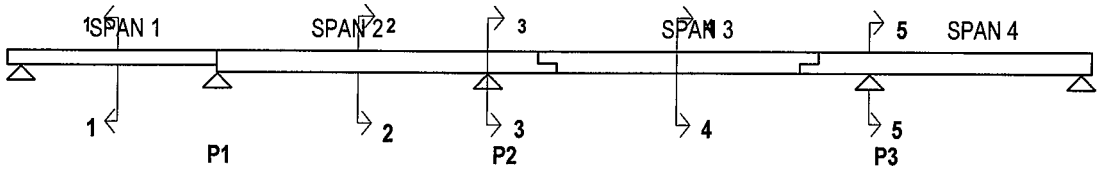
CALCULATION OF LOAD RATING - EXTERIOR GIRDER

PROJECT TITLE: PASIG-MARIKINA RIVER BRIDGE INSPECTION, VARGAS BRIDGE (UPSTREAM)



CONCRETE CAPACITY

RATING METHOD: SERVICEABILITY LIMIT STATE (ALLOWABLE STRESS)

STRESSES	SECTION		TYPE V GIRDER	TYPE VI AASHTO GIRDER (30.5+7.5+35.6+7.5+22.04)				
			1	2	3	4	5	
TDL=PS+DL+SDL	TOP	Mpa	-2.89	-1.99	3.16	-9.53	3.14	
	BOTTOM		-4.42	-10.37	-11.36	-3.89	-11.34	
LL (HS20)	TOP	Mpa	-1.75	-2.47	3.15	-2.89	2.55	
	BOTTOM		3.13	4.35	-4.21	5.10	-3.41	
Allowable Stress	Compression	Mpa	-23.40	-23.40	-23.40	-23.40	-23.40	
	Tension		3.12	3.12	3.12	3.12	3.12	
RATING FACTOR (RF=(Cap-TDL)/LL	TOP		**11.75**	**8.68**	**0.000**	**4.80**	**0.000**	
	BOTTOM		**2.41**	**3.10**	**2.86**	**1.37**	**3.54**	
Equivalent LL(HS20)	RF*(HS20)	tons	***77.00***	***99.23***	***0.00***	***43.96***	***0.00***	

PRESTRESSING STEEL CAPACITY

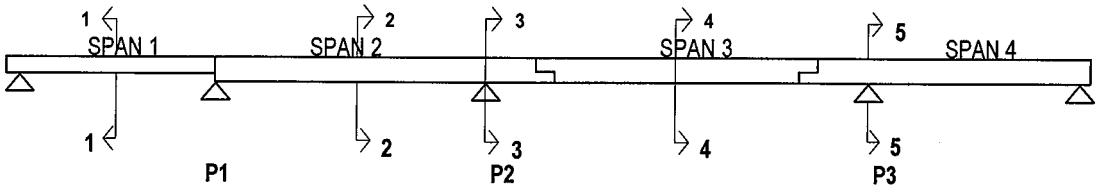
Prestressing Yield Stress, f*y	Mpa	1582.70	1582.70	1582.70	1582.70	1582.70	
Unfactored Stress due to all Dead Load, Fd	Mpa	3.49	0.99	6.09	6.09	8.94	
Unfactored Stress due to LL+I, Fl	Mpa	2.84	2.91	2.44	4.68	1.97	
Unfactored Stress due to Prestress, Fp	Mpa	1042.72	911.40	1054.85	1078.06	1054.85	
Unfactored Stress due to Secondary Prestress Force, Fs	Mpa	0.00	0.00	0.00	0.00	0.00	
INVENTORY LEVEL RF = 0.8f*y-(Fd+Fp+Fs) / Fl		**77.55**	**121.48**	**84.24**	**38.92**	**102.60**	
OPERATING LEVEL RF = 0.9f*y-(Fd+Fp+Fs) / Fl		**133.35**	**175.83**	**149.21**	**72.77**	**182.84**	

RATING METHOD: STRENGTH LIMIT STATE (LOAD FACTOR METHOD)

FORCES	SECTION		TYPE V GIRDER	TYPE VI AASHTO GIRDER (30.5+7.5+35.6+7.5+22.04)				
			1	2	3	4	5	
Moment, DL+SDL		kN-m	1719.00	914.00	7031.00	5,692.00	7,024.00	
Moment, LL+I		kN-m	1087.35	1913.32	2549.55	2,177.70	1,987.30	
Width of Flange, b		mm	2170.00	2170.00	2170.00	2,170.00	2,170.00	
Depth of Composite Section, d		mm	2040.00	2040.00	2040.00	2,040.00	2,040.00	
Comp. Strength of Conc., fc'		Mpa	39.00	39.00	39.00	39.00	39.00	
Ultimate Stress of PS Strands., f_s'		Mpa	1862.00	1862.00	1862.00	1,862.00	1,862.00	
Area of PS Strands, As*		mm^2	2370.00	4740.00	4740.00	4,740.00	4,740.00	
Steel Ratio, ρ*			0.00054	0.00107	0.00107	0.00107	0.00107	
f_{su}*		Mpa	1838.20	1814.41	0.00	1,814.41	1,814.41	
Neutral Axis, NA Bottom		mm	1.16	1.32	1.18	1.32	0.88	
R =ϕMn=ϕAs*fsu*d(1-0.6ρ*f_{su}*/fc')		kN-m	8752.79	17020.19	17020.19	17,020.19	-	
RF (INV. LEVEL) RF=(R-1.3(DL+SDL))/1.3*1.67LL			**2.76**	**3.81**	**1.42**	**2.04**	**1.83**	
RF (OPERATING LEVEL) RF=(R-1.3(DL+SDL))/1.3*1.0LL			**4.61**	**6.37**	**2.38**	**3.40**	**3.05**	

CALCULATION OF LOAD RATING - INTERIOR GIRDER

PROJECT TITLE: PASIG-MARIKINA RIVER BRIDGE INSPECTION, VARGAS BRIDGE (UPSTREAM)



CONCRETE CAPACITY

RATING METHOD: SERVICEABILITY LIMIT STATE (ALLOWABLE STRESS)

STRESSES	SECTION		TYPE V GIRDER	TYPE VI AASHTO GIRDER (30.5+7.5+35.6+7.5+22.04)				
			1	2	3	4	5	
TDL=PS+DL+SDL	TOP	Mpa	-2.63	-1.87	2.31	-8.91	2.32	
	BOTTOM		-4.76	-10.54	-10.33	-4.73	-10.34	
LL (HS20)	TOP	Mpa	-1.66	-2.13	2.15	-2.43	2.12	
	BOTTOM		2.73	3.43	-2.69	3.92	-2.65	
Allowable Stress	Compression	Mpa	-23.40	-23.40	-23.40	-23.40	-23.40	
	Tension		3.12	3.12	3.12	3.12	3.12	
RATING FACTOR	TOP		**12.48**	**10.13**	**0.38**	**5.96**	**0.38**	
(RF=(Cap-TDL)/LL	BOTTOM		**2.89**	**3.98**	**4.85**	**2.00**	**4.92**	
Equivalent LL(HS20)	RF*(HS20)	tons	***92.41***	***127.44***	***12.10***	***64.03***	***12.08***	

PRESTRESSING STEEL CAPACITY

Prestressing Yield Stress, f*y	Mpa	1582.70	1582.70	1582.70	1582.70	1582.70	
Unfactored Stress due to all Dead Load, Fd	Mpa	2.97	0.97	6.05	6.05	8.87	
Unfactored Stress due to LL+I, Fl	Mpa	2.46	2.26	1.68	3.58	1.65	
Unfactored Stress due to Prestress, Fp	Mpa	1042.72	911.40	1054.85	1078.06	1054.85	
Unfactored Stress due to Secondary Prestress Force, Fs	Mpa	0.00	0.00	0.00	0.00	0.00	
INVENTORY LEVEL RF = 0.8f*y-(Fd+Fp+Fs) / Fl		**89.62**	**156.74**	**122.30**	**50.81**	**122.43**	
OPERATING LEVEL RF = 0.9f*y-(Fd+Fp+Fs) / Fl		**153.96**	**226.86**	**216.61**	**94.98**	**218.14**	

RATING METHOD: STRENGTH LIMIT STATE (LOAD FACTOR METHOD)

FORCES	SECTION		TYPE V GIRDER	TYPE VI AASHTO GIRDER (30.5+7.5+35.6+7.5+22.04)				
			1	2	3	4	5	
Moment, DL+SDL		kN-m	1623.00	852.00	6534.00	5,386.00	6,541.00	
Moment, LL+I		kN-m	924.94	1474.36	1575.78	1,636.25	1,494.64	
Width of Flange, b		mm	2170.00	2170.00	2170.00	2,170.00	2,170.00	
Depth of Composite Section, d		mm	2040.00	2040.00	2040.00	2,040.00	2,040.00	
Comp. Strength of Conc., fc'		Mpa	39.00	39.00	39.00	39.00	39.00	
Ultimate Stress of PS Strands., f_s'		Mpa	1862.00	1862.00	1862.00	1,862.00	1,862.00	
Area of PS Strands, As*		mm^2	2370.00	4740.00	4740.00	4,740.00	4,740.00	
Steel Ratio, ρ*			0.00054	0.00107	0.00107	0.00107	0.00107	
f_{su}*		Mpa	1838.20	1814.41	0.00	1,814.41	1,814.41	
Neutral Axis, NA Bottom		mm	1.12	1.27	1.15	1.27	0.91	
R =ϕMn=ϕAs*fsu*d(1-0.6ρ*f_{su}*/fc')		kN-m	8752.79	17020.19	17020.19	17,020.19	-	
RF (INV. LEVEL) RF=(R-1.3(DL+SDL))/1.3*1.67LL			**3.31**	**4.97**	**2.49**	**2.82**	**2.63**	
RF (OPERATING LEVEL) RF=(R-1.3(DL+SDL))/1.3*1.0LL			**5.52**	**8.30**	**4.16**	**4.71**	**4.38**	

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V BRIDGE USING ALLOWABLE STRESS

FOR EXTERIOR GIRDER (AT MIDSPAN OF SPAN 1)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type V	0.65613	0.21859	0.83694	0.76306
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.041	0.401	1.156	0.644
Live Load MS-18	1.041	0.401	1.156	0.644

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V (D=1.60m; L=19.30m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	832.00
Due to Weight of Girder + Slab + Diaphragm	1441.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	278.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	857.00
With Impact	1087.35
Load Combination at Service Condition	
DL + (LL+I)	2806.35

I = 100*(15.24 / L + 38) = 27 %

TABLE C: STRESSES AT MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE IV (D-1.60M; L=36.20M)

Prestressing Force, P = 2471.25 kN (Data from As-built Plans; Drawing No. E-25)

Eccentricity:

For Basic Section = 0.737 m

For Composite Section : 1.056 m (Superimposed Loads)

For Composite Section : 1.056 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.5 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	-2.44	C	-5.22	C
Sresses due to Superimposed Loads	-0.45	C	0.80	T
Sresses due to all Live Load + Impact	-1.75	C	3.13	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 11.75 -At top fiber

RF = 2.41 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR EXTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.707	0.322	0.965	0.895
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.092	0.57	1.315	0.745
Live Load MS-18	1.092	0.570	1.315	0.745

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86m; L=30.50m)

DESCRIPTION	NEAR MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	414.00
Due to Weight of Girder + Slab + Diaphragm	712.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	202.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1543.00
With Impact	1886.29
Load Combination at Service Condition	
DL + (LL+I)	2800.29

I = 100*(15.24 / L + 38) = 22 %

TABLE C: STRESSES AT NEAR MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D-1.86M; L=30.5M)

Prestressing Force, P = 4320.04 kN (Data from As-built Plans)

Eccentricity:

For Basic Section = 0.530 m

For Composite Section : 0.880 m (Superimposed Loads)

For Composite Section : 0.880 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.50 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	-1.73	C	-10.84	C
Sresses due to Superimposed Loads	-0.26	C	0.47	T
Sresses due to all Live Load + Impact	-2.47	C	4.35	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 8.68 -At top fiber

RF = 3.10 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR EXTERIOR GIRDER (AT SUPPORT / PIER 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Top of Girder (m)	Y Bottom of Girder (m)
Basic Section				
PSCG Type IV	1.39	0.42219	0.86752	0.96148
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.775	0.724	0.882	1.178
Live Load MS-18	1.775	0.724	0.882	1.178

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86m; L=30.50m)

DESCRIPTION	NEAR MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3260.00
Due to Weight of Girder + Slab + Diaphragm	6034.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	997.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	2085.55
With Impact	2586.09
Load Combination at Service Condition	
DL + (LL+I)	9617.09

I = 100*(15.24 / L + 38) = 22 %

TABLE C: STRESSES AT NEAR MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D-1.86M; L=30.5M)

Prestressing Force, P = 5000.00 kN (Data from As-built Plans)

Eccentricity:

For Basic Section = 0.668 m

For Composite Section : 0.682 m (Superimposed Loads)

For Composite Section : 0.682 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.50 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	1.94	T	-9.74	C
Sresses due to Superimposed Loads	1.21	T	-1.62	C
Sresses due to all Live Load + Impact	3.15	T	-4.21	C

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = -0.0113 -At top fiber

RF = 2.86 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR & EXTERIOR GIRDER

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type VI	0.707	0.322	0.965	0.864
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.092	0.57	1.315	0.745
Live Load MS-18	1.092	0.57	1.315	0.745

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=36.00m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	2645.00
Due to Weight of Girder + Slab + Diaphragm	4785.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	907.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1830.00
With Impact	2212.04
Load Combination at Service Condition	
DL + (LL+I)	7904.04

I = 100*(15.24 / L + 38) = 21 %

TABLE C: STRESSES AT MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86M; L=36.0M)

Prestressing Force, P = 5110.00 kN (Data from As-built Plans; Drawing No. E-25)

Eccentricity:

For Basic Section = 0.855 m

For Composite Section : 1.205 m (Superimposed Loads)

For Composite Section : 1.205 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = $0.60\ f_c'$ = -23.40 MPa

Allowable Stress in Tension = $0.5\ \sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	-8.34	C	-5.98	C
Sresses due to Superimposed Loads	-1.19	C	2.09	T
Sresses due to all Live Load + Impact	-2.89	C	5.10	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 4.80 -At top fiber

RF = 1.37 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR & EXTERIOR GIRDER (AT SUPPORT / PIER 3)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Top of Girder (m)	Y Bottom of Girder (m)
Basic Section				
PSCG Type VI	1.39	0.42219	0.86759	0.96141
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.775	0.724	0.882	1.178
Live Load MS-18	1.775	0.724	0.882	1.178

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=22.04m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3256.00
Due to Weight of Girder + Slab + Diaphragm	6028.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	996.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1670.00
With Impact	2093.90
Load Combination at Service Condition	
DL + (LL+I)	9117.90

I = 100*(15.24 / L + 38) = 25 %

TABLE C: STRESSES AT MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86M; L=22.04M)

Prestressing Force, P = 5000.00 kN (Data from As-built Plans; Drawing No. E-25)

Eccentricity:

For Basic Section = 0.668 m

For Composite Section : 0.682 m (Superimposed Loads)

For Composite Section : 0.682 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = $0.60\, f_c'$ = -23.40 MPa

Allowable Stress in Tension = $0.5\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	1.93	T	-9.72	C
Sresses due to Superimposed Loads	1.21	T	-1.62	C
Sresses due to all Live Load + Impact	2.55	T	-3.41	C

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = -0.009 -At Top fiber

RF = 3.54 -At Bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR AND EXTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 4)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.707	0.322	0.965	0.864
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86m; L=22.04m)

DESCRIPTION	NEAR MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	546.00
Due to Weight of Girder + Slab + Diaphragm	1041.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	132.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1008.00
With Impact	1229.76
Load Combination at Service Condition	
DL + (LL+I)	2402.76

I = 100*(15.24 / L + 38) = 22 %

TABLE C: STRESSES AT NEAR MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D-1.86M; L=22.04M)

Prestressing Force, P = 4937.18 kN (Data from As-built Plans)

Eccentricity:

For Basic Section = 0.530 m

For Composite Section : 0.837 m (Superimposed Loads)

For Composite Section : 0.837 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = $0.60\, f_c'$ = -23.40 MPa

Allowable Stress in Tension = $0.50\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	2.83	T	-17.95	C
Sresses due to Superimposed Loads	0.19	T	-0.31	C
Sresses due to all Live Load + Impact	-1.80	C	2.90	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 14.70 -At top fiber

RF = 5.21 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V BRIDGE USING LOAD FACTOR

FOR EXTERIOR GIRDER (AT MIDSPAN OF SPAN 1)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type V	0.65613	0.21859	0.83694	0.76306
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.041	0.401	1.156	0.644
Live Load MS-18	1.041	0.401	1.156	0.644

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V (D=1.60m; L=19.30m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	832.00
Due to Weight of Girder + Slab + Diaphragm	1441.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	278.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	857.00
With Impact	1087.35
Load Combination at Service Condition	
DL + (LL+I)	2806.35

$I = 100*(15.24 / L + 38) =$ 27 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 2370.00 mm² $f'_c =$ 39 MPa $f'_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00054 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f'_s \{1 - [(\gamma^* / \beta_1)(\rho^* f'_s / f'_c)]\}$

$f_{su}^* =$ 1838.2 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 61 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 8752.79 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL D = 1719.00 kN LL + I = 1087.35 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 2.76 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 4.61$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING LOAD FACTOR

FOR EXTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.707	0.322	0.965	0.895
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.092	0.57	1.315	0.745
Live Load MS-18	1.092	0.570	1.315	0.745

TABLE B: MOMENT DEMAND FOR PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=30.5m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	414.00
Due to Weight of Girder + Slab + Diaphragm	712.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	202.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1543.00
With Impact	1913.32
Load Combination at Service Condition	
DL + (LL+I)	2115.32

$I = 100*(15.24 / L + 38) =$ 24 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm² $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c)]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 914.00 kN $LL + I =$ 1913.32 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 3.81 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 6.37$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING LOAD FACTOR

FOR EXTERIOR GIRDER (AT SUPPORT / PIER 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Top of Girder (m)	Y Bottom of Girder (m)
Basic Section				
PSCG Type IV	1.39	0.42219	0.86752	0.96148
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	3.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.775	0.724	0.882	1.178
Live Load MS-18	1.775	0.724	0.882	1.178

TABLE B: MOMENT DEMAND FOR PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=30.5m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3260.00
Due to Weight of Girder + Slab + Diaphragm	6034.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	997.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	2085.55
With Impact	2549.55
Load Combination at Service Condition	
DL + (LL+I)	3546.55

$I = 100*(15.24 / L + 38) =$ 22 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm² $f'_c =$ 39 MPa $f'_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f'_s \{1 - [(\gamma^* / \beta_1)(\rho^* f'_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 7031.00 kN $LL + I =$ 2549.55 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 1.42 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 2.38$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE IV BRIDGE USING LOAD FACTOR

FOR EXTERIOR GIRDER

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type VI Modified	0.707	0.322	0.965	0.864
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.092	0.57	1.315	0.745
Live Load MS-18	1.092	0.57	1.315	0.745

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI MODIFIED (D=1.86m; L=35.0m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	2645.00
Due to Weight of Girder + Slab + Diaphragm	4785.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	907.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1830.00
With Impact	2177.70
Load Combination at Service Condition	
DL + (LL+I)	7869.70

