21.95	-92.62
SEC-13	766.13	-22.18	-48.81	766.13	-37.04	-145.37	770.93	-22.63	-67.46

Stress checking at service stage (AASHTO 5.9.4.2)

Section	COMBINATION 8				COMBINATION 9				COMBINATION 10			
	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking	$\sigma_t(T/m^2)$	Checking	$\sigma_b(T/m^2)$	Checking
SEC-1	475.37	OK	431.87	OK	470.17	OK	441.51	OK	476.07	OK	438.80	OK
SEC-2	459.04	OK	484.25	OK	451.65	OK	498.48	OK	455.63	OK	499.47	OK
SEC-3	580.54	OK	429.90	OK	544.29	OK	519.70	OK	551.16	OK	514.70	OK
SEC-4	574.05	OK	391.35	OK	530.93	OK	498.05	OK	538.64	OK	491.00	OK
SEC-5	552.27	OK	327.75	OK	495.91	OK	466.92	OK	505.67	OK	454.86	OK
SEC-6	538.01	OK	196.74	OK	471.38	OK	360.89	OK	483.85	OK	342.22	OK
SEC-7	1085.36	OK	700.89	OK	679.98	OK	532.40	OK	750.66	OK	563.81	OK
SEC-8	514.17	OK	255.49	OK	455.13	OK	400.92	OK	471.50	OK	372.65	OK
SEC-9	502.10	OK	451.65	OK	458.23	OK	559.97	OK	477.72	OK	523.88	OK
SEC-10	515.41	OK	536.46	OK	476.86	OK	631.84	OK	500.69	OK	584.90	OK
SEC-11	520.41	OK	578.86	OK	480.88	OK	676.79	OK	508.54	OK	620.31	OK
SEC-12	399.92	OK	598.04	OK	322.31	OK	747.41	OK	386.93	OK	631.71	OK
SEC-13	416.04	OK	541.92	OK	328.81	OK	703.73	OK	402.07	OK	576.06	OK

Stress Check at Junction of the Girders



Moment due to Service Load	M=	145.4 tf.m		
Tensile Reinforcement	As=2xD22(Nos=2x10=20)			
Stress of Concrete	fcj=	159.4 t/m2	<	1835.5 t/m2
Stress of Tensile Reinf.	fs=	-816.5 t/m2	>	-17896.1 t/m2

Design of connetor at the interface between girder and deck slab (AASHTO 5.8.4):

Horizontal Shear per unit length of girder V_h due to Vertical Shear V_u	$V_h = V_u / d_e$	
Distance from the centroid of tensile steel to the midthickness of the deck	d_e	
Required area of reinforcement:	A_{vf}	
$A_{vf} >= \max\{0.35\, b_v / f_y;\ (V_h - c\, b_v - \mu P_c) / \mu f_y\}$		
Width of the interface between the girder and the deck:	b_v=	600 mm
Yield strength of reinforcement	f_y=	390 MPa
Cohesion factor	c =	0.17 MPa
Friction factor	μ =	0.7
Permanent net compressive force normal to the shear plan	P_c=	58750 N

Section		SEC-1	SEC-2	SEC-3	SEC-4	SEC-5	SEC-6	SEC-7	SEC-8	SEC-9	SEC-10	SEC-11	SEC-12	SEC-13
d_e (mm)		1076	1155	1475	1542	1657	1782	1793	1782	1657	1542	1475	1155	1076
Interface Shear(N):														
Girder Selfweight G_DC		349173	320848	239289	210674	165110	73982	0	-73982	-165110	-210674	-239289	-320848	-349173
Slab+Dia. Selfweight S_D		218990	207799	153657	139138	108891	48396	0	-48396	-108891	-139138	-153657	-207799	-218990
Surface + Railings DW		135318	121234	53097	39796	1731	-5341	-64779	-51323	-125929	-104385	-122656	-187797	-201881
Max. Live Load LL_MAX		96340	92551	74826	79660	70061	41824	31107	21337	10855	20465	18301	13409	13377
Min. Live Load LL_MIN		-7825	-7885	-14884	-23194	-32610	-38268	-52533	-74715	-89260	-111124	-114509	-121680	-123617
Max. Impact IM_MAX		31792	30542	24692	26288	23120	13802	10265	7041	3582	6753	6039	4425	4414
Min. Impact IM_MIN		-2582	-2602	-4912	-7654	-10761	-12629	-17336	-24656	-29456	-36671	-37788	-40154	-40794
Creep Diff. CR_D		1179148	873859	-551084	-809192	-1259938	-1784325	-1868829	-1784325	-1259938	-809192	-551084	873859	1179148
Shrinkage Diff. SH_D		69672	67595	55911	55947	56043	56195	56210	56195	56043	55947	55911	67595	69672
Temperature Diff. TG		94058	91253	75480	75529	75659	75863	75884	75863	75659	75529	75480	91253	94058
Creep CR		7009	8037	8030	8034	8036	8035	9181	10279	9654	9162	13526	-4416	-3326
Total	Max	2181500	1813719	133897	-174125	-751287	-1471570	-1750961	-1787311	-1504075	-1095532	-897429	329681	587298
	Min	2042961	1680139	14584	-310920	-887840	-1578093	-1862203	-1915060	-1637228	-1270545	-1074066	150013	405096
$A_{vf\,required}$ (mm2)		7840	6493	339	988	3101	5630	6670	6864	5846	4503	3783	1057	2000
Area of Stirrups (mm^2)		3695	3695	3695	924	924	924	924	924	924	924	3695	3695	3695
		(D14@150)	(D14@150)	(D14@150)	(D14@300)	(D14@300)	(D14@300)	(D14@300)	(D14@300)	(D14@300)	(D14@300)	(D14@150)	(D14@150)	(D14@150)
Area of Dowel bars (mm^2)		6371	6371	6371	6371	6371	6371	6371	6371	6371	6371	6371	6371	6371
		(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)	(D24@150)
Total Connector Area (mm^2)		10066	10066	10066	7295	7295	7295	7295	7295	7295	7295	10066	10066	10066
Checking		OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

