1.00 DESIGN OF PIER COLUMN, (P1)

1.1 MATERIAL AND SPECIFICATIONS

A) Concrete

Compressive strength of concrete, f'c	=	25.00 Mpa
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$	=	23650.00 Mpa
Concrete cover, cc	=	0.05 m

B) Reinforcing Steel

Tensile strength of reinforcing steel, f_y	=	275.00 Mpa
Modulus of elasticity of reinforcing steel, E_s	=	200000.00 Mpa
Main bar diameter, d_b	=	20.00 mm
Diameter of ties, d_s	=	16.00 mm

1.2 COLUMN PROPERTIES

Column dimension: (with respect to long'l direction of bridge)

Column width, B	=	25.30 m
Column depth, D	=	1.86 m

Strength reduction factor, ϕ :

1) For moment magnification factor	=	0.70
2) For lateral reinforcement	=	0.85

Unsupported length of column, L_u :

1) At longitudinal direction	=	9.70 m
2) At transversal direction	=	9.70 m

Clear height of column, H

1) At longitudinal direction	=	7.80 m
2) At transversal direction	=	7.80 m

1.3 ELASTIC FORCES FROM DYNAMIC ANALYSIS

Location	Member Number	Loading	Joint Number	Axial (kN)	Shear V_y (kN)	Shear V_z (kN)	Torsion (kN-m)	Moment M_y (kN-m)	Moment M_z (kN-m)
PIER WALL	1441	1	440	12017.00	-73.00	9.00	50.81	303.43	382.82
			441	-13224.00	73.00	-9.00	-50.81	-313.03	-461.14
		2	440	8.00	268.00	0.00	-0.01	-0.20	-1089.49
			441	-8.00	-316.00	0.00	0.01	0.22	1401.88
		3	440	0.00	0.00	510.00	-66.17	2326.99	-0.14
			441	0.00	0.00	-558.00	66.17	-2898.04	0.17
PIER WALL	1442	1	441	13224.00	-73.00	9.00	50.81	313.03	461.14
			442	-14430.00	73.00	-9.00	-50.81	-322.63	-539.46
		2	441	8.00	316.00	0.00	-0.01	-0.22	-1401.88
			442	-8.00	-364.00	0.00	0.01	0.25	1765.91
		3	441	0.00	0.00	558.00	-66.17	2898.04	-0.17
			442	0.00	0.00	-606.00	66.17	-3520.73	0.20
PIER WALL	1443	1	442	14430.00	-73.00	9.00	50.81	322.63	539.46
			443	-15636.00	73.00	-9.00	-50.81	-332.23	-617.74
		2	442	8.00	364.00	0.00	-0.01	-0.25	-1765.91
			443	-8.00	-413.00	0.00	0.01	0.27	2181.38
		3	442	0.00	0.00	606.00	-66.17	3520.73	-0.20
			443	0.00	0.00	-654.00	66.17	-4194.74	0.23

Note :

1) Loading #1 is "Dead Load". From ADAPT Program

2) Loading #2 is "Seismic Load at Longitudinal Direction". From STAAD Program

3) Loading #3 is "Seismic Load at Transversal Direction". From STAAD Program

TABULATION OF TOP AND BOTTOM COLUMN FORCES DUE TO THE CORRESPONDING LOAD CASES

A) Basic Loading

				@ LONGITUDINAL DIRECTION		@ TRANSVERSAL DIRECTION	
Loading	Joint No.	Location	Axial (kN)	Shear Vy (kN)	Moment Mz (kN-m)	Shear Vz (kN)	Moment My (kN-m)
Dead Load	0	top	12017.00	73.00	382.82	9.00	303.43
	0	bottom	15636.00	73.00	617.74	9.00	332.23
Long'l Earthquake	0	top	8.00	268.00	1089.49	0.00	0.20
	0	bottom	8.00	413.00	2181.38	0.00	0.27
Tran'l Earthquake	0	top	0.00	0.00	0.14	510.00	2326.99
	0	bottom	0.00	0.00	0.23	654.00	4194.74

B) Load Combination

				@ LONGITUDINAL DIRECTION		@ TRANSVERSAL DIRECTION	
Load Combination	Joint No.	Location	Axial (kN)	Shear Vy (kN)	Moment Mz (kN-m)	Shear Vz (kN)	Moment My (kN-m)
LC1	0	top	8.00	268.00	1089.49	0.00	0.20
	0	bottom	8.00	413.00	2181.38	0.00	0.27
LC2	0	top	0.00	0.00	0.14	510.00	2326.99
	0	bottom	0.00	0.00	0.23	654.00	4194.74

C) Modified Load Combination

Response Modification Factor (R) for LC1 = **1**
Response Modification Factor (R) for LC2 = **1**

				@ LONGITUDINAL DIRECTION		@ TRANSVERSAL DIRECTION	
Load Combination	Joint No.	Location	Axial (kN)	Shear Vy (kN)	Moment Mz (kN-m)	Shear Vz (kN)	Moment My (kN-m)
Modified LC1	0	top	12025.00	341.00	1472.31	9.00	303.63
	0	bottom	15644.00	486.00	2799.12	9.00	332.50
Modified LC2	0	top	12017.00	73.00	382.96	519.00	2630.42
	0	bottom	15636.00	73.00	617.97	663.00	4526.97

Unreduced Forces (where R = 1)

				@ LONGITUDINAL DIRECTION		@ TRANSVERSAL DIRECTION	
Load Combination	Joint No.	Location	Axial (kN)	Shear Vy (kN)	Moment Mz (kN-m)	Shear Vz (kN)	Moment My (kN-m)
Unreduced LC1	0	top	12025.00	341.00	1472.31	9.00	303.63
	0	bottom	15644.00	486.00	2799.12	9.00	332.50
Unreduced LC2	0	top	12017.00	73.00	382.96	519.00	2630.42
	0	bottom	15636.00	73.00	617.97	663.00	4526.97

D.) Design Forces

	TOP OF COLUMN		BOTTOM OF COLUMN			TOP OF COLUMN		BOTTOM OF COLUMN	
Forces	Mod. LC1	Mod. LC2	Mod. LC1	Mod. LC2	Unit	Unred. LC1	Unred. LC2	Unred. LC1	Unred. LC2
Long'l Shear	341.00	73.00	486.00	73.00	kN	341.00	73.00	486.00	73.00
Long'l Moment	1472.31	382.96	2799.12	617.97	kN-m	1472.31	382.96	2799.12	617.97
Tran'l Shear	9.00	519.00	9.00	663.00	kN	9.00	519.00	9.00	663.00
Tran'l Moment	303.63	2630.42	332.50	4526.97	kN-m	303.63	2630.42	332.50	4526.97
Max. Axial	12025.00	12017.00	15644.00	15636.00	kN	12025.00	12017.00	15644.00	15636.00
Min. Axial	12009.00	12017.00	15628.00	15636.00	kN	12009.00	12017.00	15628.00	15636.00

A) CONSIDER FORCES AT TOP OF COLUMN

A-1) Slenderness Effect

		From Modified Forces			From Unreduced Forces	
Direction		Longitudinal	Transversal	Unit	Longitudinal	Transversal
Column dimension :	Width, B	25.30	1.86	m	25.30	1.86
	Depth, D	1.86	25.30	m	1.86	25.30
Unsupported length of column, L_u		9.70	9.70	m	9.70	9.70
Compressive strength of concrete, f'_c		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, A_g = BD		47.06	47.06	m²	47.06	47.06
Moment of inertia of column, $I_g = BD^3 / 12$		13.57	2510.11	m^4	13.57	2510.11
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.54	7.30	m	0.54	7.30
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		37.94	2.79		37.94	2.79
Maximum dead load moment, M_{DL}		382.82	303.43	kN-m	382.82	303.43
Maximum total load moment, M_{max}		1472.31	2630.42	kN-m	1472.31	2630.42
$\beta_d = M_{DL} / M_{max}$		0.26	0.01		0.26	0.01
Flexural stiffness of column, $EI = (E_c I_g/2.5) / (1+\beta_d)$		1.02E+08	2.35E+10	kN-m²	1.02E+08	2.35E+10
Factored axial load, $P_u = P_{max}$		12025.00	12017.00	kN	12025.00	12017.00
Critical load, $P_c = \pi^2 EI / (kL_u)^2$		2422770.07	559217446.00	kN	2422770.07	559217446.00
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi \Sigma P_c)] \geq 1.00$		1.01	1.00		1.01	1.00

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Computer program for the Strength Design of Reinforced Concrete Sections

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General Information:

File Name: C:\MSNAVAL\PASIG~3\PASIG~1\JONES\DESIGN\OLDCODE\PIER1B.COL
Project: PASIG-MARIKINA
Column: Engineer: msn
Code: ACI 318-95 Units: Metric

Run Option: Investigation Slenderness: Not considered
Run Axis: Biaxial Column Type: Structural

Material Properties:

f'c = 17 MPa fy = 226 MPa
Ec = 19378.6 MPa Es = 200000 MPa
fc = 14.45 MPa Rupture strain = Infinity
Ultimate strain = 0.003 mm/mm
Beta1 = 0.85

Section:

Rectangular: Width = 25290 mm Depth = 1830 mm

Gross section area, Ag = 4.62807e+007 mm^2
Ix = 1.29158e+013 mm^4 Iy = 2.4667e+015 mm^4
Xo = 0 mm Yo = 0 mm

Reinforcement:

Rebar Database: CSA G30.18

Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)
# 10	11	100	# 15	16	200	# 20	20	300
# 25	25	500	# 30	30	700	# 35	36	1000
# 45	44	1500	# 55	56	2500			

Confinement: User-defined; #10 ties with #0 bars, #10 with larger bars.
phi(a) = 1, phi(b) = 1, phi(c) = 1

Layout: Rectangular
Pattern: Sides Different (Cover to transverse reinforcement)
Total steel area, As = 34800 mm^2 at 0.08%

	Top	Bottom	Left	Right
Bars	58 #20	58 #20	0 #15	0 #15
Cover(mm)	50	50	50	50

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)

No.	Pu kN	Mux kN-m	Muy kN-m	fMnx kN-m	fMny kN-m	fMn/Mu
1	17911.5	3233.7	384.1	22654.3	2670.8	7.005
2	17893.2	3233.7	384.1	22638.6	2654.9	7.000
3	17902.1	707.6	5183.3	22119.9	160436.7	30.959

*** Program completed as requested! ***

A-2) Modified Strength Reduction Factor (ϕ)

Direction	From Modified Forces Longitudinal	From Modified Forces Transversal	Unit	From Unreduced Forces Longitudinal	From Unreduced Forces Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	255.54	255.37	Kpa	255.54	255.37
20% of compressive strength of concrete, 0.20f'$_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.88	0.88		0.88	0.88

A-3) Nominal Design Forces At Top Of Column

Forces	MODIFIED FORCES LC1	MODIFIED FORCES LC2	Unit	UNREDUCED FORCES LC1	UNREDUCED FORCES LC2
Long'l M_u (M_x)	1685.88	435.41	kN-m	1685.88	435.41
Tran'l M_u (M_y)	347.67	2990.66	kN-m	347.67	2990.66
P_{Umax}	13671.65	13662.35	kN	13671.65	13662.35
P_{Umin}	13653.46	13662.35	kN	13653.46	13662.35
P_{DL}	12017.00		kN	12017.00	

... design and investigate using PCACOL Program...

B) CONSIDER FORCES AT BOTTOM OF COLUMN

B-1) Slenderness Effect

Direction		From Modified Forces Longitudinal	From Modified Forces Transversal	Unit	From Unreduced Forces Longitudinal	From Unreduced Forces Transversal
Column dimension :	Width, B	25.30	1.86	m	25.30	1.86
	Depth, D	1.86	25.30	m	1.86	25.30
Unsupported length of column, L_u		9.70	9.70	m	9.70	9.70
Compressive strength of concrete, f'$_c$		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, A_g = BD		47.06	47.06	m²	47.06	47.06
Moment of inertia of column, $I_g = BD^3 / 12$		13.57	2510.11	m^4	13.57	2510.11
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.54	7.30	m	0.54	7.30
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		37.94	2.79		37.94	2.79
Maximum dead load moment, M_{DL}		617.74	332.23	kN-m	617.74	332.23
Maximum total load moment, M_{max}		2799.12	4526.97	kN-m	2799.12	4526.97
$\beta_d = M_{DL} / M_{max}$		0.22	0.01		0.22	0.01
Flexural stiffness of column, $EI = (E_cI_g/2.5) / (1+\beta_d)$		1.05E+08	2.35E+10	kN-m²	1.05E+08	2.35E+10
Factored axial load, $P_u = P_{max}$		15644.00	15636.00	kN	15644.00	15636.00
Critical load, $P_c = \pi^2 EI / (kL_u)^2$		2500810.98	559217446.00	kN	2500810.98	559217446.00
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi\Sigma P_c)] \geq 1.00$		1.01	1.00		1.01	1.00

B-2) Modified Strength Reduction Factor (ϕ)

Direction	From Modified Forces Longitudinal	From Modified Forces Transversal	Unit	From Unreduced Forces Longitudinal	From Unreduced Forces Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	332.44	332.27	Kpa	332.44	332.27
20% of compressive strength of concrete, 0.20f'$_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.87	0.87		0.87	0.87

B-3) Nominal Design Forces At Bottom Of Pier Wall

Forces	MODIFIED FORCES LC1	MODIFIED FORCES LC2	Unit	UNREDUCED FORCES LC1	UNREDUCED FORCES LC2
Long'l M_u (M_x)	3233.74	707.56	kN-m	3233.74	707.56
Tran'l M_u (M_y)	384.13	5183.25	kN-m	384.13	5183.25
P_{Umax}	17911.51	17902.07	kN	17911.51	17902.07
P_{Umin}	17893.19	17902.07	kN	17893.19	17902.07
P_{DL}	15636.00		kN	15636.00	

... design and investigate using PCACOL Program...

2.00 DESIGN OF PIER COLUMN, (P2)

2.1 MATERIAL AND SPECIFICATIONS

A) Concrete

Compressive strength of concrete, f'c	=	25.00 Mpa
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$	=	23650.00 Mpa
Concrete cover, cc	=	0.05 m

B) Reinforcing Steel

Tensile strength of reinforcing steel, f_y	=	275.00 Mpa
Modulus of elasticity of reinforcing steel, E_s	=	200000.00 Mpa
Main bar diameter, d_b	=	20.00 mm
Diameter of ties, d_s	=	16.00 mm

2.2 COLUMN PROPERTIES

Column dimension: (with respect to long'l direction of bridge)

Column width, B	=	26.30 m
Column depth, D	=	1.83 m

Strength reduction factor, ϕ :

1) For moment magnification factor	=	0.70
2) For lateral reinforcement	=	0.85

Unsupported length of column, L_u :

1) At longitudinal direction	=	11.56 m
2) At transversal direction	=	11.56 m

Clear height of column, H

1) At longitudinal direction	=	9.66 m
2) At transversal direction	=	9.66 m

2.3 ELASTIC FORCES FROM DYNAMIC ANALYSIS

Location	Member Number	Loading	Joint Number	Axial (kN)	Shear V_y (kN)	Shear V_z (kN)	Torsion (kN-m)	Moment M_y (kN-m)	Moment M_z (kN-m)
UPPER 1/3 OF COLUMN	1451	1	536	11973.00	42.00	-1.00	-17.19	-326.62	-220.60
			537	-14006.00	-42.00	1.00	17.19	329.08	296.65
		2	536	-7.00	91.00	0.00	0.10	0.20	-166.30
			537	7.00	-173.00	0.00	-0.10	-0.21	404.23
		3	536	0.00	0.00	507.00	57.53	2311.58	0.07
			537	0.00	0.00	-588.00	-57.53	-3298.23	-0.09
MIDDLE 1/3 OF COLUMN	1452	1	537	14006.00	42.00	-1.00	-17.19	-329.08	-296.65
			538	-16040.00	-42.00	1.00	17.19	331.54	372.70
		2	537	-7.00	173.00	0.00	0.10	0.21	-404.23
			538	7.00	-254.00	0.00	-0.10	-0.23	788.80
		3	537	0.00	0.00	588.00	57.53	3298.23	0.09
			538	0.00	0.00	-669.00	-57.53	-4431.52	-0.12
LOWER 1/3 OF COLUMN	1453	1	538	16040.00	42.00	-1.00	-17.19	-331.54	-372.70
			539	-18072.00	-42.00	1.00	17.19	334.00	448.73
		2	538	-7.00	254.00	0.00	0.10	0.23	-788.80
			539	7.00	-335.00	0.00	-0.10	-0.24	1319.83
		3	538	0.00	0.00	669.00	57.53	4431.52	0.12
			539	0.00	0.00	-751.00	-57.53	-5711.06	-0.14

Note :