$I = 100*(15.24 / L + 38) =$ 19 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm^2 $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

Compression Block $= \dfrac{A_S^* f_{su}}{0.85 f'_C b} =$ 119.6 mm < t_{slab} = 200 mm -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL D = 5692.00 kN LL + I = 2177.70 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$RF = \dfrac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} =$ 2.04 $RF = \dfrac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} =$ 3.40

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE IV BRIDGE USING LOAD FACTOR

FOR INTERIOR AND EXTERIOR GIRDER

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type VI Modified	1.39	0.42219	0.8675942	0.96141
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.775	0.724	0.882	1.178
Live Load MS-18	1.775	0.724	0.882	1.178

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI MODIFIED (D=1.86m; L=35.0m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3256.00
Due to Weight of Girder + Slab + Diaphragm	6028.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	996.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1670.00
With Impact	1987.30
Load Combination at Service Condition	
DL + (LL+I)	9011.30

$I = 100*(15.24 / L + 38) =$ 19 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm^2 $f'_c =$ 39 MPa $f'_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f'_s \{1 - [(\gamma^* / \beta_1)(\rho^* f'_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 7024.00 kN $LL + I =$ 1987.30 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 1.83 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 3.05$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING LOAD FACTOR

FOR INTERIOR AND EXTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.707	0.322	0.965	0.864
Deck Slab	0.528	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=30.5m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	546.00
Due to Weight of Girder + Slab + Diaphragm	1041.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	132.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1008.00
With Impact	1249.92
Load Combination at Service Condition	
DL + (LL+I)	1381.92

$I = 100*(15.24 / L + 38) =$ 24 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm^2 $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 1173.00 kN $LL + I =$ 1249.92 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 5.71 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 9.54$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR GIRDER (AT MIDSPAN OF SPAN 1)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type V	0.65613	0.21859	0.83694	0.76306
Deck Slab	0.391	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	0.972	0.379	1.118	0.682
Live Load MS-18	0.972	0.379	1.118	0.682

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V (D=1.60m; L=19.30m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	682.00
Due to Weight of Girder + Slab + Diaphragm	1359.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	264.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	729.00
With Impact	924.94
Load Combination at Service Condition	
DL + (LL+I)	2547.94

I = 100*(15.24 / L + 38) = 27 %

TABLE C: STRESSES AT MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE IV (D-1.60M; L=36.20M)

Prestressing Force, P = 2471.25 kN (Data from As-built Plans; Drawing No. E-25)

Eccentricity:

For Basic Section = 0.737 m

For Composite Section : 1.018 m (Superimposed Loads)

For Composite Section : 1.018 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.5 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	-2.15	C	-5.54	C
Sresses due to Superimposed Loads	-0.48	C	0.78	T
Sresses due to all Live Load + Impact	-1.66	C	2.73	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 12.48 -At top fiber

RF = 2.89 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.707	0.322	0.965	0.895
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86m; L=30.50m)

DESCRIPTION	NEAR MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	410.00
Due to Weight of Girder + Slab + Diaphragm	664.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	188.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1189.00
With Impact	1453.53
Load Combination at Service Condition	
DL + (LL+I)	2305.53

I = 100*(15.24 / L + 38) = 22 %

TABLE C: STRESSES AT NEAR MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D-1.86M; L=30.5M)

Prestressing Force, P = 4320.04 kN (Data from As-built Plans)

Eccentricity:

For Basic Section = 0.530 m

For Composite Section : 0.837 m (Superimposed Loads)

For Composite Section : 0.837 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.50 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	-1.59	C	-10.98	C
Sresses due to Superimposed Loads	-0.27	C	0.44	T
Sresses due to all Live Load + Impact	-2.13	C	3.43	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 10.13 -At top fiber

RF = 3.98 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR GIRDER (AT SUPPORT / PIER 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Top of Girder (m)	Y Bottom of Girder (m)
Basic Section				
PSCG Type IV	1.39	0.42219	0.86752	0.96148
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.706	0.68	0.914	1.146
Live Load MS-18	1.706	0.680	0.914	1.146

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86m; L=30.50m)

DESCRIPTION	NEAR MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3206.50
Due to Weight of Girder + Slab + Diaphragm	5604.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	930.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1289.00
With Impact	1598.36
Load Combination at Service Condition	
DL + (LL+I)	8132.36

I = 100*(15.24 / L + 38) = 22 %

TABLE C: STRESSES AT NEAR MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D-1.86M; L=30.5M)

Prestressing Force, P = 5000.00 kN (Data from As-built Plans)

Eccentricity:

For Basic Section = 0.668 m

For Composite Section : 0.714 m (Superimposed Loads)

For Composite Section : 0.714 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.50 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	1.06	T	-8.76	C
Sresses due to Superimposed Loads	1.25	T	-1.57	C
Sresses due to all Live Load + Impact	2.15	T	-2.69	C

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 0.378 -At top fiber

RF = 4.854 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR GIRDER

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type VI	0.707	0.322	0.965	0.864
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=36.00m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	2645.00
Due to Weight of Girder + Slab + Diaphragm	4530.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	856.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1375.00
With Impact	1662.05
Load Combination at Service Condition	
DL + (LL+I)	7048.05

I = 100*(15.24 / L + 38) = 21 %

TABLE C: STRESSES AT MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86M; L=36.0M)

Prestressing Force, P = 5110.00 kN (Data from As-built Plans; Drawing No. E-25)

Eccentricity:

For Basic Section = 0.855 m

For Composite Section : 1.162 m (Superimposed Loads)

For Composite Section : 1.162 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.5 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	-7.66	C	-6.75	C
Sresses due to Superimposed Loads	-1.25	C	2.02	T
Sresses due to all Live Load + Impact	-2.43	C	3.92	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 5.96 -At top fiber

RF = 2.00 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR GIRDER (AT SUPPORT / PIER 3)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Top of Girder (m)	Y Bottom of Girder (m)
Basic Section				
PSCG Type VI	1.39	0.42219	0.86759	0.96141
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.706	0.68	0.914	1.146
Live Load MS-18	1.706	0.68	0.914	1.146

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=22.04m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3210.00
Due to Weight of Girder + Slab + Diaphragm	5610.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	931.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1256.00
With Impact	1574.81
Load Combination at Service Condition	
DL + (LL+I)	8115.81

I = 100*(15.24 / L + 38) = 25 %

TABLE C: STRESSES AT MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86M; L=22.04M)

Prestressing Force, P = 5000.00 kN (Data from As-built Plans; Drawing No. E-25)

Eccentricity:

For Basic Section = 0.668 m

For Composite Section : 0.714 m (Superimposed Loads)

For Composite Section : 0.714 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.5 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	1.07	T	-8.77	C
Sresses due to Superimposed Loads	1.25	T	-1.57	C
Sresses due to all Live Load + Impact	2.12	T	-2.65	C

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 0.378 -At Top fiber

RF = 4.921 -At Bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING ALLOWABLE STRESS

FOR INTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 4)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.70891	0.32105	0.96803	0.89197
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.86m; L=22.04m)

DESCRIPTION	NEAR MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	556.00
Due to Weight of Girder + Slab + Diaphragm	997.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	125.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	861.00
With Impact	1067.64
Load Combination at Service Condition	
DL + (LL+I)	2189.64

I = 100*(15.24 / L + 38) = 22 %

TABLE C: STRESSES AT NEAR MIDSPAN FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI (D-1.86M; L=22.04M)

Prestressing Force, P = 4937.18 kN (Data from As-built Plans)

Eccentricity:

For Basic Section = 0.533 m

For Composite Section : 0.837 m (Superimposed Loads)

For Composite Section : 0.837 m (Live Loads)

After Transfer:

f_c' = 39 MPa

Allowable Stress in Compression = 0.60 f_c' = -23.40 MPa

Allowable Stress in Tension = 0.50 $\sqrt{f_c'}$ = 3.12 MPa

LOAD DESCRIPTION	STRESSES (MPa)			
	Top Fiber		Bottom Fiber	
Sresses due Dead Loads (Girder+Slab+Diaphragm Weight+Prestressing)	3.12	T	-17.91	C
Sresses due to Superimposed Loads	0.18	T	-0.29	C
Sresses due to all Live Load + Impact	-1.56	C	2.52	T

$$RF = \frac{\text{Allowable Stress - (Stress due to Dead Loads + Stress due to Superimposed Loads)}}{\text{Stress due to Live Load + Impact}}$$

RF = 17.11 -At top fiber

RF = 5.98 -At bottom fiber

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V BRIDGE USING LOAD FACTOR

FOR INTERIOR GIRDER (AT MIDSPAN OF SPAN 1)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type V	0.65613	0.21859	0.83694	0.76306
Deck Slab	0.391	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	0.972	0.379	1.118	0.682
Live Load MS-18	0.972	0.379	1.118	0.682

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE V (D=1.60m; L=19.30m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	682.00
Due to Weight of Girder + Slab + Diaphragm	1359.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	264.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	729.00
With Impact	924.94
Load Combination at Service Condition	
DL + (LL+I)	2547.94

$I = 100*(15.24 / L + 38) =$ 27 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 2370.00 mm^2 $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00054 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1838.2 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 61 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 8752.79 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 1623.00 kN $LL + I =$ 924.94 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 3.31 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 5.52$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING LOAD FACTOR

FOR INTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.707	0.322	0.965	0.895
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=30.5m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	410.00
Due to Weight of Girder + Slab + Diaphragm	664.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	188.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1189.00
With Impact	1474.36
Load Combination at Service Condition	
DL + (LL+I)	1662.36

$I = 100*(15.24 / L + 38) =$ 24 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm² $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 852.00 kN $LL + I =$ 1474.36 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 4.97 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 8.30$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING LOAD FACTOR

FOR INTERIOR GIRDER (AT SUPPORT / PIER 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Top of Girder (m)	Y Bottom of Girder (m)
Basic Section				
PSCG Type IV	1.39	0.42219	0.86752	0.96148
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	3.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.706	0.68	0.914	1.146
Live Load MS-18	1.706	0.680	0.914	1.146

TABLE B: MOMENT DEMAND FOR PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=30.5m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3206.50
Due to Weight of Girder + Slab + Diaphragm	5604.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	930.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1289.00
With Impact	1575.78
Load Combination at Service Condition	
DL + (LL+I)	2505.78

$I = 100*(15.24 / L + 38) =$ 22 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm^2 $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 6534.00 kN $LL + I =$ 1575.78 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 2.49 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 4.16$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE IV BRIDGE USING LOAD FACTOR

FOR INTERIOR GIRDER

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type VI Modified	0.707	0.322	0.965	0.864
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI MODIFIED (D=1.86m; L=35.0m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	2645.00
Due to Weight of Girder + Slab + Diaphragm	4530.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	856.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1375.00
With Impact	1636.25
Load Combination at Service Condition	
DL + (LL+I)	7022.25

$I = 100*(15.24 / L + 38) =$ 19 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm² $f'_c =$ 39 MPa $f'_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f'_s \{1 - [(\gamma^* / \beta_1)(\rho^* f'_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 5386.00 kN $LL + I =$ 1636.25 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 2.82 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 4.71$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE IV BRIDGE USING LOAD FACTOR

FOR INTERIOR GIRDER

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type VI Modified	1.39	0.42219	0.8675942	0.96141
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.706	0.68	0.914	1.146
Live Load MS-18	1.706	0.68	0.914	1.146

TABLE B: MOMENT DEMAND FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI MODIFIED (D=1.86m; L=35.0m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	3210.00
Due to Weight of Girder + Slab + Diaphragm	5610.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	931.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	1256.00
With Impact	1494.64
Load Combination at Service Condition	
DL + (LL+I)	8035.64

$I = 100*(15.24 / L + 38) =$ 19 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm² $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL D = 6541.00 kN LL + I = 1494.64 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 2.63 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 4.38$$

EVALUATION FOR SIMPLY SUPPORTED PRESTRESSED CONCRETE GIRDER TYPE VI BRIDGE USING LOAD FACTOR

FOR INTERIOR GIRDER (AT NEAR MIDSPAN OF SPAN 2)

TABLE A: SECTION PROPERTIES

DESCRIPTION	Area (m^2)	Moment of Inertia (m^4)	Y Bottom of Girder (m)	Y Top of Girder (m)
Basic Section				
PSCG Type IV	0.70891	0.32105	0.96803	0.89197
Deck Slab	0.434	N/A	N/A	N/A
Diaphragm	2.07	N/A	N/A	N/A
Composite Section				
Suprimposed Loads	1.024	0.539	1.272	0.788
Live Load MS-18	1.024	0.539	1.272	0.788

TABLE B: MOMENT DEMAND FOR PRESTRESSED CONCRETE GIRDER TYPE VI (D=1.860m; L=30.5m)

DESCRIPTION	MIDSPAN
Dead Load Moment per Girder (kN-m)	
Basic Section	
Due to Weight of Girder	556.00
Due to Weight of Girder + Slab + Diaphragm	997.00
Composite Section	
Due to Weight of Superimposed Loads (railing, sidewalk, median and wearing surface)	125.00
MS-18 Live Load Moment per Girder (kN-m)	
Without Impact	861.00
With Impact	1067.64
Load Combination at Service Condition	
DL + (LL+I)	1192.64

$I = 100*(15.24 / L + 38) =$ 24 %

CALCULATION OF MOMENT CAPACITY AT MIDSPAN:

CONSIDERING PRESTRESSING STEEL ONLY:

$A_S^* =$ 4740.00 mm² $f'_c =$ 39 MPa $f_s =$ 1862.00 MPa $b =$ 2170.00 mm $d =$ 2040.00 mm

$\rho^* =$ 0.00107 $\gamma^* =$ 0.40 - for stress-relieved steel $\beta_1 =$ 0.80 - for f'c = 35.00 Mpa $\phi =$ 1.00

$f_{su}^* = f_s \{1 - [(\gamma^* / \beta_1)(\rho^* f_s / f'_c)]\}$

$f_{su}^* =$ 1814.41 MPa

$$\text{Compression Block} = \frac{A_S^* f_{su}}{0.85 f'_C b} = 119.6 \text{ mm} < t_{slab} = 200 \text{ mm}$$ -Consider rectangular section

$\phi M_n = \phi A_s^* f_{su}^* d [1 - (0.6 (\rho^* f_{su}^* / f'_c))]$

$\phi M_n =$ 17020.2 kN

LOAD RATING:

$\gamma_D =$ 1.30 $\gamma_L =$ 2.17 INVENTORY LEVEL $D =$ 1122.00 kN $LL + I =$ 1067.64 kN-m

$\gamma_L =$ 1.30 OPERATING LEVEL

$$RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 6.72 \qquad RF = \frac{\phi M_n - \gamma_D D}{\gamma_L (LL+I)} = 11.21$$

CALCULATION OF LOAD RATING - EXTERIOR AND INTERIOR GIRDER

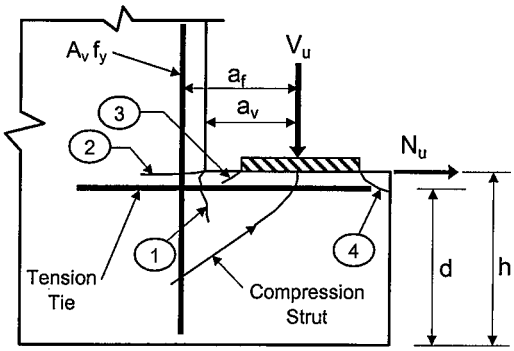
PROJECT TITLE: PASIG-MARIKINA RIVER BRIDGE INSPECTION
VARGAS BRIDGE UPSTREAM

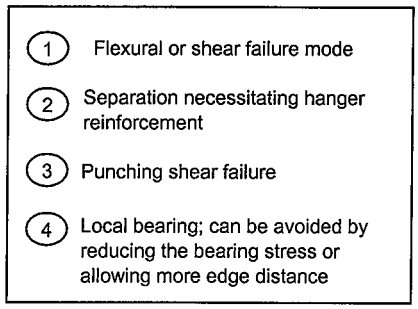
ITEM: LIVE LOAD RATING

BEAM LEDGE CAPACITY INVESTIGATION (LOAD RATING) FOR GERBER HINGE

1. BEAM LEADGE FAILURE MECHANISM

Beam ledges have to be designed for overall member actions and local failure modes as follows:



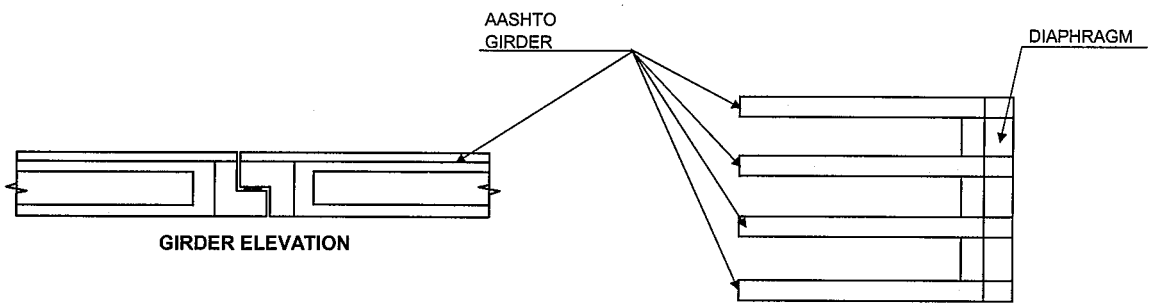


Failure Modes and Potential Cracks

Forces and actions acting on the ledge includes shear (Vu), horizontal tensile force (Nuc), and moment (Mu):

Vu = Factored Shear (Dead load + Live load + Impact)
Nuc ≥ 0.2Vu, but less than 1.0Vu
Mu = Vu (a_f) + Nu (h-d)
a_f = Flexural moment arm; distance from reaction centerline to centerline of hanger reinforcement
h - d = Moment arm for the horizontal load, Nuc