Design of Deck Slab

Sumary of Bending Moment:

Bending Moment due to Live Load:

(a) Continuous Slab

1) Effective Span Length	1.700 m		
2) Load	10.000 T		
3) Impact Factor IM	33%		
4) Positive Moment	M=0.8*(1+IM)*(0.12S+0.07)	2.92	T.m/m
5) Negative Moment	M=-(1+IM)*(0.15S+0.125)*	-5.05	T.m/m

(2) Cantilever Slab

1) Effective Span Length	0.100 m < 0.5m --> ignore		
2) Load	10.000 T		
3) Impact Factor IM	33%		
4) Negative Moment	M=	0.00	T.m/m

Bending Moment due to Self-weight of Slab:

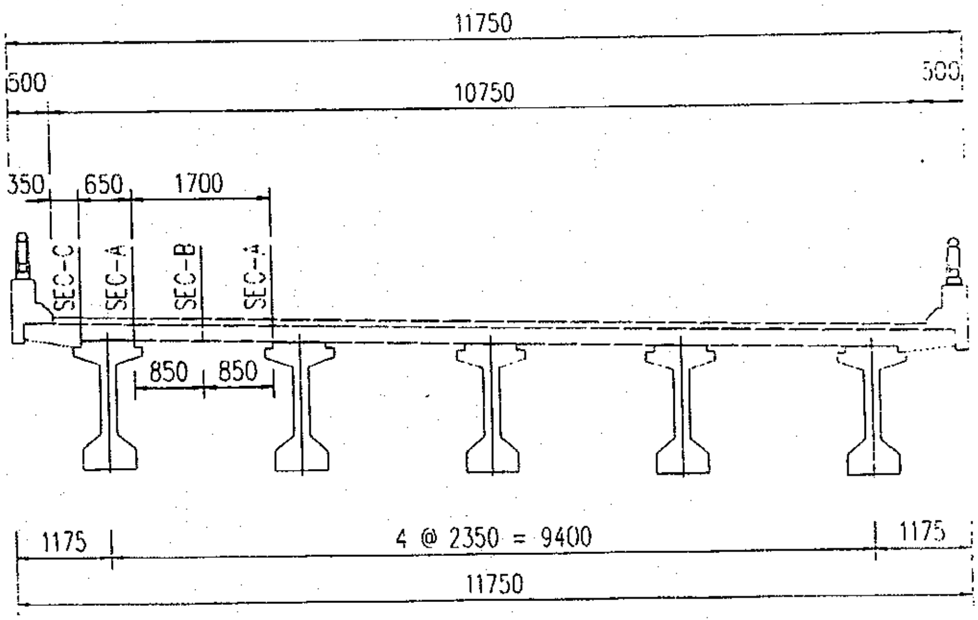
Section	A	B	C
Bending Moment (T.m)	-0.152	0.152	-0.150

Bending Moment due to Asphalt Concrete:

Section	A	B	C
Bending Moment (T.m)	-0.050	0.050	-0.030

Bending Moment due to Parapet & Railings:

Section	A	B	C
Bending Moment (T.m)	0.000	0.000	-0.424



Checking Nominal Flexural Strength of Deck Slab (Article 5.7.3.2.2 AASHTO)

			Section A	Section B	Section C
Sectional Properties					
	Depth of Slab	H	210 mm	210 mm	210 mm
	Width of Slab	ds	1000 mm	1000 mm	1000 mm
	Area of Tensile Reinforcement	A_{st}	1885 mm^2	1885 mm^2	1885 mm^2
	Distance from extreme compressive fibre to centroid of Tensile Reinforcement	d_{st}	162 mm	162 mm	162 mm
	Area of Compressive Reinforcement	A_{sc}	0 mm^2	0 mm^2	0 mm^2
	Distance from extreme compressive fibre to centroid of Compressive Reinforcement	d_{sc}	48 mm	48 mm	48 mm
Calculation of Mr	Stress block factor	β_1	0.76	0.76	0.76
	Distance from extreme compressive fibre to the Neutral Axis	c	28 mm	28 mm	28 mm
	Depth of equivalent stress block	a	22 mm	22 mm	22 mm
	Nominal Resistance	Mn	111,144,141 N.mm	111,144,141 N.mm	111,144,141 N.mm
	Flexural Resistance factor	φ	0.9	0.9	0.9
	Factored Resistance	Mr	100,029,726 N.mm	100,029,726 N.mm	100,029,726 N.mm
Checking	Factored Bending Moment due to External Loads	Mu	91,089,350 N.mm	53,663,150 N.mm	7,617,528 N.mm
			OK	OK	OK