1) *Loading #1 is "Dead Load". From ADAPT Program*
2) *Loading #2 is "Seismic Load at Longitudinal Direction". From STAAD Program*
3) *Loading #3 is "Seismic Load at Transversal Direction". From STAAD Program*
4) *Joint #536 is at top of column.*
5) *Joint #539 is at bottom of column.*

TABULATION OF TOP AND BOTTOM COLUMN FORCES DUE TO THE CORRESPONDING LOAD CASES

A) Basic Loading

				@ LONGITUDINAL DIRECTION		@ TRANSVERSAL DIRECTION	
Loading	Joint No.	Location	Axial (kN)	Shear Vy (kN)	Moment Mz (kN-m)	Shear Vz (kN)	Moment My (kN-m)
Dead Load	536	top	11973.00	42.00	220.60	1.00	326.62
	539	bottom	18072.00	42.00	448.73	1.00	334.00
Long'l Earthquake	536	top	7.00	91.00	166.30	0.00	0.20
	539	bottom	7.00	335.00	1319.83	0.00	0.24
Tran'l Earthquake	536	top	0.00	0.00	0.07	507.00	2311.58
	539	bottom	0.00	0.00	0.14	751.00	5711.06

CAPACITY-DEMAND RATIO OF EXISTING PIER WALL (OLD CODE)

B) Load Combination

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
LC1	536	top	7.00	91.00	166.30	0.00	0.20
	539	bottom	7.00	335.00	1319.83	0.00	0.24
LC2	536	top	0.00	0.00	0.07	507.00	2311.58
	539	bottom	0.00	0.00	0.14	751.00	5711.06

C) Modified Load Combination

Response Modification Factor (R) for LC1 = **1**

Response Modification Factor (R) for LC2 = **1**

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
Modified LC1	536	top	11980.00	133.00	386.90	1.00	326.82
	539	bottom	18079.00	377.00	1768.57	1.00	334.24
Modified LC2	536	top	11973.00	42.00	220.67	508.00	2638.20
	539	bottom	18072.00	42.00	448.87	752.00	6045.06

Unreduced Forces (where R = 1)

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
Unreduced LC1	536	top	11980.00	133.00	386.90	1.00	326.82
	539	bottom	18079.00	377.00	1768.57	1.00	334.24
Unreduced LC2	536	top	11973.00	42.00	220.67	508.00	2638.20
	539	bottom	18072.00	42.00	448.87	752.00	6045.06

D.) Design Forces

Forces	TOP OF COLUMN Mod. LC1	TOP OF COLUMN Mod. LC2	BOTTOM OF COLUMN Mod. LC1	BOTTOM OF COLUMN Mod. LC2	Unit	TOP OF COLUMN Unred. LC1	TOP OF COLUMN Unred. LC2	BOTTOM OF COLUMN Unred. LC1	BOTTOM OF COLUMN Unred. LC2
Long'l Shear	133.00	42.00	377.00	42.00	kN	133.00	42.00	377.00	42.00
Long'l Moment	386.90	220.67	1768.57	448.87	kN-m	386.90	220.67	1768.57	448.87
Tran'l Shear	1.00	508.00	1.00	752.00	kN	1.00	508.00	1.00	752.00
Tran'l Moment	326.82	2638.20	334.24	6045.06	kN-m	326.82	2638.20	334.24	6045.06
Max. Axial	11980.00	11973.00	18079.00	18072.00	kN	11980.00	11973.00	18079.00	18072.00
Min. Axial	11966.00	11973.00	18065.00	18072.00	kN	11966.00	11973.00	18065.00	18072.00

A) CONSIDER FORCES AT TOP OF COLUMN

A-1) Slenderness Effect

Direction		From Modified Forces: Longitudinal	From Modified Forces: Transversal	Unit	From Unreduced Forces: Longitudinal	From Unreduced Forces: Transversal
Column dimension :	Width, B	26.30	1.26	m	26.30	1.26
	Depth, D	1.26	26.30	m	1.26	26.30
Unsupported length of column, L_u		11.56	11.56	m	11.56	11.56
Compressive strength of concrete, f'_c		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, $A_g = BD$		33.14	33.14	m²	33.14	33.14
Moment of inertia of column, $I_g = BD^3 / 12$		4.38	1910.10	m^4	4.38	1910.10
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.36	7.59	m	0.36	7.59
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		66.74	3.20		66.74	3.20
Maximum dead load moment, M_{DL}		220.60	326.62	kN-m	220.60	326.62
Maximum total load moment, M_{max}		386.90	2638.20	kN-m	386.90	2638.20
$\beta_d = M_{DL} / M_{max}$		0.57	0.01		0.57	0.01
Flexural stiffness of column, $EI = (E_c I_g/2.5) / (1+\beta_d)$		2.64E+07	1.79E+10	kN-m²	2.64E+07	1.79E+10
Factored axial load, $P_u = P_{max}$		11980.00	11973.00	kN	11980.00	11973.00
Critical load, $P_c = \pi^2 EI / (kL_u)^2$		442359.04	299620686.61	kN	442359.04	299620686.61
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi \Sigma P_c)] \geq 1.00$		1.04	1.00		1.04	1.00

A-2) Modified Strength Reduction Factor (ϕ)

	From Modified Forces			From Unreduced Forces	
Direction	Longitudinal	Transversal	Unit	Longitudinal	Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	361.52	361.31	Kpa	361.52	361.31
20% of compressive strength of concrete, $0.20f'_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.87	0.87		0.87	0.87

A-3) Nominal Design Forces At Top Of Column

	MODIFIED FORCES			UNREDUCED FORCES	
Forces	LC1	LC2	Unit	LC1	LC2
Long'l M_u (M_x)	462.04	253.34	kN-m	462.04	253.34
Tran'l M_u (M_y)	390.29	3028.78	kN-m	390.29	3028.78
P_{Umax}	13753.07	13744.76	kN	13753.07	13744.76
P_{Umin}	13736.99	13744.76	kN	13736.99	13744.76
P_{DL}	11973.00		kN	11973.00	

... design and investigate using PCACOL Program...

B) CONSIDER FORCES AT BOTTOM OF COLUMN

B-1) Slenderness Effect

		From Modified Forces			From Unreduced Forces	
Direction		Longitudinal	Transversal	Unit	Longitudinal	Transversal
Column dimension :	Width, B	26.30	1.26	m	26.30	1.26
	Depth, D	1.26	26.30	m	1.26	26.30
Unsupported length of column, L_u		11.56	11.56	m	11.56	11.56
Compressive strength of concrete, f'_c		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, A_g = BD		33.14	33.14	m²	33.14	33.14
Moment of inertia of column, $I_g = BD^3 / 12$		4.38	1910.10	m^4	4.38	1910.10
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.36	7.59	m	0.36	7.59
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		66.74	3.20		66.74	3.20
Maximum dead load moment, M_{DL}		448.73	334.00	kN-m	448.73	334.00
Maximum total load moment, M_{max}		1768.57	6045.06	kN-m	1768.57	6045.06
$\beta_d = M_{DL} / M_{max}$		0.25	0.01		0.25	0.01
Flexural stiffness of column, $EI = (E_cI_g/2.5) / (1+\beta_d)$		3.31E+07	1.79E+10	kN-m²	3.31E+07	1.79E+10
Factored axial load, $P_u = P_{max}$		18079.00	18072.00	kN	18079.00	18072.00
Critical load, $P_c = \pi^2 EI / (kL_u)^2$		554013.02	299620686.61	kN	554013.02	299620686.61
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi \Sigma P_c)] \geq 1.00$		1.05	1.00		1.05	1.00

B-2) Modified Strength Reduction Factor (ϕ)

	From Modified Forces			From Unreduced Forces	
Direction	Longitudinal	Transversal	Unit	Longitudinal	Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	545.57	545.36	Kpa	545.57	545.36
20% of compressive strength of concrete, $0.20f'_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.86	0.86		0.86	0.86

B-3) Nominal Design Forces At Bottom Of Column

	MODIFIED FORCES			UNREDUCED FORCES	
Forces	LC1	LC2	Unit	LC1	LC2
Long'l M_u (M_x)	2166.21	524.20	kN-m	2166.21	524.20
Tran'l M_u (M_y)	409.39	7059.53	kN-m	409.39	7059.53
P_{Umax}	21111.58	21102.99	kN	21111.58	21102.99
P_{Umin}	21095.23	21102.99	kN	21095.23	21102.99
P_{DL}	18072.00		kN	18072.00	

... design and investigate using PCACOL Program...

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===
Computer program for the Strength Design of Reinforced Concrete Sections
===

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General Information:
====================

File Name: C:\MSNAVAL\PASIG--3\PASIG--1\JONES\DESIGN\OLDCODE\PIER2B.COL
Project: PASIG-MARIKINA
Column: Engineer: msn
Code: ACI 318-95 Units: Metric

Run Option: Investigation Slenderness: Not considered
Run Axis: Biaxial Column Type: Structural

Material Properties:
====================

f'c = 17 MPa fy = 226 MPa
Ec = 19378.6 MPa Es = 200000 MPa
fc = 14.45 MPa Rupture strain = Infinity
Ultimate strain = 0.003 mm/mm
Beta1 = 0.85

Section:
========

Rectangular: Width = 25290 mm Depth = 1830 mm

Gross section area, Ag = 4.62807e+007 mm^2
Ix = 1.29158e+013 mm^4 Iy = 2.4667e+015 mm^4
Xo = 0 mm Yo = 0 mm

Reinforcement:
==============

Rebar Database: CSA G30.18

Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)
# 10	11	100	# 15	16	200	# 20	20	300
# 25	25	500	# 30	30	700	# 35	36	1000
# 45	44	1500	# 55	56	2500			

Confinement: User-defined; #10 ties with #0 bars, #10 with larger bars.
phi(a) = 1, phi(b) = 1, phi(c) = 1

Layout: Rectangular
Pattern: Sides Different (Cover to transverse reinforcement)
Total steel area, As = 34800 mm^2 at 0.08%

	Top	Bottom	Left	Right
Bars	58 #20	58 #20	0 #15	0 #15
Cover(mm)	50	50	50	50

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)
===

No.	Pu kN	Mux kN-m	Muy kN-m	fMnx kN-m	fMny kN-m	fMn/Mu
1	21111.6	2166.2	409.4	25372.9	4781.0	11.712
2	21095.2	2166.2	409.4	25359.1	4813.0	11.708
3	21103.0	524.2	7059.5	21969.4	290431.2	41.145

*** Program completed as requested! ***

CAPACITY-DEMAND RATIO OF EXISTING CAISSON FOUNDATION (OLD CODE)

BRIDGE NAME : Jones Bridge
SUBJECT : Investigation of Spread Footing

SUMMARY OF CAPACITY/DEMAND RATIO (OLD CODE)

LOCATION	CAPACITY (kPa)	DEMAND (kPa)	C/D
PIER 1 (Case I)	300	192.86	1.56
PIER 1 (Case VII)	400	205.50	1.95
PIER 2 (Case I)	300	197.86	1.52
PIER 2 (Case VII)	400	207.97	1.92

PIER 1 (Case I)

Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel..........................	fy :	226	MPa
Factored Axial Load......................	P_u :	16666	kN
Factored Moment (x).....................	M_ux:	739	kN-m
Factored Moment (y).....................	M_uy:	5437	kN-m
Allowable Soil Bearing Capacity			
	qallow :	300	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length.............................	L :	31.80	m
Footing Thickness.........................	T :	3.00	m
Column Width...............................	b :	4.12	m
Column Thickness.........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	20	mm
Rebar Area......................	A :	314.16	mm^2
Other Pertinent Information			
Concrete Cover.....................	cc :	100	mm
Effective Depth.....................	d :	2870	mm
Strength Reduction Factor (Flexure)........	ϕ f :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	β1 :	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex_{col} :	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey_{col} :	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B*L) [1\pm (6*e_x / L) \pm (6*e_y / B)]$			
Final Eccentricity (x)	ex :	0.326	m
Final Eccentricity (y)	ey :	0.044	m
Corner Soil Pressures	q_1:	161.78	kPa
	q_2:	171.03	kPa
	q_3:	183.61	kPa
	q_4:	192.86	kPa

PIER 1 (Case VII)

Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel..........................	fy :	226	MPa
Factored Axial Load......................	P_u :	15644	kN
Factored Moment (x)......	M_ux:	3170	kN-m
Factored Moment (y).....................	M_uy:	5030	kN-m
Allowable Soil Bearing Capacity			
	qultimate :	400	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length.............................	L :	31.80	m
Footing Thickness.........................	T :	3.00	m
Column Width...............................	b :	4.12	m
Column Thickness.........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	25	mm
Rebar Area......................	A :	490.87	mm^2
Other Pertinent Information			
Concrete Cover.....................	cc :	100	mm
Effective Depth.....................	d :	2862.5	mm
Strength Reduction Factor (Flexure)........	ϕ f :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	β1 :	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex_{col} :	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey_{col} :	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B*L) [1\pm (6*e_x / L) \pm (6*e_y / B)]$			
Final Eccentricity (x)	ex :	0.322	m
Final Eccentricity (y)	ey :	0.203	m
Corner Soil Pressures	q_1:	142.85	kPa
	q_2:	184.37	kPa
	q_3:	163.98	kPa
	q_4:	205.50	kPa

CAPACITY-DEMAND RATIO OF EXISTING CAISSON FOUNDATION (OLD CODE)

PIER 2 (Case I)

Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel..........................	fy :	226	MPa
Factored Axial Load......................	P_u :	19104	kN
Factored Moment (x)....................	M_ux:	547	kN-m
Factored Moment (y)....................	M_uy:	5426	kN-m
Allowable Soil Bearing Capacity			
	qallow :	300	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length.............................	L :	31.80	m
Footing Thickness.........................	T :	3.00	m
Column Width..............................	b :	4.12	m
Column Thickness........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	20	mm
Rebar Area......................	A :	314.16	mm^2
Other Pertinent Information			
Concrete Cover....................	cc :	100	mm
Effective Depth....................	d :	2870	mm
Strength Reduction Factor (Flexure)........	ϕ f :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	β1 :	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex $_{col}$:	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey $_{col}$:	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B*L) [1 \pm (6*e_x / L) \pm (6*e_y / B)]$			
Final Eccentricity (x)	ex :	0.284	m
Final Eccentricity (y)	ey :	0.029	m
Corner Soil Pressures	q_1:	171.82	kPa
	q_2:	178.05	kPa
	q_3:	191.63	kPa
	q_4:	197.86	kPa

PIER 2 (Case VII)

Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel..........................	fy :	226	MPa
Factored Axial Load......................	P_u :	18075	kN
Factored Moment (x)....................	M_ux:	2222	kN-m
Factored Moment (y)....................	M_uy:	6944	kN-m
Allowable Soil Bearing Capacity			
	qultimate :	400	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length.............................	L :	31.80	m
Footing Thickness.........................	T :	3.00	m
Column Width..............................	b :	4.12	m
Column Thickness........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	25	mm
Rebar Area......................	A :	490.87	mm^2
Other Pertinent Information			
Concrete Cover....................	cc :	100	mm
Effective Depth....................	d :	2862.5	mm
Strength Reduction Factor (Flexure)........	ϕ f :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	β1 :	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex $_{col}$:	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey $_{col}$:	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B*L) [1 \pm (6*e_x / L) \pm (6*e_y / B)]$			
Final Eccentricity (x)	ex :	0.384	m
Final Eccentricity (y)	ey :	0.123	m
Corner Soil Pressures	q_1:	155.36	kPa
	q_2:	181.64	kPa
	q_3:	181.70	kPa
	q_4:	207.97	kPa

1.00 DESIGN OF PIER COLUMN, (P1)

1.1 MATERIAL AND SPECIFICATIONS

A) Concrete

Compressive strength of concrete, f'c	=	25.00 Mpa
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$	=	23650.00 Mpa
Concrete cover, cc	=	0.05 m

B) Reinforcing Steel

Tensile strength of reinforcing steel, f_y	=	275.00 Mpa
Modulus of elasticity of reinforcing steel, E_s	=	200000.00 Mpa
Main bar diameter, d_b	=	20.00 mm
Diameter of ties, d_s	=	16.00 mm

1.2 COLUMN PROPERTIES

Column dimension: (with respect to long'l direction of bridge)

Column width, B	=	25.30 m
Column depth, D	=	1.86 m

Strength reduction factor, ϕ :

1) For moment magnification factor	=	0.70
2) For lateral reinforcement	=	0.85

Unsupported length of column, L_u :