GERBER HINGE LAYOUT

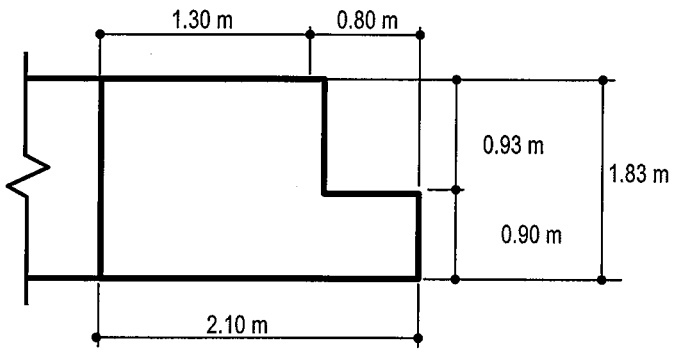


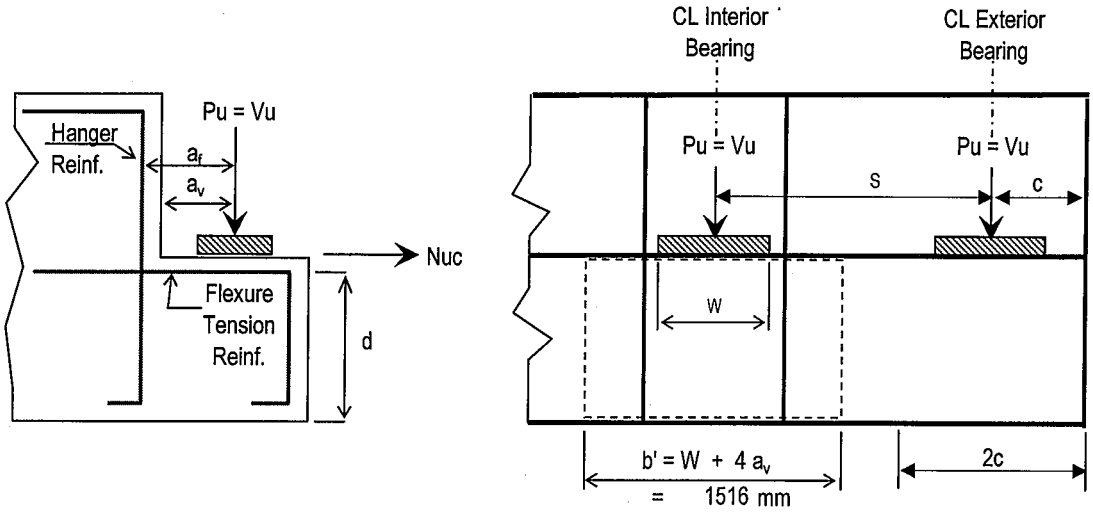
2. DIMENSION AND PROPERTIES OF LEDGE:

b = 2100 mm
D = 1830 mm
h = 900 mm

f'c = 39 Mpa
fys = 275 Mpa Reinforcing Steel
fyp = 1860 Mpa Prestressing Steel

concrete cover = 50 mm



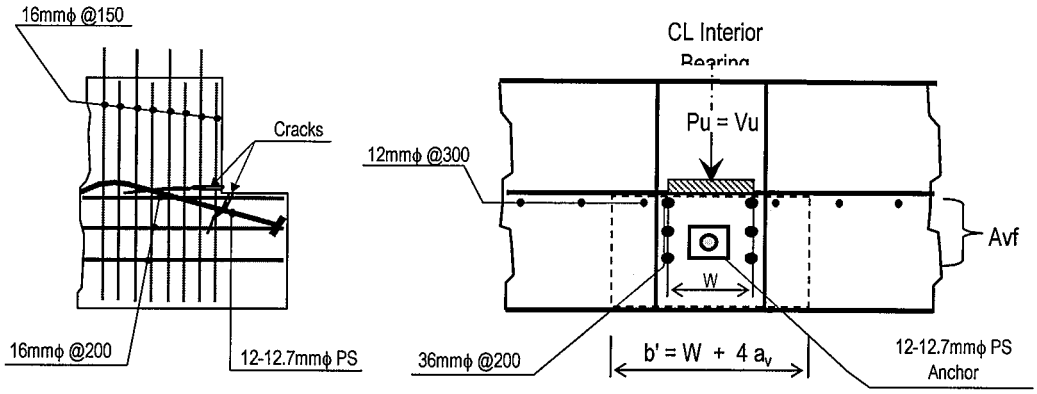


Bearing Pad Dimensions :

Width of bearing pad, W	=	500 mm	a_v	=	254	mm
Length of bearing pad, L	=	200 mm	a_f	=	304	mm
Width of Girder End Block	=	711 mm	d	=	850	mm
Girder Spacing, S	=	2170 mm (CL of bearing)	b	=	711	mm
Edge dist. of ext bearing,c	=	300 mm	b'	=	1516	mm

Bearing Edage Width:
2c = 600 mm

3. SHEAR FRICTION



Reinforcements Provided

Location	Bar Φ, mm	No. Pcs.	Area, mm^2
Interior	36	12.00	12214.5
Exterior	36	12.00	12214.5

Note: 10-ϕ36 diagonal bars are included (7-ϕ36 eq.)

μ = friction coefficient = 1.40
b' = W+4a_b = 1516 mm

Contribution of Prestressing Tendons:

Prestress, As (12-d12.7)	=	2369	mm^2
Equiv. Rebar, As'	=	14420	mm^2
Effective Area of PS	=	3465	mm^2 (2-tendons)

θ = 6.9 deg

Ledge Capacity Under Shear Friction:

For Interior Bearing:

a_v / d = 0.30 ≯ 1

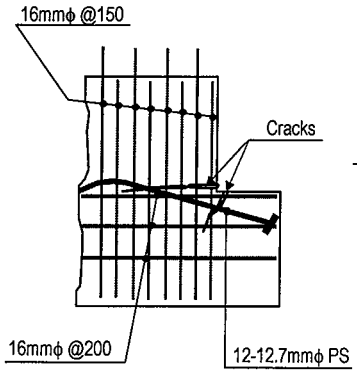
Vu ≯ ϕ (0.2f'c) (W+4a_v) (d)	=	8543	kN
Vu ≯ ϕμ A_{vf} fy	=	3997	kN
With Prestress, Vu	=	5131	kN

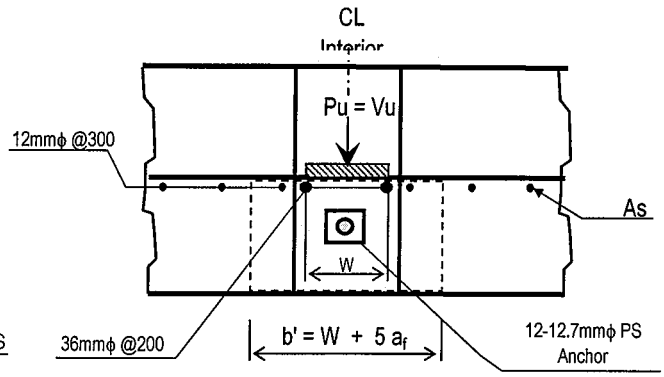
For Exterior Bearing:

a_v / d = 0.30 ≯ 1

Vu ≯ ϕ (0.2f'c) (K) (d)	=	3381	kN
Vu ≯ ϕμ A_{vf} fy	=	3997	kN
With Prestress, Vu	=	5131	kN
K = 2c	=	600	mm

4. FLEXURE





Reinforcements Provided

Location	Bar Φ, mm	No. Pcs.	Area, mm^2
Interior	36	12.00	12214.5
Exterior	36	12.00	12214.5

Note: 10-ϕ36 diagonal bars are included (5-ϕ36 eq.)

Prestressing :

Ap = 12-ϕ12.7mm = 2368.8 mm^2
Equiv. Rebar, As' 16022 mm^2
Effective Area of PS = 14173 mm^2
θ = 10.6 deg

$W + 5a_f$ = 2020 mm
2c = 600 mm

Ledge Capacity Under Flexure:

Reinforcing Bars Only

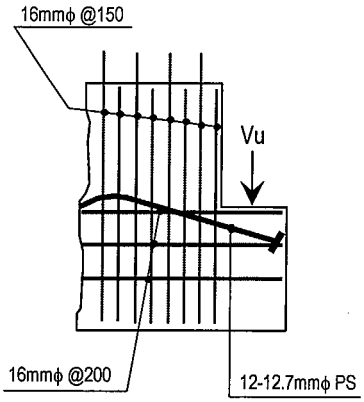
Strength:			
Vu ≤ ϕ Af fy jd /[af +0.2(h-d)]	Interiror	=	6183 kN
	Exterior	=	6183 kN

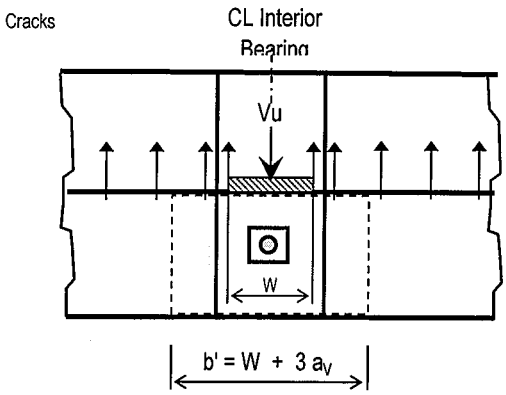
As ≥ $2(A_{vf})/3 + An$ = 8148 mm^2 < Asupplied, OK
As ≥ ρmin (W + 5af)(d) = 9740 mm^2 < Asupplied, OK
ρmin = 0.04(f'c/fy) = 0.0057

Reinforcing Bars Plus Prestressing Bars

Strength			
Vu ≤ ϕ Af fy jd /[af +0.2(h-d)]	Interiror	=	13358 kN
	Exterior	=	13358 kN

5. HANGER REINFORCEMENT





Reinforcements Provided

Location	Bar Φ, mm	No. Pcs.	Area, mm^2
Interior	16	29.00	5830.8
Exterior	16	29.00	5830.8

Note: 10-ϕ36 diagonal bars are included (25-ϕ16 eq.)

Contribution of Prestressing Tendons:

Prestress, As (12-d12.7) = 1184 mm^2
Equiv. Rebar, As' = 7210 mm^2
Effective Area of PS = 2652 mm^3
θ = 10.6 deg

Ledge Capacity Under Hanger Tension:

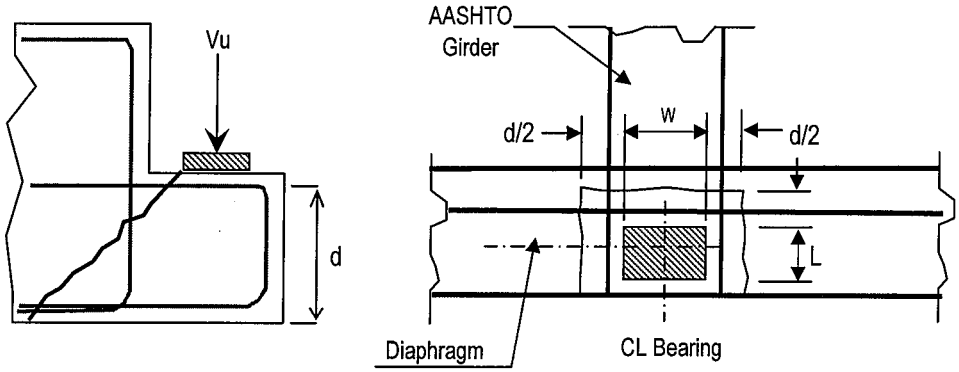
Reinforcing Bars Only

Strength	Vu = ϕ Av fy S / s	Interior	=	1363 kN
		Exterior	=	1363 kN
Serviceability		Interior	=	802 kN
V = Av (0.5 fy) (W+3a) / s		Exterior	=	802 kN

Reinforcing Bars Plus Prestressing Bars

Strength	Vu = ϕ Av fy S / s	Interior	=	1983 kN
		Exterior	=	1983 kN
Serviceability		Interior	=	1166 kN
V = Av (0.5 fy) (W+3a) / s		Exterior	=	1166 kN

6. PUNCHING SHEAR



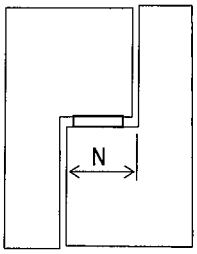
Allow. Tensile Strength for Puching = $0.33\sqrt{f'c}$ = 2.06 MPa

Ledge Capacity Under Punching Shear:

Interior Bearing: $Vu \leq \phi\ (0.33\sqrt{f'c})(W+2L'+2d)(d)$ = 3311 kN

Exterior Bearing: $Vu \leq \phi\ (0.33\sqrt{f'c})(W+L'+d)(d)$ = 1962 kN

7. AVAILABLE SEAT WIDTH



From AASHTO 7.3.1 DIVISION 1A

$N = (305 + 2.5L + 10H) (1 + 0.000125S^2)$

L = length in meters of the bridge deck to the adjacent expansion joint

S = angle of skew of support in degrees measured from a line normal to the span.

H = is the column or pier average height in meters

Seat width provided at gerber hinge = 800 mm

L = 37.5 m (Total length of deck from expansion joint to the of the expansion)

S = 0 degrees

H = 5.3 m (Average Height of Column at Main Bridge)

$N = (305 + 2.5L + 10H) (1 + 0.000125S^2)$

N = 451.75 mm **OK, Seat Width Sufficient**

8. SUMMARY OF CAPACITY

Demand / Reaction:

Dead Load	=	694.0	kN	658.0 kN
Live Load	=	255.0	kN	231.8 kN

Load Factors (Service)			Load Factors		
γ_D Dead Load	=	1.00	γ_D Dead Load	=	1.30
γ_L Inventory	=	1.00	γ_L Inventory	=	2.17
γ_L Operating	=	1.00	γ_L Operating	=	1.30

Calculated Capacity (Load Factor)

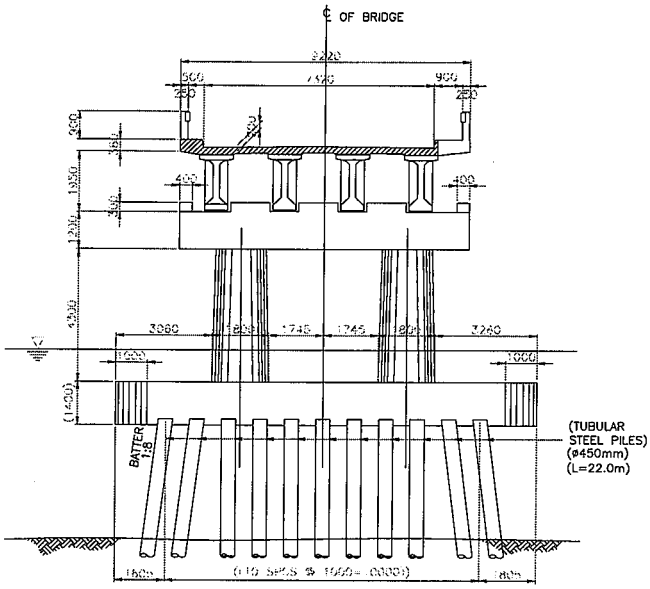
Girder Location	Shear Friction		Flexure		Hanger		Punching Shear
	Rebar	W/ PS	Rebar	W/ PS	Rebar	W/ PS	
Interior	3997	5131	6183	13358	1363	1983	3311
Exterior	3997	5131	6183	13358	1363	1983	1962

Load Rating:

By Load Factor Method:

Girder Location	Considering Reinforcing Bars Only				Reinforcing Bars Plus Prestress			
	Inventory		Operating		Inventory		Operating	
	RF	LL_{EQUIV} (HS20)	RF	LL_{EQUIV} (HS20)	RF	LL_{EQUIV} (HS20)	RF	LL_{EQUIV} (HS20)
Interior	**1.01**	**33.0 tons**	**1.68**	**55.1 tons**	**2.24**	**73.3 tons**	**3.74**	**122.4 tons**
Exterior	**0.83**	**27.2 tons**	**1.39**	**45.5 tons**	**1.92**	**62.6 tons**	**3.20**	**104.5 tons**

CAPACITY/DEMAND RATIO FOR VARGAS BRIDGE



Seismic Design Condition :

Acceleration Coefficient, A	=	0.40	
Seismic Performance Category, SPC	=	D	
Importance Classification, IC (Essential Bridge)	=	I	
Site Coefficient (Soil Profile Type II)	=	1.20	

At Top of Column (ϕ1.50m)

Particular		Longitudinal Direction	Transverse Direction	Unit
Elastic Design Forces	P_{max}	5,193.04	6,577.64	kN
	P_{min}	1,531.46	146.86	kN
	M_{DESIGN}	3,952.44	3,086.73	kN•m
	V_{DESIGN}	3,541.63	3,340.22	kN
Plastic Forces	$M_{PLASTIC}$	8,624.20	9,367.41	kN•m
	$V_{PLASTIC}$	2,005.63	4,356.93	kN
Number of Rebars		36 - ϕ32mm		
Rebar Ratio		1.63%		
Flexural Capacity	$M_{CAPACITY}$	6,634.00	6,045.40	kN•m
C/D Ratio		1.68	1.96	

At Bottom of Column (ϕ2.00m)

Particular		Longitudinal Direction	Transverse Direction	Unit
Elastic Design Forces	P_{max}	5,429.56	6,816.25	kN
	P_{min}	1,763.32	376.63	kN
	M_{DESIGN}	5,374.23	3,713.89	kN•m
	V_{DESIGN}	3,584.50	3,391.43	kN
Plastic Forces	$M_{PLASTIC}$	20,035.60	23,899.46	kN•m
	$V_{PLASTIC}$	4,659.44	11,116.03	kN
Number of Rebars		72 - ϕ32mm		
Rebar Ratio		1.84%		
Flexural Capacity	$M_{CAPACITY}$	15,412.00	14,506.00	kN•m
C/D Ratio		2.87	3.91	

ANALYSIS OF CIRCULAR COLUMN (BOTTOM)

SEISMIC DESIGN CRITERIA

Acceleration Coefficient, A	=	0.40
Importance Classification, IC **(Essential Bridge)**	=	I (I or II)
Seismic Performance Category, SPC	=	D
Site Coefficient, S **(Soil Profile Type - II)**	=	1.20

ELASTIC SEISMIC FORCES

From STAAD-III Multi-Modal Dynamic Analysis

LOADING	AXIAL (kN)	LONGITUDINAL DIRECTION SHEAR (kN)	LONGITUDINAL DIRECTION MOMENT (kN•m)	TRANSVERSE DIRECTION SHEAR (kN)	TRANSVERSE DIRECTION MOMENT (kN•m)
DEAD LOAD	3,596.44	0.00	1,901.47	13.83	21.79
LONG. EQ.	952.94	3,257.61	9,871.17	4.23	6.65
TRAN. EQ.	2,933.93	710.27	1,644.18	2,926.66	6,928.89

BOTTOM FORCES GOVERN

LOAD COMBINATION

Load Case 1 = 1.0 LONG. EQ. + 0.3 TRAN. EQ.
Load Case 2 = 0.3 LONG. EQ. + 1.0 TRAN. EQ.

LOAD COMBINATION	AXIAL (kN)	LONGITUDINAL DIRECTION SHEAR (kN)	LONGITUDINAL DIRECTION MOMENT (kN•m)	TRANSVERSE DIRECTION SHEAR (kN)	TRANSVERSE DIRECTION MOMENT (kN•m)
Load Case 1	1,833.12	3,470.69	10,364.42	882.23	2,085.32
Load Case 2	3,219.81	1,687.55	4,605.53	2,927.93	6,930.89

GROUP LOADING OF DESIGN FORCES

Group Load = 1.0 (D + B + SF + E + EQ)

LOAD COMBINATION	AXIAL Max (kN)	AXIAL Min (kN)	LONGITUDINAL DIRECTION SHEAR (kN)	LONGITUDINAL DIRECTION MOMENT (kN•m)	TRANSVERSE DIRECTION SHEAR (kN)	TRANSVERSE DIRECTION MOMENT (kN•m)
Load Case 1	5,429.56	1,763.32	3,470.69	12,265.89	896.06	2,107.11
Load Case 2	6,816.25	376.63	1,687.55	6,507.00	2,941.76	6,952.68

MODIFIED DESIGN FORCES

Group Load = 1.0 (D + EQ/R)
R = 3 (longitudinal direction)
R = 5 (transverse direction)

LOAD COMBINATION	AXIAL Max (kN)	AXIAL Min (kN)	LONGITUDINAL DIRECTION SHEAR (kN)	LONGITUDINAL DIRECTION MOMENT (kN•m)	TRANSVERSE DIRECTION SHEAR (kN)	TRANSVERSE DIRECTION MOMENT (kN•m)
Load Case 1	5,429.56	1,763.32	3,470.69	5,356.28	896.06	438.85
Load Case 2	6,816.25	376.63	1,687.55	3,436.65	2,941.76	1,407.97

... MODIFIED DESIGN MOMENT OF Load Case 1 GOVERNS !