1) At longitudinal direction	=	9.70 m
2) At transversal direction	=	9.70 m

Clear height of column, H

1) At longitudinal direction	=	7.80 m
2) At transversal direction	=	7.80 m

1.3 ELASTIC FORCES FROM DYNAMIC ANALYSIS

Location	Member Number	Loading	Joint Number	Axial (kN)	Shear V_y (kN)	Shear V_z (kN)	Torsion (kN-m)	Moment M_y (kN-m)	Moment M_z (kN-m)
UPPER 1/3 OF COLUMN	1441	1	440	13883.00	-24.00	9.00	31.00	303.34	125.91
			441	-15826.00	24.00	-9.00	-31.00	-312.86	-151.67
		2	440	393.00	6066.00	7.00	6.27	253.68	20617.87
			441	393.00	6066.00	7.00	6.27	252.59	26704.03
		3	440	38.00	5.00	7519.00	2076.09	35152.81	28.96
			441	38.00	5.00	7519.00	2076.09	42909.35	24.23
MIDDLE 1/3 OF COLUMN	1442	1	441	15826.00	-24.00	9.00	31.00	312.86	151.67
			442	-17770.00	24.00	-9.00	-31.00	-322.38	-177.43
		2	441	394.00	6838.00	9.00	6.27	252.59	26704.03
			442	394.00	6838.00	9.00	6.27	251.83	33524.43
		3	441	43.00	9.00	8061.00	2076.09	42909.35	24.23
			442	43.00	9.00	8061.00	2076.09	51116.90	15.19
LOWER 1/3 OF COLUMN	1443	1	442	17770.00	-24.00	9.00	31.00	322.38	177.43
			443	-19713.00	24.00	-9.00	-31.00	-331.90	-203.18
		2	442	394.00	7354.00	10.00	6.27	251.83	33524.43
			443	394.00	7354.00	10.00	6.27	251.59	40887.26
		3	442	47.00	12.00	8570.00	2076.09	51116.90	15.19
			443	47.00	12.00	8570.00	2076.09	59781.90	3.75

Note :

1) *Loading #1 is "Dead Load". From ADAPT Program*
2) *Loading #2 is "Seismic Load at Longitudinal Direction". From STAAD Program*
3) *Loading #3 is "Seismic Load at Transversal Direction". From STAAD Program*
4) *Joint #440 is at top of column.*
5) *Joint #443 is at bottom of column.*

TABULATION OF TOP AND BOTTOM COLUMN FORCES DUE TO THE CORRESPONDING LOAD CASES

A) Basic Loading

				@ LONGITUDINAL DIRECTION		@ TRANSVERSAL DIRECTION	
Loading	Joint No.	Location	Axial (kN)	Shear Vy (kN)	Moment Mz (kN-m)	Shear Vz (kN)	Moment My (kN-m)
Dead Load	440	top	13883.00	24.00	125.91	9.00	303.34
	443	bottom	19713.00	24.00	203.18	9.00	331.90
Long'l Earthquake	440	top	393.00	6066.00	20617.87	7.00	253.68
	443	bottom	394.00	7354.00	40887.26	10.00	251.59
Tran'l Earthquake	440	top	38.00	5.00	28.96	7519.00	35152.81
	443	bottom	47.00	12.00	3.75	8570.00	59781.90

CAPACITY-DEMAND RATIO OF EXISTING PIER WALL (LATEST CODE)

B) Load Combination

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
LC1	440	top	404.40	6067.50	20626.56	2262.70	10799.53
	443	bottom	408.10	7357.60	40888.39	2581.00	18186.16
LC2	440	top	155.90	1824.80	6214.32	7521.10	35228.91
	443	bottom	165.20	2218.20	12269.92	8573.00	59857.38

C) Modified Load Combination

Response Modification Factor (R) for LC1 = 1
Response Modification Factor (R) for LC2 = 1

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
Modified LC1	440	top	14287.40	6091.50	20752.47	2271.70	11102.86
	443	bottom	20121.10	7381.60	41091.57	2590.00	18518.06
Modified LC2	440	top	14038.90	1848.80	6340.23	7530.10	35532.25
	443	bottom	19878.20	2242.20	12473.11	8582.00	60189.28

Unreduced Forces (where R = 1)

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
Unreduced LC1	440	top	14287.40	6091.50	20752.47	2271.70	11102.86
	443	bottom	20121.10	7381.60	41091.57	2590.00	18518.06
Unreduced LC2	440	top	14038.90	1848.80	6340.23	7530.10	35532.25
	443	bottom	19878.20	2242.20	12473.11	8582.00	60189.28

D.) Design Forces

Forces	TOP OF COLUMN Mod. LC1	TOP OF COLUMN Mod. LC2	BOTTOM OF COLUMN Mod. LC1	BOTTOM OF COLUMN Mod. LC2	Unit	TOP OF COLUMN Unred. LC1	TOP OF COLUMN Unred. LC2	BOTTOM OF COLUMN Unred. LC1	BOTTOM OF COLUMN Unred. LC2
Long'l Shear	6091.50	1848.80	7381.60	2242.20	kN	6091.50	1848.80	7381.60	2242.20
Long'l Moment	20752.47	6340.23	41091.57	12473.11	kN-m	20752.47	6340.23	41091.57	12473.11
Tran'l Shear	2271.70	7530.10	2590.00	8582.00	kN	2271.70	7530.10	2590.00	8582.00
Tran'l Moment	11102.86	35532.25	18518.06	60189.28	kN-m	11102.86	35532.25	18518.06	60189.28
Max. Axial	14287.40	14038.90	20121.10	19878.20	kN	14287.40	14038.90	20121.10	19878.20
Min. Axial	13478.60	13727.10	19304.90	19547.80	kN	13478.60	13727.10	19304.90	19547.80

A) CONSIDER FORCES AT TOP OF COLUMN

A-1) Slenderness Effect

Direction		From Modified Forces Longitudinal	From Modified Forces Transversal	Unit	From Unreduced Forces Longitudinal	From Unreduced Forces Transversal
Column dimension :	Width, B	25.30	1.26	m	25.30	1.26
	Depth, D	1.26	25.30	m	1.26	25.30
Unsupported length of column, L_u		9.70	9.70	m	9.70	9.70
Compressive strength of concrete, f'_c		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, A_g = BD		31.88	31.88	m²	31.88	31.88
Moment of inertia of column, $I_g = BD^3 / 12$		4.22	1700.40	m^4	4.22	1700.40
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.36	7.30	m	0.36	7.30
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		56.00	2.79		56.00	2.79
Maximum dead load moment, M_{DL}		125.91	303.34	kN-m	125.91	303.34
Maximum total load moment, M_{max}		20752.47	35532.25	kN-m	20752.47	35532.25
$\beta_d = M_{DL} / M_{max}$		0.01	0.01		0.01	0.01
Flexural stiffness of column, $EI = (E_cI_g/2.5) / (1+\beta_d)$		3.97E+07	1.59E+10	kN-m²	3.97E+07	1.59E+10
Factored axial load, $P_u = P_{max}$		14287.40	14038.90	kN	14287.40	14038.90
Critical load, $P_c = \pi^2EI / (kL_u)^2$		943262.76	378824721.48	kN	943262.76	378824721.48
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi\Sigma P_c)] \geq 1.00$		1.02	1.00		1.02	1.00

A-2) Modified Strength Reduction Factor (ϕ)

	From Modified Forces			From Unreduced Forces	
Direction	Longitudinal	Transversal	Unit	Longitudinal	Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	448.19	440.39	Kpa	448.19	440.39
20% of compressive strength of concrete, $0.20f'_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.86	0.86		0.86	0.86

A-3) Nominal Design Forces At Top Of Column

	MODIFIED FORCES			UNREDUCED FORCES	
Forces	LC1	LC2	Unit	LC1	LC2
Long'l M_u (M_x)	24546.18	7332.10	kN-m	24546.18	7332.10
Tran'l M_u (M_y)	13132.55	41090.92	kN-m	13132.55	41090.92
P_{Umax}	16533.57	16234.29	kN	16533.57	16234.29
P_{Umin}	15597.62	15873.73	kN	15597.62	15873.73
P_{DL}	13883.00		kN	13883.00	

... design and investigate using PCACOL Program...

B) CONSIDER FORCES AT BOTTOM OF COLUMN

B-1) Slenderness Effect

		From Modified Forces			From Unreduced Forces	
Direction		Longitudinal	Transversal	Unit	Longitudinal	Transversal
Column dimension :	Width, B	25.30	1.26	m	25.30	1.26
	Depth, D	1.26	25.30	m	1.26	25.30
Unsupported length of column, L_u		9.70	9.70	m	9.70	9.70
Compressive strength of concrete, f'_c		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, A_g = BD		31.88	31.88	m²	31.88	31.88
Moment of inertia of column, $I_g = BD^3 / 12$		4.22	1700.40	m^4	4.22	1700.40
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.36	7.30	m	0.36	7.30
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		56.00	2.79		56.00	2.79
Maximum dead load moment, M_{DL}		203.18	331.90	kN-m	203.18	331.90
Maximum total load moment, M_{max}		41091.57	60189.28	kN-m	41091.57	60189.28
$\beta_d = M_{DL} / M_{max}$		0.00	0.01		0.00	0.01
Flexural stiffness of column, $EI = (E_cI_g/2.5) / (1+\beta_d)$		3.97E+07	1.59E+10	kN-m²	3.97E+07	1.59E+10
Factored axial load, $P_u = P_{max}$		20121.10	19878.20	kN	20121.10	19878.20
Critical load, $P_c = \pi^2EI / (kL_u)^2$		944316.58	378824721.48	kN	944316.58	378824721.48
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi\Sigma P_c)] \geq 1.00$		1.03	1.00		1.03	1.00

B-2) Modified Strength Reduction Factor (ϕ)

	From Modified Forces			From Unreduced Forces	
Direction	Longitudinal	Transversal	Unit	Longitudinal	Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	631.19	623.57	Kpa	631.19	623.57
20% of compressive strength of concrete, $0.20f'_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.85	0.85		0.85	0.85

B-3) Nominal Design Forces At Bottom Of Column

	MODIFIED FORCES			UNREDUCED FORCES	
Forces	LC1	LC2	Unit	LC1	LC2
Long'l M_u (M_x)	49889.82	14673.37	kN-m	49889.82	14673.37
Tran'l M_u (M_y)	22483.02	70806.70	kN-m	22483.02	70806.70
P_{Umax}	23685.68	23382.97	kN	23685.68	23382.97
P_{Umin}	22724.89	22994.32	kN	22724.89	22994.32
P_{DL}	19713.00		kN	19713.00	

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CAPACITY-DEMAND RATIO OF EXISTING PIER WALL (LATEST CODE)

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13:48:18 Licensed to: KEI, Pasig City, PI PIER1BOT

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===
Computer program for the Strength Design of Reinforced Concrete Sections
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General Information:
====================

File Name: C:\MSNAVAL\PASIG--3\PASIG--1\JONES\DESIGN\NEWCODE\PIER1BOT.COL
Project: PASIG-MARIKINA
Column: Engineer: msn
Code: ACI 318-95 Units: Metric

Run Option: Investigation Slenderness: Not considered
Run Axis: Biaxial Column Type: Structural

Material Properties:
====================

f'c = 25 MPa fy = 226 MPa
Ec = 23500 MPa Es = 200000 MPa
fc = 21.25 MPa Rupture strain = Infinity
Ultimate strain = 0.003 mm/mm
Beta1 = 0.85

Section:
========

Rectangular: Width = 25290 mm Depth = 1830 mm

Gross section area, Ag = 4.62807e+007 mm^2
Ix = 1.29158e+013 mm^4 Iy = 2.4667e+015 mm^4
Xo = 0 mm Yo = 0 mm

Reinforcement:
==============

Rebar Database: CSA G30.18

Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)
# 10	11	100	# 15	16	200	# 20	20	300
# 25	25	500	# 30	30	700	# 35	36	1000
# 45	44	1500	# 55	56	2500			

Confinement: User-defined; #10 ties with #0 bars, #10 with larger bars.
phi(a) = 1, phi(b) = 1, phi(c) = 1

Layout: Rectangular
Pattern: Sides Different (Cover to transverse reinforcement)
Total steel area, As = 34800 mm^2 at 0.08%

	Top	Bottom	Left	Right
Bars	58 #20	58 #20	0 #15	0 #15
Cover(mm)	50	50	50	50

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)
===

No.	Pu kN	Mux kN-m	Muy kN-m	fMnx kN-m	fMny kN-m	fMn/Mu
1	23685.7	49889.8	22483.0	27899.0	12580.5	0.559
2	22724.9	49889.8	22483.0	27075.7	12244.1	0.543
3	23383.0	14673.4	70806.7	27391.9	132790.4	1.875
4	22994.3	14673.4	70806.7	27068.5	129941.6	1.836
5	19713.0	0.0	0.0	24496.2	3.3	999.999

*** Program completed as requested! ***

2.00 DESIGN OF PIER COLUMN, (P2)

2.1 MATERIAL AND SPECIFICATIONS

A) Concrete

Compressive strength of concrete, f'c	=	25.00 Mpa
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$	=	23650.00 Mpa
Concrete cover, cc	=	0.05 m

B) Reinforcing Steel

Tensile strength of reinforcing steel, f_y	=	275.00 Mpa
Modulus of elasticity of reinforcing steel, E_s	=	200000.00 Mpa
Main bar diameter, d_b	=	20.00 mm
Diameter of ties, d_s	=	16.00 mm

2.2 COLUMN PROPERTIES

Column dimension: (with respect to long'l direction of bridge)

Column width, B	=	26.30 m
Column depth, D	=	1.86 m

Strength reduction factor, ϕ :

1) For moment magnification factor	=	0.70
2) For lateral reinforcement	=	0.85

Unsupported length of column, L_u :

1) At longitudinal direction	=	11.56 m
2) At transversal direction	=	11.56 m

Clear height of column, H

1) At longitudinal direction	=	9.66 m
2) At transversal direction	=	9.66 m

2.3 ELASTIC FORCES FROM DYNAMIC ANALYSIS

Location	Member Number	Loading	Joint Number	Axial (kN)	Shear V_y (kN)	Shear V_z (kN)	Torsion (kN-m)	Moment M_y (kN-m)	Moment M_z (kN-m)
UPPER 1/3 OF COLUMN	1451	1	536	11973.00	42.00	-1.00	-17.19	-326.62	-220.60
			537	-14006.00	-42.00	1.00	17.19	329.08	296.65
		2	536	277.00	3528.00	6.00	3.70	102.12	11414.31
			537	277.00	3528.00	6.00	3.70	104.39	16967.69
		3	536	69.00	3.00	7079.00	2731.73	35596.68	28.95
			537	69.00	3.00	7079.00	2731.73	48131.72	24.23
MIDDLE 1/3 OF COLUMN	1452	1	537	14006.00	42.00	-1.00	-17.19	-329.08	-296.65
			538	-16040.00	-42.00	1.00	17.19	331.54	372.70
		2	537	277.00	4406.00	6.00	3.70	104.39	16967.69
			538	277.00	4406.00	6.00	3.70	107.73	23919.94
		3	537	81.00	8.00	7513.00	2731.73	48131.72	24.23
			538	81.00	8.00	7513.00	2731.73	61272.82	10.58
LOWER 1/3 OF COLUMN	1453	1	538	16040.00	42.00	-1.00	-17.19	-331.54	-372.70
			539	-18072.00	-42.00	1.00	17.19	334.00	448.73
		2	538	278.00	5038.00	6.00	3.70	107.73	23919.94
			539	278.00	5038.00	6.00	3.70	112.20	32040.71
		3	538	89.00	11.00	7882.00	2731.73	61272.82	10.58
			539	89.00	11.00	7882.00	2731.73	74975.77	11.98

Note :

1) Loading #1 is "Dead Load". From ADAPT Program

2) Loading #2 is "Seismic Load at Longitudinal Direction". From STAAD Program

3) Loading #3 is "Seismic Load at Transversal Direction". From STAAD Program

4) Joint #536 is at top of column.

5) Joint #539 is at bottom of column.