ELASTIC DESIGN FORCES

M_{DESIGN}	=	5,374.23	kN•m
V_{DESIGN}	=	3,584.50	kN
$P_{max\ DESIGN}$	=	5,429.56	kN
$P_{min\ DESIGN}$	=	1,763.32	kN

DESIGN OF CIRCULAR COLUMN MAIN REINFORCEMENT BARS

MATERIAL SPECIFICATIONS

A) Concrete

Compressive Strength of Concrete, f'_c = 21.00 MPa

Modulus of Elasticity, $E_c = 4730\ sqrt(f'_c)$ = 21,675.58 MPa

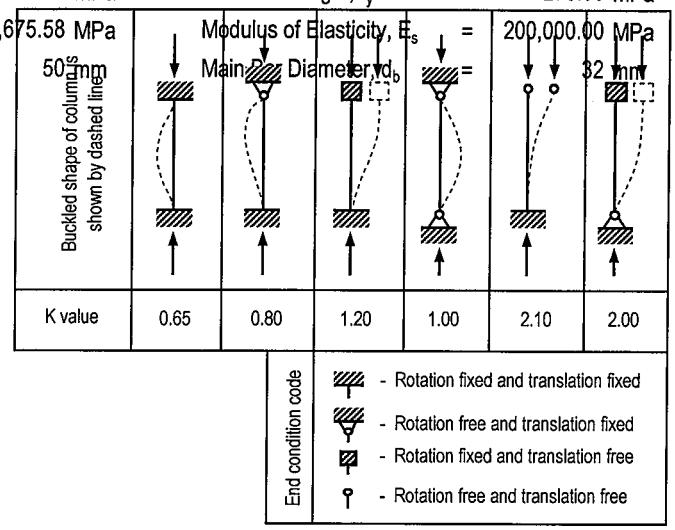
Concrete Cover, cc = 50 mm

B) Reinforcing Steel

Tensile Strength, f_y = 276.00 MPa

Modulus of Elasticity, E_s = 200,000.00 MPa

Main Bar Diameter, d_b = 32 mm



COLUMN PROPERTIES

Diameter, D	=	2.00 m
Unsupported Length, L_u	=	5.05 m
Clear Height, H	=	4.30 m
Gross Area, $A_g = \pi D^2/4$	=	3.14 m^2
Core Area, $A_c = \pi D_c^2/4$	=	2.84 m^2
Moment of Inertia, $I_g = \pi D^4/64$	=	0.79 m^4
Radius of Gyration, $r = sqrt(I_g/A_g)$	=	0.50 m
Effective Length Factor, k	=	2.10

SLENDERNESS EFFECT

a) $22.00 < kL_u / r < 100.00$

$22.00 > 21.21 < 100.00$ ... neglect slenderness effect

b) $L_u / r < 35 / sqrt[P_u / (f'_c A_g)]$

$10.10 < 122.00$

MOMENT MAGNIFICATION

Maximum Dead Load Moment, M_{DL}	=	1,901.59 kN•m
Maximum Total Load Moment, M_{max}	=	5,374.23 kN•m
Ratio $\beta_d = M_{DL} / M_{max}$	=	0.35
Flexural Stiffnes of Column, $EI = (E_c I_g/2.5)/(1+\beta_d)$	=	5,029.84 MN•m²
Factored Axial Load, $P_u = P_{max}$	=	5,429.56 kN
Buckling Load, $P_c = \pi^2 EI / (kL_u)^2$	=	441,400.67 kN
Spiral as Lateral Reinforcement, ϕ	=	0.70
Moment Magnification Factor not braced against sidesway, $\delta_s = 1 / [1-(\Sigma P_u / \phi \Sigma P_c)]$	=	1.02 ≥ 1.00
Magnified Design Moment, $Mc = \delta_s M_{max}$	=	5,374.23 kN•m

MODIFIED STRENGTH REDUCTION FACTOR ϕ

Maximum Axial Stress, $\sigma_{Pmax} = P_{max} / A_c$	=	1,914.99 kPa
20% of Compressive Strength of Concrete, $0.20f'_c$	=	4,200.00 kPa
Approximate Balanced Axial Load, $\phi P_b = 0.20f'_c \cdot A_c$	=	11,908.21 kN
Modified Strength Reduction Factor, $\phi = 0.90 - 0.40\ [\sigma_{Pmax} / (0.20f'_c)] \geq 0.50$	=	0.718

MAGNIFIED ELASTIC DESIGN FORCES

M_{DESIGN}	=	5374.23	kN•m
$P_{max\ DESIGN}$	=	5429.56	kN
$P_{min\ DESIGN}$	=	1763.32	kN

**** DESIGN COLUMN USING PCACOL PROGRAM ...*

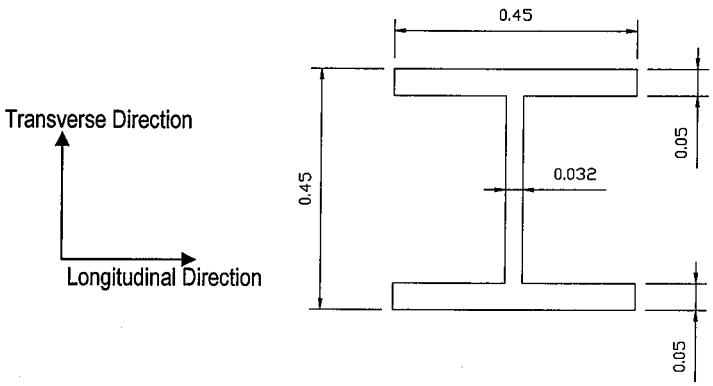
**** NOTE : 0.01 < A_s / A_g < 0.06*

ULTIMATE (Nominal) DESIGN FORCES FOR COLUMN

$M_{ULTIMATE}$	=	7488.96	kN•m
$P_{max\ ULTIMATE}$	=	7566.07	kN
$P_{min\ ULTIMATE}$	=	2457.18	kN

**** INVESTIGATE COLUMN PLASTIC CAPACITY FROM PCACOL INTERACTION DIAGRAM...*

INVESTIGATION OF DRIVEN STEEL PILES

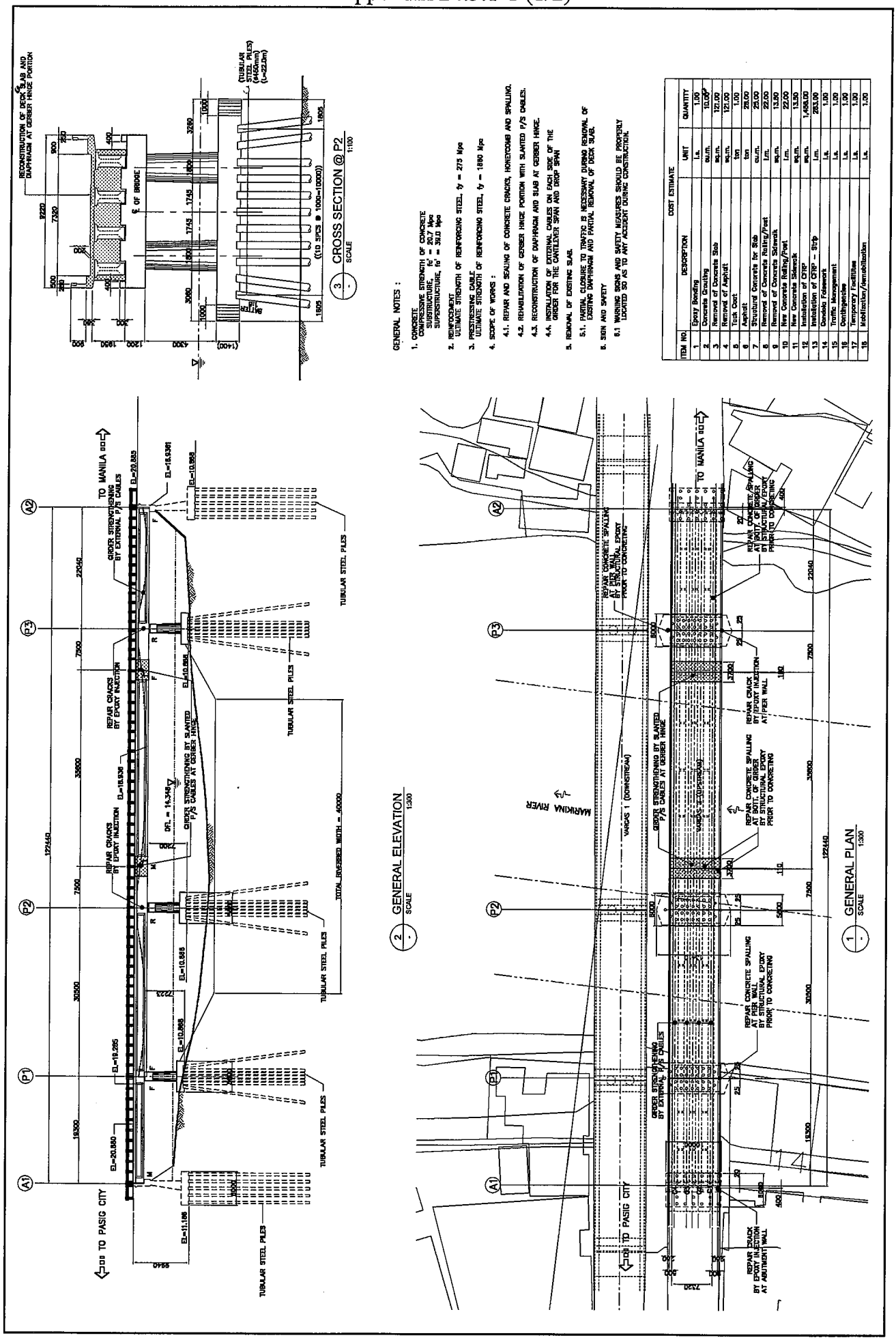


LONGITUDINAL DIRECTION

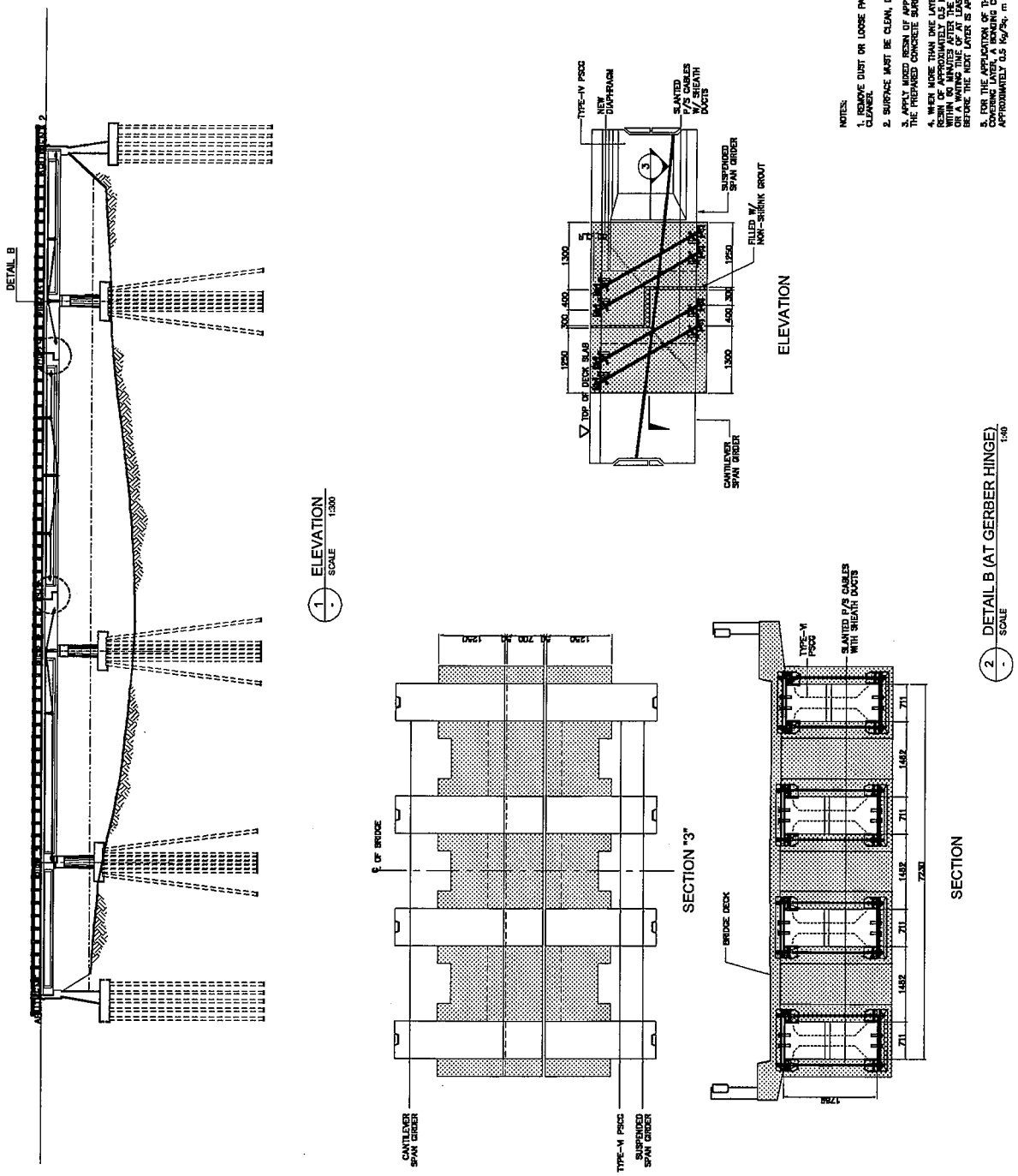
Area	=	0.0562	m^2
Moment of Inertia, I	=	0.0054	m^4
Distance from NA to edge, y_b	=	0.2250	m
Section Modulus, S	=	0.0240	m^3
Fy	=	248	MPa
Design Moment	=	323.00	kNm
Moment Capacity = 0.6•Fy•S	=	3571.20	kNm
C/D Ratio	=	**11.06**	

TRANSVERSE DIRECTION

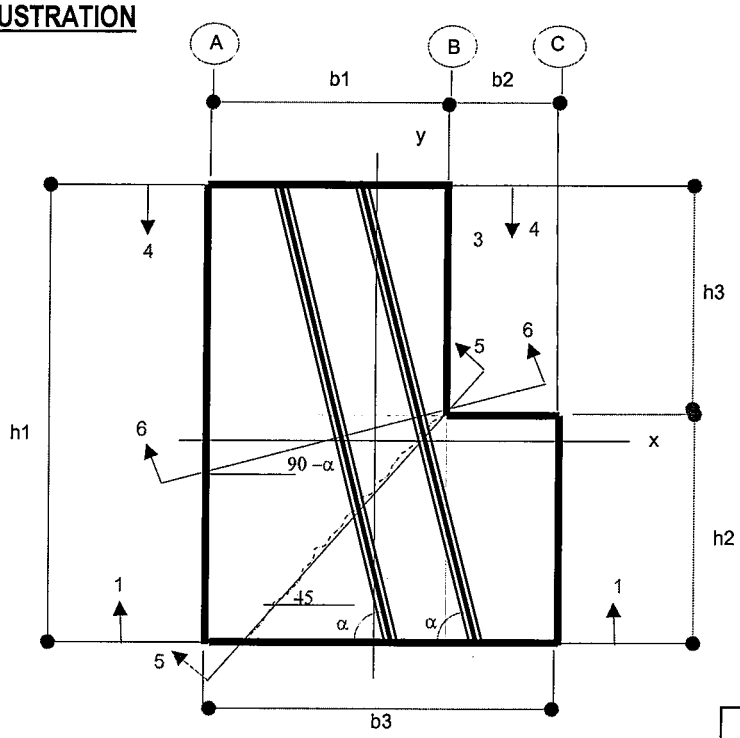
Area	=	0.0562	m^2
Moment of Inertia, I	=	0.0066	m^4
Distance from NA to edge, y_b	=	0.2250	m
Section Modulus, S	=	0.0293	m^3
Fy	=	248	MPa
Design Moment	=	706.00	kNm
Moment Capacity = 0.6•Fy•S	=	4364.80	kNm
C/D Ratio	=	**6.18**	



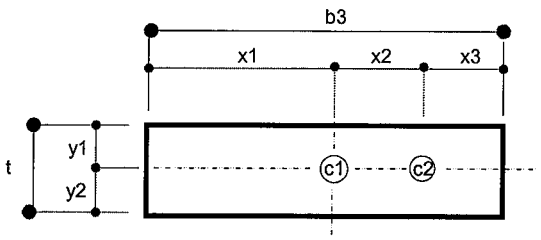
DRAWING DETAILS FOR REHABILITATION (VARGAS BRIDGE)


DETAIL B
1 ELEVATION
SCALE 1:300
TYPE-W PSCG
NEW DIAPHRAGM
SLANTED P/S CABLES W/ SHEATH DUCTS
SUSPENDED SPAN GIRDER
FILLED W/ NON-SHRINK GROUT
CANTILEVER SPAN GIRDER
ELEVATION
NOTES:
1. REMOVE DUST OR LOOSE PARTICLES USING INDUSTRIAL VACUUM CLEANER.
2. SURFACE MUST BE CLEAN, DRY AND FREE FROM GREASE AND OIL.
3. APPLY MIXED RESIN OF APPROXIMATELY 0.2 TO 1.2 Kg/Sq. m. TO THE PREPARED CONCRETE SURFACE USING A TROWEL OR BRUSH.
4. WHEN MORE THAN ONE LAYER OF FABRIC IS REQUIRED, APPLY RESIN OF APPROXIMATELY 0.5 Kg/Sq. m AND APPLY THE NEXT LAYER WITHIN 60 MINUTES AFTER THE APPLICATION OF THE PREVIOUS LAYER OR A WAITING TIME OF AT LEAST 12 HOURS MUST BE OBSERVED BEFORE THE NEXT LAYER IS APPLIED.
5. FOR THE APPLICATION OF THE CEMENT COATING AS THE FINAL COVERING LAYER, A BONDING COAT SHALL CONSIST OF RESIN APPROXIMATELY 0.5 Kg/Sq. m BROADCAST WITH QUARTZ SAND.
2 DETAIL B (AT GERBER HINGE)
SCALE 1:40
℄ OF BRIDGE
SECTION "3"
CANTILEVER SPAN GIRDER
TYPE-W PSCG
SUSPENDED SPAN GIRDER
TYPE-W PSCG
SLANTED P/S CABLES WITH SHEATH DUCTS
BRIDGE DECK
SECTION