TABULATION OF TOP AND BOTTOM COLUMN FORCES DUE TO THE CORRESPONDING LOAD CASES

A) Basic Loading

Loading	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
Dead Load	536	top	11973.00	42.00	220.60	1.00	326.62
	539	bottom	18072.00	42.00	448.73	1.00	334.00
Long'l Earthquake	536	top	277.00	3528.00	11414.31	6.00	102.12
	539	bottom	278.00	5038.00	32040.71	6.00	112.20
Tran'l Earthquake	536	top	69.00	3.00	28.95	7079.00	35596.68
	539	bottom	89.00	11.00	11.98	7882.00	74975.77

CAPACITY-DEMAND RATIO OF EXISTING PIER WALL (LATEST CODE)

B) Load Combination

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
LC1	536	top	297.70	3528.90	11423.00	2129.70	10781.13
	539	bottom	304.70	5041.30	32044.30	2370.60	22604.93
LC2	536	top	152.10	1061.40	3453.24	7080.80	35627.32
	539	bottom	172.40	1522.40	9624.19	7883.80	75009.43

C) Modified Load Combination

Response Modification Factor (R) for LC1 = **1**

Response Modification Factor (R) for LC2 = **1**

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
Modified LC1	536	top	12270.70	3570.90	11643.60	2130.70	11107.75
	539	bottom	18376.70	5083.30	32493.04	2371.60	22938.92
Modified LC2	536	top	12125.10	1103.40	3673.85	7081.80	35953.94
	539	bottom	18244.40	1564.40	10072.92	7884.80	75343.43

Unreduced Forces (where R = 1)

Load Combination	Joint No.	Location	Axial (kN)	@ LONGITUDINAL DIRECTION Shear Vy (kN)	@ LONGITUDINAL DIRECTION Moment Mz (kN-m)	@ TRANSVERSAL DIRECTION Shear Vz (kN)	@ TRANSVERSAL DIRECTION Moment My (kN-m)
Unreduced LC1	536	top	12270.70	3570.90	11643.60	2130.70	11107.75
	539	bottom	18376.70	5083.30	32493.04	2371.60	22938.92
Unreduced LC2	536	top	12125.10	1103.40	3673.85	7081.80	35953.94
	539	bottom	18244.40	1564.40	10072.92	7884.80	75343.43

D.) Design Forces

	TOP OF COLUMN		BOTTOM OF COLUMN			TOP OF COLUMN		BOTTOM OF COLUMN	
Forces	Mod. LC1	Mod. LC2	Mod. LC1	Mod. LC2	Unit	Unred. LC1	Unred. LC2	Unred. LC1	Unred. LC2
Long'l Shear	3570.90	1103.40	5083.30	1564.40	kN	3570.90	1103.40	5083.30	1564.40
Long'l Moment	11643.60	3673.85	32493.04	10072.92	kN-m	11643.60	3673.85	32493.04	10072.92
Tran'l Shear	2130.70	7081.80	2371.60	7884.80	kN	2130.70	7081.80	2371.60	7884.80
Tran'l Moment	11107.75	35953.94	22938.92	75343.43	kN-m	11107.75	35953.94	22938.92	75343.43
Max. Axial	12270.70	12125.10	18376.70	18244.40	kN	12270.70	12125.10	18376.70	18244.40
Min. Axial	11675.30	11820.90	17767.30	17899.60	kN	11675.30	11820.90	17767.30	17899.60

A) CONSIDER FORCES AT TOP OF COLUMN

A-1) Slenderness Effect

		From Modified Forces			From Unreduced Forces	
Direction		Longitudinal	Transversal	Unit	Longitudinal	Transversal
Column dimension :	Width, B	26.30	1.26	m	26.30	1.26
	Depth, D	1.26	26.30	m	1.26	26.30
Unsupported length of column, L_u		11.56	11.56	m	11.56	11.56
Compressive strength of concrete, f'_c		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, A_g = BD		33.14	33.14	m²	33.14	33.14
Moment of inertia of column, $I_g = BD^3 / 12$		4.38	1910.10	m^4	4.38	1910.10
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.36	7.59	m	0.36	7.59
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		66.74	3.20		66.74	3.20
Maximum dead load moment, M_{DL}		220.60	326.62	kN-m	220.60	326.62
Maximum total load moment, M_{max}		11643.60	35953.94	kN-m	11643.60	35953.94
$\beta_d = M_{DL} / M_{max}$		0.02	0.01		0.02	0.01
Flexural stiffness of column, $EI = (E_c I_g/2.5) / (1+\beta_d)$		4.07E+07	1.79E+10	kN-m²	4.07E+07	1.79E+10
Factored axial load, $P_u = P_{max}$		12270.70	12125.10	kN	12270.70	12125.10
Critical load, $P_c = \pi^2 EI / (kL_u)^2$		681665.86	299620686.61	kN	681665.86	299620686.61
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi\Sigma P_c)] \geq 1.00$		1.03	1.00		1.03	1.00

A-2) Modified Strength Reduction Factor (ϕ)

Direction	From Modified Forces Longitudinal	From Modified Forces Transversal	Unit	From Unreduced Forces Longitudinal	From Unreduced Forces Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	370.29	365.90	Kpa	370.29	365.90
20% of compressive strength of concrete, $0.20f'_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.87	0.87		0.87	0.87

A-3) Nominal Design Forces At Top Of Column

Forces	MODIFIED FORCES LC1	MODIFIED FORCES LC2	Unit	UNREDUCED FORCES LC1	UNREDUCED FORCES LC2
Long'l M_u (M_x)	13730.75	4219.52	kN-m	13730.75	4219.52
Tran'l M_u (M_y)	13098.84	41294.19	kN-m	13098.84	41294.19
P_{Umax}	14098.15	13925.24	kN	14098.15	13925.24
P_{Umin}	13414.08	13575.88	kN	13414.08	13575.88
P_{DL}	11973.00		kN	11973.00	

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B) CONSIDER FORCES AT BOTTOM OF COLUMN

B-1) Slenderness Effect

Direction		From Modified Forces Longitudinal	From Modified Forces Transversal	Unit	From Unreduced Forces Longitudinal	From Unreduced Forces Transversal
Column dimension :	Width, B	26.30	1.26	m	26.30	1.26
	Depth, D	1.26	26.30	m	1.26	26.30
Unsupported length of column, L_u		11.56	11.56	m	11.56	11.56
Compressive strength of concrete, f'_c		25.00	25.00	Mpa	25.00	25.00
Modulus of elasticity of concrete, $E_c = 4730(f'_c)^{0.50}$		23650.00	23650.00	Mpa	23650.00	23650.00
Gross area of column, $A_g = BD$		33.14	33.14	m²	33.14	33.14
Moment of inertia of column, $I_g = BD^3 / 12$		4.38	1910.10	m^4	4.38	1910.10
Radius of gyration, $r = (I_g/A_g)^{0.50}$		0.36	7.59	m	0.36	7.59
Effective length factor, k		2.10	2.10		2.10	2.10
kL_u/r		66.74	3.20		66.74	3.20
Maximum dead load moment, M_{DL}		448.73	334.00	kN-m	448.73	334.00
Maximum total load moment, M_{max}		32493.04	75343.43	kN-m	32493.04	75343.43
$\beta_d = M_{DL} / M_{max}$		0.01	0.01		0.01	0.01
Flexural stiffness of column, $EI = (E_cI_g/2.5) / (1+\beta_d)$		4.09E+07	1.79E+10	kN-m²	4.09E+07	1.79E+10
Factored axial load, $P_u = P_{max}$		18376.70	18244.40	kN	18376.70	18244.40
Critical load, $P_c = \pi^2 EI / (kL_u)^2$		685119.22	299620686.61	kN	685119.22	299620686.61
For members with ties as lateral reinforcement, ϕ		0.70	0.70		0.70	0.70
$\delta_s = 1 / [1-(\Sigma P_u/\phi\Sigma P_c)] \geq 1.00$		1.04	1.00		1.04	1.00

B-2) Modified Strength Reduction Factor (ϕ)

Direction	From Modified Forces Longitudinal	From Modified Forces Transversal	Unit	From Unreduced Forces Longitudinal	From Unreduced Forces Transversal
Maximum axial stress, $\sigma_{Pmax} = P_{max}/A_g$	554.55	550.56	Kpa	554.55	550.56
20% of compressive strength of concrete, $0.20f'_c$	5000.00	5000.00	Kpa	5000.00	5000.00
Modified strength reduction factor, $\phi = 0.90 - 0.40[\sigma_{Pmax}/(0.20f'c)] \geq 0.50$	0.86	0.86		0.86	0.86

B-3) Nominal Design Forces At Bottom Of Column

Forces	MODIFIED FORCES LC1	MODIFIED FORCES LC2	Unit	UNREDUCED FORCES LC1	UNREDUCED FORCES LC2
Long'l M_u (M_x)	39488.42	11769.07	kN-m	39488.42	11769.07
Tran'l M_u (M_y)	27877.42	88030.27	kN-m	27877.42	88030.27
P_{Umax}	21477.24	21314.66	kN	21477.24	21314.66
P_{Umin}	20765.02	20911.84	kN	20765.02	20911.84
P_{DL}	18072.00		kN	18072.00	

... design and investigate using PCACOL Program...

CAPACITY-DEMAND RATIO OF EXISTING PIER WALL (LATEST CODE)

02/21/04 PCACOL V3.00 - PORTLAND CEMENT ASSOCIATION - Page 1
13:47:10 Licensed to: KEI, Pasig City, PI PIER2BOT

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Computer program for the Strength Design of Reinforced Concrete Sections

02/21/04 PCACOL V3.00 - PORTLAND CEMENT ASSOCIATION - Page 2
13:47:10 Licensed to: KEI, Pasig City, PI PIER2BOT

General Information:

File Name: C:\MSNAVAL\PASIG--3\PASIG--1\JONES\DESIGN\NEWCODE\PIER2BOT.COL
Project: PASIG-MARIKINA
Column: Engineer: msn
Code: ACI 318-95 Units: Metric

Run Option: Investigation Slenderness: Not considered
Run Axis: Biaxial Column Type: Structural

Material Properties:

f'c = 25 MPa fy = 226 MPa
Ec = 23500 MPa Es = 200000 MPa
fc = 21.25 MPa Rupture strain = Infinity
Ultimate strain = 0.003 mm/mm
Beta1 = 0.85

Section:

Rectangular: Width = 25290 mm Depth = 1830 mm

Gross section area, Ag = 4.62807e+007 mm^2
Ix = 1.29158e+013 mm^4 Iy = 2.4667e+015 mm^4
Xo = 0 mm Yo = 0 mm

Reinforcement:

Rebar Database: CSA G30.18

Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)	Size	Diam (mm)	Area (mm^2)
# 10	11	100	# 15	16	200	# 20	20	300
# 25	25	500	# 30	30	700	# 35	36	1000
# 45	44	1500	# 55	56	2500			

Confinement: User-defined; #10 ties with #0 bars, #10 with larger bars.
phi(a) = 1, phi(b) = 1, phi(c) = 1

Layout: Rectangular
Pattern: Sides Different (Cover to transverse reinforcement)
Total steel area, As = 34800 mm^2 at 0.08%

	Top	Bottom	Left	Right
Bars	58 #20	58 #20	0 #15	0 #15
Cover(mm)	50	50	50	50

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)

No.	Pu kN	Mux kN-m	Muy kN-m	fMnx kN-m	fMny kN-m	fMn/Mu
1	21477.2	39488.4	27877.4	26001.5	18340.7	0.658
2	20765.0	39488.4	27877.4	25390.0	17899.3	0.643
3	21314.7	11769.1	88030.3	25316.1	189212.6	2.149
4	20911.8	11769.1	88030.3	24969.6	188611.0	2.142
5	18072.0	0.0	0.0	23086.0	3.4	999.999

*** Program completed as requested! ***

CAPACITY-DEMAND RATIO OF EXISTING CAISSON FOUNDATION (LATEST CODE)

BRIDGE NAME : **Jones Bridge**
SUBJECT : **Investigation of Spread Footing**

SUMMARY OF CAPACITY/DEMAND RATIO (LATEST CODE)

LOCATION	CAPACITY (kPa)	DEMAND (kPa)	C/D
PIER 1 (Case I)	300	219.50	1.37
PIER 1 (Case VII)	400	446.44	0.90
PIER 2 (Case I)	300	226.09	1.33
PIER 2 (Case VII)	400	450.57	0.89

PIER 1 (Case I)

Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel...........................	fy :	226	MPa
Factored Axial Load.......................	P_u :	22563	kN
Factored Moment (x)......................	M_ux:	1016.4	kN-m
Factored Moment (y)......................	M_uy:	11508	kN-m
Allowable Soil Bearing Capacity			
	qallow :	300	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length.............................	L :	31.80	m
Footing Thickness..........................	T :	3.00	m
Column Width..............................	b :	4.12	m
Column Thickness........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	20	mm
Rebar Area......................	A :	314.16	mm^2
Other Pertinent Information			
Concrete Cover....................	cc :	100	mm
Effective Depth.....................	d :	2870	mm
Strength Reduction Factor (Flexure)........	ϕf :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	$\beta 1$:	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex_{col} :	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey_{col} :	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B*L)\ [1\pm (6*e_x / L) \pm (6*e_y / B)]$			
Final Eccentricity (x)	ex :	0.510	m
Final Eccentricity (y)	ey :	0.045	m
Corner Soil Pressures	q_1:	171.51	kPa
	q_2:	181.87	kPa
	q_3:	209.14	kPa
	q_4:	219.50	kPa

PIER 1 (Case VII)

Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel...........................	fy :	226	MPa
Factored Axial Load.......................	P_u :	20121	kN
Factored Moment (x)......	M_ux:	41092	kN-m
Factored Moment (y)......................	M_uy:	18518	kN-m
Allowable Soil Bearing Capacity			
	qultimate :	400	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length.............................	L :	31.80	m
Footing Thickness..........................	T :	3.00	m
Column Width..............................	b :	4.12	m
Column Thickness........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	25	mm
Rebar Area......................	A :	490.87	mm^2
Other Pertinent Information			
Concrete Cover....................	cc :	100	mm
Effective Depth.....................	d :	2862.5	mm
Strength Reduction Factor (Flexure)........	ϕf :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	$\beta 1$:	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex_{col} :	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey_{col} :	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B*L)\ [1\pm (6*e_x / L) \pm (6*e_y / B)]$			
Final Eccentricity (x)	ex :	0.920	m
Final Eccentricity (y)	ey :	2.042	m
Corner Soil Pressures	q_1:	-70.48	kPa
	q_2:	381.15	kPa
	q_3:	-5.20	kPa
	q_4:	446.44	kPa

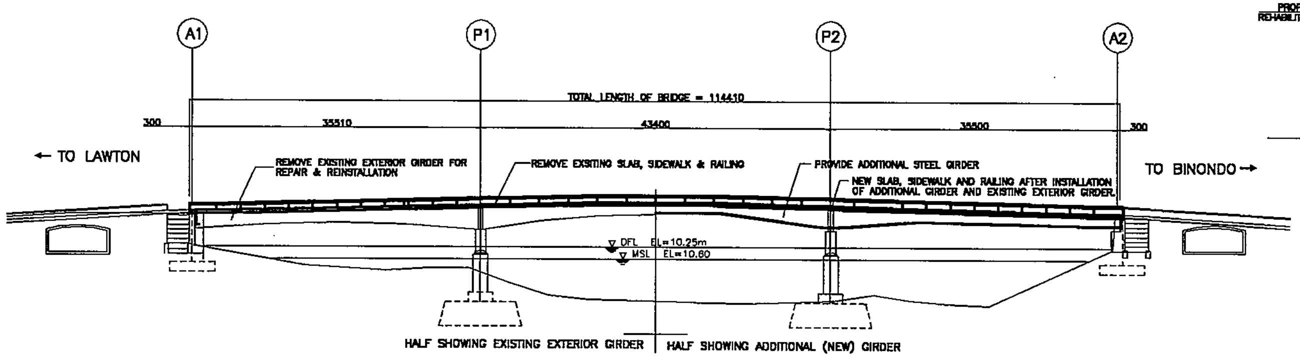
CAPACITY-DEMAND RATIO OF EXISTING CAISSON FOUNDATION (LATEST CODE)

PIER 2 (Case I)