ILLUSTRATION

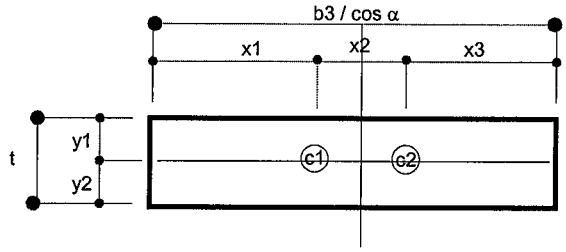


b1 =	1.25	m
b2 =	0.75	m
b3 =	2.00	m
h1 =	1.83	m
h2 =	0.90	m
h3 =	0.93	m
α =	60.00	deg



SECTION

Section	1	4	Unit
t =	0.300	0.300	m
y1 =	0.150	0.150	m
y2 =	0.150	0.150	m
x1 =	1.264	0.208	m
x2 =	0.400	0.400	m
x3 =	0.336	0.642	m
b3 or b1=	2.000	1.250	m



SECTION

Section	5	6	Unit
t =	0.300	0.300	m
y1 =	0.150	0.150	m
y2 =	0.150	0.150	m
x1 =	0.820	1.006	m
x2 =	0.359	0.346	m
x3 =	0.095	0.091	m
base, b =	1.274	1.443	m

SECTION PROPERTIES

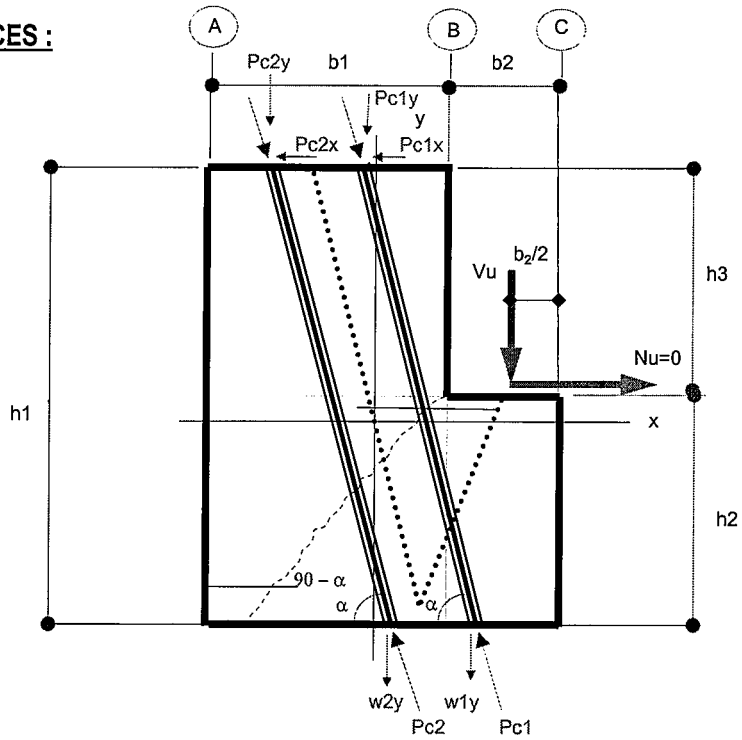
Section	1	5	6	4	Unit
Area, A	0.600	0.382	0.433	0.375	m^2
Dist. from N.A. to edge a, Xa =	1.000	0.637	0.722	0.625	m
Dist. from N.A. to edge c, Xc =	1.000	0.637	0.722	0.625	m
Moment of Inertia, I = t * b^3/12	0.200	0.052	0.075	0.049	m^4
Section modulus @ a, Sa	0.200	0.081	0.104	0.078	m^3
Section modulus @ c, S_c	0.200	0.081	0.104	0.078	m^3

MATERIAL SPECIFICATIONS

Compressive strength of concrete :

at time of initial prestress, f'ci	=	22.40	Mpa
at 28th day, f'_c	=	28.00	Mpa
Ultimate strength of HTS, f'_s	=	1860.00	Mpa
Elastic modulus of HTS, E_S	=	195000	Mpa
Nominal area of HTS, A_{ps}	=	383.90	mm²
Jacking stress, $0.70f'_s$	=	1302.00	Mpa
Number of HTS, N	=	1	pcs
.70Pu	=	499.84	kN
Total number of Prestressing steel =		4	pcs

FORCES :



Section	1	5	6	4	Unit
Shear reaction due to Dead Load, Wy =	738.38	738.38	738.38	738.38	kN
Shear reaction due to Live Load, Vll =	163.21	163.21	163.21	163.21	kN
Impact = (15.21 / 38.1 + L) =	0.21	0.21	0.21	0.21	
Wylocal = sin(90-α) * Wy due to DL	639.45	639.45	639.45	639.45	kN
Wxlocal = cos(90-α) * Wy due to DL	369.19	369.19	369.19	369.19	kN
Wylocal = sin(90-α) * Wy due to DL+LL+i	809.96	809.96	809.96	809.96	kN
Wxlocal = cos(90-α) * Wy due to DL+LL+i	467.63	467.63	467.63	467.63	kN
Effective 0.70Pu	432.87	499.84	499.84	432.87	kN

Assumption :

1) Shear,V are carried equally by the oblique prestress cables since spacing is not far apart.
2) Favorable effects of internal prestress tendon in the girders are neglected.
3) Horizontal force, Nu is neglected due to cable restrainer/or slab made continuous, preventing the horizontal force from developing.

ACTUAL ECCENTRICITY "e"

Section	1	5	6	4	No. of HTS
Distance of c.g. of C1 from edge c =	736 mm	454 mm	437 mm	1042 mm	1
Distance of c.g. of C2 from edge c =	336 mm	95 mm	91 mm	642 mm	1
Ya of strands	536 mm	275 mm	264 mm	842 mm	Total = 2
Eccentricity "e"	464 mm	363 mm	458 mm	-217 mm	

LOSSES

A) Friction and Anchorage Draw-In

Section	1	5	6	4	Unit
Loss due to friction and anchorage draw-in, FS	0.00	0.00	0.00	0.00	Mpa

Note :
-Live End device using SEE (Screw type).
-Tendon profile is straight.

B) Elastic Shortening, ES

$$ES = \frac{0.50E_s f_{cir}}{E_{ci}}$$

where :

f_{cir} = Concrete stress at the center of gravity of the prestressing steel due to prestressing force and dead load of beam immediately after transfer, in mpa.

Section	1	5	6	4	Unit
Eci, modulus of elasticity of concrete in mpa at transfer =	22386.45	22386.45	22386.45	22386.45	Mpa
Concrete stress, f_{cir}	2.37	5.16	5.09	3.14	Mpa
Loss due to elastic shortening, ES	10.34	22.46	22.19	13.69	Mpa

C) Concrete Shrinkage, SH

Mean annual ambient relative humidity in percent, RH = 80.00 %
Loss due to concrete shrinkage, SH = 0.80(117-1.03RH)
= 92.94 Mpa

D) Creep of Concrete, CR_C

$CR_C = 12f_{cir} - 7f_{cds}$

where : f_{cds} = Concrete stress at center of gravity of the prestressing steel due to all dead loads except the dead load present at the time the prestressing force is applied, in Mpa.

Section	1	2	6	4	Unit
Moment due to dead load (w/o beam weight)	0.00	0.00	0.00	0.00	kN-m
Concrete stress, f_{cds}	0.00	2.98	0.00	0.00	Mpa
Loss due to creep of concrete, CR_C	28.50	41.03	61.14	37.72	Mpa

E) Relaxation of Prestressing Steel, CR_S

$CR_S = 138 - 0.30FR - 0.40ES - 0.20(SH+CR_C)$ *... for stress relieved strands*

Section	1	5	6	4	Unit
Loss due to relaxation of prestressing steel, CR_S	109.57	102.22	98.31	106.39	Mpa

F) Effective Prestress at Initial and Final Condition

Section	1	5	6	4	Unit
Initial losses, FR + ES	10.34	22.46	22.19	13.69	Mpa
Effective prestress at initial condition	**1291.66**	**1279.54**	**1279.81**	**1288.31**	**Mpa**
Final losses, FR + ES + SH + CR_C + CR_S	241.36	258.66	181.63	157.80	Mpa
Effective prestress at final condition	**1060.64**	**1043.34**	**1120.37**	**1144.20**	**Mpa**

CHECK STRESSES

A) Only Prestress Force Acting.

Section	1	5	6	4	Unit
Number of strands, N	2	2	2	2	pcs.
Effective jacking force @ intial condition, Pj	858.87	982.43	982.64	856.64	kN
Eccentricity, e	0.464	0.363	0.458	-0.217	m
Stress at edge c, f c	3.42 C	6.96 C	6.59 C	-0.10 T	Mpa
Remarks	safe!	safe!	safe!	safe!	
Stress at edge a, f a	-0.56 T	-0.14 T	-2.05 T	4.66 C	Mpa
Remarks	safe!	safe!	carried by rebar	safe!	

Allowable stresses : Compression = $0.55f'_{ci}$ = 12.32 Mpa
Tension = 1.40 Mpa or $0.25(f'_{ci})^{1/2}$ = -1.18 Mpa

B) If All DL is Acting.

Section	1	5	6	4	Unit
Axial Force due to dead load	-369.19	-319.73	-319.73	-369.19	kN
Number of strands, N	2	2	2	2	pcs.
Effective jacking force, Pj	705.26	801.08	860.22	760.81	kN
Eccentricity, e	0.464	0.363	0.458	-0.217	m
Stress at edge c, f c	1.34 C	3.41 C	3.62 C	-0.04 T	Mpa
Remarks	safe!	safe!	safe!	safe!	
Stress at edge a, f a	-0.22 T	-0.89 T	-1.13 T	2.13 C	Mpa
Remarks	safe!	safe!	safe!	safe!	

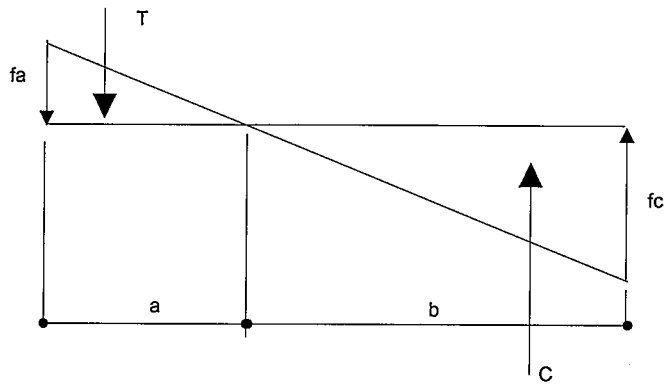
Allowable stresses : Compression = $0.40f'_c$ = 11.20 Mpa
Tension = $.50*(fc')^{.5}$ = -2.65 Mpa

C) Due to All Dead Load and Live Load Plus Impact (Service Condition)

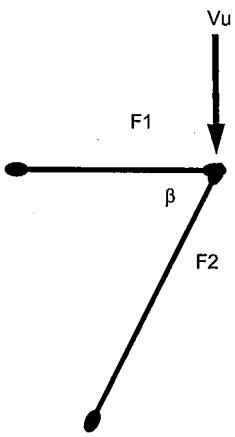
Section	1	5	6	4	Unit
Axial Force due to DL + LL+i	-450.79	-233.82	-233.82	-450.79	kN
Number of strands, N	2	2	2	2	pcs
Effective jacking force, Pj	705.26	801.08	860.22	760.81	kN
Eccentricity, e	0.464	0.363	0.458	-0.217	m
Stress at edge c, f c	1.014 C	4.018 C	4.200 C	-0.034 T	Mpa
Remarks	safe!	safe!	safe!	safe!	
Stress at edge a, f a	-0.17 T	-1.05 T	-1.31 T	1.69 C	Mpa
Remarks	safe!	safe!	safe!	safe!	

Allowable stresses : Compression = $0.40f'_c$ = 11.20 Mpa
Tension = $.50*(fc')^{.5}$ = -2.65 Mpa

Reinforcement Bars :



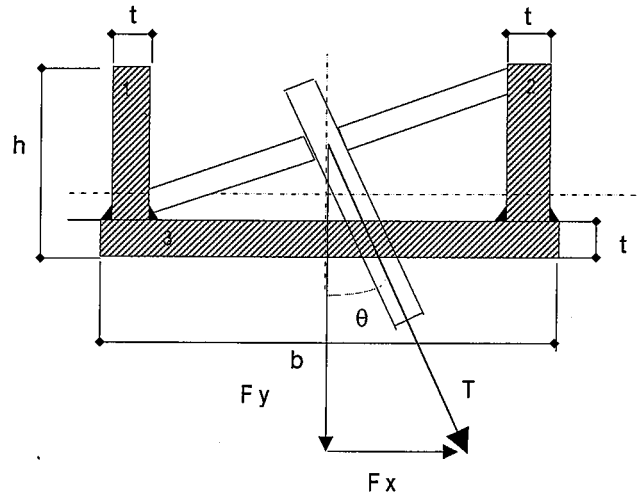
t = 0.30 m
a+b = 1.443 m
fa = 2.050 mpa
fc = 6.590 mpa
b = 1.101 m
a = 0.342 m
T = 105.3 kN
Fy = 414 mpa
As = T / .90 * Fy ;
As = 282.6 mm2
provide = 2 - 16 ; Ap = 402.1239 mm^2
cos (90 - α) * T = 130 kN O.K!



F_2 = Vu * sin β ; F_2 = 1346.124 kN
F_1 = Vu / tan β ; F_1 = 345.90 kN ; As = F1 / (.90 * Fy)
β = 76 deg Fy = 414 mpa
Vu = 1387.334 kN As = 928.3446 mm^2
provide = 1 - 36 ; Ap = 1017.876 mm^2

Dimension & Material Properties of steel channel anchorage::

Specified minimum yield stress of structural steel, Fy = 245 mpa



element	t (mm)	h (mm)	Area (mm2)	y (mm)	A*y (mm3)	Ix = bh3/3 (mm4)	A(Y-y)2 (mm4)
1	22	125	2750	62.5	171875	14322916.67	1236645.978
2	22	125	2750	62.5	171875	14322916.67	1236645.978
3	22	175	3850	11	42350	621133.3333	3533274.221
			9350		386100	29266966.67	6006566.176

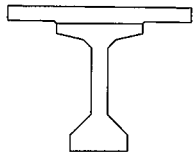
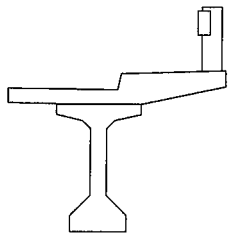
Y =	41.29	mm
Ix =	35273532.84	mm^4
Sx =	854202.36	mm^3

Check bending and shear stress :

F =	499.84	kN	
θ =	30	deg	
0.70Puy =	432.87	kN	
0.70Pux =	249.92	kN	
cantilever arm =	0	m	
moment =	0.00	kN-m	
.55Fy =	134.75	mpa	
fb = M/Sx =	0.00	mpa	OK!
Fv = .33Fy	80.85	mpa	
Fv = V / A	78.70	mpa	OK!

LOADINGS

Unit Weight of Concrete, γ = 24.00 kN/m³
Unit Weight of Wearing Surface, γ_{ws} = 22.00 kN/m³

	Interior Girder	Exterior Girder
		
DEAD LOAD		
GIRDER : Girder area = 0.700 m²	16.80 kN/m	16.80 kN/m
SLAB : Slab area = 0.443 m² (interior) = 0.676 m² (exterior)	10.63 kN/m	16.22 kN/m
TOTAL DEAD LOAD :	**27.43 kN/m**	**33.02 kN/m**
SUPERIMPOSED DEAD LOAD		
RAILING :	0.00 kN/m	1.84 kN/m
TOTAL SUPERIMPOSED DEAD LOAD :	**0.00 kN/m**	**1.84 kN/m**

EXTERNAL PRESTRESSING ANALYSIS (DROP BEAM)

DESIGN FORCES

Moment due to Girder Weight. M_G	2661.00
Moment due to Slab & Diaphragm, M_S	2570.00
Moment due to Superimposed Dead Load, M_{SDL}	291.00
Moment due to Live Load, M_{LL}	1245.00
Moment due to Live Load w/ Impact, M_{LL+I}	1502.80
Moment for Non-Composite Section, M_{NC}	5231.00
Moment for Composite Section, M_C	1793.80

Section Properties of Girder

Particular	Non-Composite	Composite
Area	0.700 m²	1.169 m²
Top Section Modulus, S_t	0.337 m³	0.825 m³
Bottom Section Modulus, S_b	0.330 m³	0.511 m³

Pier-to-pier Distance, L = 35.600 m

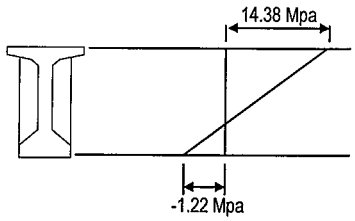
Impact Factor, IF = 15.24/(L+38) = 1.207

STRESSES AT PRESENT CONDITION USING EFFECTIVE PRESTRESSING FORCE FROM CONSTRUCTION DRAWING

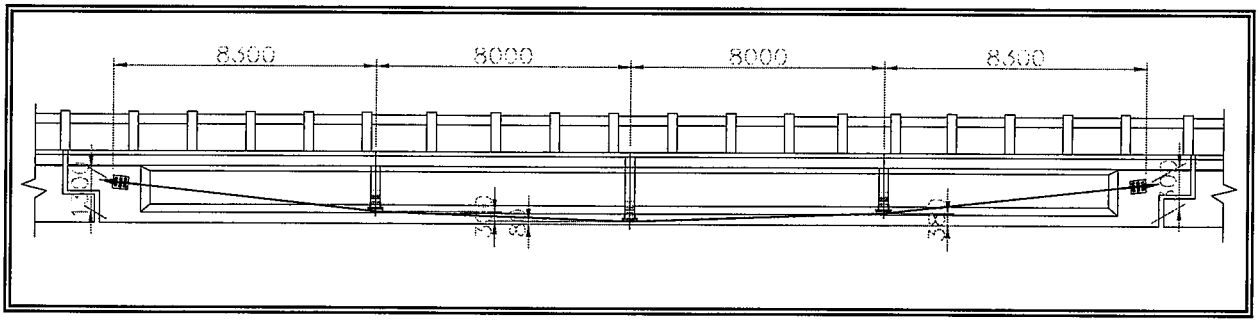
Stress at Top of Girder		
Due to Prestress, (+) P_f/A	7.30	Mpa
Due to Prestress w/ Eccentricity, (-) P_fe/S_t	-10.61	Mpa
Due to Girder and Slab Moment, (+) M_{NC}/S_t	15.52	Mpa
Due to SDL and Live Load Moment, (+) M_C/S_t	2.17	Mpa
Total Stress at Top of Girder, f_{top}	14.38	Mpa
Allowable $f_{bot} = 0.40 \cdot f'_c$ *(compression)*	15.60	Mpa
Remarks	within allowable	
Stress at Bottom of Girder		
Due to Prestress, (+) P_f/A	7.30	Mpa
Due to Prestress w/ Eccentricity, (+) P_fe/S_b	10.84	Mpa
Due to Girder and Slab Moment, (-) M_{NC}/S_b	-15.85	Mpa
Due to SDL and Live Load Moment, (-) M_C/S_b	-3.51	Mpa
Total Stress at Bottom of Girder, f_{bot}	-1.22	Mpa
Allowable f_{top} *(tension)*	0.00	Mpa
Remarks	exceeds allowable	