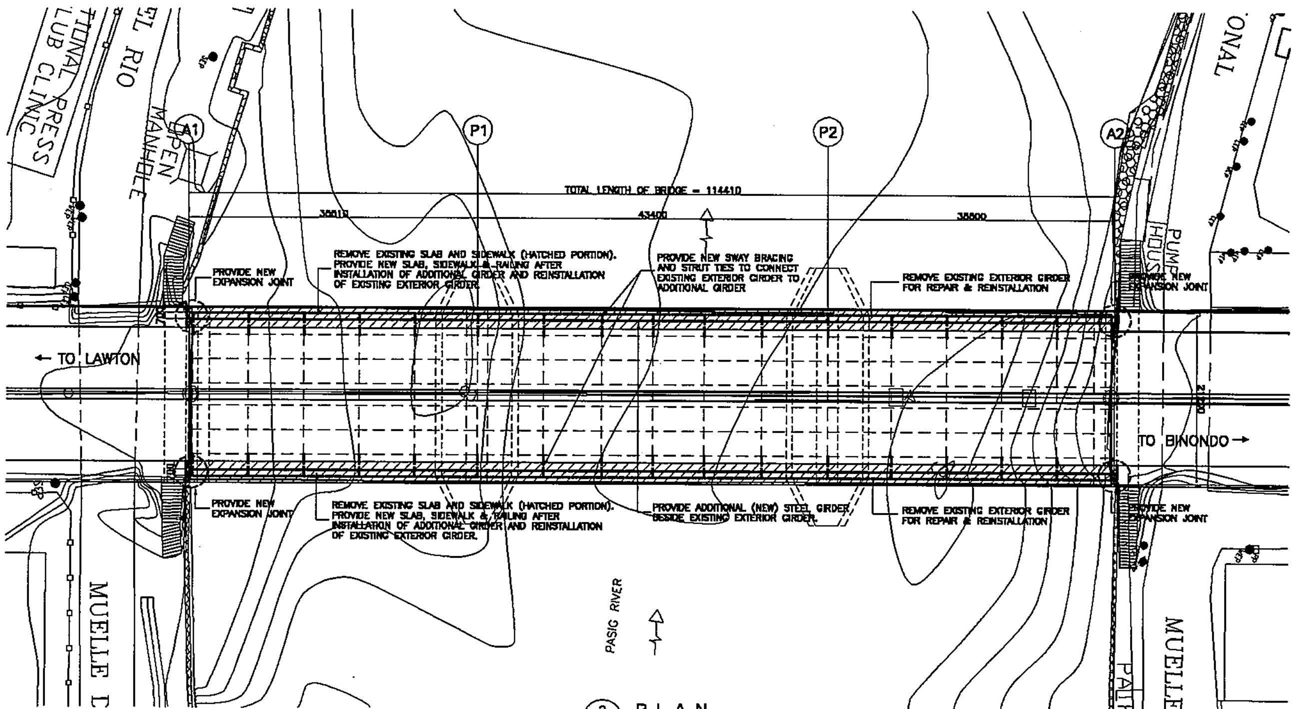
Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel...........................	fy :	226	MPa
Factored Axial Load.......................	P_u :	25731	kN
Factored Moment (x).....................	M_ux:	752.04	kN-m
Factored Moment (y).....................	M_uy:	11487	kN-m
Allowable Soil Bearing Capacity			
	qallow :	300	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length..............................	L :	31.80	m
Footing Thickness..........................	T :	3.00	m
Column Width...............................	b :	4.12	m
Column Thickness.........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	20	mm
Rebar Area......................	A :	314.16	mm^2
Other Pertinent Information			
Concrete Cover....................	cc :	100	mm
Effective Depth....................	d :	2870	mm
Strength Reduction Factor (Flexure)........	ϕ f :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	β1 :	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex $_{col}$:	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey $_{col}$:	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B{*}L)\ [1 \pm (6{*}e_x / L) \pm (6{*}e_y / B)]$			
Final Eccentricity (x)	ex :	0.446	m
Final Eccentricity (y)	ey :	0.029	m
Corner Soil Pressures	q_1:	184.45	kPa
	q_2:	191.51	kPa
	q_3:	219.03	kPa
	q_4:	226.09	kPa

PIER 2 (Case VII)

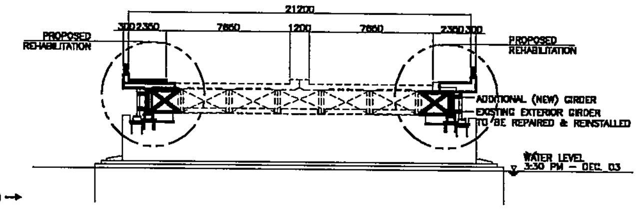
Design Data			
Design Strengths / Load			
Concrete	fc' :	17	MPa
Reinforcing Steel...........................	fy :	226	MPa
Factored Axial Load.......................	P_u :	20765	kN
Factored Moment (x).....................	M_ux:	39488	kN-m
Factored Moment (y).....................	M_uy:	27877	kN-m
Allowable Soil Bearing Capacity			
	qultimate :	400	kPa
Footing & Column Dimensions			
Footing Width...............................	B :	10.20	m
Footing Length..............................	L :	31.80	m
Footing Thickness..........................	T :	3.00	m
Column Width...............................	b :	4.12	m
Column Thickness.........................	t :	27.60	m
Rebar Diameters / Area			
Rebar Dia.........................	$\phi_{(m)}$:	25	mm
Rebar Area......................	A :	490.87	mm^2
Other Pertinent Information			
Concrete Cover....................	cc :	100	mm
Effective Depth....................	d :	2862.5	mm
Strength Reduction Factor (Flexure)........	ϕ f :	0.9	
Strength Reduction Factor (Shear)...........	ϕ_s :	0.85	
	β1 :	0.85	
Footing Founding Depth	H :	5.00	m
Unit Wt. of Soil	γs :	18.00	kN/m^3
Unit Wt. of Concrete	γc :	24.50	kN/m^3
Wt. of Footing	W_{ftg} :	23840.46	kN
Wt. of Overburden Soil	W_s :	7583.33	kN
Load Factor used for DL	:	1.00	
Col. Ecc. (x) fr. Cen. of Ftg.	ex $_{col}$:	0	m
Col. Ecc. (y) fr. Cen. of Ftg.	ey $_{col}$:	0	m
Design Calculations			
$q_{actual} = (P_{uT} / B{*}L)\ [1 \pm (6{*}e_x / L) \pm (6{*}e_y / B)]$			
Final Eccentricity (x)	ex :	1.342	m
Final Eccentricity (y)	ey :	1.902	m
Corner Soil Pressures	q_1:	-70.65	kPa
	q_2:	354.34	kPa
	q_3:	25.58	kPa
	q_4:	450.57	kPa



1 ELEVATION
SCALE 1:300



2 PLAN
SCALE 1:300



3 SECTION AT PIER
SCALE 1:150

GENERAL NOTES :

1. CONCRETE

COMPRESSIVE STRENGTH OF CONCRETE, fc' = 20.7 Mpa

2. REINFOCEMENT

ULTIMATE STRENGTH OF REINFORCING STEEL; fy = 275 Mpa

3. STRUCTURAL STEEL

STEEL GIRDER, Fy = 248 Mpa (A36)

4. SCOPE OF WORKS :

4.1. REMOVAL OF EXISTING SIDEWALK AND RAILING.

4.2. INSTALLATION OF NEW GIRDER AS DETAILED.

4.3. REMOVAL OF EXISTING EXTERIOR GIRDER, REPAIR AND REINSTALL TO BE USED AS PROTECTION FOR VESSEL COLLISION.

4.4. INSTALLATION OF SWAY BRACES AND TIE PLATES.

4.5. CONSTRUCTION OF NEW SLAB, SIDEWALKS, RAILINGS AND DOWNSPOUT.

4.6. CLEANING AND PAINTING OF INSTALLED STEEL COMPONENTS.

5. REMOVAL OF EXISTING SLAB, SIDEWALK AND RAILING.

5.1. DURING THE REMOVAL OF EXISTING SLAB, SIDEWALK AND RAILING, THE CONTRACTOR SHOULD PROVIDE SAFETY MEASURES UNDERNEATH AND OVER THE PORTION OF THE BRIDGE WHICH IS DUE FOR CONSTRUCTION. SAFETY NETS SHOULD ALSO BE PROVIDED TO CONTAIN FALLING DEBRIS INTO THE RIVER.

5.2. REINFORCEMENT FROM THE EXISTING SLAB SHOULD PROTRUDE TO THE NEW SLAB OF AT LEAST 600 mm IN LENGTH. THE EDGE OF EXISTING SLAB SHOULD BE INTENTIONALLY ROUGHENED TO AN INTENSITY AND SHOULD BE PROPERLY CLEANED BEFORE POURING THE NEW CONCRETE.

6. TRAFFIC FLOW DURING CONSTRUCTION

6.1. THE CONTRACTOR SHOULD SUBMIT TO THE AUTHORITIES A SCHEMATIC TRAFFIC MANAGEMENT FLOW THAT WILL BE IMPLEMENTED DURING CONSTRUCTION.

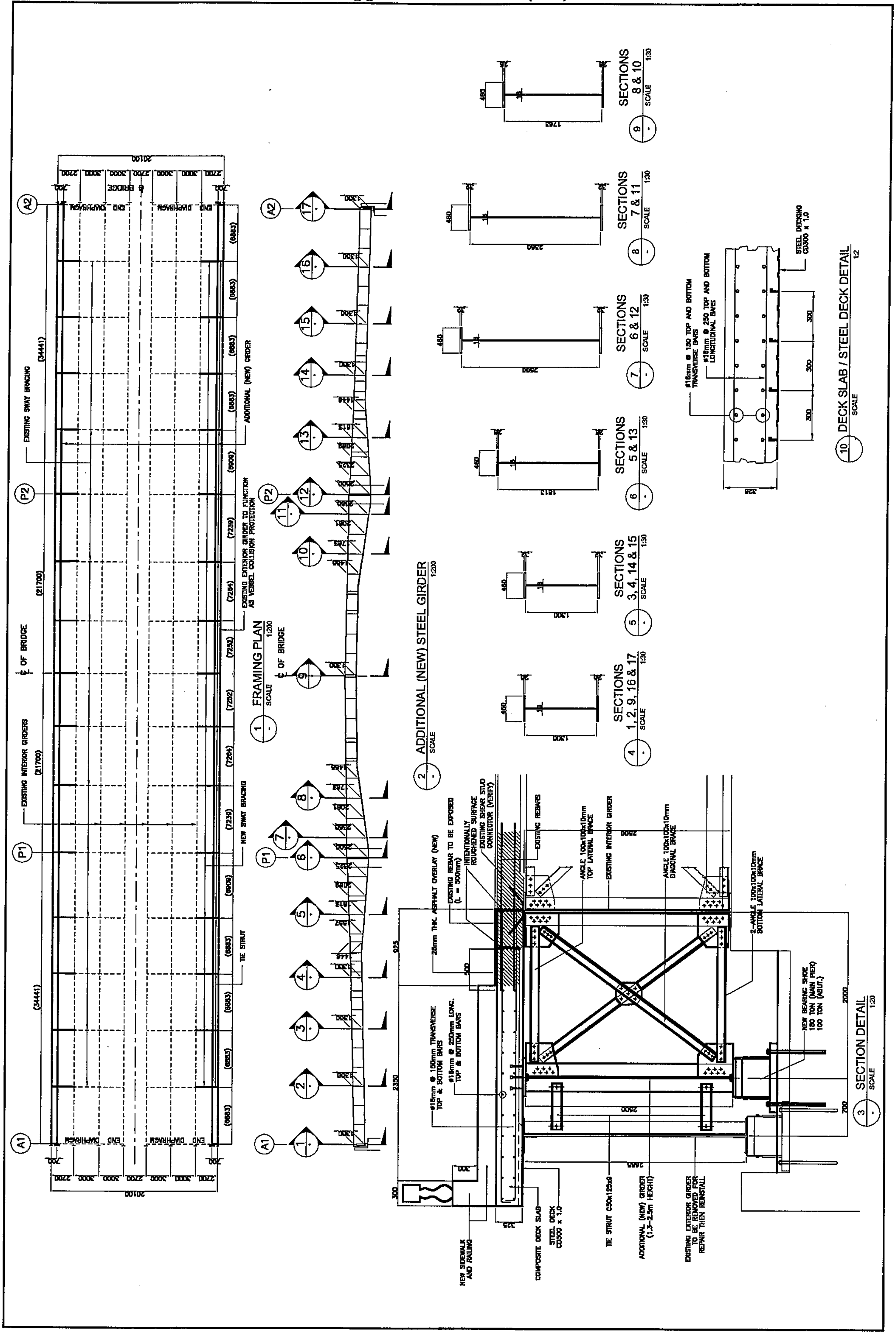
7. SIGNS AND SAFETY

7.1. WARNING SIGNS AND SAFETY MEASURES SHOULD BE PROPERLY INSTALLED SO AS TO AVOID ANY ACCIDENT DURING CONSTRUCTION.

SUMMARY OF QUANTITIES

ITEM	DESCRIPTION	UNIT	QUANTITY
A.	STEEL STRUCTURES		
1.0	Steel I-Girder (1.3m – 2.5m Height) (A36)	kgs	132,700
2.0	Steel Plate 150 x (1.3m – 2.5m) x 12.5	kgs	9,494
3.0	Shear Connectors	kgs	2,364
4.0	Angle Bar 100 x 100 x 10 mm Braces	kgs	5,180
5.0	Gusset Plates 12.5 thk	kgs	2,582
6.0	Channel 125 x 50 x 9 mm Tie-Strut	kgs	734
7.0	#22 Bolts, Nuts and Washers	kgs	682
8.0	Bearing Shoe	each	8
B.	CONCRETE DECK		
1.0	Concrete Deck Slab, fc' = 20.7	m3	268
2.0	Concrete Sidewalk, fc' = 20.7	m3	158
3.0	Asphalt Overlay 25mm Thick	sm	138
4.0	Deformed Bars (Slab & Sidewalk Reinforcement)	kgs	84,200
5.0	Steel Decking CD300 x 1.0 (fc' = 20.7)	sm	802
C.	OTHERS		
1.0	Steel Pipe Downspout, #100 mm dia	LM	196
2.0	Decorative Railing	LM	230
3.0	Expansion Joint	LM	18.8

JONES BRIDGE PROPOSED REHABILITATION



JONES BRIDGE PROPOSED REHABILITATION

DESIGN OF ADDITIONAL STEEL GIRDER

1.0 DESIGN OF STEEL PLATE GIRDERS (3 CONTINUOUS SPANS)

1.1 MATERIALS AND SPECIFICATIONS

Fy (SMA490), plate g = 335 MPa

Fy (A36) for other ste = 248 MPa

Unit weight of steel, w_s = 77 kN/m^3

1.2 BASIC LAYOUT, DIMENSIONS AND SECTION PROPERTIES

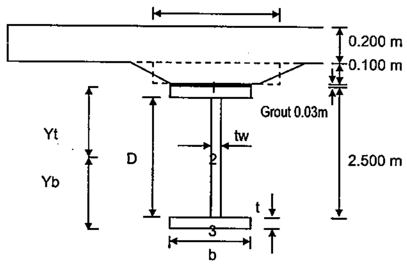
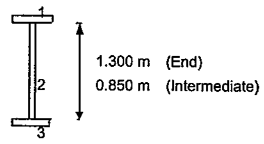


PLATE GIRDER



DIAPHRAGMS

Fy (SMA490)for plate gi	MPa	335
Fb = 0.55 Fy (bending)	MPa	184.3
Fy (A36) for other steel	MPa	248
Fb = 0.55 Fy (bending)	MPa	136.5
Es	MPa	200,000
f'c (slab)	MPa	35
Ec = 5350√f'c	MPa	31,651
n = Es/Ec		6
3n		19

SECTION PROPERTIES

Plate Girder	SECTION	Thickness (t) Top flange (m)	Web (m)	Bot flange (m)	Base (b) or Depth (D) Top flange (m)	Web, D (m)	Bot flange (m)	Ax (m^2)	Yb (m)	Yt (m)	Ix or J (m^4)	Iy (m^4)	Iz (m^4)
End-J29 (J50-End)	1	0.025	0.010	0.025	0.460	1.350	0.460	0.0365	0.700	0.700	0.000005	0.000406	0.01253
J29-J31 (J48-J50)	2	0.025	0.016	0.025	0.460	1.350	0.460	0.0446	0.700	0.700	0.000007	0.00041	0.01376
J31-J32 (J47-J48)	3	0.032	0.016	0.032	0.460	1.350	0.460	0.0510	0.707	0.707	0.000012	0.00052	0.0167
J32-J33 (J46-J47)	4	0.025	0.016	0.025	0.460	1.350	0.460	0.0446	0.700	0.700	0.000007	0.00041	0.0138
J33-J34 (J45-J46)	5	0.025	0.016	0.025	0.460	1.908	0.460	0.0535	0.979	0.979	0.000007	0.00041	0.0302
J34-J35 (J44-J45)	6	0.032	0.016	0.032	0.460	2.500	0.460	0.0694	1.282	1.282	0.000014	0.00052	0.0668
J35-J36 (J43-J44)	7	0.028	0.016	0.028	0.460	2.326	0.460	0.0630	1.191	1.191	0.000010	0.00046	0.0516
J36-J38 (J41-J43)	8	0.025	0.016	0.025	0.460	1.746	0.460	0.0509	0.898	0.898	0.000007	0.00041	0.0246
J38-J39 (J40-J41)	9	0.028	0.016	0.028	0.460	1.300	0.460	0.0466	0.678	0.678	0.000009	0.00046	0.0138
J39-J40	10	0.056	0.019	0.056	0.900	2.444	0.900	0.1472	1.278	1.278	0.000111	0.00681	0.1737
End Diaphragm	11	0.025	0.015	0.025	0.380	1.300	0.380	0.0385	0.675	0.675	0.000005	0.00023	0.0111
Intermediate Diaph.	12	0.025	0.015	0.025	0.250	0.850	0.250	0.0253	0.450	0.450	0.000004	0.00007	0.0069

CHECK AASHTO 10.34 REQUIREMENTS :

Set		1	2	3	4	5	6	7	8	9	10	11	12
Top flange : b/t		18	18	14	18	18	14	16	18	16	16	15	10
b/t < 270 / √fb or 24 =	20	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Bottom flange : b/t		18	18	14	18	18	14	16	18	16	16	15	10
b/t < 270 / √fb or 24 =	20	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Web thickness: tw		0.010	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.019	0.015	0.015
Girders not stiffened longitudinally: tw > D √fb / 1910 =		0.010	0.010	0.010	0.010	0.014	0.018	0.017	0.012	0.009	0.017	0.008	0.005
Girders stiffened longitudinally: tw > D √fb / 3820 =		0.005	0.005	0.005	0.005	0.007	0.009	0.008	0.006	0.005	0.009	0.004	0.003
		Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok

b eff = b min/(n or 3n)

	1/4 Span	12 tmin.	12 tave.	c/c spacing	b min
b min	16.250	2.400	3.000	4.825	2.400

DESIGN OF ADDITIONAL STEEL GIRDER

1.2) SECTION FOR CURBS, BARRIER/RAILING & ASPHALT LOADS

			beff = bmin / 3n (m)	tslab (m)		Ax (m^2)	Yb (m)	Yt (m)	Ix or J (m^4)	Iy (m^4)	Iz (m^4)
		4) Slab	0.142	0.100		0.0142			0.000027		
		5) Slab	0.127	0.200		0.0253			0.000082		
	Set				Total	0.0396	0.146	0.154	0.000109	0.00006	0.0003
Composite Slab-Girder	1					0.0761	1.725	0.800	0.000114	0.00046	0.0482
	2					0.0842	1.627	0.898	0.000116	0.00047	0.0572
	3					0.0906	1.568	0.964	0.000121	0.00058	0.0658
	4					0.0842	1.627	0.898	0.000116	0.00047	0.0572
	5					0.0931	1.698	0.827	0.000116	0.00047	0.0679
	6					0.1090	1.789	0.743	0.000122	0.00058	0.0984
	7					0.1025	1.763	0.765	0.000119	0.00052	0.0847
	8					0.0905	1.673	0.852	0.000116	0.00047	0.0643
	9					0.0861	1.595	0.933	0.000118	0.00051	0.0602
	10					0.1868	1.580	0.976	0.000220	0.00687	0.2239

1.3) SECTION FOR LIVE LOAD

			beff = bmin / n (m)	tslab (m)		Ax (m^2)	Yb (m)	Yt (m)	Ix or J (m^4)	Iy (m^4)	Iz (m^4)
		4) Slab	0.427	0.100		0.0427			0.000121		
		5) Slab	0.380	0.200		0.0760			0.000679		
	Set				Total	0.1187	0.146	0.154	0.000800	0.00156	0.0009
Composite Slab-Girder	1					0.1552	2.207	0.318	0.000806	0.00197	0.0389
	2					0.1633	2.133	0.392	0.000807	0.00197	0.0491
	3					0.1697	2.085	0.447	0.000812	0.00209	0.0593
	4					0.1633	2.133	0.392	0.000807	0.00197	0.0491
	5					0.1722	2.145	0.380	0.000808	0.00197	0.0639
	6					0.1881	2.163	0.369	0.000814	0.00209	0.0993
	7					0.1817	2.160	0.368	0.000810	0.00202	0.0839
	8					0.1696	2.139	0.386	0.000808	0.00197	0.0592
	9					0.1653	2.112	0.416	0.000809	0.00202	0.0523
	10					0.2659	1.914	0.642	0.000912	0.00838	0.2484

DESIGN OF ADDITIONAL STEEL GIRDER

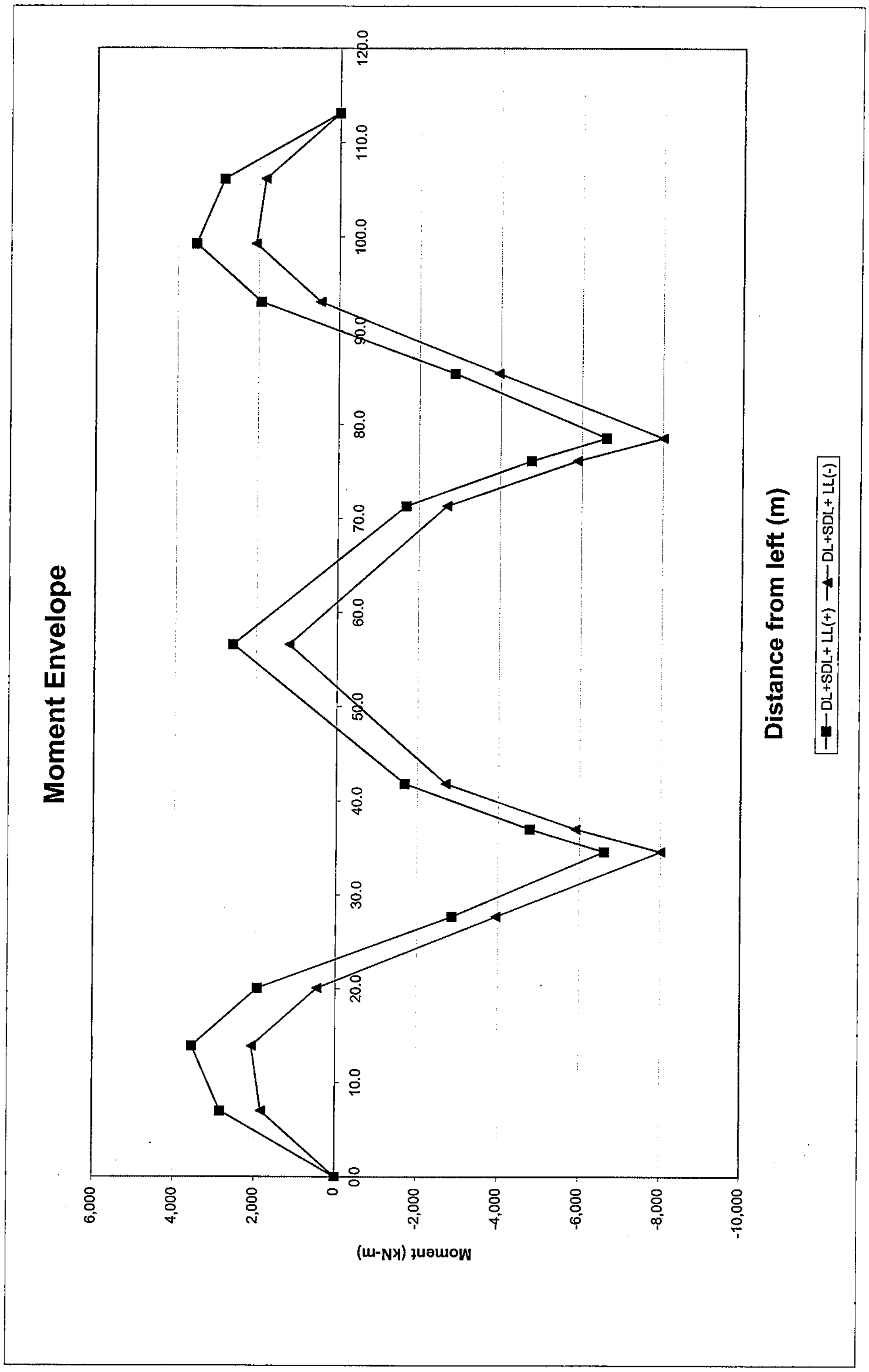
1.3 SUMMARY OF SECTION FORCES

DL = Girder + Slab
SDL = Superimposed Dead Loads (Curb,Barrier/Railing,Asphalt)
LL = Live Load (UCL or TL)
UCL = Uniform and Concentrated Load w/ Impact plus Sidewalk Live Load
TL = Truck Load (HS 20-44)

Max. Moment for Live Load is determined from loading pattern for maximum moment.
Max. Shear for Live Load is determined from loading pattern for maximum shear.

Section		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		SUPPORT					SUPPORT			MID			SUPPORT					SUPPORT
Distance from left:	m	0.000	7.000	13.900	20.090	27.700	34.600	37.010	41.830	56.575	71.320	76.140	78.550	85.450	93.060	99.250	106.150	113.150
MAX. MOMENT (M):																		
DL: Girder+Slab	kN-m	0.00	1,721.00	2,132.00	899.00	-2,830.00	-5,807.00	-4,229.00	-1,728.00	1,385.00	-1,725.00	-4,215.00	-5,803.00	-2,828.00	898.00	2,130.00	1,719.00	0.00
SDL:Curb+Rail+Asphalt	kN-m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DL +SDL	kN-m	0.00	1,721.00	2,132.00	899.00	-2,830.00	-5,807.00	-4,229.00	-1,728.00	1,385.00	-1,725.00	-4,215.00	-5,803.00	-2,828.00	898.00	2,130.00	1,719.00	0.00
LL: Live Load																		
Impact = 15.24/(L+38)		0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209
UCL (Lane load): + M	kN-m	0.00	381.00	612.00	554.00	116.00	0.00	0.00	58.80	547.00	58.40	0.00	0.00	116.00	556.00	612.00	391.00	0.00
- M	kN-m	0.00	-129.00	-241.00	-357.00	-556.00	-897.00	-725.00	-359.00	-299.00	-359.00	-725.00	-897.00	-506.00	-357.00	-241.00	-129.00	0.00
+ V	kN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- V	kN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TL (Truck load): + M	kN-m	0.00	674.00	905.00	748.00	232.00	259.00	206.00	298.00	850.00	293.00	207.00	260.00	220.00	750.00	904.00	688.00	0.00
- M	kN-m	0.00	-157.00	-314.00	-471.00	-668.00	-778.00	-632.00	-536.00	-218.00	-536.00	-639.00	-780.00	-668.00	-472.00	-314.00	-157.00	0.00
+ Mmax	kN-m	0.00	814.71	1,093.93	904.16	280.43	313.07	249.01	360.21	1,027.45	354.17	250.21	314.28	265.93	906.58	1,092.73	831.63	0.00
- Mmax	kN-m	0.00	-189.78	-379.55	-569.33	-807.46	-1,084.26	-876.36	-647.90	-361.42	-647.90	-876.36	-1,084.26	-807.46	-570.54	-379.55	-189.78	0.00
T: Temperature Load	kN-m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAX. SHEAR (V) :																		
DL: Girder+Slab	kN	369.00	173.00	-83.00	-289.00	-532.00	-733.00	615.00	450.00	-22.00	-449.00	-615.00	733.00	561.00	289.00	83.20	-173.00	-369.00
SDL: Curb+Rail+Asphalt	kN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DL+SDL		369.00	173.00	-83.00	-289.00	-532.00	-733.00	615.00	450.00	-22.00	-449.00	-615.00	733.00	561.00	289.00	83.20	-173.00	-369.00
LL: Live Load																		
UCL (Lane load): + V	kN	54.10	56.00	22.60	0.00	0.00	74.74	77.00	79.20	30.70	0.00	0.00	77.80	83.00	68.00	36.40	0.00	0.00
- V	kN	0.00	0.00	-36.40	-68.00	-82.30	-77.00	0.00	0.00	-30.50	-79.20	-75.00	-74.00	0.00	0.00	-22.60	-56.00	-55.10
TL (Truck load): + V	kN	101.00	92.80	51.20	22.00	20.50	121.00	121.00	95.30	55.10	29.10	29.10	121.00	120.00	88.90	53.70	22.60	22.80
- V	kN	-22.80	-22.80	-57.80	-94.40	-121.00	-121.00	-21.91	-21.90	-60.60	-121.00	-122.00	-122.00	-7.58	-25.20	-56.40	-97.00	-102.00
+ Vmax	kN	122.09	112.17	61.89	26.59	24.78	146.26	146.26	115.20	66.60	35.18	35.18	146.26	145.05	107.46	64.91	27.32	27.56
- Vmax	kN	-27.56	-27.56	-69.87	-114.11	-146.26	-146.26	-26.48	-26.47	-73.25	-146.26	-147.47	-147.47	-9.16	-30.46	-68.17	-117.25	-123.29
T: Temperature Load	kN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SIDEWALK LIVE LOAD :																		
Sidewalk LL Moment	kN-m	0.00	307.09	320.39	128.15	-314.34	-1,112.88	-802.22	-326.87	166.84	-320.39	-803.99	-1,119.70	-314.34	131.78	320.39	307.09	0.00
Sidewalk LL Shear	kN	73.74	29.52	-23.13	-54.28	-106.68	-144.23	118.63	83.03	17.29	-81.24	-120.33	145.08	107.53	54.28	23.13	-29.52	-73.71
Load Combination: MOMENT (M)																		
[DL+SDL + LL(+)]	kN-m	0.00	2,842.80	3,546.32	1,931.31	-2,863.91	-6,606.81	-4,782.21	-1,694.65	2,579.29	-1,691.22	-4,768.77	-6,608.42	-2,876.41	1,936.36	3,543.11	2,857.72	0.00
[DL+SDL + LL(-)]	kN-m	0.00	1,838.31	2,072.83	457.82	-3,951.80	-8,004.15	-5,907.58	-2,702.76	1,190.42	-2,693.28	-5,895.34	-8,006.97	-3,949.80	459.24	2,070.83	1,836.31	0.00
[DL+SDL + LL(+)]	kN-m	0.00	2,842.80	3,546.32	1,931.31	-2,863.91	-6,606.81	-4,782.21	-1,694.65	2,579.29	-1,691.22	-4,768.77	-6,608.42	-2,876.41	1,936.36	3,543.11	2,857.72	0.00
[DL+SDL + LL(-)]	kN-m	0.00	1,838.31	2,072.83	457.82	-3,951.80	-8,004.15	-5,907.58	-2,702.76	1,190.42	-2,693.28	-5,895.34	-8,006.97	-3,949.80	459.24	2,070.83	1,836.31	0.00
Load Combination: SHEAR (V)																		
[DL+SDL + LL(+)]	kN	564.82	285.17	-21.11	-262.41	-507.22	-586.74	761.26	565.20	44.60	-413.82	-579.82	879.26	706.05	396.46	148.11	-145.68	-341.44
[DL+SDL + LL(-)]	kN	415.18	145.44	-152.87	-403.11	-678.26	-879.26	588.52	423.53	-95.25	-595.26	-762.47	585.53	551.84	258.54	15.03	-290.25	-492.29
[DL+SDL + LL(+)]	kN	564.82	314.70	-44.24	-316.69	-613.90	-730.97	879.89	648.23	61.89	-495.07	-700.16	1,024.34	813.58	450.74	171.24	-175.21	-415.15
[DL+SDL + LL(-)]	kN	415.18	174.96	-175.99	-457.39	-784.94	-1,023.49	707.14	506.56	-77.96	-676.51	-882.80	730.61	659.37	312.82	38.15	-319.77	-566.01

DESIGN OF ADDITIONAL STEEL GIRDER



DESIGN OF ADDITIONAL STEEL GIRDER

ALLOWABLE BENDING STRESS : (AASHTO Table 10.32.1A)

Laterally-supported comp. flange : Fb = 0.55 Fy 184.25 MPa

Partially-supported comp. flange : Fb = (344,700 Cb / Sxc) (Iyc / Lb) $\sqrt{[0.772\ J / Iyc + 9.87\ (d / Lb)^2]} \le$ 0.55 Fy

Fb = allowable bending stress, MPa Fy = yield strength of steel, MPa

Lb = unbraced length of compression flange, m

Iyc = moment of inertia of compression flange about the vertical axis in the plane of the web, m^4

Sxc = section modulus with respect to compression flange, m^3

d = depth of girder, m

J = $[(bt^3)_c + (bt^3)_t + Dtw^3] / 3$ where b and t represent the flange width and thickness of the compression and tension flange, respectively, m^4

Cb = $1.75 + 1.05\ (M1/M2) + 0.3(M1/M2)^2 \le 2.3$

where M1 is the smaller and M2 the larger end moment in the unbraced segment of the beam

M1/M2 is positive when the moments cause reverse curvature and negative when bent in single curvature

= 1.0 for unbraced cantilevers and for members where the moment within a significant portion of the unbraced segment is greater than or equal to the larger of the segment end moments.