GIVEN DATA : ***(based on available drawing)***

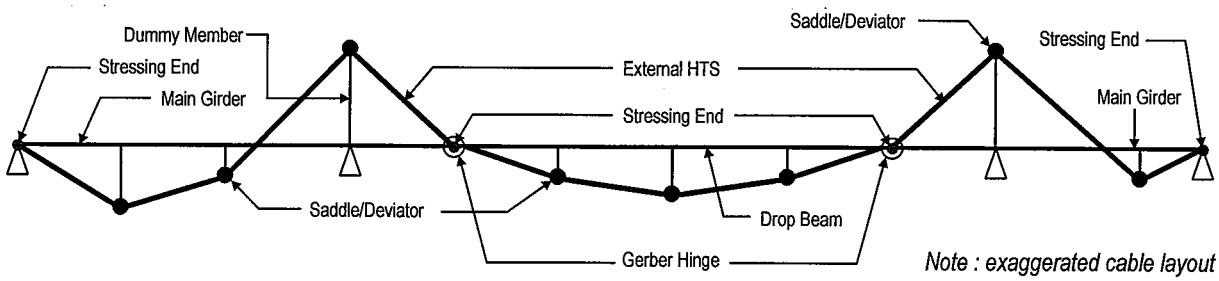
Assumed Number of HTS	=	48 pcs
Tensile Strength of HTS, f_{pu}	=	1862.00 Mpa
Effective Prestress at Section	=	1078.61 Mpa
		(58% of f_{pu})
Net Effective Prestressing Force, P_f	=	5110.00 kN
Concrete Strength at Service, f'_c	=	39.00 Mpa
Eccentricity of HTS, e	=	0.700 m
Exceeded Tensile Stress, $f_{ex} = f_{bot}$	=	**-1.22 Mpa**



CABLE LAYOUT



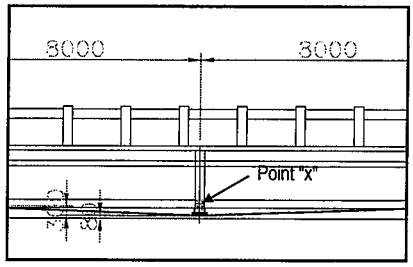
STAAD MODEL



Note : exaggerated cable layout

ANCHORAGE DRAW-IN AND FRICTION LOSS FOR EXTERNAL HTS

Assumed Jacking Stress at Anchorage = $0.75 \cdot f_{pu}$ = 1396.50 Mpa
Distance from Stressing End to Point of Consideration, x = 16.30 m
Wobble Friction Coefficient due to Tendon Curvatures, k = 0.00492 K/m
Coefficient of Friction, μ = 0.25
Angular deviation, α = 0.148 radians



Total Number of External 12.70mm HTS	6	8	10	12	14	pcs
Total Area of External HTS, P_j	592.20	789.60	987.00	1184.40	1381.80	mm²
Jacking Force at Anchorage, P_j	827.01	1102.68	1378.35	1654.01	1929.68	kN
Prestressing Force at Point "x", $P_x = e^{-(\mu\alpha+kx)}$	735.55	980.73	1225.92	1471.10	1716.28	kN
Prestressing Force Loss due to Draw-in, 4% of f_{pu}	33.08	44.11	55.13	66.16	77.19	kN
Eff. Prestressing Force at Point "x", $P_x - P_{Draw\text{-}in}$	**702.47**	**936.63**	**1170.78**	**1404.94**	**1639.09**	kN

Total Number of External 12.70mm HTS	16	18	20	22	24	pcs
Total Area of External HTS, P_j	1579.20	1776.60	1974.00	2171.40	2368.80	mm²
Jacking Force at Anchorage, P_j	2205.35	2481.02	2756.69	3032.36	3308.03	kN
Prestressing Force at Point "x", $P_x = e^{-(\mu\alpha+kx)}$	1961.46	2206.65	2451.83	2697.01	2942.20	kN
Prestressing Force Loss due to Draw-in, 4% of f_{pu}	88.21	99.24	110.27	121.29	132.32	kN
Eff. Prestressing Force at Point "x", $P_x - P_{Draw\text{-}in}$	**1873.25**	**2107.41**	**2341.56**	**2575.72**	**2809.88**	kN

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (No Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	702.47	488.00	-1.45	1.48	696.00	0.99	-0.45	2.47
8	936.63	649.00	-1.93	1.97	927.00	1.32	-0.60	3.29
10	1170.78	810.00	-2.40	2.45	1158.00	1.65	-0.75	4.11
12	1404.94	971.00	-2.88	2.94	1389.00	1.98	-0.90	4.93
14	1639.09	1132.00	-3.36	3.43	1620.00	2.31	-1.04	5.74
16	1873.25	1293.00	-3.84	3.92	1851.00	2.64	-1.19	6.56
18	2107.41	1454.00	-4.31	4.41	2082.00	2.97	-1.34	7.38
20	2341.56	1615.00	-4.79	4.89	2313.00	3.30	-1.49	8.20
22	2575.72	1776.00	-5.27	5.38	2544.00	3.63	-1.64	9.02
24	2809.88	1937.00	-5.75	5.87	2775.00	3.96	-1.78	9.83

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (5% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	667.35	463.00	-1.37	1.40	662.00	0.95	-0.43	2.35
8	889.79	617.00	-1.83	1.87	881.00	1.26	-0.57	3.13
10	1112.24	771.00	-2.29	2.34	1100.00	1.57	-0.72	3.91
12	1334.69	925.00	-2.74	2.80	1319.00	1.88	-0.86	4.69
14	1557.14	1079.00	-3.20	3.27	1538.00	2.20	-1.00	5.47
16	1779.59	1233.00	-3.66	3.74	1757.00	2.51	-1.15	6.25
18	2002.04	1387.00	-4.12	4.20	1976.00	2.82	-1.29	7.03
20	2224.49	1541.00	-4.57	4.67	2195.00	3.14	-1.44	7.81
22	2446.93	1695.00	-5.03	5.14	2414.00	3.45	-1.58	8.58
24	2669.38	1849.00	-5.49	5.60	2633.00	3.76	-1.73	9.36

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (10% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	600.61	417.00	-1.24	1.26	596.00	0.85	-0.39	2.12
8	800.81	555.00	-1.65	1.68	793.00	1.13	-0.51	2.81
10	1001.02	693.00	-2.06	2.10	990.00	1.41	-0.64	3.51
12	1201.22	831.00	-2.47	2.52	1187.00	1.70	-0.77	4.21
14	1401.43	969.00	-2.88	2.94	1384.00	1.98	-0.90	4.91
16	1601.63	1107.00	-3.28	3.35	1581.00	2.26	-1.03	5.61
18	1801.83	1245.00	-3.69	3.77	1778.00	2.54	-1.15	6.31
20	2002.04	1383.00	-4.10	4.19	1975.00	2.82	-1.28	7.01
22	2202.24	1521.00	-4.51	4.61	2172.00	3.10	-1.41	7.71
24	2402.44	1659.00	-4.92	5.03	2369.00	3.38	-1.54	8.41

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (15% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	510.52	355.00	-1.05	1.08	507.00	0.72	-0.33	1.80
8	680.69	472.00	-1.40	1.43	674.00	0.96	-0.44	2.39
10	850.87	589.00	-1.75	1.78	841.00	1.20	-0.55	2.99
12	1021.04	706.00	-2.09	2.14	1008.00	1.44	-0.65	3.58
14	1191.21	823.00	-2.44	2.49	1175.00	1.68	-0.76	4.17
16	1361.38	940.00	-2.79	2.85	1342.00	1.92	-0.87	4.77
18	1531.56	1057.00	-3.14	3.20	1509.00	2.16	-0.98	5.36
20	1701.73	1174.00	-3.48	3.56	1676.00	2.39	-1.09	5.95
22	1871.90	1291.00	-3.83	3.91	1843.00	2.63	-1.20	6.54
24	2042.08	1408.00	-4.18	4.27	2010.00	2.87	-1.31	7.14

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (20% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	408.42	283.00	-0.84	0.86	429.00	0.61	-0.23	1.47
8	544.55	378.00	-1.12	1.15	539.00	0.77	-0.35	1.92
10	680.69	473.00	-1.40	1.43	649.00	0.93	-0.48	2.36
12	816.83	568.00	-1.69	1.72	759.00	1.08	-0.60	2.81
14	952.97	663.00	-1.97	2.01	869.00	1.24	-0.73	3.25
16	1089.11	758.00	-2.25	2.30	979.00	1.40	-0.85	3.70
18	1225.25	853.00	-2.53	2.58	1089.00	1.56	-0.98	4.14
20	1361.38	948.00	-2.81	2.87	1199.00	1.71	-1.10	4.59
22	1497.52	1043.00	-3.09	3.16	1309.00	1.87	-1.22	5.03
24	1633.66	1138.00	-3.38	3.45	1419.00	2.03	-1.35	5.48

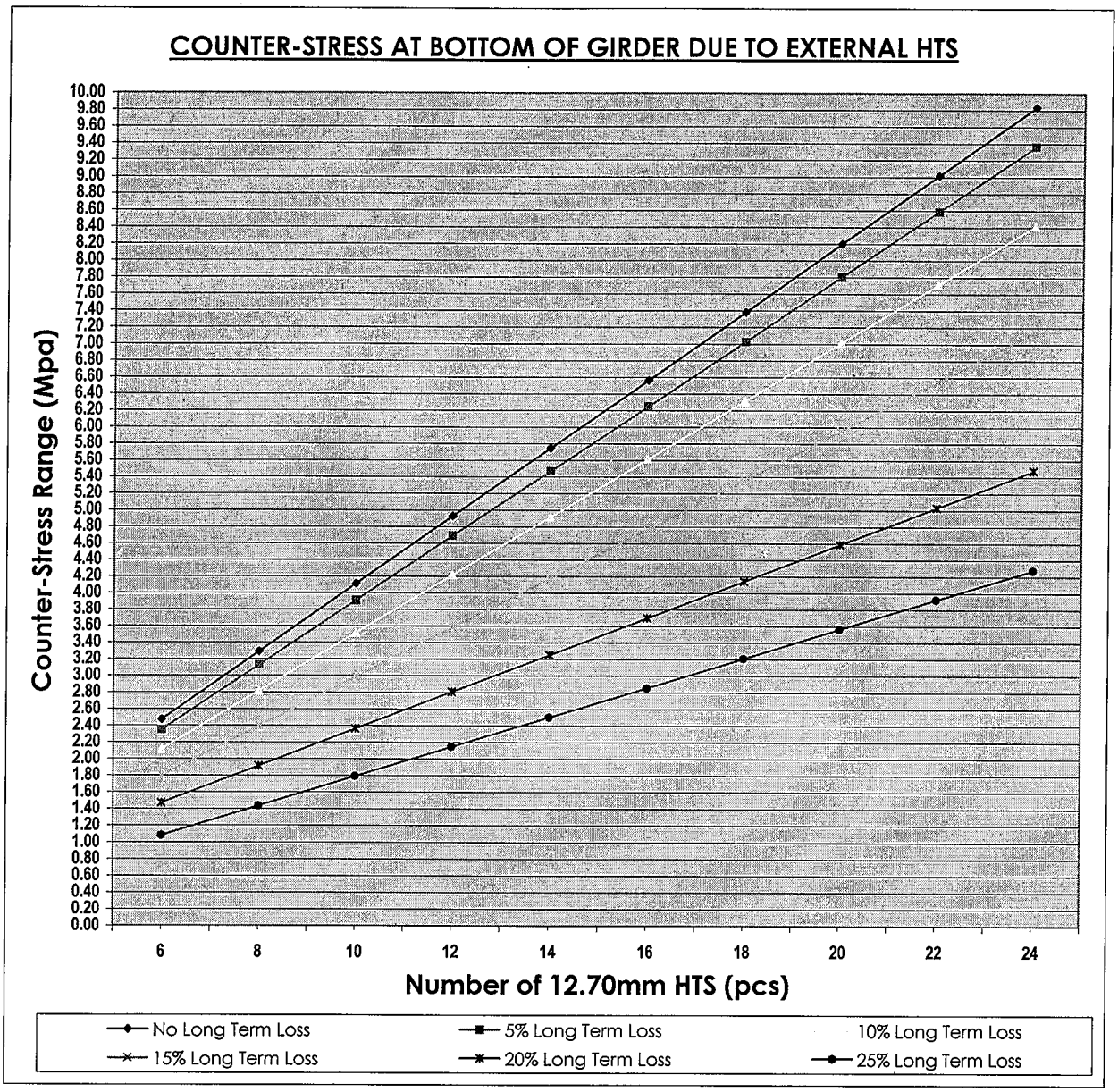
COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (25% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	306.31	213.00	-0.63	0.65	304.00	0.43	-0.20	1.08
8	408.42	283.00	-0.84	0.86	404.00	0.58	-0.26	1.43
10	510.52	353.00	-1.05	1.07	504.00	0.72	-0.33	1.79
12	612.62	423.00	-1.26	1.28	604.00	0.86	-0.39	2.14
14	714.73	493.00	-1.46	1.49	704.00	1.01	-0.46	2.50
16	816.83	563.00	-1.67	1.71	804.00	1.15	-0.52	2.85
18	918.93	633.00	-1.88	1.92	904.00	1.29	-0.59	3.21
20	1021.04	703.00	-2.09	2.13	1004.00	1.43	-0.65	3.56
22	1123.14	773.00	-2.29	2.34	1104.00	1.58	-0.72	3.92
24	1225.25	843.00	-2.50	2.55	1204.00	1.72	-0.78	4.27

SUMMARY OF COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS

Number of HTS	Girder Top Stresses due to External HTS					
	No Long Term Loss	5% Long Term Loss	10% Long Term Loss	15% Long Term Loss	20% Long Term Loss	25% Long Term Loss
6	-0.45	-0.43	-0.39	-0.33	-0.23	-0.20
8	-0.60	-0.57	-0.51	-0.44	-0.35	-0.26
10	-0.75	-0.72	-0.64	-0.55	-0.48	-0.33
12	-0.90	-0.86	-0.77	-0.65	-0.60	-0.39
14	-1.04	-1.00	-0.90	-0.76	-0.73	-0.46
16	-1.19	-1.15	-1.03	-0.87	-0.85	-0.52
18	-1.34	-1.29	-1.15	-0.98	-0.98	-0.59
20	-1.49	-1.44	-1.28	-1.09	-1.10	-0.65
22	-1.64	-1.58	-1.41	-1.20	-1.22	-0.72
24	-1.78	-1.73	-1.54	-1.31	-1.35	-0.78

Number of HTS	Girder Bottom Stresses due to External HTS					
	No Long Term Loss	5% Long Term Loss	10% Long Term Loss	15% Long Term Loss	20% Long Term Loss	25% Long Term Loss
6	2.47	2.35	2.12	1.80	1.47	1.08
8	3.29	3.13	2.81	2.39	1.92	1.43
10	4.11	3.91	3.51	2.99	2.36	1.79
12	4.93	4.69	4.21	3.58	2.81	2.14
14	5.74	5.47	4.91	4.17	3.25	2.50
16	6.56	6.25	5.61	4.77	3.70	2.85
18	7.38	7.03	6.31	5.36	4.14	3.21
20	8.20	7.81	7.01	5.95	4.59	3.56
22	9.02	8.58	7.71	6.54	5.03	3.92
24	9.83	9.36	8.41	7.14	5.48	4.27



Note : Losses Due to Anchorage Draw-in and Friction are Considered.

CONCLUSION

WITH FUTURE WEARING COURSE CONSIDERED :

Moment due to Future Wearing Course, M_{wc} = 279.00 kN•m

Top Stress due to Future Wearing Course, $f_{twc} = M_{wc}/S_t$ = 0.83 Mpa

Bottom Stress due to Future Wearing Course, $f_{bwc} = M_{wc}/S_t$ = -0.85 Mpa

A) Due to Existing Condition Using Effective Prestressing Force from Construction Drawing

Design Stresses (Mpa)		No. of HTS to be Provided / Corresponding Counter-Stresses											
		No Long Term Loss		5% Long Term Loss		10% Long Term Loss		15% Long Term Loss		20% Long Term Loss		25% Long Term Loss	
		6 HTS	Stress Result	6 HTS	Stress Result	6 HTS	Stress Result	8 HTS	Stress Result	10 HTS	Stress Result	12 HTS	Stress Result
Top	15.21	-0.45	**14.76**	-0.43	**14.78**	-0.39	**14.82**	-0.44	**14.77**	-0.48	**14.73**	-0.39	**14.82**
Bottom	-2.07	2.47	**0.40**	2.35	**0.28**	2.12	**0.05**	2.39	**0.32**	2.36	**0.29**	2.14	**0.07**

Note :

1) Negative (-) values denote tension.
2) Positive values denote compression.
3) Allowable Tensile Stress = 0
4) Allowable Compressive Stress = $0.40 \cdot f'_c$ = 15.60 Mpa

EXTERNAL PRESTRESSING ANALYSIS (SIDE SPAN)

DESIGN FORCES

Moment due to Girder Weight. M_G	2715.00
Moment due to Slab & Diaphragm, M_S	2622.00
Moment due to Superimposed Dead Load, M_{SDL}	297.00
Moment due to Live Load, M_{LL}	1118.00
Moment due to Live Load w/ Impact, M_{LL+I}	1328.35
Moment for Non-Composite Section, M_{NC}	5337.00
Moment for Composite Section, M_C	1625.35

Section Properties of Girder

Particular	Non-Composite	Composite
Area	1.353 m²	2.468 m²
Top Section Modulus, S_t	0.451 m³	0.852 m³
Bottom Section Modulus, S_b	0.420 m³	0.624 m³

Pier-to-pier Distance, L = 43.000 m

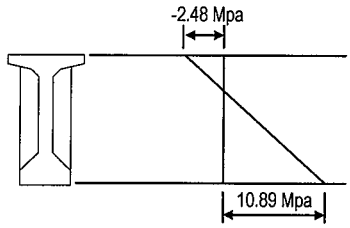
Impact Factor, IF = 15.24/(L+38) = 1.188