Section		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Distance from left:	m	0.000	7.000	13.900	20.090	27.700	34.600	37.010	41.830	56.575	71.320	76.140	78.550	85.450	93.060	99.250	106.150	113.150
Plate Girder Set		1	2	3	4	5	6	7	8	9	8	7	6	5	4	3	2	1
b1 (top flange)	m	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460
t1 (top flange)	m	0.025	0.025	0.032	0.025	0.025	0.032	0.028	0.025	0.028	0.025	0.028	0.032	0.025	0.025	0.032	0.025	0.025
b2 (bot flange)	m	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460
t2 (bot flange)	m	0.025	0.025	0.032	0.025	0.025	0.032	0.028	0.025	0.028	0.025	0.028	0.032	0.025	0.025	0.032	0.025	0.025
D	m	1.350	1.350	1.350	1.350	1.908	2.500	2.326	1.746	1.300	1.746	2.326	2.500	1.908	1.350	1.350	1.350	1.350
tw	m	0.010	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.010
I	m^4	0.0125	0.0138	0.0167	0.0138	0.0302	0.0668	0.0516	0.0246	0.0138	0.0246	0.0516	0.0668	0.0302	0.0138	0.0167	0.0138	0.0125
Yt	m	0.700	0.700	0.707	0.700	0.979	1.282	1.191	0.898	0.678	0.898	1.191	1.282	0.979	0.700	0.707	0.700	0.700
Yb	m	0.700	0.700	0.707	0.700	0.979	1.282	1.191	0.898	0.678	0.898	1.191	1.282	0.979	0.700	0.707	0.700	0.700
Compression flange location:		Top	Top	Top	Top	Bottom	Bottom	Bottom	Bottom	Top	Bottom	Bottom	Bottom	Bottom	Top	Top	Top	Top
Lb	m	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
Iyc = t b^3/12	m^4	0.000203	0.000203	0.000260	0.000203	0.000203	0.000260	0.000227	0.000203	0.000227	0.000203	0.000227	0.000260	0.000203	0.000203	0.000260	0.000203	0.000203
Sxc = I / Yt or I / Yb	m^4	0.017906	0.019664	0.023627	0.019664	0.030847	0.052140	0.043348	0.027428	0.020383	0.027428	0.043348	0.052140	0.030847	0.019664	0.023627	0.019664	0.017906
d = D+t1+t2	m	1.400	1.400	1.414	1.400	1.958	2.564	2.382	1.796	1.356	1.796	2.382	2.564	1.958	1.400	1.414	1.400	1.400
J	m^4	0.000005	0.000007	0.000012	0.000007	0.000007	0.000013	0.000010	0.000007	0.000009	0.000007	0.000010	0.000013	0.000007	0.000007	0.000012	0.000007	0.000005
Use Cb		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Allowable stress: Fb	MPa	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25

DESIGN OF ADDITIONAL STEEL GIRDER

1.4 CHECK OF BENDING STRESS

Stress at Top of Girder : $f_{Top} = - M\ Yt / I$ | Yt = distance from top fiber to neutral axis | Sign Convention: Tension (+)

Stress at Bottom of Girder : $f_{Bot} = M\ Yb / I$ | Yb = distance from bottom fiber to neutral axis | Compression (-)

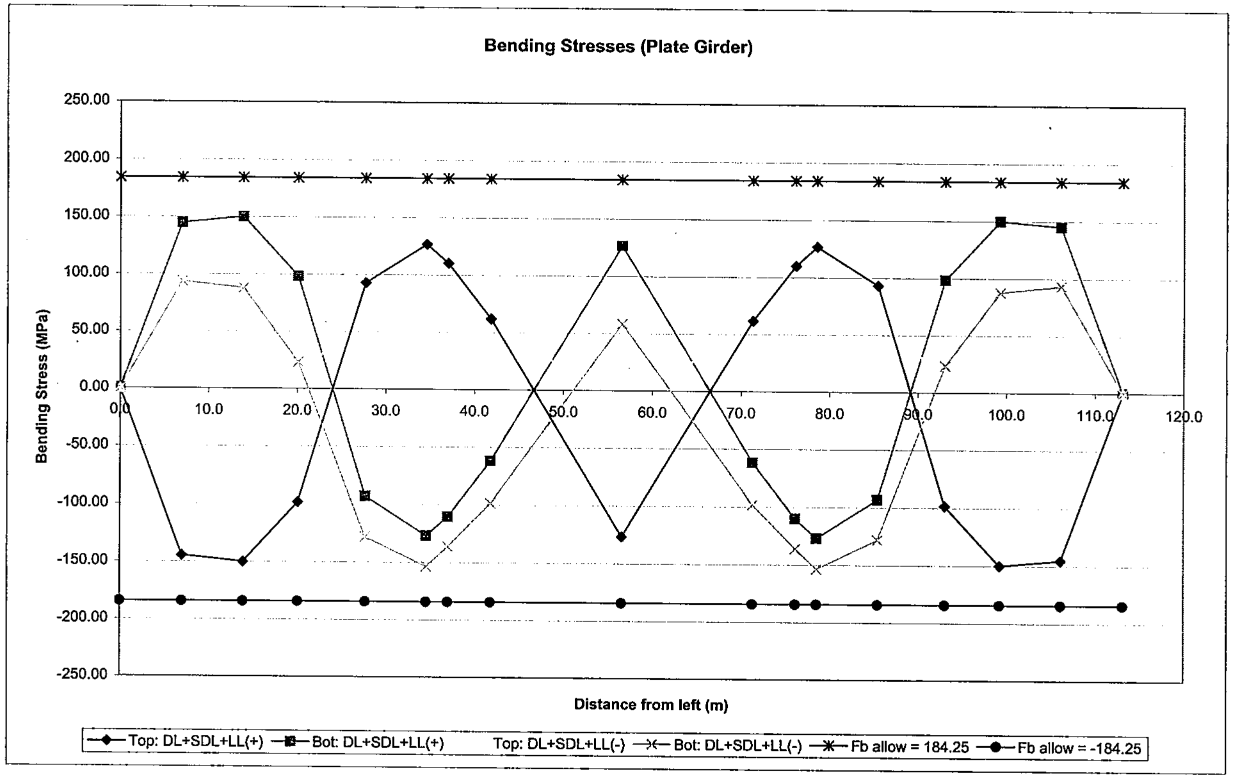
NON-COMPOSITE : (All loads will be carried by plate girder section alone) | I = moment of inertia

Section		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Distance from left:	m	0.000	7.000	13.900	20.090	27.700	34.600	37.010	41.830	56.575	71.320	76.140	78.550	85.450	93.060	99.250	106.150	113.150
Plate Girder Set		1	2	3	4	5	6	7	8	9	8	7	6	5	4	3	2	1
Yt	m	0.700	0.700	0.707	0.700	0.979	1.282	1.191	0.898	0.678	0.898	1.191	1.282	0.979	0.700	0.707	0.700	0.700
Yb	m	0.700	0.700	0.707	0.700	0.979	1.282	1.191	0.898	0.678	0.898	1.191	1.282	0.979	0.700	0.707	0.700	0.700
I	m^4	0.0125	0.0138	0.0167	0.0138	0.0302	0.0668	0.0516	0.0246	0.0138	0.0246	0.0516	0.0668	0.0302	0.0138	0.0167	0.0138	0.0125
1) DL: Girder+Slab, M	kN-m	0	1,721	2,132	899	-2,830	-5,807	-4,229	-1,728	1,385	-1,725	-4,215	-5,803	-2,828	898	2,130	1,719	0
f_{Top}	MPa	0.00	-87.52	-90.24	-45.72	91.74	111.37	97.56	63.00	-67.95	62.89	97.24	111.30	91.68	-45.67	-90.15	-87.42	0.00
f_{Bot}	MPa	0.00	87.52	90.24	45.72	-91.74	-111.37	-97.56	-63.00	67.95	-62.89	-97.24	-111.30	-91.68	45.67	90.15	87.42	0.00
2) SDL: Curb+Rail+Asph	kN-m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
f_{Top}	MPa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
f_{Bot}	MPa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3) DL+SDL	kN-m	0	1,721	2,132	899	-2,830	-5,807	-4,229	-1,728	1,385	-1,725	-4,215	-5,803	-2,828	898	2,130	1,719	0
f_{Top}	MPa	0.00	-87.52	-90.24	-45.72	91.74	111.37	97.56	63.00	-67.95	62.89	97.24	111.30	91.68	-45.67	-90.15	-87.42	0.00
f_{Bot}	MPa	0.00	87.52	90.24	45.72	-91.74	-111.37	-97.56	-63.00	67.95	-62.89	-97.24	-111.30	-91.68	45.67	90.15	87.42	0.00
4a) LL: + M	kN-m	0	1,122	1,414	1,032	-34	-800	-553	33	1,194	34	-554	-805	-48	1,038	1,413	1,139	0
f_{Top}	MPa	0.00	-57.05	-59.86	-52.50	1.10	15.34	12.76	-1.22	-58.59	-1.23	12.77	15.45	1.57	-52.81	-59.81	-57.91	0.00
f_{Bot}	MPa	0.00	57.05	59.86	52.50	-1.10	-15.34	-12.76	1.22	58.59	1.23	-12.77	-15.45	-1.57	52.81	59.81	57.91	0.00
4b) LL: - M	kN-m	0	117	-59	-441	-1,122	-2,197	-1,679	-975	-195	-968	-1,680	-2,204	-1,122	-439	-59	117	0
f_{Top}	MPa	0.00	-5.97	2.50	22.44	36.37	42.14	38.72	35.54	9.55	35.30	38.76	42.27	36.37	22.31	2.50	-5.97	0.00
f_{Bot}	MPa	0.00	5.97	-2.50	-22.44	-36.37	-42.14	-38.72	-35.54	-9.55	-35.30	-38.76	-42.27	-36.37	-22.31	-2.50	5.97	0.00
5) 3+4a f_{Top}	MPa	0.00	-144.57	-150.10	-98.22	92.84	126.71	110.32	61.78	-126.54	61.66	110.01	126.74	93.25	-98.47	-149.96	-145.33	0.00
DL+SDL+LL(+) f_{Bot}	MPa	0.00	144.57	150.10	98.22	-92.84	-126.71	-110.32	-61.78	126.54	-61.66	-110.01	-126.74	-93.25	98.47	149.96	145.33	0.00
6) 3+4b f_{Top}	MPa	0.00	-93.49	-87.73	-23.28	128.11	153.51	136.28	98.54	-58.40	98.19	136.00	153.57	128.05	-23.35	-87.65	-93.39	0.00
DL+SDL+LL(-) f_{Bot}	MPa	0.00	93.49	87.73	23.28	-128.11	-153.51	-136.28	-98.54	58.40	-98.19	-136.00	-153.57	-128.05	23.35	87.65	93.39	0.00
max f_{Top}	MPa	0.00	-87.52	-87.73	-23.28	128.11	153.51	136.28	98.54	-58.40	98.19	136.00	153.57	128.05	-23.35	-87.65	-87.42	0.00
max f_{Bot}	MPa	0.00	144.57	150.10	98.22	-91.74	-111.37	-97.56	-61.78	126.54	-61.66	-97.24	-111.30	-91.68	98.47	149.96	145.33	0.00
min f_{Top}	MPa	0.00	-144.57	-150.10	-98.22	91.74	111.37	97.56	61.78	-126.54	61.66	97.24	111.30	91.68	-98.47	-149.96	-145.33	0.00
min f_{Bot}	MPa	0.00	87.52	87.73	23.28	-128.11	-153.51	-136.28	-98.54	58.40	-98.19	-136.00	-153.57	-128.05	23.35	87.65	87.42	0.00
Allow. Tens. (+) : Fb	MPa	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25	184.25
Allow. Comp. (-) : Fb	MPa	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25	-184.25
		Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok

CHECK STRESS REVERSAL (FATIGUE)

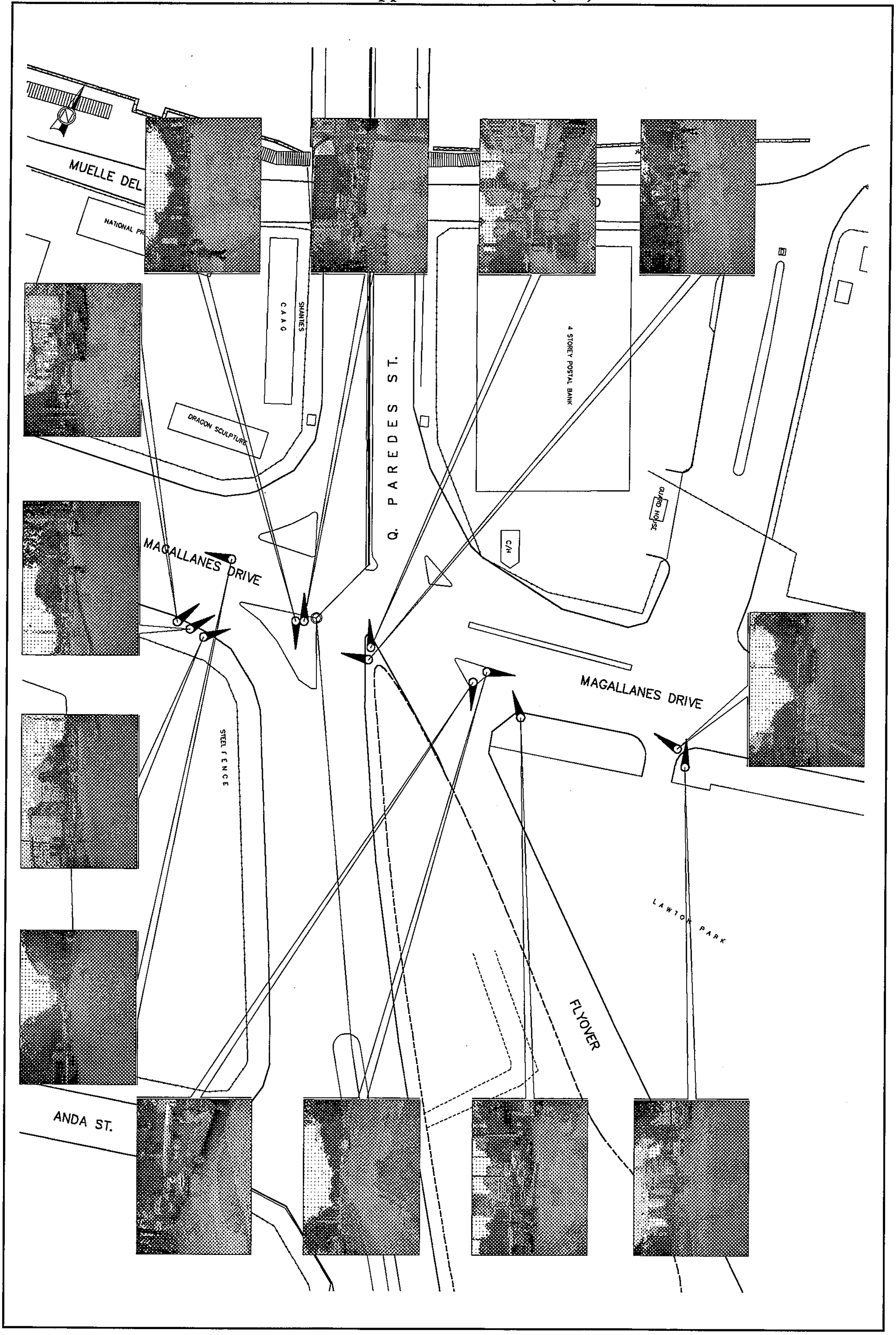
[DL+SDL + LL(+)]	kN-m																	
[DL+SDL + LL(-)]	kN-m																	
[DL+SDL+LL(+) +T] /1.25	kN-m																	
[DL+SDL+LL(-) +T] /1.25	kN-m																	
Mr = M(+) - M (-)	kN-m																	
f_{Top} = Mr Yt/I	MPa																	
f_{Bot} = Mr Yb/I	MPa																	
< Allow. Fb		Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok

DESIGN OF ADDITIONAL STEEL GIRDER

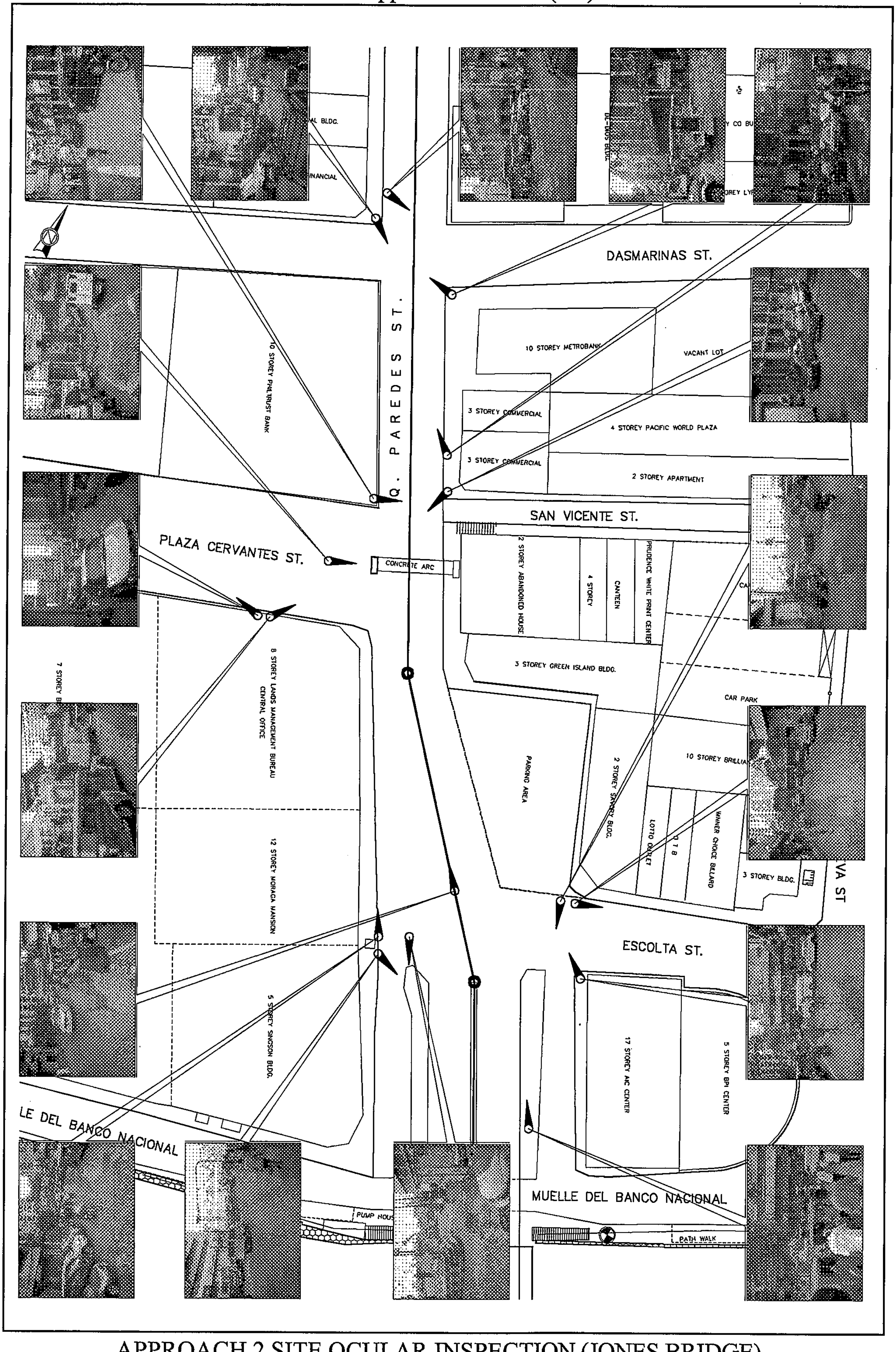


1.5 CHECK OF SHEAR GROSS WEB

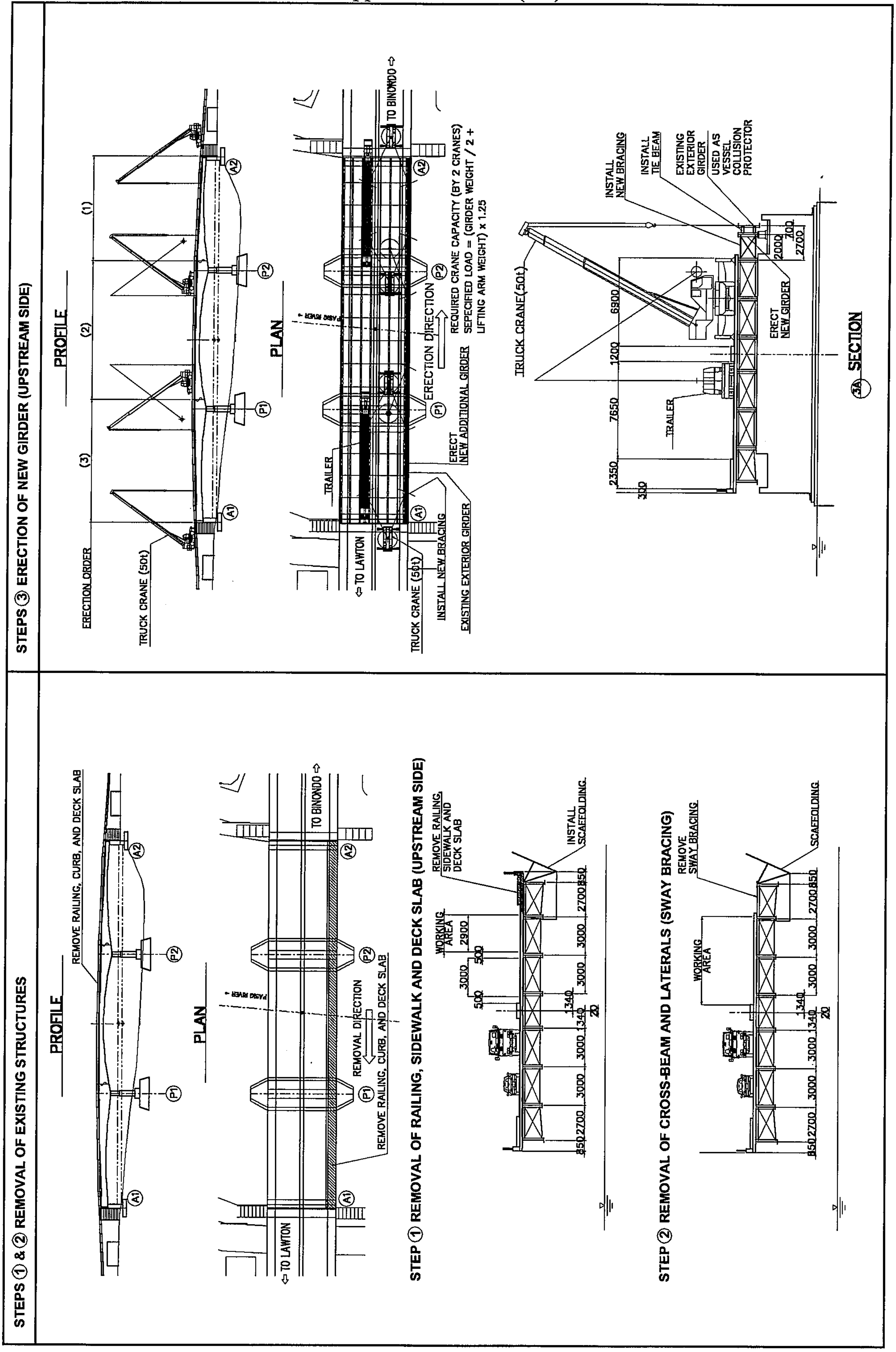
Section			1 SUPPORT	2	3 J29	4	5 J30	6	7 MID	8 J31	9	10	11 J32	12	13	14 J33	15 SUPPORT	16 J34	17
Distance from left:		m	0.000	7.000	13.900	20.090	27.700	34.600	37.010	41.830	56.575	71.320	76.140	78.550	85.450	93.060	99.250	106.150	113.150
Thickness of web (tw)		m	0.010	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.010
Depth of web (D)		m	1.350	1.350	1.350	1.350	1.908	2.500	2.326	1.746	1.300	1.746	2.326	2.500	1.908	1.350	1.350	1.350	1.350
A = Area of Web		m^2	0.0135	0.0216	0.0216	0.0216	0.0305	0.0400	0.0372	0.0279	0.0208	0.0279	0.0372	0.0400	0.0305	0.0216	0.0216	0.0216	0.0135
SHEAR STRESS : fv = V / A																			
DL : Girder+Slab		kN	369.00	173.00	83.00	289.00	532.00	733.00	615.00	450.00	22.00	449.00	615.00	733.00	561.00	289.00	83.20	173.00	369.00
	fv	MPa	27.33	8.01	3.84	13.38	17.43	18.33	16.53	16.11	1.06	16.07	16.53	18.33	18.38	13.38	3.85	8.01	27.33
SDL: Curb+Rail+Asphalt		kN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	fv	MPa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DL+SDL		kN	369.00	173.00	83.00	289.00	532.00	733.00	615.00	450.00	22.00	449.00	615.00	733.00	561.00	289.00	83.20	173.00	369.00
	fv	MPa	27.33	8.01	3.84	13.38	17.43	18.33	16.53	16.11	1.06	16.07	16.53	18.33	18.38	13.38	3.85	8.01	27.33
Live Load: max(+V,-V)		kN	122.09	112.17	69.87	114.11	146.26	146.26	146.26	115.20	73.25	146.26	147.47	147.47	145.05	107.46	68.17	117.25	123.29
		MPa	9.04	5.19	3.23	5.28	4.79	3.66	3.93	4.12	3.52	5.24	3.96	3.69	4.75	4.97	3.16	5.43	9.13
	Σ fv	MPa	36.38	13.20	7.08	18.66	22.22	21.98	20.46	20.23	4.58	21.31	20.49	22.01	23.13	18.35	7.01	13.44	36.47
	< Fv = 0.33 Fy = 10.55	MPa	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok



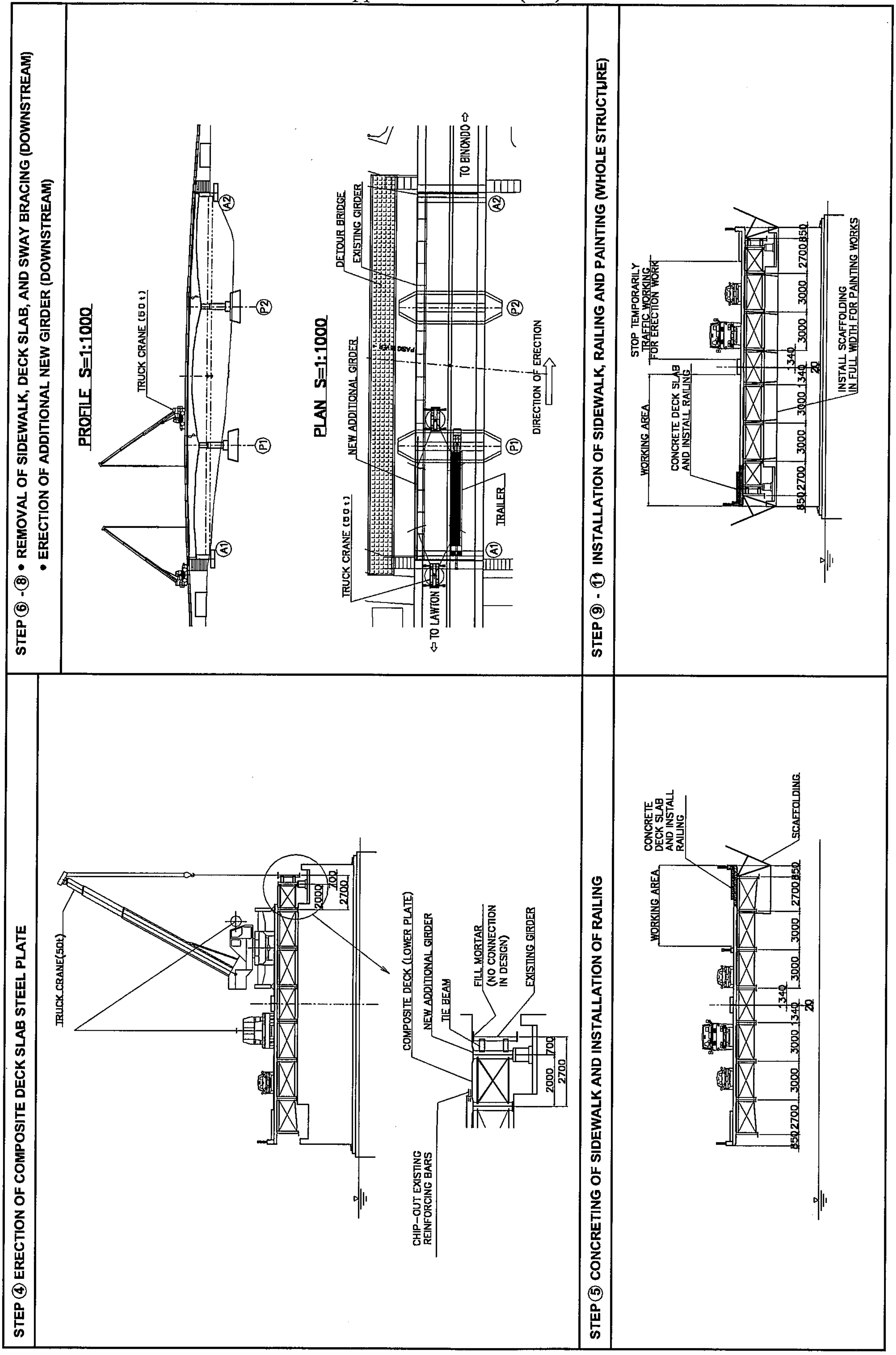
APPROACH 1 SITE OCULAR INSPECTION (JONES BRIDGE)



APPROACH 2 SITE OCULAR INSPECTION (JONES BRIDGE)



CONSTRUCTION SEQUENCE FOR JONES BRIDGE



CONSTRUCTION SEQUENCE FOR JONES BRIDGE

BREAKDOWN OF COSTS FOR JONES BRIDGE

Annex VI - Construction Cost for Retrofitting of Jones Bridge

Description		Unit	Quantity	Unit Price	Cost	Components		
						Foreign	Local	Taxes
A. Steel Structures (Furnish/Fabricate, Transport & Erection)								
408(1)	Steel I Girder (1.3m - 2.5m height)	kgs	132,700.00	150.00	19,905,000.00	14,729,700.00	2,189,550.00	2,985,750.00
B. Scaffolding (including scaffolding for painting)								
SPL	Scaffoldings/Temporary Works	sq. m.	2,530.00	750.00	1,897,500.00	1,290,300.00	341,550.00	265,650.00
C. Siteworks								
101(3)	Removal of Deck Slab and Railing	l.m.	1,072.00	6,300.00	6,753,600.00	4,389,840.00	1,418,256.00	945,504.00
SPL	Deck Slab	sq. m.	268.00	35,000.00	9,380,000.00	6,097,000.00	1,969,800.00	1,313,200.00
408(2)	Existing Exterior Girders Repair	kgs	132,700.00	50.00	6,635,000.00	4,909,900.00	729,850.00	995,250.00
SPL	Bridge Surface	sq. m.	805.00	2,500.00	2,012,500.00	1,529,500.00	201,250.00	281,750.00
401(1)	Railing Works	l.m.	230.00	50,000.00	11,500,000.00	7,475,000.00	2,415,000.00	1,610,000.00
411	Painting (includes cleaning)	sq. m.	9,111.00	4,020.00	36,626,220.00	27,103,402.80	4,028,884.20	5,493,933.00
500(1)	Steel Pipe Downspout, 100 mm dia	l.m.	196.00	1,028.16	201,519.36	130,987.58	42,319.07	28,212.71
401(3)	Decorative Railing	l.m.	230.00	14,792.00	3,402,160.00	2,517,598.40	374,237.60	510,324.00
SPL	Expansion Joint	l.m.	15.50	130,000.00	2,015,000.00	1,491,100.00	221,650.00	302,250.00
503(1)a	Clogged Drainage with Missing Steel Grating		8.00	17,298.93	138,391.44	89,954.44	29,062.20	19,374.80
SPL	Epoxy Injection	l.s	1.00	11,636,630.63	11,636,630.63	8,494,740.36	1,745,494.59	1,396,395.68
SPL	Replacement of New Concrete (Spalling with Exposed Rebars)	l.s.	1.00	3,490,989.19	3,490,989.19	2,478,602.32	523,648.38	488,738.49
				Sub-total	93,792,010.62	66,707,625.90	13,699,452.04	13,384,932.67
D. Total Direct Cost					115,594,510.62	82,727,625.90	16,230,552.04	16,636,332.67
E. Indirect Cost								
	Traffic Management							
	Temporary Facilities							
	Mobilization/Demobilization							
	40% of Total Direct Cost				46,237,804.25	32,828,841.02	6,935,670.64	6,473,292.59
F. Total Construction Cost					**161,832,314.87**	**115,556,466.92**	**23,166,222.68**	**23,109,625.27**

BREAKDOWN OF COSTS FOR JONES BRIDGE

Annex VII - Roadway Improvement (Jones Bridge)

Item No.	Description	Unit	Quantity	Unit Cost	Amount	Component		
						Foreign	Local	Tax
	Earthworks							
101(3)a	Removal of Island	m^3	123.80	114.15	14,131.40	9,185.41	2,967.59	1,978.40
101(3)b	Removal of Curb and Gutter	l.m.	303.00	85.62	25,944.07	16,863.65	5,448.26	3,632.17
101(3)c	Removal of Plant Box	m^2	90.00	82.62	7,435.89	4,833.33	1,561.54	1,041.02
101(3)d	Removal of Sidewalk	m^2	53.00	154.06	8,164.92	5,307.19	1,714.63	1,143.09
101(3)e	Removal of Parking Space	m^2	70.00	99.21	6,944.63	4,514.01	1,458.37	972.25
	Surface Course							
301(1)	Tack Coat	tonne	0.50	25,000.00	12,500.00	8,125.00	2,625.00	1,750.00
310	Asphalt	tonne	46.00	3,100.00	142,600.00	92,690.00	29,946.00	19,964.00
	Miscellaneous							
311	Concrete Median	m^2	897.00	272.93	244,820.00	159,133.00	51,412.20	34,274.80
600(1)	Concrete Curb	l.m.	855.00	562.46	480,905.87	312,588.81	100,990.23	67,326.82
600(1)	Combination of Concrete Curb and Gutter	l.m.	815.00	1,100.00	896,500.00	582,725.00	188,265.00	125,510.00
612(1)	Pavement Markings	m^2	483.00	862.13	416,406.38	270,664.14	87,445.34	58,296.89
	Contingencies	l.s.	1.00	112,817.66	112,817.66	84,613.24	16,922.65	11,281.77
				Total	**2,369,170.81**	**1,551,242.79**	**490,756.81**	**327,171.21**
				% Component	**100%**	**65%**	**21%**	**14%**