STRESSES AT PRESENT CONDITION USING EFFECTIVE PRESTRESSING FORCE FROM CONSTRUCTION DRAWING

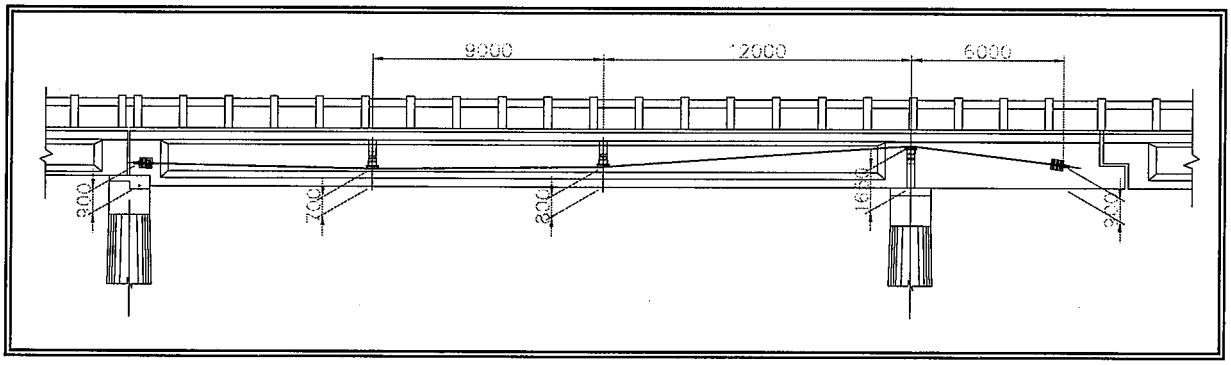
Stress at Top of Girder		
Due to Prestress, (+) P_f/A	3.70	Mpa
Due to Prestress w/ Eccentricity, (+) $P_f e/S_t$	7.56	Mpa
Due to Girder and Slab Moment, (-) M_{NC}/S_t	-11.83	Mpa
Due to SDL and Live Load Moment, (-) M_C/S_t	-1.91	Mpa
Total Stress at Top of Girder, f_{top}	-2.48	Mpa
Allowable f_{top} *(tension)*	0.00	Mpa
Remarks	within allowable	
Stress at Bottom of Girder		
Due to Prestress, (+) P_f/A	3.70	Mpa
Due to Prestress w/ Eccentricity, (-) $P_f e/S_b$	-8.11	Mpa
Due to Girder and Slab Moment, (+) M_{NC}/S_b	12.70	Mpa
Due to SDL and Live Load Moment, (+) M_C/S_b	2.60	Mpa
Total Stress at Bottom of Girder, f_{bot}	10.89	Mpa
Allowable $f_{bot} = 0.40 \cdot f'_c$ *(compression)*	15.60	Mpa
Remarks	within allowable	

GIVEN DATA : ***(based on available drawing)***

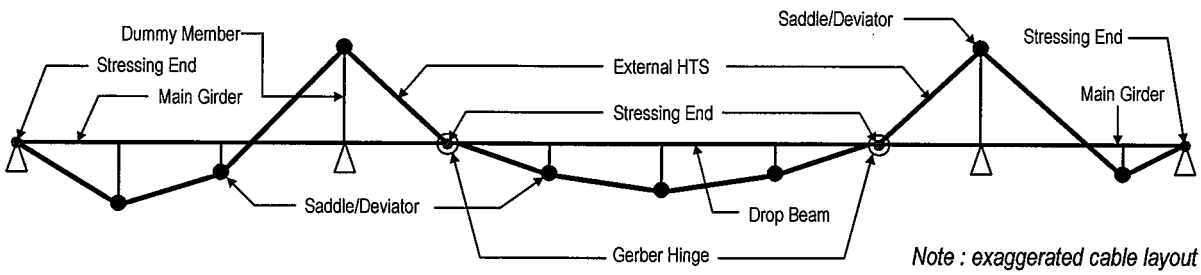
Assumed Number of HTS	=	48 pcs
Tensile Strength of HTS, f_{pu}	=	1862.00 Mpa
Effective Prestress at Section	=	1055.39 Mpa
		(57% of f_{pu})
Net Effective Prestressing Force, P_f	=	5000.00 kN
Concrete Strength at Service, f'_c	=	39.00 Mpa
Eccentricity of HTS, e	=	0.682 m
Exceeded Tensile Stress, $f_{ex} = f_{top}$	=	**-2.48 Mpa**



CABLE LAYOUT



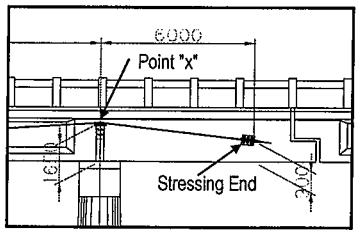
STAAD MODEL



Note : exaggerated cable layout

ANCHORAGE DRAW-IN AND FRICTION LOSS FOR EXTERNAL HTS

Assumed Jacking Stress at Anchorage = $0.75 \cdot f_{pu}$ = 1396.50 Mpa
Distance from Stressing End to Point of Consideration, x = 6.00 m
Wobble Friction Coefficient due to Tendon Curvatures, k = 0.00492 K/m
Coefficient of Friction, μ = 0.25
Angular deviation, α = 0.125 radians



Total Number of External 12.70mm HTS	6	8	10	12	14	pcs
Total Area of External HTS, P_j	592.20	789.60	987.00	1184.40	1381.80	mm²
Jacking Force at Anchorage, P_j	827.01	1102.68	1378.35	1654.01	1929.68	kN
Prestressing Force at Point "x", $P_x = e^{-(\mu\alpha+kx)}$	778.25	1037.66	1297.08	1556.49	1815.91	kN
Prestressing Force Loss due to Draw-in, 4% of f_{pu}	33.08	44.11	55.13	66.16	77.19	kN
Eff. Prestressing Force at Point "x", $P_x - P_{Draw\text{-}in}$	**745.17**	**993.56**	**1241.94**	**1490.33**	**1738.72**	kN

Total Number of External 12.70mm HTS	16	18	20	22	24	pcs
Total Area of External HTS, P_j	1579.20	1776.60	1974.00	2171.40	2368.80	mm²
Jacking Force at Anchorage, P_j	2205.35	2481.02	2756.69	3032.36	3308.03	kN
Prestressing Force at Point "x", $P_x = e^{-(\mu\alpha+kx)}$	2075.32	2334.74	2594.16	2853.57	3112.99	kN
Prestressing Force Loss due to Draw-in, 4% of f_{pu}	88.21	99.24	110.27	121.29	132.32	kN
Eff. Prestressing Force at Point "x", $P_x - P_{Draw\text{-}in}$	**1987.11**	**2235.50**	**2483.89**	**2732.28**	**2980.67**	kN

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (No Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	745.17	481.00	1.07	-1.14	738.00	0.55	1.61	-0.60
8	993.56	640.00	1.42	-1.52	984.00	0.73	2.15	-0.80
10	1241.94	798.00	1.77	-1.90	1228.00	0.91	2.68	-0.99
12	1490.33	958.00	2.12	-2.28	1473.00	1.09	3.21	-1.19
14	1738.72	1118.00	2.48	-2.66	1718.00	1.27	3.75	-1.39
16	1987.11	1278.00	2.83	-3.04	1963.00	1.45	4.28	-1.59
18	2235.50	1438.00	3.19	-3.42	2208.00	1.63	4.82	-1.79
20	2483.89	1598.00	3.54	-3.80	2453.00	1.81	5.35	-1.99
22	2732.28	1758.00	3.90	-4.18	2698.00	1.99	5.89	-2.19
24	2980.67	1918.00	4.25	-4.56	2943.00	2.18	6.43	-2.39

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (5% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	707.91	457.00	1.01	-1.09	701.00	0.52	1.53	-0.57
8	943.88	608.00	1.35	-1.45	934.00	0.69	2.04	-0.76
10	1179.85	759.00	1.68	-1.81	1166.00	0.86	2.54	-0.94
12	1415.82	910.00	2.02	-2.17	1398.00	1.03	3.05	-1.13
14	1651.79	1061.00	2.35	-2.52	1630.00	1.20	3.56	-1.32
16	1887.75	1212.00	2.69	-2.88	1862.00	1.38	4.06	-1.51
18	2123.72	1363.00	3.02	-3.24	2094.00	1.55	4.57	-1.70
20	2359.69	1514.00	3.36	-3.60	2326.00	1.72	5.07	-1.88
22	2595.66	1665.00	3.69	-3.96	2558.00	1.89	5.58	-2.07
24	2831.63	1816.00	4.02	-4.32	2790.00	2.06	6.09	-2.26

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (10% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	637.12	411.00	0.91	-0.98	631.00	0.47	1.38	-0.51
8	849.49	547.00	1.21	-1.30	840.00	0.62	1.83	-0.68
10	1061.86	683.00	1.51	-1.63	1050.00	0.78	2.29	-0.85
12	1274.23	819.00	1.81	-1.95	1260.00	0.93	2.75	-1.02
14	1486.61	955.00	2.12	-2.27	1470.00	1.09	3.20	-1.19
16	1698.98	1091.00	2.42	-2.60	1680.00	1.24	3.66	-1.35
18	1911.35	1227.00	2.72	-2.92	1890.00	1.40	4.12	-1.52
20	2123.72	1363.00	3.02	-3.24	2100.00	1.55	4.57	-1.69
22	2336.10	1499.00	3.32	-3.57	2310.00	1.71	5.03	-1.86
24	2548.47	1635.00	3.62	-3.89	2520.00	1.86	5.49	-2.03

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (15% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	541.55	350.00	0.78	-0.83	537.00	0.40	1.17	-0.44
8	722.07	465.00	1.03	-1.11	714.00	0.53	1.56	-0.58
10	902.58	580.00	1.29	-1.38	892.00	0.66	1.94	-0.72
12	1083.10	695.00	1.54	-1.65	1069.00	0.79	2.33	-0.86
14	1263.62	810.00	1.80	-1.93	1246.00	0.92	2.72	-1.01
16	1444.13	925.00	2.05	-2.20	1423.00	1.05	3.10	-1.15
18	1624.65	1040.00	2.30	-2.47	1600.00	1.18	3.49	-1.29
20	1805.17	1155.00	2.56	-2.75	1777.00	1.31	3.87	-1.43
22	1985.68	1270.00	2.81	-3.02	1954.00	1.44	4.26	-1.58
24	2166.20	1385.00	3.07	-3.30	2131.00	1.58	4.64	-1.72

COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (20% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	433.24	279.00	0.62	-0.66	429.00	0.32	0.94	-0.35
8	577.65	372.00	0.82	-0.89	572.00	0.42	1.25	-0.46
10	722.07	464.00	1.03	-1.10	714.00	0.53	1.56	-0.58
12	866.48	557.00	1.23	-1.33	857.00	0.63	1.87	-0.69
14	1010.89	650.00	1.44	-1.55	1000.00	0.74	2.18	-0.81
16	1155.31	743.00	1.65	-1.77	1143.00	0.84	2.49	-0.92
18	1299.72	836.00	1.85	-1.99	1286.00	0.95	2.80	-1.04
20	1444.13	929.00	2.06	-2.21	1429.00	1.06	3.11	-1.15
22	1588.55	1022.00	2.26	-2.43	1572.00	1.16	3.43	-1.27
24	1732.96	1115.00	2.47	-2.65	1715.00	1.27	3.74	-1.39

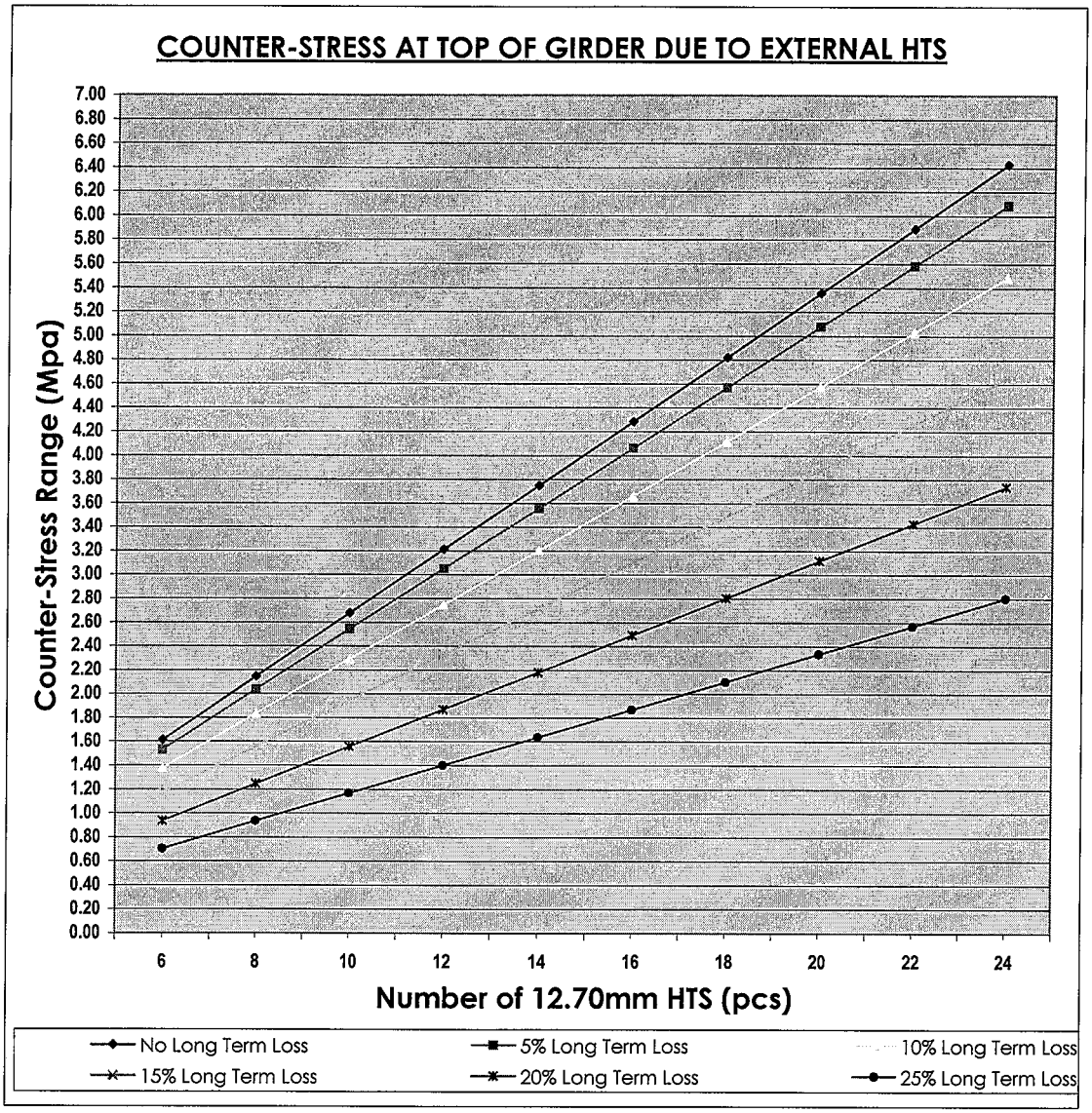
COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS (25% Long Term Loss Considered)

No. of HTS	Jacking Force at Stressing End (kN)	Moment due to External HTS (kN•m)	Top Stress due to Moment, M_{ps}/S_t (Mpa)	Bottom Stress due to Moment, M_{ps}/S_b (Mpa)	Axial due to External HTS (kN)	Top Stress due to Axial, P_{ps}/A (Mpa)	Total Top Stress due to External HTS, (Mpa)	Total Bottom Stress due to External HTS, (Mpa)
6	324.93	210.00	0.47	-0.50	322.00	0.24	0.70	-0.26
8	433.24	279.00	0.62	-0.66	428.00	0.32	0.93	-0.35
10	541.55	348.00	0.77	-0.83	536.00	0.40	1.17	-0.43
12	649.86	417.00	0.92	-0.99	645.00	0.48	1.40	-0.52
14	758.17	486.00	1.08	-1.16	754.00	0.56	1.63	-0.60
16	866.48	555.00	1.23	-1.32	863.00	0.64	1.87	-0.68
18	974.79	624.00	1.38	-1.48	972.00	0.72	2.10	-0.77
20	1083.10	693.00	1.54	-1.65	1081.00	0.80	2.33	-0.85
22	1191.41	762.00	1.69	-1.81	1190.00	0.88	2.57	-0.93
24	1299.72	831.00	1.84	-1.98	1299.00	0.96	2.80	-1.02

SUMMARY OF COUNTER-STRESS AT GIRDER DUE TO EXTERNAL HTS

Number of HTS	Girder Top Stresses due to External HTS					
	No Long Term Loss	5% Long Term Loss	10% Long Term Loss	15% Long Term Loss	20% Long Term Loss	25% Long Term Loss
6	1.61	1.53	1.38	1.17	0.94	0.70
8	2.15	2.04	1.83	1.56	1.25	0.93
10	2.68	2.54	2.29	1.94	1.56	1.17
12	3.21	3.05	2.75	2.33	1.87	1.40
14	3.75	3.56	3.20	2.72	2.18	1.63
16	4.28	4.06	3.66	3.10	2.49	1.87
18	4.82	4.57	4.12	3.49	2.80	2.10
20	5.35	5.07	4.57	3.87	3.11	2.33
22	5.89	5.58	5.03	4.26	3.43	2.57
24	6.43	6.09	5.49	4.64	3.74	2.80

Number of HTS	Girder Bottom Stresses due to External HTS					
	No Long Term Loss	5% Long Term Loss	10% Long Term Loss	15% Long Term Loss	20% Long Term Loss	25% Long Term Loss
6	-0.60	-0.57	-0.51	-0.44	-0.35	-0.26
8	-0.80	-0.76	-0.68	-0.58	-0.46	-0.35
10	-0.99	-0.94	-0.85	-0.72	-0.58	-0.43
12	-1.19	-1.13	-1.02	-0.86	-0.69	-0.52
14	-1.39	-1.32	-1.19	-1.01	-0.81	-0.60
16	-1.59	-1.51	-1.35	-1.15	-0.92	-0.68
18	-1.79	-1.70	-1.52	-1.29	-1.04	-0.77
20	-1.99	-1.88	-1.69	-1.43	-1.15	-0.85
22	-2.19	-2.07	-1.86	-1.58	-1.27	-0.93
24	-2.39	-2.26	-2.03	-1.72	-1.39	-1.02



Note : Losses Due to Anchorage Draw-in and Friction are Considered.

CONCLUSION

WITH FUTURE WEARING COURSE CONSIDERED :

Moment due to Future Wearing Course, M_{wc} = 284.00 kN•m

Top Stress due to Future Wearing Course, $f_{twc} = M_{wc}/S_t$ = -0.63 Mpa

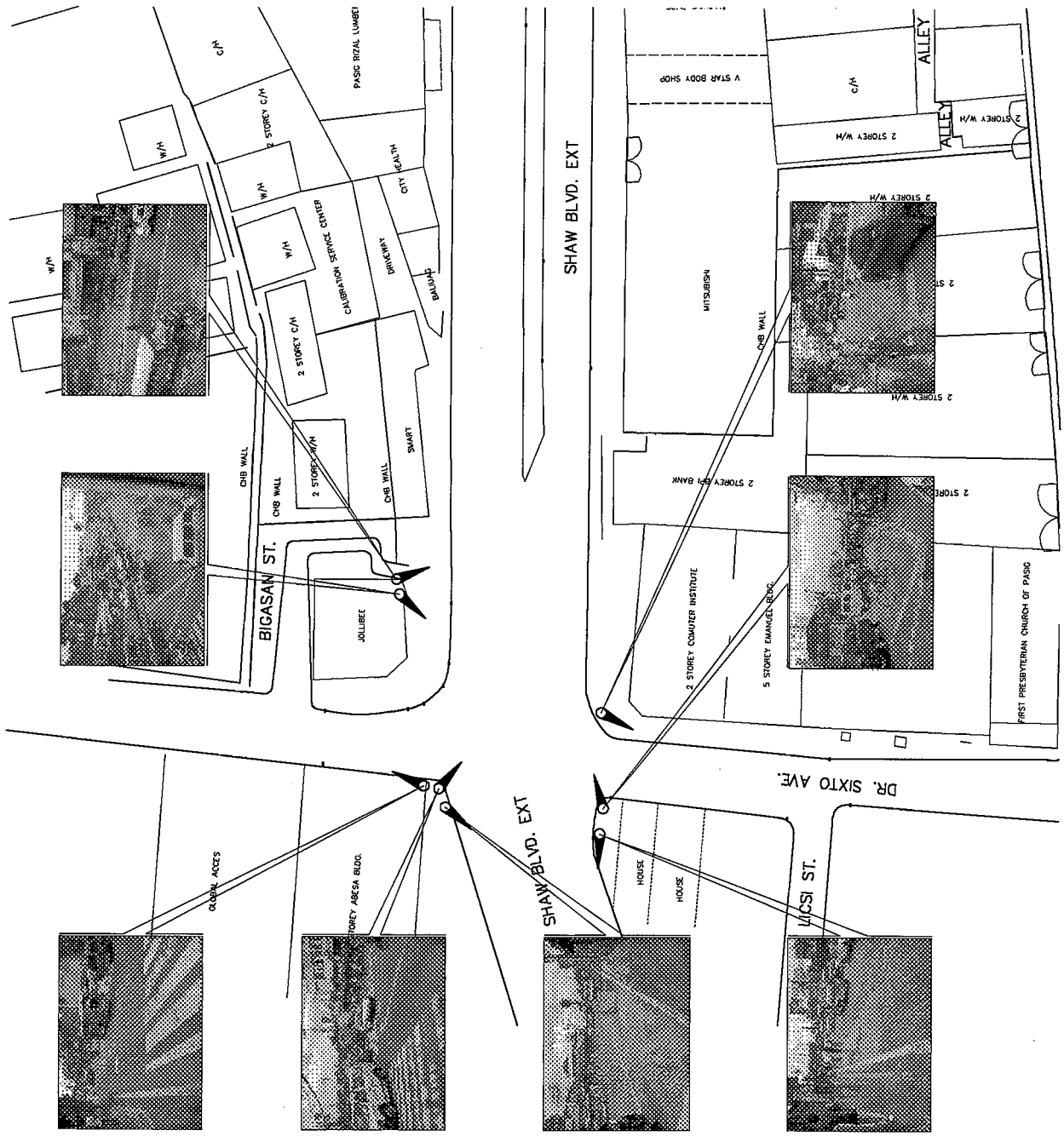
Bottom Stress due to Future Wearing Course, $f_{bwc} = M_{wc}/S_t$ = 0.68 Mpa

A) Due to Existing Condition Using Effective Prestressing Force from Construction Drawing

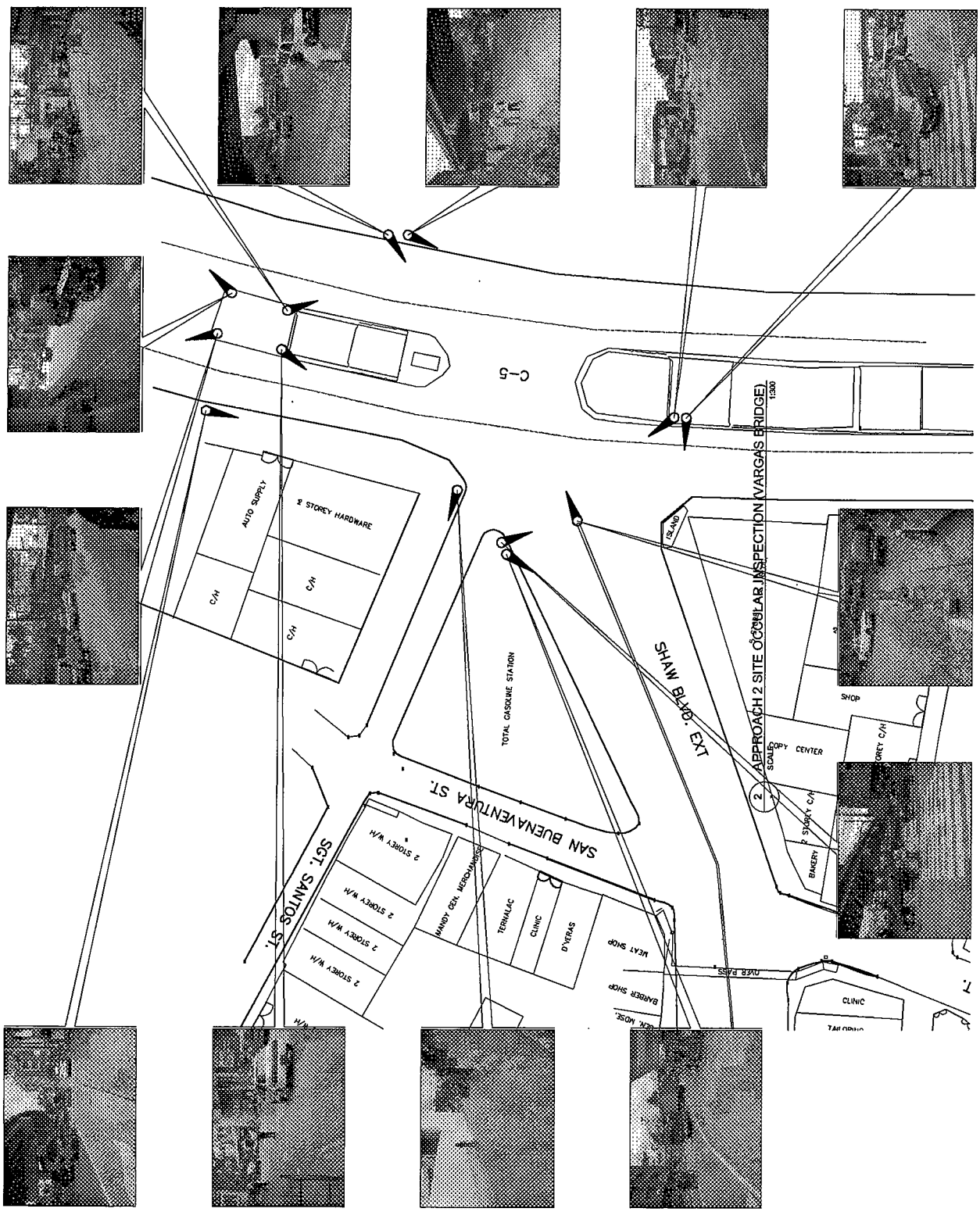
Design Stresses (Mpa)		No. of HTS to be Provided / Corresponding Counter-Stresses											
		No Long Term Loss		5% Long Term Loss		10% Long Term Loss		15% Long Term Loss		20% Long Term Loss		25% Long Term Loss	
		12 HTS	Stress Result	14 HTS	Stress Result	14 HTS	Stress Result	18 HTS	Stress Result	20 HTS	Stress Result	24 HTS	Stress Result
Top	-3.11	3.21	**0.10**	3.56	**0.45**	3.20	**0.09**	3.49	**0.38**	3.11	**0.00**	2.80	**-0.31**
Bottom	11.56	-1.19	**10.37**	-1.32	**10.24**	-1.19	**10.37**	-1.29	**10.27**	-1.15	**10.41**	-1.02	**10.54**

Note :

1) Negative (-) values denote tension.
2) Positive values denote compression.
3) Allowable Tensile Stress = 0
4) Allowable Compressive Stress = 0.40•f'_c = 15.60 Mpa



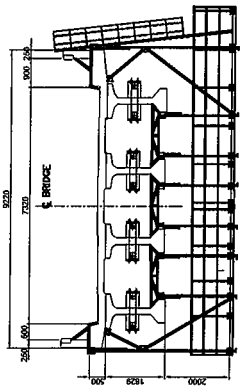
APPROACH 1 SITE OCULAR INSPECTION (VARGAS BRIDGE)



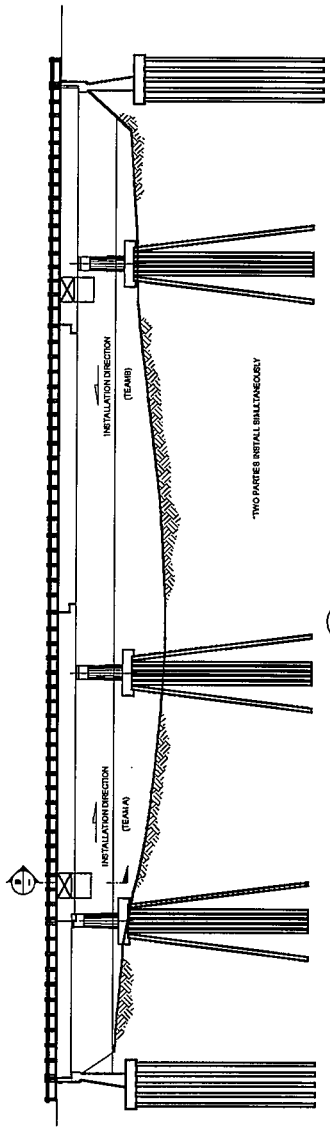
APPROACH 2 SITE OCULAR INSPECTION (VARGAS BRIDGE)

CONSTRUCTION SEQUENCE FOR VARGAS BRIDGE REHABILITATION (Sheet 1 of 2)

STEP (1) INSTALLATION OF GONDULA/CATWALK



B - CROSS SECTION SHOWING CATWALK SCALE 1:75



A - ELEVATION SCALE 1:300

STEP (2) SPALLED CONCRETE AND HONEYCOMB REPAIRS

Surface Preparation ← Expose and Clean all Corroded Reinforcements ← Application of Bonding Coat ← Application of Resin-based Material ← Curing of Repaired Area

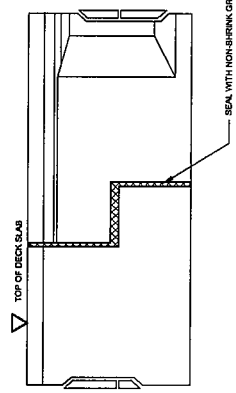
STEP (3) SEALING OF CONCRETE CRACKS BY EPOXY RESIN INJECTION

Surface Preparation ← Clean Cracks by Blowing with Compressed Air ← Seal Cracks at the Surface with Epoxy Resin Grout ← Install Entry Ports and Vents Fittings ← Inject Epoxy Resin ← Cure Epoxy Resin

Remove All Fittings ← Grind and Repair the Surface

STEP (4) REHABILITATION OF GERBER HINGE PORTION

Surface Preparation ← Seal Gerber Hinge Gaps with Non-shrink Grout



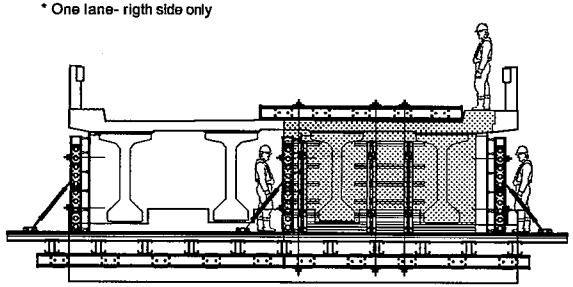
ELEVATION @ GERBER HINGE SCALE 1:30

CONSTRUCTION SEQUENCE FOR VARGAS BRIDGE REHABILITATION

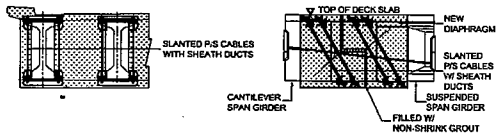
CONSTRUCTION SEQUENCE FOR VARGAS BRIDGE REHABILITATION (Sheet 2 of 2)

STEP (5) RECONSTRUCTION OF DIAPHRAGM AND DECK SLAB AT GERBER HINGE(1st Stage)

* One lane- rigth side only



FIRST STAGE
SCALE 1:50



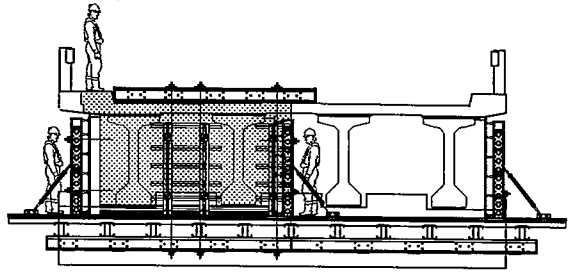
SECTION @ GERBER HINGE
SCALE 1:75

ELEVATION @ GERBER HINGE
SCALE 1:75

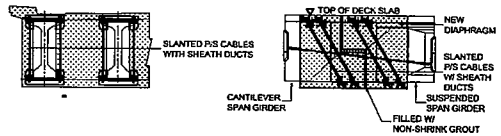
Removal of Deck Slab & Diaphragm → Installation of Reinforcing bars, Formworks and Slanted P/S Cables w/ Sheath Ducts → Concreting of New Diaphragm & Deck Slab → Stressing and Lock-Off for P/S Cables → Grouting of Tendons → Concreting of Anchorages Recess.

STEP (6) RECONSTRUCTION OF DIAPHRAGM AND DECK SLAB AT GERBER HINGE(2nd Stage)

* One lane- left side only



SECOND STAGE
SCALE 1:50



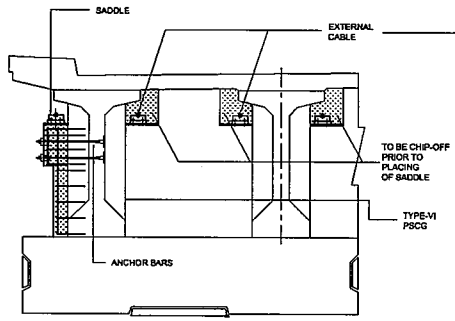
SECTION @ GERBER HINGE
SCALE 1:75

ELEVATION @ GERBER HINGE
SCALE 1:75

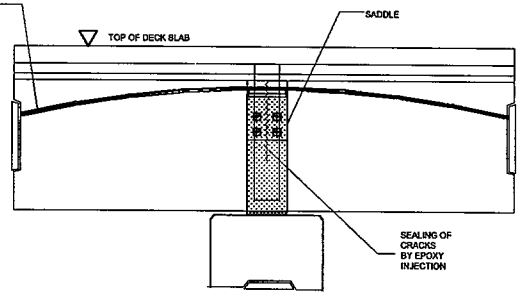
Removal of Deck Slab & Diaphragm → Installation of Reinforcing bars, Formworks and Slanted P/S Cables w/ Sheath Ducts → Concreting of New Diaphragm & Deck Slab → Stressing and Lock-Off for P/S Cables → Grouting of Tendons → Concreting of Anchorages Recess.

STEP (7) LONGITUDINAL EXTERNAL P/S CABLE STRENGTHENING

Construction of Reinforced Concrete Blocks and Saddles Cast Against the Webs of Girders for Tendons Anchorages → Installation of P/S Cable through Anchorage Ends and Saddles → Stressing Works upon approval of Cable Positions, Anchorages and Saddles → Fireproofing (all exposed tendons shall be fire protected by wrapping with fire proofing materials)



SECTION @ PIER
SCALE 1:30



ELEVATION @ PIER
SCALE 1:30

Annex IV - Construction Cost for Retrofitting of Vargas Bridge

Description		Unit	Quantity	Unit Price	Cost	Components		
						Foreign	Local	Taxes
A. Repair/Sealing of Concrete Cracks								
SPL	Epoxy Bonding	l.s.	1.00	2,568,243.05	2,568,243.05	1,874,817.43	385,236.46	308,189.17
SPL	Concrete Grouting	l.s.	1.00	1,027,297.22	1,027,297.22	667,743.19	256,824.31	102,729.72
B. New Diaphragm/Concrete Slab								
101(3)	Removal of Concrete Slab	sq.m.	600.00	500.00	300,000.00	195,000.00	63,000.00	42,000.00
101(3)b	Removal of Asphalt	sq.m.	600.00	150.00	90,000.00	58,500.00	18,900.00	12,600.00
301(1)	Tack Coat	ton	1.00	25,000.00	25,000.00	19,000.00	2,500.00	3,500.00
310	Asphalt	ton	46.00	3,100.00	142,600.00	108,376.00	14,260.00	19,964.00
405(1)a	Structural Concrete for Slab	cu.m.	123.00	4,500.00	553,500.00	359,775.00	116,235.00	77,490.00
	Structural Concrete for New Diaphragm	cu.m.	68.00	6,000.00	408,000.00	265,200.00	85,680.00	57,120.00
	Formworks	sq.m.	76.00	810.00	61,560.00	40,014.00	12,927.60	8,618.40
	Reinforcing Steel Bars	kgs	17,900.00	50.00	895,000.00	581,750.00	187,950.00	125,300.00
	External Cable	kgs	3,840.93	1,087.69	4,177,729.70	2,715,524.31	877,323.24	584,882.16
	Prestressing Bar	kgs	820.00	604.27	495,504.68	322,078.04	104,055.98	69,370.66
C. Guadrail Post								
	Removal of Concrete Railing/Post	l.m.	22.00	150.00	3,300.00	2,145.00	693.00	462.00
	Removal of Concrete Sidewalk	sq.m.	13.50	160.00	2,160.00	1,404.00	453.60	302.40
	New Concrete Railing/Post	l.m.	22.00	3,500.00	77,000.00	50,050.00	16,170.00	10,780.00
	New Concrete Sidewalk	sq.m.	13.50	350.00	4,725.00	3,071.25	992.25	661.50
D. Gondola Falsework						-	-	-
SPL	Gondola Falsework	l.s.	1.00	7,216,546.64	7,216,546.64	4,907,251.72	1,298,978.40	1,010,316.53
E. Traffic Management								
SPL	Traffic Management	l.s.	1.00	2,000,000.00	2,000,000.00	1,420,000.00	300,000.00	280,000.00
F. Contingencies								
	Contingencies	l.s.	1.00	1,002,408.31	1,002,408.31	751,806.24	150,361.25	100,240.83
G. Temporary Facilitites								
	Temporary Facilitites	l.s.	1.00	2,659,826.40	2,659,826.40	1,728,887.16	558,563.54	372,375.70
H. Mobilization/Demobilization								
	Mobilization/demobilization	l.s.	1.00	601,444.99	601,444.99	451,083.74	90,216.75	60,144.50
				Total	**24,311,846.00**	**16,523,477.07**	**4,541,321.37**	**3,247,047.56**
				% Component	**100%**	**68%**	**19%**	**13%**

Annex V - Roadway Improvement (Vargas Bridge)

Item No.	Description	Unit	Quantity	Unit Cost	Amount	Component		
						Foreign	Local	Tax
	Earthworks							
101(3)b	Removal of Curb and Gutter	l.m.	28.00	85.62	2,397.47	1,558.36	503.47	335.65
101(3)e	Removal of Parking Space	m^2	30.00	99.21	2,976.27	1,934.58	625.02	416.68
	Miscellaneous							
600(1)	Combination of Concrete Curb and Gutter	l.m.	113.00	1,100.00	124,300.00	80,795.00	26,103.00	17,402.00
612(1)	Pavement Markings	m^2	118.00	862.13	101,730.75	66,124.99	21,363.46	14,242.31
	Contingencies	l.s.	1.00	11,570.22	11,570.22	8,677.67	1,735.53	1,157.02
	Traffic Signal (1 Intersection)	l.s.	1.00	1,500,000.00	1,500,000.00	1,125,000.00	225,000.00	150,000.00
				Total	**1,742,974.72**	**1,284,090.59**	**275,330.48**	**183,553.65**
				% Component	**100%**	**74%**	**16%**	**10%**